

ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
REGULATIONS 2017
B. TECH. BIOTECHNOLOGY AND BIOCHEMICAL ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)
I TO VIII SEMESTERS (FULL TIME) CURRICULA AND SYLLABI

SEMESTER I

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	HS8151	Communicative English	HS	4	4	0	0	4
2.	MA8151	Engineering Mathematics – I	BS	4	4	0	0	4
3.	PH8151	Engineering Physics	BS	3	3	0	0	3
4.	CY8151	Engineering Chemistry	BS	3	3	0	0	3
5.	GE8151	Problem Solving and Python Programming	ES	3	3	0	0	3
6.	GE8152	Engineering Graphics	ES	6	2	0	4	4
PRACTICALS								
7.	GE8161	Problem Solving and Python Programming Lab	ES	4	0	0	4	2
8.	BS8161	Physics and Chemistry Lab	BS	4	0	0	4	2
TOTAL				31	19	0	12	25

SEMESTER II

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	HS8251	Technical English	HS	4	4	0	0	4
2.	MA8251	Engineering Mathematics – II	BS	4	4	0	0	4
3.	PH8254	Physics of Materials	BS	3	3	0	0	3
4.	BE8252	Basic Civil and Mechanical Engineering	ES	4	4	0	0	4
5.	BT8291	Microbiology	BS	3	3	0	0	3
6.	BT8251	Biochemistry	PC	3	3	0	0	3
PRACTICALS								
7.	GE8261	Engineering Practices Lab	ES	4	0	0	4	2
8.	BT8261	Biochemistry Lab	PC	4	0	0	4	2
TOTAL				29	21	0	8	25

SEMESTER III

SI. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA8353	Transforms and Partial Differential Equation	BS	4	4	0	0	4
2.	BT8302	Applied Thermodynamics for Biotechnologists	PC	3	3	0	0	3
3.	BI8301	Basics of Fluid and Solids Operations	ES	3	3	0	0	3
4.	BT8305	Cell Biology	PC	3	3	0	0	3
5.	BT8301	Stoichiometry	PC	5	3	2	0	4
6.	BT8304	Bioorganic Chemistry	PC	3	3	0	0	3
PRACTICALS								
7.	BI8311	Bioorganic Chemistry Lab	PC	4	0	0	4	2
8.	BI8312	Cell Biology and Microbiology Lab	PC	4	0	0	4	2
9.	HS8381	Interpersonal Skills/Listening and Speaking	EEC	2	0	0	2	1
TOTAL				27	18	1	8	25

SEMESTER IV

SI. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA8391	Probability and Statistics	BS	4	4	0	0	4
2.	GE8291	Environmental Science and Engineering	HS	3	3	0	0	3
3.	BT8404	Bioprocess Principles	PC	3	3	0	0	3
4.	BI8401	Heat Transfer Operations	PC	3	3	0	0	3
5.	BT8502	Analytical Methods and Instrumentation	PC	3	3	0	0	3
6.	BT8501	Mass Transfer Operations	PC	3	3	0	0	3
PRACTICALS								
7.	BT8512	Analytical Methods and Instrumentation Lab	PC	4	0	0	4	2
8.	BI8411	Chemical Engineering Lab I	ES	4	0	0	4	2
9.	HS8461	Advanced Reading and Writing	EEC	2	0	0	2	1
TOTAL				27	18	1	8	24

SEMESTER V

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	BI8501	Molecular Biology and Genetic Engineering	PC	3	3	0	0	3
2.	MA8491	Numerical Methods	BS	4	4	0	0	4
3.	BT8591	Bioprocess Engineering	PC	3	3	0	0	3
4.		Professional Elective I	PE	3	3	0	0	3
5.		Professional Elective II	PE	3	3	0	0	3
6.		Open Elective I*	OE	3	3	0	0	3
PRACTICALS								
7.	BI8511	Chemical Engineering Lab II	ES	4	0	0	4	2
8.	BT8511	Bioprocess Lab I	PC	4	0	0	4	2
9.	HS8581	Professional Communication	EEC	2	0	0	2	1
TOTAL				26	18	0	8	24

*Course from the curriculum of other UG programme

SEMESTER VI

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	BT8013	Metabolic Engineering	PC	3	3	0	0	3
2.	GE8077	Total Quality Management	HS	3	3	0	0	3
3.	BI8601	Biological Reaction Engineering	PC	3	3	0	0	3
4.		Professional Elective III	PE	3	3	0	0	3
5.		Professional Elective IV	PE	3	3	0	0	3
6.		Professional Elective V	PE	3	3	0	0	3
PRACTICALS								
7.	BT8611	Bioprocess Lab II	PC	4	0	0	4	2
8.	BT8612	Genetic Engineering Lab	PC	4	0	0	4	2
TOTAL				27	18	1	8	22

SEMESTER VII

SI. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACTI RIODS	L	T	P	C
THEORY								
1.	BI8701	Bioprocess Modelling and Simulation	PC	3	3	0	0	3
2.	BT8751	Down Stream Processing	PC	3	3	0	0	3
	BI8702	Bioprocess Dynamics and Control	PC	3	3	0	0	3
4.	BI8703	Good Manufacturing Practice and Validation	PC	3	3	0	0	3
5.		Professional Elective VI	PE	3	3	0	0	3
6.		Open Elective II*	OE	3	3	0	0	3
PRACTICALS								
8.	BI8711	Bioprocess Modelling and Simulation Lab	PC	4	0	0	4	2
9.	BT8711	Down Stream Processing Lab	PC	4	0	0	4	2
TOTAL				26	18	0	8	22

*Course from the curriculum of other UG programme

SEMESTER VIII

SI. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1.	BI8811	Project Work	EEC	20	0	0	20	10
TOTAL				25	3	0	22	10

TOTAL NUMBER OF CREDITS : 177

PROFESSIONAL ELECTIVES COURSES (PEC)

Sl. No.	COURSE CODE	COURSE TITLE	CATEG ORY	CONTACT PERIODS	L	T	P	C
ELECTIVES I								
1.	CH8791	Transport Phenomena	PEC	3	3	0	0	3
2.	BT8403	Enzyme Technology and Bio-transformations	PEC	3	3	0	0	3
3.	CH8078	Process Plant Utilities	PEC	3	3	0	0	3
ELECTIVES II								
1.	BT8021	Genetics	PEC	3	3	0	0	3
2.	BT8651	Bioinformatics	PEC	5	3	2	0	4
3.	BT8005	Animal Biotechnology	PEC	3	3	0	0	3
ELECTIVES III								
1.	BI8001	Bioreactor Design	PEC	3	3	0	0	3
2.	CH8076	Piping and Instrumentation	PEC	3	3	0	0	3
3.	BT8024	Biosafety and Hazard Management	PEC	3	3	0	0	3
ELECTIVES IV								
1.	BT8016	Genomics and Proteomics	PEC	3	3	0	0	3
2.	BT8503	Protein Engineering	PEC	3	3	0	0	3
3.	BT8007	Cancer Biology	PEC	3	3	0	0	3
ELECTIVES V								
1.	BI8002	Molecular Modeling and Drug Design	PEC	3	3	0	0	3
2.	BT8008	Molecular Pathogenesis of Infectious Diseases	PEC	3	3	0	0	3
3.	BT8026	Stem Cell Technology	PEC	3	3	0	0	3
ELECTIVES VI								
1.	BI8003	Process Economics and Plant Design	PEC	3	3	0	0	3
2.	BT8017	Biofuel	PEC	3	3	0	0	3
3.	BI8004	Computational Fluid Dynamics	PEC	3	3	0	0	3

SUBJECT AREAWISE DETAILS

HUMANITIES AND SOCIAL SCIENCES (HS)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	HS8151	Communicative English	HS	4	4	0	0	4
2.	HS8251	Technical English	HS	4	4	0	0	4
3.	GE8291	Environmental Science and Engineering	HS	3	3	0	0	3
4.	GE8077	Total Quality Management	HS	3	3	0	0	3

ENGINEERING SCIENCES (ES)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	GE8151	Problem Solving and Python Programming	ES	3	3	0	0	3
2.	GE8152	Engineering Graphics	ES	6	2	0	4	4
3.	GE8161	Problem Solving and Python Programming Lab	ES	4	0	0	4	2
4.	BE8252	Basic Civil and Mechanical Engineering	ES	4	4	0	0	4
5.	GE8261	Engineering Practices Lab	ES	4	0	0	4	2
6.	BI8301	Basics of Fluid and Solids Operations	ES	3	3	0	0	3
7.	BI8411	Chemical Engineering Lab I	ES	4	0	0	4	2
8.	BI8511	Chemical Engineering Lab II	ES	4	0	0	4	2
9.	BT8591	Bioprocess Engineering	ES	3	3	0	0	3

BASIC SCIENCES (BS)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	MA8151	Engineering Mathematics I	BS	4	4	0	0	4
2.	PH8151	Engineering Physics	BS	3	3	0	0	3
3.	CY8151	Engineering Chemistry	BS	3	3	0	0	3
4.	BS8161	Physics and Chemistry Lab	BS	4	0	0	4	2
5.	MA8251	Engineering Mathematics II	BS	4	4	0	0	4
6.	PH8254	Physics of Materials	BS	3	3	0	0	3
7.	BT8291	Microbiology	BS	3	3	0	0	3
8.	MA8353	Transforms and Partial Differential Equations	BS	4	4	0	0	4
9.	MA8391	Probability and Statistics	BS	4	4	0	0	4
10.	MA8491	Numerical Methods	BS	4	4	0	0	4

PROFESSIONAL CORE (PC)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	BT8251	Biochemistry	PC	3	3	0	0	3
2.	BT8261	Biochemistry Laboratory	PC	4	0	0	4	2
3.	BT8302	Applied Thermodynamics for Biotechnologists	PC	3	3	0	0	3
4.	BT8305	Cell Biology	PC	3	3	0	0	3
5.	BT8301	Stoichiometry	PC	5	3	2	0	4
6.	BT8304	Biorganic Chemistry	PC	3	3	0	0	3
7.	BI8311	Bioorganic Chemistry Lab	PC	4	0	0	4	2
8.	BI8312	Cell Biology and Microbiology Lab	PC	4	0	0	4	2
9.	BT8404	Bioprocess Principles	PC	3	3	0	0	3
10.	BI8401	Heat Transfer Operations	PC	3	3	0	0	3
11.	BT8502	Analytical Methods and Instrumentation	PC	3	3	0	0	3
12.	BT8501	Mass Transfer Operations	PC	3	3	0	0	3
13.	BT8512	Analytical Methods and Instrumentation Lab	PC	4	0	0	4	2
14.	BI8501	Molecular Biology And Genetic Engineering	PC	3	3	0	0	3
15.	BT8511	Bioprocess Lab I	PC	4	0	0	4	2
16.	BT8013	Metabolic Engineering	PC	3	3	0	0	3
17.	BI8601	Biological Reaction Engineering	PC	3	3	0	0	3
18.	BT8611	Bioprocess Lab II	PC	4	0	0	4	2
19.	BT8612	Genetic Engineering Lab	PC	4	0	0	4	2
20.	BI8701	Bioprocess Modelling and Simulation	PC	3	3	0	0	3
21.	BT8751	Downstream Processing	PC	3	3	0	0	3
22.	BI8702	Bioprocess Dynamics and Control	PC	3	3	0	0	3
23.	BI8703	Good Manufacturing Practice And Validation	PC	3	3	0	0	3
24.	BI8711	Bioprocess Modelling and Simulation Lab	PC	4	0	0	4	2
25.	BT8711	Downstream Processing Lab	PC	4	0	0	4	2

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	HS8381	Interpersonal Skills/Listening and Speaking	EEC	2	0	0	2	1
2.	HS8461	Advanced Reading and Writing	EEC	2	0	0	2	1
3.	HS8581	Professional Communication	EEC	2	0	0	2	1
4.	BT8811	Project Work	EEC	20	0	0	20	10

SUMMARY

S. No.	SUBJECT AREA	CREDITS PER SEMESTER								TOTAL CREDITS
		I	II	III	IV	V	VI	VII	VIII	
1	HS	4	4	-	3	-	3	-	-	14
2	BS	12	10	4	4	4	-	-	-	34
3	ES	9	6	3	2	5	-	-	-	25
4	PC	-	5	17	14	5	10	16	-	67
5	PE	-	-	-	-	6	9	3	-	18
6	OE	-	-	-	-	3	-	3	-	6
7	EEC	-	-	1	1	1	-	-	10	13
TOTAL		25	25	25	24	24	22	22	10	177

OBJECTIVES:

- To develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop their listening skills, which will, enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills

UNIT I SHARING INFORMATION RELATED TO ONESELF/FAMILY& FRIENDS 12

Reading- short comprehension passages, practice in skimming-scanning and predicting- **Writing-** completing sentences - developing hints. **Listening-** short texts- short formal and informal conversations. **Speaking-** introducing oneself - exchanging personal information- **Language development-** Wh- Questions- asking and answering-yes or no questions- parts of speech. **Vocabulary development--** prefixes- suffixes- articles.- count/ uncount nouns.

UNIT II GENERAL READING AND FREE WRITING 12

Reading - comprehension-pre-reading-post reading- comprehension questions (multiple choice questions and /or short questions/ open-ended questions)-inductive reading- short narratives and descriptions from newspapers including dialogues and conversations (also used as short Listening texts)- register- **Writing** – paragraph writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures –**Listening-** telephonic conversations. **Speaking** – sharing information of a personal kind—greeting – taking leave- **Language development** – prepositions, conjunctions **Vocabulary development-** guessing meanings of words in context.

UNIT III GRAMMAR AND LANGUAGE DEVELOPMENT 12

Reading- short texts and longer passages (close reading) **Writing-** understanding text structure- use of reference words and discourse markers-coherence-jumbled sentences **Listening** – listening to longer texts and filling up the table- product description- narratives from different sources. **Speaking-** asking about routine actions and expressing opinions. **Language development-** degrees of comparison- pronouns- direct vs indirect questions- **Vocabulary development** – single word substitutes- adverbs.

UNIT IV READING AND LANGUAGE DEVELOPMENT 12

Reading- comprehension-reading longer texts- reading different types of texts- magazines **Writing-** letter writing, informal or personal letters-e-mails-conventions of personal email- **Listening-** listening to dialogues or conversations and completing exercises based on them. **Speaking-** speaking about oneself- speaking about one's friend- **Language development-** Tenses- simple present-simple past- present continuous and past continuous- **Vocabulary development-** synonyms-antonyms- phrasal verbs

UNIT V EXTENDED WRITING**12**

Reading- longer texts- close reading –**Writing-** brainstorming -writing short essays – developing an outline- identifying main and subordinate ideas- dialogue writing-**Listening** – listening to talks- conversations- **Speaking** – participating in conversations- short group conversations-**Language development**-modal verbs- present/ past perfect tense - **Vocabulary development**-collocations- fixed and semi-fixed expressions

TOTAL : 60 PERIODS**OUTCOMES:****At the end of the course, learners will be able to:**

- Read articles of a general kind in magazines and newspapers.
- Participate effectively in informal conversations; introduce themselves and their friends and express opinions in English.
- Comprehend conversations and short talks delivered in English
- Write short essays of a general kind and personal letters and emails in English.

TEXT BOOKS:

1. Board of Editors. **Using English** A Coursebook for Undergraduate Engineers and Technologists. Orient BlackSwan Limited, Hyderabad: 2015.
2. Richards, C. Jack. **Interchange Students' Book-2** New Delhi: CUP, 2015.

REFERENCES

1. Bailey, Stephen. **Academic Writing: A practical guide for students**. New York: Rutledge,2011.
2. Comfort, Jeremy, et al. **Speaking Effectively : Developing Speaking Skillsfor BusinessEnglish**. Cambridge University Press, Cambridge: Reprint 2011.
3. Dutt P. Kiranmai and RajeevanGeeta. **Basic Communication Skills**, Foundation Books: 2013.
4. Means,L. Thomas and Elaine Langlois. **English & Communication For Colleges**. CengageLearning ,USA: 2007.
5. Redston, Chris & Gillies Cunningham **Face2Face** (Pre-intermediate Student's Book& Workbook) Cambridge University Press, New Delhi: 2005.

MA8151**ENGINEERING MATHEMATICS – I****L T P C****4 0 0 4****OBJECTIVES :**

- The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

UNIT I DIFFERENTIAL CALCULUS**12**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of functions of one variable.

UNIT II FUNCTIONS OF SEVERAL VARIABLES**12**

Partial differentiation – Homogeneous functions and Euler’s theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor’s series for functions of two variables – Maxima and minima of functions of two variables – Lagrange’s method of undetermined multipliers.

UNIT III INTEGRAL CALCULUS**12**

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

UNIT IV MULTIPLE INTEGRALS**12**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

UNIT V DIFFERENTIAL EQUATIONS**12**

Higher order linear differential equations with constant coefficients - Method of variation of parameters – Homogenous equation of Euler’s and Legendre’s type – System of simultaneous linear differential equations with constant coefficients - Method of undetermined coefficients.

TOTAL : 60 PERIODS**OUTCOMES :**

After completing this course, students should demonstrate competency in the following skills:

- Use both the limit definition and rules of differentiation to differentiate functions.
- Apply differentiation to solve maxima and minima problems.
- Evaluate integrals both by using Riemann sums and by using the Fundamental Theorem of Calculus.
- Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables.
- Evaluate integrals using techniques of integration, such as substitution, partial fractions and integration by parts.
- Determine convergence/divergence of improper integrals and evaluate convergent improper integrals.
- Apply various techniques in solving differential equations.

TEXT BOOKS :

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015. [For Units I & III - Sections 1.1, 2.2, 2.3, 2.5, 2.7(Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1(Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCES :

1. Anton, H, Bivens, I and Davis, S, "Calculus", Wiley, 10th Edition, 2016.

imperfections in plastic deformation - growth of single crystals: solution and melt growth techniques.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course,

- the students will gain knowledge on the basics of properties of matter and its applications,
- the students will acquire knowledge on the concepts of waves and optical devices and their applications in fibre optics,
- the students will have adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers,
- the students will get knowledge on advanced physics concepts of quantum theory and its applications in tunneling microscopes, and
- the students will understand the basics of crystals, their structures and different crystal growth techniques.

TEXT BOOKS:

1. Bhattacharya, D.K. & Poonam, T. "Engineering Physics". Oxford University Press, 2015.
2. Gaur, R.K. & Gupta, S.L. "Engineering Physics". Dhanpat Rai Publishers, 2012.
3. Pandey, B.K. & Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2012.

REFERENCES:

1. Halliday, D., Resnick, R. & Walker, J. "Principles of Physics". Wiley, 2015.
2. Serway, R.A. & Jewett, J.W. "Physics for Scientists and Engineers". Cengage Learning, 2010.
3. Tipler, P.A. & Mosca, G. "Physics for Scientists and Engineers with Modern Physics". W.H.Freeman, 2007.

CY8151

ENGINEERING CHEMISTRY

**L T P C
3 0 0 3**

OBJECTIVES:

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- Preparation, properties and applications of engineering materials.
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.

UNIT I WATER AND ITS TREATMENT

9

Hardness of water – types – expression of hardness – units – estimation of hardness of water by EDTA – numerical problems – boiler troubles (scale and sludge) – treatment of boiler feed water – Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) external treatment – Ion exchange process, zeolite process – desalination of brackish water - Reverse Osmosis.

UNIT II SURFACE CHEMISTRY AND CATALYSIS

9

Adsorption: Types of adsorption – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms – Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – contact theory – kinetics of surface reactions, unimolecular reactions, Langmuir - applications of adsorption on pollution abatement.

Catalysis: Catalyst – types of catalysis – criteria – autocatalysis – catalytic poisoning and catalytic promoters - acid base catalysis – applications (catalytic convertor) – enzyme catalysis– Michaelis – Menten equation.

UNIT III ALLOYS AND PHASE RULE

9

Alloys: Introduction- Definition- properties of alloys- significance of alloying, functions and effect of alloying elements- Nichrome and stainless steel (18/8) – heat treatment of steel. Phase rule: Introduction, definition of terms with examples, one component system -water system - reduced phase rule - thermal analysis and cooling curves - two component systems - lead-silver system - Pattinson process.

UNIT IV FUELS AND COMBUSTION

9

Fuels: Introduction - classification of fuels - coal - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - manufacture of synthetic petrol (Bergius process) - knocking - octane number - diesel oil - cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) - power alcohol and biodiesel. Combustion of fuels: Introduction - calorific value - higher and lower calorific values- theoretical calculation of calorific value - ignition temperature - spontaneous ignition temperature - explosive range - flue gas analysis (ORSAT Method).

UNIT V ENERGY SOURCES AND STORAGE DEVICES

9

Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant - breeder reactor - solar energy conversion - solar cells - wind energy. Batteries, fuel cells and supercapacitors: Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H₂-O₂ fuel cell.

TOTAL: 45 PERIODS

OUTCOMES:

- The knowledge gained on engineering materials, fuels, energy sources and water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.

TEXT BOOKS:

1. S. S. Dara and S. S. Umare, "A Textbook of Engineering Chemistry", S. Chand & Company LTD, New Delhi, 2015
2. P. C. Jain and Monika Jain, "Engineering Chemistry" Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
3. S. Vairam, P. Kalyani and Suba Ramesh, "Engineering Chemistry", Wiley India PVT, LTD, New Delhi, 2013.

REFERENCES:

1. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
2. Prasanta Rath, "Engineering Chemistry", Cengage Learning India PVT, LTD, Delhi, 2015.
3. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2015.

OBJECTIVES:

- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures -- lists, tuples, dictionaries.
- To do input/output with files in Python.

UNIT I ALGORITHMIC PROBLEM SOLVING 9

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

UNIT V FILES, MODULES, PACKAGES 9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

OUTCOMES:**Upon completion of the course, students will be able to**

- Develop algorithmic solutions to simple computational problems
- Read, write, execute by hand simple Python programs.
- Structure simple Python programs for solving problems.

- Decompose a Python program into functions.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python Programs.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (<http://greenteapress.com/wp/think-python/>)
2. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCES:

1. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
2. John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press , 2013
3. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
4. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3", Second edition, Pragmatic Programmers, LLC, 2013.
5. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
6. Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd., 2015.

GE8152

ENGINEERING GRAPHICS

L T P C

2 0 4 4

OBJECTIVES:

- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination)

1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREEHAND SKETCHING

7+12

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12
Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 5+12
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 5+12
Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+12
Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method .

TOTAL: 90 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- familiarize with the fundamentals and standards of Engineering graphics
- perform freehand sketching of basic geometrical constructions and multiple views of objects.
- project orthographic projections of lines and plane surfaces.
- draw projections and solids and development of surfaces.
- visualize and to project isometric and perspective sections of simple solids.

TEXT BOOK:

1. Natrajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2009.
2. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2008.

REFERENCES:

1. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
2. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010.
3. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern

- Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. N S Parthasarathy And Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
 6. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson, 2nd Edition, 2009.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

GE8161

PROBLEM SOLVING AND PYTHON PROGRAMMING LAB

L T P C

0 0 4 2

OBJECTIVES:

- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python.

LIST OF PROGRAMS

1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton's method)
3. Exponentiation (power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. Merge sort
8. First n prime numbers
9. Multiply matrices
10. Programs that take command line arguments (word count)
11. Find the most frequent words in a text read from a file
12. Simulate elliptical orbits in Pygame
13. Simulate bouncing ball using Pygame

PLATFORM NEEDED

Python 3 interpreter for Windows/Linux

OUTCOMES:

Upon completion of the course, students will be able to

- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.

TOTAL :60 PERIODS

BS8161	PHYSICS AND CHEMISTRY LAB	L	T	P	C
	(Common to all branches of B.E. / B.Tech Programmes)	0	0	4	2

OBJECTIVES:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, properties of matter and liquids.

LIST OF EXPERIMENTS: PHYSICS LABORATORY (Any 5 Experiments)

1. Determination of rigidity modulus – Torsion pendulum
2. Determination of Young's modulus by non-uniform bending method
3. (a) Determination of wavelength, and particle size using Laser
(b) Determination of acceptance angle in an optical fiber.
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
6. Determination of wavelength of mercury spectrum – spectrometer grating
7. Determination of band gap of a semiconductor
8. Determination of thickness of a thin wire – Air wedge method

TOTAL: 30 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able to

- apply principles of elasticity, optics and thermal properties for engineering applications.

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)**OBJECTIVES:**

- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by viscometry.

1. Estimation of HCl using Na₂CO₃ as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.

3. Determination of DO content of water sample by Winkler's method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by Iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline / thiocyanate method).
10. Estimation of sodium and potassium present in water using flame photometer.
11. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
12. Pseudo first order kinetics-ester hydrolysis.
13. Corrosion experiment-weight loss method.
14. Determination of CMC.
15. Phase change in a solid.
16. Conductometric titration of strong acid vs strong base.

OUTCOMES:

- The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

TOTAL: 30 PERIODS

TEXTBOOKS:

1. Vogel's Textbook of Quantitative Chemical Analysis (8TH edition, 2014)

HS8251

TECHNICAL ENGLISH

L T P C
4 0 0 4

OBJECTIVES:

The Course prepares second semester engineering and Technology students to:

- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Develop their speaking skills to make technical presentations , participate in group discussions.
- Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialisation.

UNIT I INTRODUCTION TECHNICAL ENGLISH

12

Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises- **Speaking** –Asking for and giving directions- **Reading** – reading short technical texts from journals- newspapers- **Writing-** purpose statements – extended definitions – issue- writing instructions – checklists-recommendations-**Vocabulary Development-** technical vocabulary **Language Development** –subject verb agreement - compound words.

UNIT II READING AND STUDY SKILLS

12

Listening- Listening to longer technical talks and completing exercises based on them-**Speaking** – describing a process-**Reading** – reading longer technical texts- identifying the various transitions

in a text- paragraphing- **Writing**- interpreting charts, graphs- **Vocabulary Development**- vocabulary used in formal letters/emails and reports **Language Development**- impersonal passive voice, numerical adjectives.

UNIT III TECHNICAL WRITING AND GRAMMAR 12

Listening- Listening to classroom lectures/ talks on engineering/technology -**Speaking** – introduction to technical presentations- **Reading** – longer texts both general and technical, practice in speed reading; **Writing**-Describing a process, use of sequence words- **Vocabulary Development**- sequence words- Misspelled words. **Language Development**- embedded sentences

UNIT IV REPORT WRITING 12

Listening- Listening to documentaries and making notes. **Speaking** – mechanics of presentations- **Reading** – reading for detailed comprehension- **Writing**- email etiquette- job application – cover letter –Résumé preparation(via email and hard copy)- analytical essays and issue based essays-- **Vocabulary Development**- finding suitable synonyms-paraphrasing-. **Language Development**- clauses- if conditionals.

UNIT V GROUP DISCUSSION AND JOB APPLICATIONS 12

Listening- TED/Ink talks; **Speaking** –participating in a group discussion -**Reading**– reading and understanding technical articles **Writing**– Writing reports- minutes of a meeting- accident and survey-**Vocabulary Development**- verbal analogies **Language Development**- reported speech

TOTAL :60 PERIODS

OUTCOMES: At the end of the course learners will be able to:

- Read technical texts and write area- specific texts effortlessly.
- Listen and comprehend lectures and talks in their area of specialisation successfully.
- Speak appropriately and effectively in varied formal and informal contexts.
- Write reports and winning job applications.

TEXT BOOKS:

1. Board of editors. **Fluency in English A Course book for Engineering and Technology.** Orient Blackswan, Hyderabad: 2016.
2. Sudharshana.N.P and Saveetha. C. **English for Technical Communication.** Cambridge University Press: New Delhi, 2016.

REFERENCES

1. Booth-L. Diana, **Project Work**, Oxford University Press, Oxford: 2014.
2. Grussendorf, Marion, **English for Presentations**, Oxford University Press, Oxford: 2007
3. Kumar, Suresh. E. **Engineering English.** Orient Blackswan: Hyderabad,2015.
4. Means, L. Thomas and Elaine Langlois, **English & Communication For Colleges.** Cengage Learning, USA: 2007
5. Raman, Meenakshi and Sharma, Sangeetha- **Technical Communication Principles and Practice.**Oxford University Press: New Delhi,2014.

Students can be asked to read Tagore, Chetan Bhagat and for supplementary reading.

OBJECTIVES :

- This course is designed to cover topics such as Matrix Algebra, Vector Calculus, Complex Analysis and Laplace Transform. Matrix Algebra is one of the powerful tools to handle practical problems arising in the field of engineering. Vector calculus can be widely used for modelling the various laws of physics. The various methods of complex analysis and Laplace transforms can be used for efficiently solving the problems that occur in various branches of engineering disciplines.

UNIT I MATRICES**12**

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II VECTOR CALCULUS**12**

Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

UNIT III ANALYTIC FUNCTIONS**12**

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $w = z + c$, cz , $\frac{1}{z}$, z^2 - Bilinear transformation.

UNIT IV COMPLEX INTEGRATION**12**

Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.

UNIT V LAPLACE TRANSFORMS**12**

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

TOTAL: 60 PERIODS**OUTCOMES :**

After successfully completing the course, the student will have a good understanding of the following topics and their applications:

- Eigenvalues and eigenvectors, diagonalization of a matrix, Symmetric matrices, Positive definite matrices and similar matrices.
- Gradient, divergence and curl of a vector point function and related identities.
- Evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification.
- Analytic functions, conformal mapping and complex integration.

- Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients.

TEXT BOOKS :

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.

REFERENCES :

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 7th Edition, 2009.
2. Jain R.K. and Iyengar S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi , 3rd Edition, 2007.
3. O'Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.
4. Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014.
5. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

PH8254

PHYSICS OF MATERIALS

L T P C

(Common to courses offered in Faculty of Technology except Fashion Technology)

3 0 0 3

OBJECTIVES:

- To introduce the physics of various materials relevant to different branches of technology

UNIT I

PREPARATION OF MATERIALS

9

Phases - phase rule – binary systems – tie line rule – lever rule – phase diagram – invariant reactions - nucleation – homogeneous and heterogeneous nucleation – free energy of formation of a critical nucleus – Thin films – preparation: PVD, CVD method – Nanomaterials Preparation: wet chemical, solvothermal, sol-gel method.

UNIT II

CONDUCTING MATERIALS

9

Classical free electron theory - expression for electrical conductivity – thermal conductivity, - Wiedemann-Franz law – electrons in metals: particle in a three-dimensional box- degenerate states – Fermi-Dirac statistics – density of energy states – electron in periodic potential (concept only) – electron effective mass – concept of hole. Superconducting phenomena, properties of superconductors – Meissner effect and isotope effect. Type I and Type II superconductors, High T_c superconductors – Magnetic levitation and SQUIDS.

UNIT III SEMICONDUCTING MATERIALS 9

Elemental Semiconductors - Compound semiconductors - Origin of band gap in solids (qualitative) - carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – variation of Fermi level with temperature – electrical conductivity – band gap determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration – Hall effect – determination of Hall coefficient – LED - Solar cells.

UNIT IV DIELECTRIC AND MAGNETIC MATERIALS 9

Dielectric, Paraelectric and ferroelectric materials - Electronic, Ionic, Orientational and space charge polarization – Internal field and deduction of Clausius Mosotti equation – dielectric loss – different types of dielectric breakdown – classification of insulating materials and their applications - Ferroelectric materials - Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites, magnetoresistance materials.

UNIT V NEW MATERIALS AND APPLICATIONS 9

Metallic glasses – Shape memory alloys: Copper, Nickel and Titanium based alloys – graphene and its properties - Ceramics: types and applications – Composites: classification, role of matrix and reinforcement – processing of fibre reinforced plastics and fibre reinforced metals – Biomaterials: hydroxyapatite – PMMA – Silicone - Sensors: Chemical Sensors - Bio-sensors – conducting, semiconducting and photoresponsive polymers.

TOTAL : 45 PERIODS

OUTCOMES:

At the end of the course, the students will able to

- gain knowledge on phase diagrams and various material processing methods,
- acquire knowledge on basics of conducting materials, superconductors and their applications
- get knowledge on the functioning of semiconducting materials and their applications in LED and solar cells,
- understand the functioning of various dielectric and magnetic materials ,
- have the necessary understanding on various advanced materials.

TEXT BOOKS:

1. Balasubramaniam, R. "Callister's Materials Science and Engineering". Wiley India Pvt. Ltd. 2014.
2. Kasap, S.O. "Principles of Electronic Materials and Devices". McGraw-Hill Education, 2007.
3. Wahab, M.A. "Solid State Physics: Structure and Properties of Materials". Narosa Publishing House, 2009.

REFERENCES

1. Askeland, D. "Materials Science and Engineering". Brooks/Cole, 2010
2. Raghavan, V. "Materials Science and Engineering : A First course". PHI Learning, 2015.
3. Smith, W.F., Hashemi, J. & Prakash. R. "Materials Science and Engineering". Tata Mcgraw Hill Education Pvt. Ltd., 2014.

OBJECTIVES:

- To impart basic knowledge on Civil and Mechanical Engineering.
- To familiarize the materials and measurements used in Civil Engineering.
- To provide the exposure on the fundamental elements of civil engineering structures.
- To enable the students to distinguish the components and working principle of power plant units, IC engines, and R & AC system.

A – OVER VIEW**UNIT I SCOPE OF CIVIL AND MECHANICAL ENGINEERING 10**

Overview of Civil Engineering - Civil Engineering contributions to the welfare of Society – Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering

Overview of Mechanical Engineering - Mechanical Engineering contributions to the welfare of Society –Specialized sub disciplines in Mechanical Engineering - Production, Automobile, Energy Engineering - Interdisciplinary concepts in Civil and Mechanical Engineering.

B – CIVIL ENGINEERING**UNIT II SURVEYING AND CIVIL ENGINEERING MATERIALS 10**

Surveying: Objects – classification – principles – measurements of distances – angles – leveling – determination of areas– contours - examples.

Civil Engineering Materials:Bricks – stones – sand – cement – concrete – steel - timber - modern materials

UNIT III BUILDING COMPONENTS AND STRUCTURES 15

Foundations: Types of foundations - Bearing capacity and settlement – Requirement of good foundations.

Civil Engineering Structures: Brickmasonry – stonemasonry – beams – columns – lintels – roofing – flooring – plastering – floor area, carpet area and floor space index - Types of Bridges and Dams – water supply - sources and quality of water - Rain water harvesting - introduction to high way and rail way.

C – MECHANICAL ENGINEERING**UNIT IV INTERNAL COMBUSTION ENGINES AND POWER PLANTS 15**

Classification of Power Plants - Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines – Working principle of steam, Gas, Diesel, Hydro - electric and Nuclear Power plants – working principle of Boilers, Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps

UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM**10**

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner.

OUTCOMES:

On successful completion of this course, the student will be able to

- appreciate the Civil and Mechanical Engineering components of Projects.
- explain the usage of construction material and proper selection of construction materials.
- measure distances and area by surveying
- identify the components used in power plant cycle.
- demonstrate working principles of petrol and diesel engine.
- elaborate the components of refrigeration and Air conditioning cycle.

TOTAL: 60PERIODS**TEXTBOOKS:**

1. Shanmugam Gand Palanichamy MS, "Basic Civil and Mechanical Engineering", Tata McGraw Hill Publishing Co., New Delhi, 1996.

REFERENCES:

1. Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2010.
2. Ramamrutham S., "Basic Civil Engineering", Dhanpat Rai Publishing Co.(P) Ltd. 1999.
3. Seetharaman S., "Basic Civil Engineering", Anuradha Agencies, 2005.
4. ShanthaKumar SRJ., "Basic Mechanical Engineering", Hi-tech Publications, Mayiladuthurai, 2000.
5. Venugopal K. and Prahua Raja V., "Basic Mechanical Engineering", Anuradha Publishers, Kumbakonam, 2000.

BT8291**MICROBIOLOGY****L T P C****3 0 0 3****OBJECTIVES**

- To introduce students to the principles of Microbiology to emphasize structure and biochemical aspects of various microbes.
- To solve the problems in microbial infection and their control.

UNIT I INTRODUCTION**6**

Basics of microbial existence; history of microbiology, classification and nomenclature of microorganisms, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining.

UNIT II MICROBES- STRUCTURE AND MULTIPLICATION**12**

Structural organization and multiplication of bacteria, viruses, algae and fungi, with special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophages.

UNIT III MICROBIAL NUTRITION, GROWTH AND METABOLISM 12
Nutritional requirements of bacteria; different media used for bacterial culture; growth curve and different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.

UNIT IV CONTROL OF MICROORGANISMS 6
Physical and chemical control of microorganisms; host-microbe interactions; anti-bacterial, anti-fungal and anti-viral agents; mode of action and resistance to antibiotics; clinically important microorganisms.

UNIT V INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY 9
Primary metabolites; secondary metabolites and their applications; preservation of food; production of penicillin, alcohol, vitamin B-12; biogas; bioremediation; leaching of ores by microorganisms; biofertilizers and biopesticides; microorganisms and pollution control; biosensors

TOTAL: 45 PERIODS

TEXT BOOKS

1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
2. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
3. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

BT8251 BIOCHEMISTRY L T P C
3 0 0 3

OBJECTIVE

- To enable students learn the fundamentals of Biochemical Processes and Biomolecules.

UNIT I INTRODUCTION TO BIOMOLECULES - CARBOHYDRATES 8
Basic principles of organic chemistry, role of carbon, types of functional groups, chemical, nature of water, pH and biological buffers, biomolecules. Structure and properties of Carbohydrates (mono, di, oligo & polysaccharides) Proteoglycans, glucosaminoglycans. mutarotation, glycosidic bond, reactions of monosaccharides, reducing sugars. Starch, glycogen, cellulose and chitin. Proteoglycans, glycosaminoglycans. hyaluronic acid, chondroitin sulfate.

UNIT II STRUCTURE AND PROPERTIES OF OTHER BIOMOLECULES 12
Structure and properties of Important Biomolecules.
Lipids: fatty acids, glycerol, saponification, iodination, hydrogenation, phospholipids, glycolipids, sphingolipids, cholesterol, steroids, prostaglandins.
Protein: Amino Acids, Peptides, Proteins, measurement, structures, hierarchy of organization primary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins. Determine of primary structure.

Nucleic acids: purines, pyrimidines, nucleoside, nucleotide, RNA, DNA-Watson-Crick structure of DNA, reactions, properties, measurement, nucleoprotein complexes

UNIT III METABOLISM CONCEPTS AND CARBOHYDRATE METABOLISM 8

Functions of Proteins, Enzymes, introduction to biocatalysts, metabolic pathways, primary and secondary metabolites. Interconnection of pathways and metabolic regulation. Glycolysis, TCA cycle, gluconeogenesis, pentose phosphate shunt & glyoxalate shunt.

UNIT IV INTERMEDIARY METABOLISM AND REGULATION 12

Fatty acid synthesis and oxidation, reactions of amino acids, deamination, transamination and decarboxylation, urea cycle, Bioenergetics - High energy compounds, electronegative potential of compounds, respiratory chain, ATP cycle, calculation of ATP yield during oxidation of glucose and fatty acids.

UNIT V PROTEIN TRANSPORT AND DEGRADATION 5

Protein targeting, signal sequence, secretion; Folding, Chaperone and targeting of organelle proteins, Protein degradation, receptor-mediated endocytosis, turnover.

TOTAL: 45 PERIODS

OUTCOMES

- To ensure students have a strong foundation in the structure and reactions of Biomolecules.
- To introduce them to metabolic pathways of the major biomolecules and relevance to clinical conditions.
- To correlate Biochemical processes with Biotechnology applications.

TEXT BOOKS

1. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox
2. Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.
3. Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.
4. Conn, E.E., et al., "Outlines of Biochemistry" 5th Edition, John Wiley & Sons, 1987.
5. Outlines of biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi. pp 693. John Wiley and Sons, New York. 1987.

REFERENCES

1. Berg, Jeremy M. et al. "Biochemistry", 6th Edition, W.H. Freeman & Co., 2006.
2. Murray, R.K., et al "Harper's Illustrated Biochemistry", 27th Edition, McGraw-Hill, 2006.
3. Voet, D. and Voet, J.G., "Biochemistry", 3rd Edition, John Wiley & Sons Inc., 2004.

OBJECTIVES:

To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)**I CIVIL ENGINEERING PRACTICE 13****Buildings:**

- (a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:

- (a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
- (b) Study of pipe connections requirements for pumps and turbines.
- (c) Preparation of plumbing line sketches for water supply and sewage works.
- (d) Hands-on-exercise:
Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
- (e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:

- (a) Study of the joints in roofs, doors, windows and furniture.
- (b) Hands-on-exercise:
Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE 18**Welding:**

- (a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
- (b) Gas welding practice

Basic Machining:

- (a) Simple Turning and Taper turning
- (b) Drilling Practice

Sheet Metal Work:

- (a) Forming & Bending:
- (b) Model making – Trays and funnels.
- (c) Different type of joints.

Machine assembly practice:

- (a) Study of centrifugal pump
- (b) Study of air conditioner

Demonstration on:

- (a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.
- (b) Foundry operations like mould preparation for gear and step cone pulley.
- (c) Fitting – Exercises – Preparation of square fitting and V – fitting models.

GROUP B (ELECTRICAL & ELECTRONICS)

- III ELECTRICAL ENGINEERING PRACTICE** **13**
1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
 2. Fluorescent lamp wiring.
 3. Stair case wiring
 4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
 5. Measurement of energy using single phase energy meter.
 6. Measurement of resistance to earth of an electrical equipment.

- IV ELECTRONICS ENGINEERING PRACTICE** **16**
1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
 2. Study of logic gates AND, OR, EX-OR and NOT.
 3. Generation of Clock Signal.
 4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
 5. Measurement of ripple factor of HWR and FWR.

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- fabricate carpentry components and pipe connections including plumbing works.
- use welding equipments to join the structures.
- Carry out the basic machining operations
- Make the models using sheet metal works
- Illustrate on centrifugal pump, Air conditioner, operations of smithy, foundary and fittings
- Carry out basic home electrical works and appliances
- Measure the electrical quantities
- Elaborate on the components, gates, soldering practices.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL

- | | |
|---|----------|
| 1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings. | 15 Sets. |
| 2. Carpentry vice (fitted to work bench) | 15 Nos. |
| 3. Standard woodworking tools | 15 Sets. |
| 4. Models of industrial trusses, door joints, furniture joints | 5 each |
| 5. Power Tools: (a) Rotary Hammer | 2 Nos |
| (b) Demolition Hammer | 2 Nos |
| (c) Circular Saw | 2 Nos |
| (d) Planer | 2 Nos |

- (e) Hand Drilling Machine 2 Nos
 (f) Jigsaw 2 Nos

MECHANICAL

1. Arc welding transformer with cables and holders 5 Nos.
2. Welding booth with exhaust facility 5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush, etc. 5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit. 2 Nos.
5. Centre lathe 2 Nos.
6. Hearth furnace, anvil and smithy tools 2 Sets.
7. Moulding table, foundry tools 2 Sets.
8. Power Tool: Angle Grinder 2 Nos
9. Study-purpose items: centrifugal pump, air-conditioner One each.

ELECTRICAL

1. Assorted electrical components for house wiring 15 Sets
2. Electrical measuring instruments 10 Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp 1 each
4. Megger (250V/500V) 1 No.
5. Power Tools: (a) Range Finder 2 Nos
 (b) Digital Live-wire detector 2 Nos

ELECTRONICS

1. Soldering guns 10 Nos.
2. Assorted electronic components for making circuits 50 Nos.
3. Small PCBs 10 Nos.
4. Multimeters 10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply

BT8261

BIOCHEMISTRY LAB

L T P C

0 0 4 2

AIM

- To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules (proteins, carbohydrates, lipids, metabolites etc.,) and laboratory analysis of the same in the body fluids.

EXPERIMENTS

1. General guidelines for working in biochemistry lab (theory)
2. Units of volume, weight, density and concentration measurements and their range in biological measurements. Demonstration of proper use of volume and weight measurement devices.
3. Accuracy, precision, sensitivity and specificity (theory)
4. Preparation of buffer –titration of a weak acid and a weak base.
5. Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars.

6. Quantitative method for amino acid estimation using ninhydrin – distinguishing amino from imino acid.
7. Protein estimation by Biuret and Lowry's methods.
8. Protein estimation by Bradford and spectroscopic methods.
9. Extraction of lipids and analysis by TLC.
10. Estimation of nucleic acids by absorbance at 260 nm and hyperchromic effect (demo).
11. Enzymatic assay: phosphatase from potato.
12. Enzymatic assay: estimation of glucose by GOD-POD method after hydrolysis of starch with acid and specificity of the enzymatic method.

Equipment Needed for 20 Students

Autoclave	1
Hot Air Oven	1
Incubators	2
Light Microscopes	4
Incubator Shaker	1
Colorimeter	2
Laminar Flow Chamber	2
Glassware, Chemicals, Media as required	

TOTAL: 60 PERIODS

TEXT BOOKS

1. Practical Biochemistry by R.C. Gupta and S. Bhargavan.
2. Introduction of Practical Biochemistry by David T. Phummer. (II Edition)

REFERENCES

1. Harpers Biochemistry Ed. R.K. Murray , D.K. Granner, P.A. Mayes and V.W.Rodwell, Appleton and Lange ,Stanford ,Conneticut.
2. Textbook of Biochemistry with clinical correlations. Ed. Thomas M. Devlin. Wiley Liss Publishers

OBJECTIVE:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12

Formation of partial differential equations – Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II FOURIER SERIES 12

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier series – Parseval's identity – Harmonic analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12

Classification of PDE – Method of separation of variables - Fourier Series Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction.

UNIT IV FOURIER TRANSFORMS 12

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 12

Z-transforms - Elementary properties – Inverse Z-transform (using partial fraction and residues) – Initial and final value theorems - Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS**OUTCOMES:**

Upon successful completion of the course, students should be able to:

- Understand how to solve the given standard partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.

- Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.
- Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, New Delhi, 2014.
2. Narayanan S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

REFERENCES:

1. Andrews, L.C and Shivamoggi, B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt. Ltd, 2014.
3. Erwin Kreyszig, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, India, 2016.
4. James, G., "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

BT8302 APPLIED THERMODYNAMICS FOR BIOTECHNOLOGISTS L T P C
3 0 0 3

OBJECTIVE:

- To enable the students to learn about basic concepts of classical and statistical thermodynamics

UNIT I THERMODYNAMIC LAW AND PROPERTIES OF FLUIDS 9

First Law of thermodynamics, a generalized balance equation and conserved quantities, Volumetric properties of fluids exhibiting non ideal behavior; residual properties; estimation of thermodynamic properties using equations of state; calculations involving actual property exchanges; Maxwell's relations and applications.

UNIT II SOLUTION THERMODYNAMICS 9

Partial molar properties; concepts of chemical potential and fugacity; ideal and non-ideal solutions; concepts and applications of excess properties of mixtures; activity coefficient; composition models; Gibbs Duhem equation.

UNIT III PHASE EQUILIBRIA 9

Criteria for phase equilibria; VLE calculations for binary and multi component systems; liquid-liquid equilibria and solid-solid equilibria.

UNIT IV CHEMICAL REACTION EQUILIBRIA 9

Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; calculation of equilibrium conversion and yields for single and multiple reactions.

UNIT V THERMODYNAMIC DESCRIPTION OF MICROBIAL GROWTH AND PRODUCT FORMATION 9

Thermodynamics of microbial growth stoichiometry thermodynamics of maintenance, Calculation of the Operational Stoichiometry of a growth process at Different growth rates, Including Heat using the Herbert –Pirt Relation for Electron Donor, thermodynamics and stoichiometry of Product Formation

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the student would have the ability

- To explain the theoretical concepts of thermodynamics and how it applies to energy conversion in technological applications and biological systems.
- To demonstrate the capability to analyze the energy conversion performance in a variety of modern applications in biological systems.
- To design and carry out bioprocess engineering experiments, and analyze and interpret fundamental data to do the design and operation of bioprocesses.
- To describe the criteria when two phases coexist in equilibrium and the vapour liquid equilibrium calculations microbial growth and product formation.

TEXT BOOKS:

1. Smith J.M., Van Ness H.C., and Abbot M.M. "Introduction to Chemical Engineering Thermodynamics", VIth Edition. Tata McGraw-Hill, 2003.
2. Narayanan K.V. "A Text Book of Chemical Engineering Thermodynamics", PHI, 2003.
3. Christiana D. Smolke, " The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2010.

REFERENCE:

1. Sandler S.I. "Chemical and Engineering Thermodynamics", John Wiley, 1989.

COURSE OBJECTIVES

To enable the students to

- learn the basics mechanics of fluid particles
- learn the properties and handling behaviour of particulate solids
- understand the principle and working of size reduction equipment
- understand the working mechanism of the size separation equipment
- enable the students to learn the basic concepts of fluid particles

UNIT I BASIC CONCEPTS OF MOMENTUM TRANSFER 9

Introduction and Significance of Momentum Transfer. Definition of fluid - Classification of fluids – Newtonian fluid – Characteristic properties of fluids – Non - Newtonian Fluids and their classification. Fluid statics: Pressure and its measurement- Manometers; Importance of metering – Classification flow measuring devices, Principle and working of Orifice meter, Venturi meter, Pitot tube, Variable area meters: Rotameter

UNIT II FLUID FLOW THROUGH PACKED AND FLUIDIZED BED 9

Flow past immersed bodies – Significance of form friction - Concept of Drag, Drag Coefficients and Particle Reynolds number -. Flow of fluids through packed beds – Packing and types of packing - Pressure drop across packed beds –Kozeny Carman equation – Ergun"s equation - Concept of Fluidization – Condition for Solid particles to be in a suspended in a flowing fluid – minimum fluidization velocity

UNIT III PROPERTIES OF PARTICULATE SOLIDS AND SIZE REDUCTION 9

Characterization of solid particles, properties of masses of particles, storage and handling of solids, mixing of solids, equipment used for mixing of solids, liquid- solid and gas-solid systems. Crushing laws, classification of the size reduction equipment, principles, construction, working and application of the size reduction equipment like crushers, grinders, ultra-fine grinders and cutters.

UNIT IV MECHANICAL SEPARATIONS 9

Screening and classification, ideal and actual screens, capacity and effectiveness of screen, study of the filtration techniques, types of filters, filter aids, filter media, sedimentation and thickening, centrifugal sedimentation process, principle of other separation methods like flotation, jiggling, electrostatic and magnetic separation, tabling

UNIT V PARTICLE SIZE ENLARGEMENT 9

Inter-particle forces, comparison and interaction between forces, nucleation and growth of particles, granulation equipment, Transport of fluid-solid systems: Hydraulic and pneumatic transport, flow regimes, rheological models, dilute and dense phase, Colloids and nanoparticles: surface forces, suspension rheology and application

TOTAL : 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students would know about:

- CO1: The basic concepts of fluid mechanics and its properties
- CO2: Evaluate the fluid flow phenomena through packed and fluidized bed

- CO3: Design agitation vessel based on standard design criterion
 CO4: The working principles and mechanism of size reduction and size separation equipments
 CO5: The concepts related to fluid particles and its rheology

TEXT BOOKS

1. Fox R.W., McDonald A.T., Pritchard P.J., Mitchell J. W., Introduction to Fluid Mechanics, 9 th ed., Wiley Publications, 2015
2. Martin J Rhodes; Introduction to Particle Technology, 2ndEdn., John Wiley & Sons Ltd. 2013
3. Coulson, J. M. and Richardson, J. F.; Chemical Engineering, Volume 2: Particle Technology and Separation Processes, 5thEdn., Butterworth-Heinemann, 2002
4. McCabe, W. L., Smith, J. C., and Harriott, P., Unit operations in Chemical Engineering, 7 Edn., McGraw Hill. 2014

REFERENCES

1. Perry's Chemical Engineers' Handbook, 9th Edn., McGraw-Hill Professional, 2018
2. Mechanical Operations, 1E, Anup K Swain, Hemalata Patra, GK Roy, McGraw Hill, 2014
3. Introduction to Particle Technology by Rhodes, Martin, John Wiley & Sons, 1999

BT8305

CELL BIOLOGY

L T P C

3 0 0 3

OBJECTIVES:

- To provide knowledge on the fundamentals of cell biology
- To help students understand the signalling mechanisms

UNIT I CELL STRUCTURE AND FUNCTION OF THE ORGANELLES 9

Prokaryotic, Eukaryotic cells, Sub-cellular organelles and functions. Principles of membrane organization membrane proteins, cytoskeletal proteins. Extra cellular matrix, cell-cell junctions.

UNIT II CELL DIVISION, CANCER, APOPTOSIS AND IMMORTALIZATION OF CELLS 9

Cell cycle – Mitosis, Meiosis, Molecules controlling cell cycle, cancer, role of Ras and Raf in oncogenesis and apoptosis. Stem cells, Cell culture and immortalization of cells and its applications.

UNIT III TRANSPORT ACROSS CELL MEMBRANE 9

Passive and Active Transport, Permeases, Ion channels, ATP pumps. Na⁺ / K⁺ / Ca²⁺ pumps, uniport, symport antiporter system. Ligand gated / voltage gated channels, Agonists and Antagonists.

UNIT IV SIGNAL TRANSDUCTION 9

Receptors – extracellular signaling, Cell surface / cytosolic receptors and examples, Different classes of receptors autocrine / paracrine / endocrine models, Secondary messengers molecules.

UNIT V TECHNIQUES USED TO STUDY CELLS**9**

Cell fractionation and flow cytometry, Morphology and identification of cells using microscopic studies like SEM, TEM and Confocal Microscopy. Localization of proteins in cells – Immunostaining.

TOTAL: 45 PERIODS**OUTCOMES:**

Upon completion of this course, the students

- Would have deeper understanding of cell at structural and functional level.
- Would have broad knowledge on the molecular interaction between cells.
- Would demonstrate a clear understanding of the signal transduction, secondary messengers.
- Would develop skill on working principles of microscopy and identification of cell types.

TEXT BOOKS:

1. Lodish, Harvey et al., "Molecular Cell Biology", 7th Edition, W.H.Freeman, 2005.
2. Cooper, G.M. and R.E. Hansman "The Cell: A Molecular Approach", VIIth Edition, ASM Press, 2007.
3. Alberts, Bruce et al., "Molecular Biology of the Cell", IVth Edition, Garland Science (Taylors Francis), 2002.
4. Sadava, D.E. "Cell Biology: Organelle Structure and Function", Panima Publishing, 2004.
5. Rastogi, S.C. "Cell Biology" IInd Edition, New Age International, 2002.

REFERENCES:

1. Becker, W.M. et al., "The World of the Cell", 9th Edition, Pearson Education, 2003.
2. Campbell, N.A., J.B. Reece and E.J. Simon "Essential Biology", VIIrd Edition, Pearson International, 2007.
3. Alberts, Bruce et al., "Essential Cell Biology", IVth Edition, Garland Press (Taylor & Francis), 2004.

BT8301**STOICHIOMETRY****L T P C****3 2 0 4****OBJECTIVES:**

- The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics.
- This will enable the students to perform calculations pertaining to processes and operations.

UNIT I BASIC CHEMICAL CALCULATIONS**(9 + 6)**

Dimension – Systems of units esp. engineering FPS, Engineering MKS & SI systems – Conversion from one system to the other – composition of mixtures and solutions – mass fraction, mass %, mole fraction, mole %, mass ratios, molarity, molality, normality, ppm, composition by density.

UNIT II IDEAL AND ACTUAL GAS EQUATIONS (9 + 6)

Ideal and actual gas equations, Vander Walls, compressibility factor equations, Application to pure gas & gas mixtures – partial pressures, partial volumes – Air-water vapour systems, Humidity, Molar Humidity, Relative Humidity, % Saturation, humid Volume – Humidity chart – wet, Dry bulb, Dew point temperatures, pH of solutions, Vapour pressure.

UNIT III MATERIAL BALANCE (9 + 6)

Material balance concept – overall & component – material balance applications for evaporator, gas absorber without reaction, Distillation (Binary system), Liquid extraction, solid-liquid extraction, drying, crystallization, Humidification, Reverse Osmosis separation and Mixing Recycle and Bypass illustration

UNIT IV ENERGY BALANCE (9 + 6)

General energy balance equation for open systems, closed system sensible heat calculation, Heat required for phase change thermo chemistry, application of steam tables, Saturated and superheated steam application in bioprocess

UNIT V CHEMICAL REACTION (9 + 6)

Chemical Reaction-Limiting, excess component, Fractional conversion, Percent conversion, Fractional yield in multiple reactions. Simple problems, Combustion Reactions.

TOTAL: 75 PERIODS

OUTCOMES:

Upon success completion of this course, the students will be able to:

- Solve problems related to units and conversions and fit the given data using the methodologies
- Solve problems related to material and energy balance concepts & design reactors for biochemical processes
- Apply their knowledge in the field of biochemical engineering from the principles of thermodynamics

TEXT BOOKS:

1. Bhatt B.I & SB Thakore, Stoichiometry - Fifth edition Tata McGraw Hill 2012
2. Geankopolis C.J. "Transport process & Separation process Principles 4th edition-PHI 2006.

REFERENCES:

1. McCabe W.L & J.C. Smith & P. Harriot "Unit operations of chemical Engineering" 6th Edn McGraw Hill 2001
2. Robert W. Fox, Alan T. McDonald & Philip J. Pritchard "Introduction to Fluid Mechanics" 6th edn John Wiley & Sons 2003.
3. Himmelblau D.M "Basic principles & Calculations in Chemical Engineering" 6th edn PHI 2006.

OBJECTIVES:

To enable the students

- To know in detail about the elements of atom, charges and their bonding rule.
- To understand the various kinetic properties and types of reaction mechanisms
- To understand the possible bio-organic reactions involved in biosynthesis

UNIT I BONDING AND STEREOCHEMISTRY 9

Atoms Electrons and orbitals - Covalent Bonds - Octet rule - Polar covalent Bonds - Electronegativity- formal charge - Resonance Acids and Bases - Arrhenius and Bronsted Lowry Theories - Acid Base equilibria - SP³ hybridization - Conformations analysis ethane, butane and cyclohexane - Cis- trans isomerism. Stereochem activity around the tetrahedral carbon – optical activity - Conformation of the peptide bond.

UNIT II MECHANISMS OF SUBSTITUTION AND ADDITION REACTIONS 9

SN₁ and SN₂ reactions on tetrahedral carbon- nucleophiles- mechanism steric effects – nucleophilic addition on Acetals and ketals -Aldehyde and ketone groups – reactions of carbonyl group with amines- acid catalyzed ester hydrolysis – Saponification of an ester- hydrolysis of amides. Ester enolates - claisen .condensation – Michael condensation.

UNIT III KINETICS AND MECHANISM 9

Kinetic method – Rate law and mechanism – Transition states- Intermediates – Trapping of intermediates – Microscopic reversibility – Kinetic and thermodynamic reversibility – Isotopes for detecting intermediates. Primary and secondary isotopes – the Arrhenius equation Eyring equation - ΔG , ΔS , ΔH , Thermodynamics of coupled reactions.

UNIT IV CATALYSIS 9

Reactivity – Coenzymes – Proton transfer – metal ions – Intra molecular reactions – Covalent catalysis – Catalysis by organized aggregates and phases. Inclusion complexation

UNIT V BIOORGANIC REACTIONS 9

Timing of Bond formation and fission – Acyl group transfer – C-C bond formation and fission – Catalysis of proton transfer reactions – Transfer of hydride ion – Alkyl group. Transfer – Terpene biosynthesis – Merrifield state peptide synthesis – Sanger method for peptide and DNA sequencing

TOTAL: 45 PERIODS

OUTCOME:

- On completion of this course, the students will learn the basics principles of chemical Bonding, Stereochemistry of Bio-organic molecules and their kinetics, mechanisms of reactions and catalysis.

TEXT BOOKS:

1. Carey, Francis A.” Organic Chemistry”. VIth Edition, Tata MCGraw Hill, 2009.
2. Page, M.I. and Andrew Williams “Organic and Bio-organic Mechanisms”. Pearson, 2010.

REFERENCE:

1. Dugas, Hermann “ Bioorganic Chemistry: A Chemical Approach to Enzyme Action” 3rd Edition, Springer, 2003.

BI8311

BIOORGANIC CHEMISTRY LAB

L T P C
0 0 4 2

COURSE OBJECTIVES

To enable the students to

- gain knowledge on the various kinetic properties and types of reaction mechanisms
- understand the possible bio-organic reactions involved in biosynthesis

LIST OF EXPERIMENTS

1. Synthesis of aspirin
2. Hydrolysis of sucrose
3. Preparation of pyruvic acid from tartaric acid
4. Preparation of oleic acid from tartaric acid
5. Preparation of alpha D-glucofuranose pentaacetate
6. Preparation of 1,2,5,6 dicyclohexylnoine alpha d glucofuranose
7. Isolation of lycopene from tomato paste
8. Preparation of L-proline
9. Preparation of L-cysteine from hair
10. Preparation of S-ethyl hydroxybutonate from ethyl acetoacetate using yeast
11. Resolution of S-ethyl hydroxybutonate using 3,5dinitrobenzoate.
12. Preparation of 5,10,15,20-tetrakisphenyl porphyrin.

TOTAL : 60 PERIODS

COURSE OUTCOMES

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

CO1 :Identify various kinetic properties and the types of reaction mechanisms in bio-organic molecules

CO2 :Understand their kinetics and mechanisms of the reactions.

BI8312

CELL BIOLOGY AND MICROBIOLOGY LAB

L T P C
0 0 4 2

COURSE OBJECTIVES

- To establish an understanding about the basic techniques (concept of aseptic work, cultivation and identification) in microbiology.
- To describe the different aspects of microbial nutrition and growth
- To describe the microbial interactions and their significance in environment
- To describe the microbial interactions and their significance in agriculture, food and pharmaceuticals

LIST OF EXPERIMENTS

1. Microscopy principle & identification of given plant, animal and bacterial cells
2. Gram's Staining, Leishman Staining & Giemsa Staining
3. Thin Layer Chromatography
4. Separation of Peripheral Blood Mononuclear Cells
5. Osmosis and Tonicity
6. Trypan Blue Assay
7. Staining for different stages of cell division
8. Preparation of culture media using nutrient broth and nutrient agar
9. Isolation of microorganisms from different sources (Soil and water) using Serial Dilution Technique
10. Culturing of microorganisms – Broth and Plates (Pour plates, Streak plates, Spread plate)
11. Growth curve observation on bacteria
12. Acid Fast Staining, Capsular Staining and Endospore Staining
13. Biochemical Analysis 1 - i) Carbohydrate Fermentation test ii) Triple Sugar Ion Test iii) Hydrogen Sulphide Test
14. Biochemical Analysis 2 - IMVIC Test
15. Biochemical Analysis 3 - i) Urease Activity Test ii) Catalase Activity test iii) Oxidase activity test iv) Starch hydrolysis test
16. Antibiotic sensitivity assay

TOTAL : 60 PERIODS

COURSE OUTCOMES

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

- CO1 Identify the microbiological techniques, the defining characteristics of the major group of microorganisms and apply the concepts to study microbial phylogeny.
- CO2 Classify the methods to measure microbial growth
- CO3 Evaluate the interaction of the microorganisms with the environment in beneficial or detrimental ways
- CO4 Identify the industrially important microbes
- CO5 Apply the scientific method by stating a question; researching the topic; determining appropriate tests; performing tests; collecting, analysing, and presenting data.

HS8381	INTERPERSONAL SKILLS/LISTENING AND SPEAKING	L	T	P	C
		0	0	2	1

OBJECTIVES: The Course will enable learners to:

- Equip students with the English language skills required for the successful undertaking of academic studies with primary emphasis on academic speaking and listening skills.
- Provide guidance and practice in basic general and classroom conversation and to engage in specific academic speaking activities.
- improve general and academic listening skills
- Make effective presentations.

UNIT I

Listening as a key skill- its importance- speaking - give personal information - ask for personal information - express ability - enquire about ability - ask for clarification Improving pronunciation - pronunciation basics taking lecture notes - preparing to listen to a lecture - articulate a complete idea as opposed to producing fragmented utterances.

UNIT II

Listen to a process information- give information, as part of a simple explanation - conversation starters: small talk - stressing syllables and speaking clearly - intonation patterns - compare and contrast information and ideas from multiple sources- converse with reasonable accuracy over a wide range of everyday topics.

UNIT III

Lexical chunking for accuracy and fluency- factors influence fluency, deliver a five-minute informal talk - greet - respond to greetings - describe health and symptoms - invite and offer - accept - decline - take leave - listen for and follow the gist- listen for detail

UNIT IV

Being an active listener: giving verbal and non-verbal feedback - participating in a group discussion - summarizing academic readings and lectures conversational speech listening to and participating in conversations - persuade.

UNIT V

Formal and informal talk - listen to follow and respond to explanations, directions and instructions in academic and business contexts - strategies for presentations and interactive communication - group/pair presentations - negotiate disagreement in group work.

TOTAL : 30 PERIODS

OUTCOMES: At the end of the course Learners will be able to:

- Listen and respond appropriately.
- Participate in group discussions
- Make effective presentations
- Participate confidently and appropriately in conversations both formal and informal

TEXT BOOKS:

1. Brooks, Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford: 2011.
2. Richards, C. Jack. & David Bholke. Speak Now Level 3. Oxford University Press, Oxford: 2010

REFERENCES:

1. Bhatnagar, Nitin and MamtaBhatnagar. Communicative English for Engineers and Professionals. Pearson: New Delhi, 2010.
2. Hughes, Glyn and Josephine Moate. Practical English Classroom. Oxford University Press: Oxford, 2014.
3. Vargo, Mari. Speak Now Level 4. Oxford University Press: Oxford, 2013.
4. Richards C. Jack. Person to Person (Starter). Oxford University Press: Oxford, 2006.
5. Ladousse, Gillian Porter. Role Play. Oxford University Press: Oxford, 2014

MA8391**PROBABILITY AND STATISTICS****L T P C****4 0 0 4****OBJECTIVE:**

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

UNIT I PROBABILITY AND RANDOM VARIABLES**12**

Probability – The axioms of probability – Conditional probability – Baye’s theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES**12**

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III TESTING OF HYPOTHESIS**12**

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS**12**

One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design - 2^2 factorial design.

UNIT V STATISTICAL QUALITY CONTROL**12**

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

TOTAL: 60 PERIODS**OUTCOMES:**

Upon successful completion of the course, students will be able to:

- Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.
- Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

TEXT BOOKS:

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.

REFERENCES:

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
2. Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
4. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.

GE8291**ENVIRONMENTAL SCIENCE AND ENGINEERING****L T P C****3 0 0 3****OBJECTIVES:**

- To study the nature and facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY

14

Definition, scope and importance of environment—need for public awareness—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 (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity—bio geographical 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—threat to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION

8

Definition—causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution—pollution case studies—disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES

10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people –Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies –Land resources: Land as a resource, land degradation, man induced and slides, soil erosion and desertification—role of an individual in conservation of natural resources—Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets—river/forest/grassland/hill/ mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT

7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies— role of non-governmental organization—environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies.—waste land reclamation—consumerism and waste products—environment production act – Air (Prevention and Control of Pollution) act—Water (Prevention and Control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT**6**

Population growth, variation among nations—population explosion—family welfare programme – environment and human health—human rights—value education—HIV/ AIDS—women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS**OUTCOMES:**

- Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.
- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions
- Development and improvement in std. of living has lead to serious environmental disasters

TEXT BOOKS:

1. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.

REFERENCES:

1. Dharmendra S.Sengar, 'Environmentallaw', PrenticehallofIndiaPVT LTD, New Delhi, 2007.
2. Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) PVT, LTD, Hyderabad, 2015.
3. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
4. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.

BT8404**BIOPROCESS PRINCIPLES****L T P C
3 0 0 3****OBJECTIVES:**

- To impart knowledge on design and operation of fermentation processes with all its prerequisites.
- To endow the students with the basics of microbial kinetics, metabolic stoichiometry and energetics.

UNIT I OVERVIEW OF FERMENTATION PROCESSES**9**

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermentor (CSTR) and ancillaries, main parameters to be monitored and controlled in fermentation processes.

UNIT II RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS 9

Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization methods

UNIT III STERILIZATION KINETICS 9

Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of sterilization equipment - batch and continuous.

UNIT IV METABOLIC STOICHIOMETRY AND ENERGETICS 9

Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

UNIT V KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION 9

Batch cultivation and continuous cultivation. Simple unstructured models for microbial growth, Monod model, growth of filamentous organisms, product formation kinetics - Leudeking- Piret models, substrate and product inhibition on cell growth and product formation. Biomass estimation – Direct and Indirect methods.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course in Bioprocess Principles graduates will be able to

- Apply engineering principles to systems containing biological catalysts to meet the needs of the society.
- Convert the promises of molecular biology and genetic engineering into new processes to make bio-products in economically feasible way.

TEXT BOOKS:

1. Shuler, Michael L. and FikretKargi, “ Bioprocess Engineering “, Prentice Hall, 1992.
2. Doran, Pauline “of Bioprocess Engineering Principles “. Elsevier, 1995

REFERENCES:

1. Lydersen, Bjorn K. “Bioprocess Engineering Systems, Equipment and Facilities” John Wiley, 1994.
2. Bailey, James E. and David F. Ollis, “ Biochemical Engineering Fundamentals”, IIndEdition. McGraw Hill , 1986.
3. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books.
4. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc.

COURSE OBJECTIVES

To enable the students to

- understand the fundamental concepts of conduction and its evaluation in different criterias
- understand the fundamental concepts of convection.
- understand the basic concepts of radiation and the laws governing it.
- understand the phenomenon of boiling and condensation.
- have knowledge on the concepts of heat transfer in different heat exchangers

UNIT I CONDUCTION**9**

Basic Concepts: Modes of heat transfer, conduction, convection and radiation, analogy between heat flow and electrical flow. Conduction: One dimensional steady state heat conduction, the Fourier heat conduction equation, conduction through plane wall, conduction through cylindrical wall, spherical wall, conduction through composite slab, cylinder and sphere, critical radius of insulation, Extended surfaces: heat transfer from a fin, fin effectiveness and efficiency, Introduction to unsteady state heat conduction.

UNIT II CONVECTION**9**

Natural and forced convection, the convective heat transfer coefficient. Forced Convection: Correlation equations for heat transfer in laminar and turbulent flows in a Circular tube and duct, Reynolds and Colburn analogies between momentum and heat transfer, heat transfer to liquid metals and heat transfer to tubes in cross flow. Natural Convection: Natural convection from vertical and horizontal surfaces.

UNIT III RADIATION**9**

Basic Concepts of radiation from surface: black body radiation, Planks law, Wien's displacement law, Stefan Boltzmann's law, Kirchhoff's law, grey body, Radiation intensity of black body, View factor, emissivity, radiation between black surfaces and grey surfaces. Solar radiations, combined heat transfer coefficients by convection and radiation.

UNIT IV BOILING AND CONDENSATION**9**

Pool boiling, pool boiling curve for water, maximum and minimum heat fluxes, correlations for nucleate and film pool boiling, drop wise and film wise condensation, Nusselt analysis for laminar film wise condensation on a vertical plate, film wise condensation on a horizontal tube, effect of non-condensable gases on rate of condensation. Evaporation: Types of evaporators, boiling point elevation and Duhring's rule, material and energy balances for single effect evaporator, multiple effect evaporators: forward, mixed and backward feeds, capacity and economy of evaporators.

UNIT V HEAT EXCHANGERS**9**

Introduction, Industrial use, Types of heat exchangers, Co-current, Counter-current & Cross-current, Principal Components of a Concentric tube & Shell-and Tube Heat Exchanger, Baffles, Tubes and Tube Distribution, Tubes to Tube sheets Joint, Heat Exchangers with Multiple Shell & tube Passes, Fixed-Tube sheet and Removable-Bundle Heat Exchangers, log-mean temperature difference, overall heat transfer coefficient, fouling factors, Design of double pipe and shell and tube heat exchangers.

TOTAL : 45 PERIODS

COURSE OUTCOMES

On successful completion of the course, the students would

- CO1: Understand the concept and solve problems related to heat transfer by conduction in solids for steady state and transient conditions
- CO2: Understand the concept and solve heat transfer problems in forced and natural convection.
- CO3: Have the ability to discuss and solve heat transfer problems related to radiation.
- CO4: Understand the mechanism of heat transfer in boiling, condensation and apply the concepts in evaporators.
- CO5: Be able to apply the concepts of heat transfer in heat exchangers.

TEXT BOOKS

1. Holman, J. P., 'Heat Transfer', 9th Edn., McGraw Hill, 2004.
2. Kern, D.Q., Process Heat Transfer, McGraw-Hill, 1999.
3. Cengel, Y.A., Heat Transfer -A Practical Approach, McGraw-Hill, 1998.

REFERENCES

1. Incropera, F.P. and Dewitt, D.P., Fundamentals of Heat and Mass Transfer, 5th Edn., John Wiley, 2002.
2. McCabe, W.L., Smith, J.C., and Harriot, P., Unit Operations in Chemical Engineering, 6th Edn., McGraw-Hill, 2001.
3. Coulson, J.M. and Richardson, J.F., Chemical Engineering Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998

BT8502

ANALYTICAL METHODS AND INSTRUMENTATION

L T P C

3 0 0 3

OBJECTIVES:

To enable the students

- To have a fundamental knowledge about the Light spectrum, Absorption, Fluorescence, NMR, Mass spectroscopy
- To acquire knowledge on the different chromo to graphic methods for separation of biological products.

UNIT I INTRODUCTION TO SPECTROMETRY

9

Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Principle of Fourier Transform optical Measurements.

UNIT II MOLECULAR SPECTROSCOPY

9

Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer's law – Instrumentation - Applications -Theory of fluorescence and Phosphorescence – Instrumentation – Applications – Theory of Infrared absorption spectrometry – IR instrumentation – Applications – Theory of Raman spectroscopy – Instrumentation – applications.

UNIT III MAGNETIC RESONANCE SPECTROSCOPY AND MASS SPECTROMETRY 9

Theory of NMR – environmental effects on NMR spectra – chemical shift- NMR-spectrometers – applications of ¹H and ¹³C NMR- Molecular mass spectra – ion sources – Mass spectrometer. Applications of molecular mass - Electron paramagnetic resonance- g values –instrumentation.

UNIT IV SEPARATION METHODS 9

General description of chromatography – Band broadening and optimization of column performance- Liquid chromatography – Partition chromatography – Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography- Affinity chromatography- principles of GC and applications – HPLC- Capillary electrophoresis – Applications.

UNIT V ELECTRO ANALYSIS AND SURFACE MICROSCOPY 9

Electrochemical cells- Electrode potential cell potentials – potentiometry- reference electrode – ion selective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probe microscopes – AFM and STM.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, students will have a better understanding of spectroscopy and the separation techniques used for biological products.

TEXT BOOKS:

1. Skoog, D.A. F. James Holler, and Stanky, R.Crouch “Instrumental Methods of Analysis”. CengageLearning , 2007.
2. Willard, Hobart, etal., “Instrumental Methods of Analysis”. VIIth Edition, CBS, 1986.
3. Braun, Robert D. “Introduction to Instrumental Analysis”. Pharma Book Syndicate, 1987.
4. Ewing,G.W. “Instrumental Methods of Chemical Analysis”, Vth Edition, McGraw-Hill, 1985

REFERENCES:

1. Sharma, B.K. “Instrumental Methods of Chemical Analysis: Analytical Chemistry” Goel Publishing House, 1972.
2. Haven, Mary C., etal., “Laboratory Instrumentation “. IVth Edition, John Wiley, 1995.

OBJECTIVES:

- To define the principles of adsorption, absorption, leaching and drying extraction, distillation crystallization operations.
- To begin the concept of membrane separation process and develop skills of the students in the area of mass transfer operations with emphasis on separation and purification of products.

UNIT I DIFFUSION AND MASS TRANSFER 9

Molecular diffusion in fluids and solids; Interphase Mass Transfer; Mass Transfer coefficients; Analogies in Transport Phenomenon.

UNIT II GAS LIQUID OPERATIONS 9

Principles of gas absorption; Single and Multi component absorption; Absorption with Chemical Reaction; Design principles of absorbers; Industrial absorbers; HTU, NTU concepts.

UNIT III VAPOUR LIQUID OPERATIONS 9

V-L Equilibria; Simple, Steam and Flash Distillation; Continuous distillation; McCabe-THIELE & ONCHON-SAVARIT Principles; Industrial distillation equipments, HETP, HTU and NTU concepts.

UNIT IV EXTRACTION OPERATIONS 9

L-L equilibria, Staged and continuous extraction, Solid-liquid equilibria, Leaching Principles.

UNIT V SOLID FLUID OPERATIONS 9

Adsorption equilibria – Batch and fixed bed adsorption; Drying-Mechanism-Drying curves- Time of Drying; Batch and continuous dryers.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course the students will be able

- To demonstrate about gas -liquid, vapour- liquid and solid- liquid and liquid-liquid equilibrium.
- To classify and use the accurate engineering correlations of diffusion and mass transfer coefficients to model a separation process.
- To investigate a multi-stage equilibrium separation processes, simultaneous phase equilibrium and mass balances in continuous separation processes (absorbers, strippers, and distillation columns) and sizing continuous separation units.
- To design and construction with operating principles of process economics of separating equipments

TEXT BOOKS:

1. Treybal R.E. Mass Transfer Operations. IIIrd edition. Mcgraw Hill, 1981.
2. Geankopolis C.J. Transport Processes and Unit Operations. IIIrd edition, Prentice Hall of India, 2002.

REFERENCE:

1. Coulson and Richardson’s Chemical Engineering. Vol I & II, Asian Books Pvt Ltd, 1998.

OBJECTIVES:

To train the students

- To have a practical hands on experience on Absorption Spectroscopic methods
- To acquire experience in the purification by performing chromatography
- To validate and analysis using spectrometric and microscopic techniques

LIST OF EXPERIMENTS

1. Precision and validity in an experiment using absorption spectroscopy .
2. Validating Lambert-Beer's law using KMnO_4
3. Finding the molar absorptivity and stoichiometry of the $\text{Fe} (1,10 \text{ phenanthroline})_3$ using absorption spectrometry.
4. Finding the pK_a of 4-nitrophenol using absorption spectroscopy.
5. UV spectra of nucleic acids.
6. Chemical actinometry using potassium ferrioxalate.
7. Estimation of SO_4^{--} by nephelometry.
8. Estimation of Al^{3+} by Fluorimetry.
9. Limits of detection using aluminium alizarin complex.
10. Chromatography analysis using TLC.
11. Chromatography analysis using column chromatography.

TOTAL: 60 PERIODS

OUTCOME:

- The students would visualize and interpret the theory of spectroscopic methods by hands on experiments.

REFERENCES:

1. Skoog, D.A. etal. "Principles of Instrumental Analysis", Vth Edition, Thomson / Brooks – Cole, 1998.
2. Braun, R.D. "Introduction to Instrumental Analysis", Pharma Book Syndicate, 1987.
3. Willard, H.H. etal. "Instrumental Methods of Analysis", VIth Edition, CBS, 1986.
4. Ewing, G.W. "Instrumental Methods of Chemical Analysis", Vth Edition, McGraw-Hill, 1985.

Equipment Needed for 20 Students

Colorimeter 2

Glassware, Chemicals, Media as required

COURSE OBJECTIVES

To provide practical experience on operating the equipments,

- calibration of flow meters,
- determining pressure loss in fluid flow

LIST OF EXPERIMENTS

1. Flow measurement a) Orifice meter b) Venturimeter, c) Rotameter
2. Determination of separation efficiency of centrifugal separator
3. Determination of energy requirement in size reduction and reduction ratio using the ball mill and hammer mill.
4. Determination of particle size of granular foods by sieve analysis.
5. Stokes law: To study C_d vs N_{Re} graph of the steel ball in different fluids
6. Determination of efficiency of liquid solid separation by filtration
7. Batch filtration studies using a Plate and Frame Filter press
8. Characteristics of batch Sedimentation
9. Reduction ratio in Jaw Crusher
10. Sampling methods: To study different sampling method to determine the average diameter of the particle.
11. Reduction ratio of Roll Crusher
12. Reduction ratio of Drop weight crusher
13. Size separation using Sub-Sieving

TOTAL 60 PERIODS**COURSE OUTCOMES**

On successful completion of the course, the student will be able to operate the equipments and determine the parameter related to flow measurements

OBJECTIVES:

- Strengthen the reading skills of students of engineering.
- Enhance their writing skills with specific reference to technical writing.
- Develop students' critical thinking skills.
- Provide more opportunities to develop their project and proposal writing skills.

UNIT I

Reading - Strategies for effective reading-Use glosses and footnotes to aid reading comprehension- Read and recognize different text types-Predicting content using photos and title **Writing**-Plan before writing- Develop a paragraph: topic sentence, supporting sentences, concluding sentence –Write a descriptive paragraph

UNIT II

Reading-Read for details-Use of graphic organizers to review and aid comprehension **Writing**- State reasons and examples to support ideas in writing- Write a paragraph with reasons and examples- Write an opinion paragraph

UNIT III

Reading- Understanding pronoun reference and use of connectors in a passage- speed reading techniques-**Writing**- Elements of a good essay-Types of essays- descriptive-narrative-issue-based-argumentative-analytical.

UNIT IV

Reading- Genre and Organization of Ideas- **Writing**- Email writing- visumes – Job application-project writing-writing convincing proposals.

UNIT V

Reading- Critical reading and thinking- understanding how the text positions the reader- identify **Writing**- Statement of Purpose- letter of recommendation- Vision statement

TOTAL : 30 PERIODS

OUTCOMES: At the end of the course Learners will be able to:

- Write different types of essays.
- Write winning job applications.
- Read and evaluate texts critically.
- Display critical thinking in various professional contexts.

TEXT BOOKS:

1. Gramer F. Margot and Colin S. Ward Reading and Writing (Level 3) Oxford University Press: Oxford, 2011
2. Debra Daise, CharlNorloff, and Paul Carne Reading and Writing (Level 4) Oxford University Press: Oxford, 2011

REFERENCES:

1. Davis, Jason and Rhonda Liss.Effective Academic Writing (Level 3) Oxford University Press: Oxford, 2006
2. E. Suresh Kumar and et al. Enriching Speaking and Writing Skills. Second Edition. Orient Black swan: Hyderabad, 2012
3. Withrow, Jeans and et al. Inspired to Write. Readings and Tasks to develop writing skills. Cambridge University Press: Cambridge, 2004
4. Goatly, Andrew. Critical Reading and Writing. Routledge: United States of America, 2000
5. Petelin, Roslyn and Marsh Durham. The Professional Writing Guide: Knowing Well and Knowing Why. Business & Professional Publishing: Australia, 2004

COURSE OBJECTIVES

- Introduce the knowledge about the basic concepts of molecular biology techniques
- Exemplify the different types of polymerase chain reactions and their applications
- Implement, organize and design different vectors for gene cloning and expression
- Generate the contextual and conditional knowledge of gene function for in various applications
- To understand DNA damage and repair systems

UNIT I GENETICS**9**

Classical Genetics Mendelian genetics, linkage, crossing over, classical experiments – Hershey and chase; Avery McLeod & McCarty. Bacterial conjugation, transduction and transformation.

UNIT II DNA REPLICATION**9**

DNA Replication, Replication in prokaryotes and eukaryotes, D-loop and rolling circle mode of replication, replication of linear viral DNA. Organization of eukaryotic chromosome – cot value, replication of telomeres in eukaryotes, DNA repair.

UNIT III TRANSCRIPTION**9**

Structure and function of mRNA, rRNA and tRNA. Characteristics of promoter and enhancer sequences. RNA synthesis: Initiation, elongation and termination of RNA synthesis, Proteomics of RNA synthesis, Fidelity of RNA synthesis, Inhibitors of transcription, Differences in prokaryotic and eukaryotic transcription

UNIT IV TRANSLATION**9**

Translation Elucidation of genetic code, process of translation in prokaryotes and eukaryotes, suppressor mutation, post-translational modifications, inhibitors of protein synthesis.

UNIT V GENETIC ENGINEERING**9**

Restriction and Modification enzymes, Design of linkers and adaptors. Maxam Gilbert's and Sanger's methods of DNA sequencing. Polymerase Chain Reaction: Thermostable DNA Polymerases, PCR technique and its variants, Applications of PCR. Site directed mutagenesis. Methods of transformation, transgenic plants and animals Safety guidelines of recombinant DNA research.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

- CO 1** : Apply the principles of molecular biology techniques.
- CO 2** : Analyze the experimental data to select a suitable PCR for a particular application.
- CO 3** : Evaluate selectivity and specificity of vectors for cloning genes and their expressions.
- CO 4** : Examine gene function, gene modulation and their effects on improvement of crops and animals
- CO5**: Comprehend the role of operons and cis/trans elements in gene regulation

TEXT BOOKS

1. George M Malacinski, Friefelder's, Essentials of Molecular Biology, 4thEdn, Jones & Bartleet, 2015
2. Gardner, Simmons, Snustad, Principles of Genetics, 12thEdn, John Wiley, 2006
3. Muhammad Sarwar Khan, Iqrar Ahmed Khan, Debmalya Barh, Applied Molecular Biotechnology The Next Generation of Genetic Engineering, Taylor & Francis, 2016

REFERENCES

1. Mukhopadhaya S.N. Process Biotechnology Fundamentals. Viva Books Pvt. Ltd. New Delhi, 2001
2. P.K. Gupta, Molecular Biology and Genetic Engineering, Global Media Publications, 2008
3. Desmond S. T. Nicholl, An Introduction to Genetic Engineering (Studies in Biology), Cambridge University Press 2002
4. Michael Wink, An Introduction to Molecular Biotechnology Fundamentals, Methods and Applications Wiley, 2013
5. Lodish, H., Baltimore, D; fesk, A., Zipursky S.L., Matsudaride, P. and Darnel, Molecular Cell Biology - 4th edn. American Scientific Books. W.H. Freeman, New York, 2000.
7. J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick, Molecular Biology of the Gene, 5th edn., Pearson Education Inc, 2004

MA8491

NUMERICAL METHODS

L T P C

4 0 0 4

OBJECTIVE:

- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals in real life situations.
- To acquaint the student with understanding of numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
- To understand the knowledge of various techniques and methods of solving various types of partial differential equations.

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS

12

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT II INTERPOLATION AND APPROXIMATION

12

Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines - Difference operators and relations - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION

12

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule – Romberg's Method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 12

Single step methods - Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge - Kutta method for solving first order equations - Multi step methods - Milne's and Adams - Bash forth predictor corrector methods for solving first order equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 12

Finite difference methods for solving second order two - point linear boundary value problems - Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

TOTAL: 60 PERIODS**OUTCOMES:**

Upon successful completion of the course, students should be able to:

- Understand the basic concepts and techniques of solving algebraic and transcendental equations.
- Appreciate the numerical techniques of interpolation and error approximations in various intervals in real life situations.
- Apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

TEXT BOOKS:

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.

REFERENCES:

1. Brian Bradie, "A Friendly Introduction to Numerical Analysis", Pearson Education, Asia, New Delhi, 2007.
2. Gerald. C. F. and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 6th Edition, New Delhi, 2006.
3. Mathews, J.H. "Numerical Methods for Mathematics, Science and Engineering", 2nd Edition, Prentice Hall, 1992.
4. Sankara Rao. K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi, 2007.
5. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition, 2015.

OBJECTIVES:

- To provide the students with the basics of bioreactor engineering.
- To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

UNIT I CONFIGURATION OF BIOREACTORS 9

Ideal reactors and its characteristics Fed batch cultivation, Cell recycle cultivation, Cell recycle cultivation in waste water treatment, two stage cultivation Packed bed reactor, airlift reactor, introduction to fluidized bed reactor bubble column reactors

UNIT II BIOREACTOR SCALE – UP 9

Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors – microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed.

UNIT III BIOREACTOR CONSIDERATION IN ENZYME SYSTEMS 9

Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors

UNIT IV MODELLING AND SIMULATION OF BIOPROCESSES 9

Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.

UNIT V RECOMBINANT CELL CULTIVATION 9

Different host vector system for recombinant cell cultivation strategies and advantages. E.coli, yeast *Pichia pastoris* / *Saccharomyces cerevisiae*, Animal cell cultivation, plant cell cultivation, Insect cell cultivation. High cell density cultivation, process strategies, reactor considerations in the above system

TOTAL: 45 PERIODS**OUTCOMES:**

Upon completion of Bioprocess Engineering course graduates will be able to

- Select appropriate bioreactor configurations and operation modes based upon the nature of bioproducts and cell lines and other process criteria.
- Apply modeling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems.
- Plan a research career or to work in the biotechnology industry with strong foundation about bioreactor design and scale-up.
- Integrate research lab and Industry; identify problems and seek practical solutions for large scale implementation of Biotechnology.

TEXT BOOKS:

1. Michael L. Shuler and Fikret Kargi, Bioprocess Engineering, Basic Concept, 2nd Edition Prentice Hall PTR, 2002.
2. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications

REFERENCES

1. Anton Moser, "Bioprocess Technology, Kinetics and Reactors", , Springer Verlag.
2. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill.
3. James M. Lee, Biochemical Engineering, PHI, USA.
4. Atkinson, Handbook of Bioreactors, Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Decker Inc.
5. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc

BI8511**CHEMICAL ENGINEERING LAB II****L T P C
0 0 4 2****COURSE OBJECTIVES:**

- To learn chemical engineering principles
- To enable the students to develop a sound working knowledge on the different types of heat transfer equipments
- To provide extensive knowledge on various unit operations involved in bioprocess industries
- To provide knowledge on practical applications in the areas of mass transfer
- To provide knowledge on reaction engineering and particle mechanics.

LIST OF EXPERIMENTS

1. Performance studies on Cooling Tower
2. Batch drying kinetics using Tray Dryer
3. Boiling Heat Transfer
4. Heat Transfer in a Double Pipe Heat Exchanger
5. Heat Transfer in a Condenser
6. Heat Transfer in Helical Coils
7. Heat Transfer in Agitated Vessels
8. Separation of binary mixture using Simple distillation
9. Liquid-liquid extraction
10. Drying characteristics of Rotary dryer
11. Mass transfer characteristics of Rotating disc contactor
12. Estimation of mass/heat transfer coefficient for cooling tower
13. Demonstration of Gas – Liquid absorption

TOTAL 60 PERIODS

COURSE OUTCOMES

CO1 :Design machine elements and Piping system/presentation of PFD and PID

CO2 :Apply the skill in thermal design of heat transfer equipments like shell and tube and double pipe heat exchangers

CO3 :Perform the process design of evaporators.

CO4 :Determine diffusivity and mass transfer co-efficient of a given system

CO5 :Generate vapour liquid equilibrium data and liquid equilibrium data for different systems

BT8511

BIOPROCESS LAB I

L T P C

0 0 4 2

OBJECTIVES:

- To train the students on enzyme characterization, immobilization and medium optimization methods.
- To train on methods to investigate the growth of microorganisms in different systems under different conditions.

LIST OF EXPERIMENTS:

1. Enzyme kinetics – Determination of Michaelis - Menten parameters
2. Enzyme activity – Effect of Temperature and Deactivation Kinetics
3. Enzyme activity – Effect of pH
4. Enzyme inhibition kinetics
5. Enzyme immobilization – Gel entrapment
6. Enzyme immobilization –Cross-linking
7. Enzymatic conversion in Packed bed Column
8. Growth of Bacteria – Estimation of Biomass, Calculation of Specific Growth Rate, Yield Coefficient
9. Optimization by Plackett Burman Design
10. Optimization by Response Surface Methodology

TOTAL: 60 PERIODS

OUTCOMES:

At the end of this course, students will be able to:

- Explain about Enzyme kinetics and characterization and how to use them for practical applications.
- Evaluate the growth kinetics of microorganisms and become adept with medium optimization techniques.
- Determine an experimental objective, understand the theory behind the experiment, and operate the relevant equipment safely.
- Demonstrate good lab citizenry and the ability to work in team.

Equipment Needed for 20 Students

Autoclave	1
Hot Air Oven	1
Incubators	2
Light Microscopes	4
Incubator Shaker	1
Colorimeter	2
Laminar Flow Chamber	2

Chemicals

Invertase enzyme
Phosphate mono basic salt
Phosphate di basic salt
Sucrose
Sodium alginate
Calcium chloride
GOD/POD reagent
Nutrient broth
Glucose
Yeast extract
Cas aminoacid
Ammonium chloride
Glycine
Magnesium sulphate
Sodium chloride

REFERENCES:

1. Bailey and Ollis, " Biochemical Engineering Fundamentals", McGraw Hill (2nd Ed.), 1986.
2. Shuler and Kargi, " Bioprocess Engineering ", Prentice Hall, 1992.
3. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications.
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology,
5. Science & Technology Books.

OBJECTIVES:**The course aims to:**

- Enhance the Employability and Career Skills of students
- Orient the students towards grooming as a professional
- Make them Employable Graduates
- Develop their confidence and help them attend interviews successfully

UNIT I

Introduction to Soft Skills-- Hard skills & soft skills - employability and career Skills—Grooming as a professional with values—Time Management—General awareness of Current Affairs

UNIT II

Self-Introduction-organizing the material - Introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice— presenting the visuals effectively – 5 minute presentations

UNIT III

Introduction to Group Discussion— Participating in group discussions – understanding group dynamics - brainstorming the topic – questioning and clarifying –GD strategies- activities to improve GD skills

UNIT IV

Interview etiquette – dress code – body language – attending job interviews– telephone/skype interview -one to one interview &panel interview – FAQs related to job interviews

UNIT V

Recognizing differences between groups and teams- managing time-managing stress- networking professionally- respecting social protocols-understanding career management-developing a long-term career plan-making career changes

TOTLA: 30 PERIODS**OUTCOMES:****At the end of the course Learners will be able to:**

- Make effective presentations
- Participate confidently in Group Discussions.
- Attend job interviews and be successful in them.
- Develop adequate Soft Skills required for the workplace

Recommended Software

1. Open Source Software
2. Win English

REFERENCES:

1. Butterfield, Jeff **Soft Skills for Everyone**. Cengage Learning: New Delhi, 2015
2. **Interact** English Lab Manual for Undergraduate Students,. OrientBalckSwan: Hyderabad, 2016.
3. E. Suresh Kumar et al. **Communication for Professional Success**. Orient Blackswan: Hyderabad, 2015.

4. Raman, Meenakshi and Sangeeta Sharma. **Professional Communication**. Oxford University Press: Oxford, 2014
5. S. Hariharanetal. **Soft Skills**. MJP Publishers: Chennai, 2010.

BT8013

METABOLIC ENGINEERING

L T P C

3 0 0 3

OBJECTIVES:

- To provide a quantitative basis, based on thermodynamics, enzyme kinetics, for the understanding of metabolic networks in single cells and at the organ level.
- To enable the students to use organisms to produce valuable substances on an industrial scale in cost effective manner.

UNIT I INTRODUCTION TO EXAMPLES OF PATHWAY MANIPULATION - QUALITATIVE TREATMENT

9

Enhancement of Product Yield and Productivity, Extension of substrate Range, Extension of Product spectrum and Novel products, Improvement of Cellular properties, Xenobiotic degradation.

UNIT II MATERIAL BALANCES AND DATA CONSISTENCY

9

Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, yield coefficients and linear rate equations, analysis of over determined systems- identification of gross measurement errors. Introduction to MATLAB®

UNIT III METABOLIC FLUX ANALYSIS

9

Theory, overdetermined systems, underdetermined systems- linear programming, sensitivity analysis, methods for the experimental determination of metabolic fluxes by isotope labeling, applications of metabolic flux analysis.

UNIT IV METABOLIC CONTROL ANALYSIS

9

Fundamentals of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations

UNIT V ANALYSIS OF METABOLIC NETWORKS

9

Control of flux distribution at a single branch point, Grouping of reactions, case studies, extension of control analysis to intermetabolite, optimization of flux amplifications, consistency tests and experimental validation.

TOTAL: 45 PERIODS

OUTCOMES:

After completion of metabolic engineering, students will be able

- To learn stoichiometry and energetics of metabolism.
- To apply practical applications of metabolic engineering in chemical,energy,medical and environmental fields.

- To integrate modern biology with engineering principles.
- To design a system, component, or process to meet desired needs.

TEXT BOOKS:

1. Gregory N. Stephanopoulos ,Aristos A. Aristidou, Jens Nielsen, Metabolic Engineering: Principles and Methodologies ,Academic Press 1998.
2. Sang Yup Lee E. Terry Papoutsakis Marcel Dekker, Metabolic Engineering.inc 1998
3. Nielsen J and Villadsen J. (1994) Bioreaction Engineering Principles. New york: Plenum Press

REFERENCES:

1. Computational Analysis of Biochemical Systems: A Practical Guide for Biochemists and Molecular Biologists by Eberhard O. Voit Cambridge University Press 2000
2. Applications of Plant Metabolic Engineering. R. Verpoorte, A. W. Alfermann and T. S. Johnson (eds). Springer, P.O. Box 17, 3300 AA Dordrecht, The Netherlands. 2007.
3. Systems Modeling in Cellular Biology: From Concepts to Nuts and Bolts Edited by Zoltan Szallasi, JorgStelling and VipulPeriwal MIT Press Cambridge 2006

GE8077

TOTAL QUALITY MANAGEMENT

L T P C

3 0 0 3

OBJECTIVE:

- To facilitate the understanding of Quality Management principles and process.

UNIT I INTRODUCTION

9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

UNIT II TQM PRINCIPLES

9

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUES I

9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES II

9

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY MANAGEMENT SYSTEM**9**

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration--ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.

TOTAL: 45 PERIODS**OUTCOME:**

- The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

TEXT BOOK:

1. Dale H.Besterfield, Carol B.Michna,Glen H. Besterfield,MaryB.Sacre,HemantUrdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

REFERENCES:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
4. ISO9001-2015 standards

BI8601**BIOLOGICAL REACTION ENGINEERING****L T P C****3 0 0 3****COURSE OBJECTIVES**

- Design of chemical and biochemical reaction systems, in the backdrop of the knowledge of existing fundamental theory of reaction kinetics.
- Applications of reaction engineering using a variety of process engineering situations.
- To provide knowledge on estimation of kinetic parameter
- To derive design equations for various reactors.
- To make the students aware of Non-ideal reactors

UNIT I BASIC CONCEPTS OF CHEMICAL KINETICS**9**

Rate equations, rate constant, temperature dependency-Arrhenius law, collision theory, transition state theory, Integral method; irreversible first order ,second order and third order type reactions, zero order reactions, reversible first and second order reactions, autocatalytic reactions, variable volume batch reactor, Differential method of rate analysis, method of half-life.

UNIT II TYPES OF REACTORS**9**

Design equations for batch, tubular and stirred tank reactors. Space time and space velocity, steady state mixed flow, plug flow and laminar flow reactors. Multiple reactor systems, Plug flow reactor in series and parallel, equal sized mixed reactors in series, mixed flow reactors of different

sizes in series. Residence time distribution for chemical reactors: General characteristics -RTD functions. Measurement of the RTD -pulse input, step tracer input, integral relationships, mean residence time.

UNIT III PROCESS ENGINEERING

9

Kinetics of microbial growth and product formation-Phases of growth in a microbial culture, Microbial growth kinetics-Monod Kinetics, Inhibition kinetics, Maintenance energy and endogeneous metabolism, Influence of pH, Temperature and other factors on microbial growth kinetics; Product formation-Classification schemes for microbial products, kinetics of product formation-Leudeking-Piret equation.

UNIT IV MICROBIAL GROWTH PROCESSES

9

Model structure and complexity-different perspectives for kinetic representations using models-prediction of specific growth rate using unstructured, un-segregated models-logistic equation-growth models for filamentous organisms-structured kinetic models-compartment models, metabolic models, cybernetic models.

UNIT V REACTION KINETICS

9

Kinetic analysis of Batch growth of micro-organisms, Kinetics of growth in continuous culture-Monod Chemostat model, cell productivity, optimal dilution rate, productivity ratio, wash out; Stirred tank bioreactor with recycle of biomass, Continuous stirred tank fermenters in series, plug flow fermenters. Estimation of kinetic parameters-use of batch and continuous culture experiments. Bioreactor dynamics -stability analysis in bioreactors-nontrivial and wash out steady states.

TOTAL : 45 PERIODS

COURSE OUTCOMES

- CO 1 :Aware of the basic concepts in reaction kinetics and their applications in process engineering context.
- CO 2 : Develop a flare for developing feasible designs for chemical and biochemical reaction systems in an engineer's perspective.
- CO 3 : Determine reaction kinetics of various reactors
- CO 4 : Analyze the performance of reactor equipment
- CO 5 : Create design of various fermentor / bioreactors

TEXT BOOKS

1. Levenspiel O., Chemical Reaction Engineering, 3/Edn., John Wiley and Sons, 2001
2. Fogler H.S., Elements of Chemical Reaction Engineering,4/Edn., Prentice Hall, 2006.
3. Coulson J.M. and J.F. Richardson, Coulson and Richardson's Chemical Engineering Vol.3: Chemical and Biochemical Reactors and Process Control, 3/Edn., Butterworth-Heinemann, 1991

REFERENCES

1. Steinfeld, J. I., J. S. Francisco, and W. L. Hase. *Chemical Kinetics and Dynamics*. 2ndEdn., Upper Saddle River, NJ: Prentice Hall, 1999.
2. Bailey, J. E., and D. F. Ollis. *Biochemical Engineering Fundamentals*. 2ndEdn., New York, NY: McGraw-Hill, 1986.
3. Stephanopoulos, G., A. Aristidou, and J. Nielsen. *Metabolic Engineering: Principles and Methodologies*. San Diego, CA: Academic Press, 1998.

OBJECTIVES:

- The course applies earlier learned knowledge about mass transfer in bio reactors and sterilization kinetics.
- Skills and knowledge gained is useful by analogy when solving problems typical for the bio industry or for research

LIST OF EXPERIMENTS:

1. Batch Sterilization kinetics
2. Batch cultivation with exhaust gas analysis.
3. Estimation of KLa – Dynamic Gassing-out method,
4. Estimation of KLa – Sulphite Oxidation Method
5. Estimation of KLa – Power Correlation Method
6. Fed batch cultivation and Total cell retention cultivation
7. Photobioreactor
8. Residence time distribution
9. Estimation of Overall Heat Transfer Coefficient
10. Estimation of Mixing Time in reactor

TOTAL: 60 PERIODS**OUTCOMES:**

At the end of this course,

- Graduates gain ability to investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems.
- Graduates become creative, innovative and adaptable engineers as leaders or team members in their organizations and society.
- Graduates perform competently in chemical and bioprocess industries and become important contributors to national development.
- Graduates will demonstrate advancement in their careers through increasing professional responsibility and continued life-long learning.

Equipment Needed for 30 Students

Electrophoresis Kit	1
Reactors	6
Incubators	2
Light Microscopes	1
Incubator Shaker	1
Spectrophotometer	2
Laminar Flow Chamber	1
chemicals	
Sodium sulfite	
Starch	
Disodium disulfate	
Copper sulphate	
Potassium iodide	
Glucose	

GOD kit
Nutrient medium
Ammonium chloride
Magnesium sulphate
Sodium chloride
sodium mono basic salt
sodium di basic salt

REFERENCES:

1. Anton Moser, "Bioprocess Technology, Kinetics and Reactors", , Springer Verlag.
2. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill.
3. James M. Lee, Biochemical Engineering, PHI, USA.
4. Atkinson, Handbook of Bioreactors,Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Decker Inc.

BT8612

GENETIC ENGINEERING LAB

L T P C
0 0 4 2

OBJECTIVES:

- Provide hands-on experience in performing basic recombinant DNA techniques.
- Introduce students to the theory behind in each techniques and to describe common applications of each methodology in biological research.

LIST OF EXPERIMENTS

1. Preparation of plasmid DNA
2. Elution of DNA from agarose gels
3. Restriction digestion
4. Ligation of DNA into expression vectors
5. Transformation& Selection of recombinants – Blue white screening assay
6. Optimisation of time of inducer for recombinant protein expression
7. Expression of protein profiling by SDS - PAGE
8. Western blotting, Southern blotting
9. PCR amplification of genes
10. Colony lysate PCR.

TOTAL: 60 PERIODS

OUTCOMES:

By the end of this course, students should be able to:

- Describe the main principles, methods for preparation and cloning of DNA in various organisms.
- Express clearly about the gene amplification and methods for analysis of DNA, such as hybridization, restriction analysis and gene expressions.
- Use genetic and biotechnological techniques to manipulate genetic materials and develops new and improved living organisms.
- Students will be aware of the hazardous chemicals and safety precautions in case of emergency.

Equipment Needed for 30 Students

Electrophoresis Kit	1
PCR	1
Incubators	2
Light Microscopes	4
Incubator Shaker	1
Spectrophotometer	2
Laminar Flow Chamber	2
Tris – EDTA buffer	
RNase	
Isopropyl alcohol	
Potassium acetate	
Agarose	
Restriction enzyme	
Lambda DNA	
10X Tango buffer	
10X cohesive buffer	
T4 DNA ligase	
Loading dye	
Antibiotics	
Glycerol	
Bromophenol blue	
Ethidium bromide	
PCR kit	
sodium dodecyl sulfate	
TEMED	
ammonium persulfate	
coomassie brilliant blue	
nitrocellulose membrane	
polyacrylamide	
tween 20	
bovine serum albumin (BSA)	
Tris buffered saline (TBS)	
Phosphate buffered saline	
Horseradish peroxidase (HRP)	
saline-sodium citrate (SSC) buffer	
hybridization probe	

REFERENCES:

1. Old RW, Primrose SB, "Principles Of Gene Manipulation, An Introduction To Genetic Engineering ", Blackwell Science Publications, 1993.
2. Ansel FM, Brent R, Kingston RE, Moore DD, "Current Protocols In Molecular Biology ", Greene Publishing Associates, NY, 1988.
3. Berger SI, Kimmer AR, "Methods In Enzymology", Vol 152, Academic Press, 1987

COURSE OBJECTIVE

- To give a sound understanding of the fundamental principles of modelling in bioprocessing applications
- To give an overview of various methods of process modeling, different computational techniques for simulation.
- The focus shall be on the techniques themselves, rather than specific applications so that the student can take up modeling and simulation challenges in his profession.
- Have an understanding of computational techniques to solve the process models.
- Use economics to derive an objective function.

UNIT I APPROACH TO MODELLING**9**

Significance of modelling and simulation, kinetic models on different approaches; deterministic and stochastic, structured and unstructured, segregated and unsegregated; Compartmental models (two); product formation model; genetically structured models, modelling of extra cellular enzyme production.

UNIT II MODELLING OF BIOPROCESS**9**

Modelling of continuous sterilization of medium; modelling of activated sludge process with a control system; model for anaerobic digestion, model for SCP production from spent sulphite liquor.

UNIT III MODELLING OF BIOREACTORS**9**

Models for external mass transfer, internal diffusion and reaction within biocatalysts, model for antibiotic formation; modelling of therapeutic protein production with recombinant cells. Modelling of Non-ideal Behaviour in Bioreactors-Tanks-in-series and Dispersion models

UNIT IV SIMULATION -SOFTWARE TECHNIQUES**9**

Process simulators such as Aspen (model based) and gPROMS (equation based) simulations
Fluent CFX and STAR-CD are designed to perform CFD, FRONTIER

UNIT V SIMULATION -NUMERICAL TECHNIQUES**9**

Programs based on numerical methods like algebraic equations, Newton_Raphson method for algebraic convergence.

TOTAL : 45 PERIODS**COURSE OUTCOMES**

CO1: Apply modelling methods in bioprocessing techniques

CO2: Apply simulation of economic bioprocess methods for better quality products.

CO3: Develop mathematical and software techniques

CO4: Correlate the various mechanical separation techniques and evaluate its associated design variables

CO5: Understand the concept of various ideal and non-ideal reactors and assess their performance

TEXT BOOKS

1. Bailey, J.E and D.F Ollis, Biochemical Engineering Fundamentals, 2nd Edn., McGraw HillBook Co., 1982.

- Blanch, H.W and I.J. Dunn, "Modelling and Simulation in Biochemical Engg in advances in Biochemical Engg.," Vol-3 edited by T.K. Ghosh, A.Fiechler and N. Blakebrngh

REFERENCES

- R.G.E Franks, "Modelling and Simulation in Chemical Engineering" Wiley International 1972
- .Kleinstreuer ,C. and T. Powegha, " Modelling and Simulation of Bioreactor Process Dynamics in Advances in Biochemical Engg./ Biotechnology", Vol.30, edited by A. Fiechler Springer Verlag, Berlin, Heidelberg,1984.

BT8751

DOWNSTREAM PROCESSING

L T P C

3 0 0 3

OBJECTIVES:

To enable the students to

- Understand the methods to obtain pure proteins, enzymes and in general about product development R & D
- Have depth knowledge and hands on experience with on Downstream processes required in multi-factorial manufacturing environment in a structured and logical fashion

UNIT I INTRODUCTION

9

Introduction to downstream processing, principles, characteristics of bio-molecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pre treatment and stabilisation of bio-products.

UNIT II PHYSICAL METHODS OF SEPARATION

9

Unit operations for solid-liquid separation - filtration and centrifugation.

UNIT III ISOLATION OF PRODUCTS

9

Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation – ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods.

UNIT IV PRODUCT PURIFICATION

9

Chromatography – principles, instruments and practice, adsorption, reverse phase, ion exchange, size exclusion, hydrophobic interaction, bio-affinity and pseudo affinity chromatographic techniques.

UNIT V FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS

9

Crystallization, drying and lyophilization in final product formulation.

TOTAL: 45 PERIODS

OUTCOMES:

Upon success completion of this course, the students will be able to:

- Define the fundamentals of downstream processing for product recovery
- Understand the requirements for successful operations of downstream processing
- Describe the components of downstream equipment and explain the purpose of each

- Apply principles of various unit operations used in downstream processing and enhance problem solving techniques

TEXT BOOKS:

1. Belter, P.A., E.L. Cussler and Wei-Houhu "Bioseparations – Downstream Processing for Biotechnology", John Wiley, 1988.
2. Sivasankar, B. "Bioseparations: Principles and Techniques". PHI, 2005.
3. Asenjo, Juan A. "Separation Processes in Biotechnology". CRC / Taylor & Francis, 1990.

REFERENCES:

1. Ghosh, Raja "Principles of Bioseparations Engineering". World Scientific, 2006
2. "Product Recovery in Bioprocess Technology". (BIOTOL – Biotechnology by Open Learning Series). Butterworth – Heinmann / Elsevier, 2004.

BI8702

BIOPROCESS DYNAMICS AND CONTROL

**L T P C
3 0 0 3**

COURSE OBJECTIVE

- To impart basic knowledge on instrumentation and process control strategies adopted in bioprocess systems
- Systems that vary in time, with some tools for attacking the problems
- Single-loop feedback control of processes - concepts, terminology, methods, and performance
- To enhance feedback control
- To learn the hardware used in a control system

UNIT I INSTRUMENTATION METHODS 9

Methods of measuring process variables like temperature, flow measurement, pressure, microbial biomass, dissolved oxygen, inlet and exit gas analysis, pH, Redox, Medium chemical sensors. Online analysis for other biochemical factors

UNIT II BASICS OF PROCESS CONTROL 9

Process control system. Design elements of a control system. Introduction to mathematical modelling. Basics and examples of mathematical modelling. Linearization of non-linear systems

UNIT III PROCESS ANALYSIS 9

Qualitative analysis of a response of a system. Dynamic behaviour of first order systems. Study of different order systems. Dynamic behaviour of higher order systems

UNIT IV PROCESS CONTROL 9

Concept of feedback control. Types of feedback controllers. Block diagrams, manual control, automatic control-proportional, integral, derivative and composite control. Control actions on the dynamic response of a system.

UNIT V PROCESS STABILITY 9

Notion of stability. Criterion for stability –Routh test, Frequency response analysis –Bode plot

Process control in bioprocess systems. Direct regulatory control. Cascade control of metabolism. Programmed batch bioreaction.

TOTAL : 45 PERIODS

COURSE OUTCOMES

- CO1 : Ability to apply knowledge on process control
- CO2 : Develop idea on controlling bioprocess plant and operations
- CO3 : Develop mathematical models of various chemical processes.
- CO4 : Explain different control modes and their application in controlling various processes.
- CO5 : Explain the working of electric, hydraulic and pneumatic controllers.

TEXT BOOKS

1. Coughanowr & Koppel, Process Systems Analysis and Control; McGraw Hill.
2. Johnson, C.D., Process Control Instrumentation Technology, Prentice-Hall of India Private Limited (1992)
3. Blanch, H.W and I.J. Dunn, "Modelling and Simulation in Biochemical Engg" in Advances in Biochemical Engg. Vol-3 edited by T.K. Ghosh, A. Fiechler and N. Blakebrngh

REFERENCES

1. P. F. Stanbury, A. Whitaker and S.J. Hall, Principles of Fermentation Technology; Aditya Books (P) Ltd.
2. James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals; McGraw Hill

BI8703 GOOD MANUFACTURING PRACTICE AND VALIDATION

L T P C
3 0 0 3

COURSE OBJECTIVES

- To introduce the strategy for producing high quality safe pharmaceuticals.
- To focus on traditional approaches to ensure product quality using facility design, validation and good manufacturing practice (GMP).
- Understand the regulatory and application perspective.
- Familiar with technical terms from the field of GMP and their meaning
- to impart fundamental knowledge on various Good Regulatory Practices viz., cGMP, GLP, GALP and GDP for Pharmaceuticals,

UNIT I GOOD MANUFACTURING PRACTICES

9

Concepts and Philosophy of Good Manufacturing Practice (GMP). introduction of CGMP

UNIT II VALIDATION

9

Concepts and Philosophy of Validation. Validation methods of equipment, Validation methods of water supply systems, deionised and distilled water and water for injection

UNIT III CALIBRATION

9

Introduction to calibration of Analytical Instruments. Calibration of Spectrophotometer and HPLC instrument as per ICH guidelines.

UNIT IV QUALITY CONTROL**9**

Sampling Techniques, Computer applications in GMP and GLP, Statistical quality control and control charts. Concepts and Philosophy of GLP, SOP, ICH and ISO-9000

UNIT V VALIDATION OF SYSTEMS**9**

Utilities and cleaning validation: validation of pharmaceutical water system and pure steam; validation of HVAC system and air handling units; cleaning of equipment and cleaning of facilities, validation of computer systems

TOTAL : 45 PERIODS**COURSE OUTCOMES**

CO1 : Explain the regulatory basics for process validation and outline of prospective validation

CO2 : Use the GMP regulation regarding the utilities in Pharmaceutical manufacturing

CO3 : Examine harmonization, GMPs and validations at global level

CO4 : Assess the environmental impact of an industrial process.

CO5: Learn and adopt quickly in a GMP environment.

TEXT BOOKS

1. Sidney H. Willig, Good Manufacturing Practices for Pharmaceuticals, A Plan for Total Quality Control from Manufacturer to Consumer: 5thEdn., 2000

REFERENCES

1. Ira. R. Berry & Robert Nash, Pharmaceutical Process Validation, , 2ndEdn., Marcel Dekker Inc.
2. F.J. Carleton and J.P. Agalloco, Validation of Pharmaceutical process (Sterile products), 2ndEdn., (Revised and Expanded), Marcel Dekker Inc.
3. M.A. Potda, NialiPrakashan, Pharmaceutical Quality Assurance,
4. M.A .Potda, Current Good Manufacturing Practices, Pharma, - Med press.

BI8711**BIOPROCESS MODELING AND SIMULATION LAB****L T P C****0 0 4 2****COURSE OBJECTIVES:**

- To make the students be aware of modelling and simulation.
- To make the students familiar about MATLAB tool.
- To provide a working introduction to the MATLAB technical computing environment.
- To introduce students the use of a high-level programming language, MATLAB
- Reinforce a structured, top-down approach to formulate and solve problems.

LIST OF EXPERIMENTS

1. Parameters estimation in adsorption kinetics using curve fitting tool in MATLAB
2. Estimation of bacterial growth kinetic parameter using curve fitting tool in MATLAB
3. Modeling of batch culture using MATLAB
4. Modeling in continuous culture using MATLAB
5. Modeling in product formation using MATLAB
6. Modelling of batch culture by Berkeley-Madonna
7. Modelling of continuous culture by Berkeley-Madonna
8. Modelling of fed batch culture by Berkeley-Madonna
9. Simulation by simulink in batch culture

10. Simulation by simulink in continuous culture
11. Simulation by simulink in fed batch culture
12. SoClving material balance using superpro design

TOTAL : 60 PERIODS

COURSE OUTCOMES:

- CO1 : Complete understanding about MATLAB tool.
 CO2 : Familiarize with microbiological techniques
 CO3 : Better understanding about various methods to detect pathogens
 CO4: Use MATLAB effectively to analyze and visualize data
 CO5: Create and control simple plot and user-interface graphics objects in MATLAB

BT8711

DOWNSTREAM PROCESSING LAB

L T P C
0 0 4 2

OBJECTIVES:

To provide hands on training in Down stream processing through simple experimentations in the laboratory. This will be a pre-requisite for project work.

The objectives of this course is to practice the students

- To understand the nature of the end product, its concentration, stability and degree of purification required
- To design processes for the recovery and subsequent purification of target biological products.

LIST OF EXPERIMENTS:

1. Solid liquid separation – centrifugation
2. Solid liquid separation - microfiltration
3. Cell disruption techniques – ultrasonication or French pressure cell or Dynamill
4. Precipitation – ammonium sulphite precipitation
5. Ultra filtration separation
6. Aqueous two phase extraction of biologicals
7. High resolution purification – affinity chromatography
8. High resolution purification – ion exchange chromatography
9. Product polishing – spray drying or freeze drying
10. Size exclusion chromatography

TOTAL: 60 PERIODS

List of Equipment for 30 students

Centrifuge	1
Cross flow filtration set up	2
FPLC	1
Sonicator or French press or Dynamill	1

OUTCOMES:

Upon successful completion of this course, the students would have

- Acquired knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.
- Learned cell disruption techniques to release intracellular products
- Learned various techniques like evaporation, extraction, precipitation, membrane separation for concentrating biological products
- Learned the basic principles and techniques of chromatography to purify the biological products and formulate the products for different end uses.

REFERENCES:

1. P.A. Belter, E.L. Cussler And Wei-Houhu – Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pub. (1988).
2. R.O. Jenkins, (Ed.) – Product Recovery In Bioprocess Technology – Biotechnology ByOpen Learning Series, Butterworth-Heinemann (1992).
3. J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.

BI8811**PROJECT WORK****L T P C
0 0 20 10****OBJECTIVE:**

- The objective of the project is to make use of the knowledge gained by the student at various stages of the degree programme.

The students are assigned project work related to product / process development, solution to the technical problems in industry and current research at national and international level. The student is required to submit a report at the end of semester based on the findings. The evaluation is made as per the Regulations of University.

OBJECTIVE:

- To develop a fundamental knowledge of the physical principles that govern the transport of momentum, energy and mass, with emphasis on the mathematical formulation of the conservation principles.

UNIT I TRANSPORT PHENOMENA BY MOLECULAR MOTION 9

Vectors/Tensors, Newton's law of viscosity, Newtonian & Non-Newtonian fluids, rheological models, Temperature, pressure and composition dependence of viscosity, Kinetic theory of viscosity, Fourier's law of heat conduction, Temperature, pressure and composition dependence of thermal conductivity, Kinetic theory of thermal conductivity, Fick's law of diffusion, Temperature, pressure and composition dependence of diffusivity, Kinetic theory of diffusivity.

UNIT II ONE DIMENSIONAL MOMENTUM TRANSPORT 9

Shell Momentum balances, boundary conditions, velocity profiles, average velocity, momentum flux at the surfaces, of Newtonian and non-Newtonian for flow of a falling film, flow through circular tube, slits, flow through an Annulus, Adjacent flow of two Immiscible fluids. Equations of Change (Isothermal), equation of continuity, equation of motion, equation of energy (isothermal) their applications in fluid flow problems.

UNIT III ONE DIMENSIONAL HEAT TRANSPORT 9

Shell energy balances, boundary conditions, temperature profiles, average temperature, energy fluxes at surfaces for different types of heat sources such as electrical, nuclear viscous and chemical, Equations of change (non-isothermal), equation of motion for forced and free convection, equation of energy (non-isothermal).

UNIT IV ONE DIMENSIONAL MASS TRANSPORT 9

Shell mass balances, boundary conditions, concentration profiles, average concentration, mass flux at surfaces for Diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneous chemical reaction, Diffusion in to a falling liquid film, Diffusion and chemical reaction in porous catalyst and the effectiveness factor, equation of continuity for binary mixtures, equation of change to set up diffusion problems for simultaneous heat and mass transfer.

UNIT V TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 9

Turbulence phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface. Introduction to macroscopic balances for isothermal flow systems, non-isothermal systems and multicomponent systems.

TOTAL: 45 PERIODS**OUTCOME:**

- Students would gain the knowledge of fundamental connections between the conservation laws in heat, mass, and momentum in terms of vector and tensor fluxes. The students would be able to understand the mechanism of fluids in motion under different conditions.

TEXT BOOKS:

1. R. B. Bird, W.E. Stewart, E.W. Lightfoot, Transport Phenomena, 2nd Revised Edition, John Wiley, 2007
2. Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena A Unified Approach", Brodkey Publishing 2003.

REFERENCES:

1. C. J. Geankoplis, Transport Processes and Separation Process Principles, Prentice- Hall Inc., 4th Edition 2003.
2. C. O. Bennett, J. O. Myers, Momentum, Heat and Mass Transfer, 2nd International Student Edition Mc-Graw Hill, 1983.
3. R. Welty, R.W. Wilson, and C.W.Wicks, Rorer G.E, Wilson R.W. "Fundamentals of Momentum Heat and Mass Transfer", 5th Edition, John Wiley, New York, 2007.

BT8403 ENZYME TECHNOLOGY AND BIO-TRANSFORMATIONS**L T P C
3 0 0 3****OBJECTIVES:**

To enable the students

- To learn enzyme reactions and its characteristics along with the production and purification process
- To give the student a basic knowledge concerning biotransformation reactions with the usage of enzymes

UNIT I INTRODUCTION TO ENZYMES 9

Classification of enzymes. Mechanisms of enzyme action; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, transition state theory; role of entropy in catalysis.

UNIT II KINETICS OF ENZYME ACTION 9

Kinetics of single substrate reactions; estimation of Michelis – Menten parameters, multisubstrate reactions - mechanisms and kinetics; turnover number; types of inhibition & models –substrate, product. Allosteric regulation of enzymes, Monod Changeux Wyman model, pH and temperature effect on enzymes & deactivation kinetics.

UNIT III ENZYME IMMOBILIZATION AND BIOSENSORS 9

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages, design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

UNIT IV PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES 9

Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes; development of enzymatic assays

UNIT V BIOTRANSFORMATION APPLICATIONS OF ENZYMES 9

Hydrolytic- Ester bond, Amide, Epoxides, Nitriles, Reduction reactions –aldehydes, Ketones, C=C, Oxidation reactions – Alkanes, Aromatic, Baeyer-Villiger, Enzymes in organic synthesis – esters, amide, peptide , Modified and Artificial Enzymes , Catalytic antibodies

TOTAL: 45 PERIODS

OUTCOMES:

- The knowledge on enzyme and enzyme reactions will be the key step in to proceed towards various concepts in biotechnology.
- The theoretical and practical aspects of kinetics will provide the importance and utility of enzyme kinetics towards research.
- The process of immobilization has been increased steadily in food, pharmaceutical and chemical industries and thus this study will provide simple and easy method of implementation.
- Ideas on Processing, Production and Purification of enzymes at an industrial scale will be helpful to work technologically.

TEXT BOOKS:

1. Trevor Palmer , Enzymes IInd Horwood Publishing Ltd
2. Faber K , Biotransformations in Organic Chemistry, IV edition , Springer

REFERENCES:

1. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc.
2. James M. Lee, Biochemical Engineering, PHI, USA.
3. James. E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill.
4. Wiseman, Enzyme Biotechnology, Ellis Horwood Pub.

AIM:

- To give an understanding on the fundamentals of conventional genetics and its relevance in disease and therapy

OBJECTIVES:

- To describe various genetic laws, learn the chromosome structure function and understand methodologies for cytogenetic applications

UNIT I BACTERIAL GENETICS 9

Transformation, Transduction, Conjugation – mapping, fine structure mapping in merozygotes-plasmids and episomes

UNIT II CLASSICAL GENETICS 9

Mendel's principles and experiments, segregation, multiple alleles – Independent Assortments, Genotypic interactions, epistasis and Sex chromosomes, Sex determination, Dosage compensation, sex linkage and pedigree analysis

UNIT III APPLIED GENETICS 9

Chromosome organization, structure and variation in prokaryotes and eukaryotes, Giant chromosomes – polytene and lampbrush, deletion, inversion, translocation, duplication. variation in chromosomal numbers – aneuploidy, euploidy, polyploidy, Ames test, karyotyping, Linkage, Crossing over – cytological basis of crossing over, chromosome mapping – two and three factor cross – interference, somatic cell hybridization

UNIT IV POPULATION GENETICS 9

Hardy-Weinberg equilibrium, Extensions of Hardy- Weinberg equilibrium, non random mating, population analysis, Models for population genetics. Mutation and Migration size, Genetic variation and Sociobiology

UNIT V GENETIC DISEASES 9

Inborn errors of metabolism, Sickle cell, hemochromatosis, cystic fibrosis, hypogonadotropic hypogonadism, Gaucher's disease, achondroplasia, phenylketonuria, Huntington's Disease, Cystic fibrosis, hemoglobinopathies, Age-related macular degeneration, Obesity, Type 2 diabetes, Psychiatric disease, including missing heritability, autism

TOTAL: 45 PERIODS**TEXT BOOKS:**

- Tamarin, R.H., "Principles of Genetics", Tata McGraw Hill, New Delhi, 2002
- De Robertis, E. D. P. and De Robertis, E. M. F., "Cell and Molecular Biology", 8th Edition, Lippincott Williams & Wilkins, New York, USA, 2001.

REFERENCES:

- Gardner, E.J, Simmons, M.J, and Snustad, D.P., "Principles of Genetics", 8th Edition, JohnWiley& Sons, Singapore, 2003.
- Strickberger, M.W., "Genetics", 3rd Edition, Prentice Hall of India, New Delhi, 2008.
- Klug, W.S. and Cummings, M.R., "Concepts of Genetics", Pearson Education, New Delhi, 2003.

OBJECTIVES:

- To improve the programming skills of the student
- To let the students know the recent evolution in biological science

UNIT I INTRODUCTION (9 + 6)

Introduction to Operating systems, Linux commands, File transfer protocols ftp and telnet, Introduction to Bioinformatics and Computational Biology, Biological sequences, Biological databases, Genome specific databases, Data file formats, Data life cycle, Database management system models, Basics of Structured Query Language (SQL).

UNIT II SEQUENCE ALIGNMENT (9 + 6)

Sequence Analysis, Pair wise alignment, Dynamic programming algorithms for computing edit distance, string similarity, shotgun DNA sequencing, end space free alignment. Multiple sequence alignment, Algorithms for Multiple sequence alignment, Generating motifs and profiles, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, BLAST, PSIBLAST and PHIBLAST algorithms.

UNIT III PHYLOGENETIC METHODS (9 + 6)

Introduction to phylogenetics, Distance based trees UPGMA trees, Molecular clock theory, Ultrametric trees, Parsimonious trees, Neighbour joining trees, trees based on morphological traits, Bootstrapping. Protein Secondary structure and tertiary structure prediction methods, Homology modeling, abinitio approaches, Threading, Critical Assessment of Structure Prediction, Structural genomics.

UNIT IV PROTEIN STRUCTURE ANALYSIS (9 + 6)

Machine learning techniques: Artificial Neural Networks in protein secondary structure prediction, Hidden Markov Models for gene finding, Decision trees, Support Vector Machines. Introduction to Systems Biology and Synthetic Biology, Microarray analysis, DNA computing, Bioinformatics approaches for drug discovery, Applications of informatics techniques in genomics and proteomics: Assembling the genome, STS content mapping for clone contigs, Functional annotation, Peptide mass fingerprinting.

UNIT V PERL PROGRAMMING (9 + 6)

Basics of PERL programming for Bioinformatics: Data types: scalars and collections, operators, Program control flow constructs, Library Functions: String specific functions, User defined functions, File handling.

TOTAL: 75 PERIODS**OUTCOMES:**

Upon completion of this course, students will be able to

- Develop bioinformatics tools with programming skills.
- Apply computational based solutions for biological perspectives.
- Pursue higher education in this field.
- Practice life-long learning of applied biological science.

TEXT BOOKS:

1. Introduction to Bioinformatics by Arthur K. Lesk , Oxford University Press.
2. Algorithms on Strings, Trees and Sequences by Dan Gusfield, Cambridge University Press.
3. Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids by R.Durbin, S.Eddy, A.Krogh, G.Mitchison.
4. Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press.
5. Beginning Perl for Bioinformatics: An introduction to Perl for Biologists by James Tindall, O'Reilley Media

REFERENCE:

1. Bioinformatics The Machine Learning Approach by Pierre Baldi and Soren Brunak.

BT8005**ANIMAL BIOTECHNOLOGY****L T P C****3 0 0 3****OBJECTIVES:**

To provide the fundamentals of animal cell culture, details of the diseases and therapy

- To offer the knowledge about the micromanipulation and transgenic animals

UNIT I ANIMAL CELL CULTURE 9

Introduction to basic tissue culture techniques; chemically defined and serum free media; animal cell cultures, their maintenance and preservation; various types of cultures suspension cultures, continuous flow cultures, immobilized cultures; somatic cell fusion; cell cultures as a source of valuable products; organ cultures.

UNIT II ANIMAL DISEASES AND THEIR DIAGNOSIS 9

Bacterial and viral diseases in animals; monoclonal antibodies and their use in diagnosis; molecular diagnostic techniques like PCR, in-situ hybridization; northern and southern blotting; RFLP.

UNIT III THERAPY OF ANIMAL DISEASES 9

Recombinant cytokines and their use in the treatment of animal infections; monoclonal antibodies in therapy; vaccines and their applications in animal infections; gene therapy for animal diseases.

UNIT IV MICROMANIPULATION OF EMBRYO'S 9

What is micromanipulation technology; equipments used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.

UNIT V TRANSGENIC ANIMALS 9

Concepts of transgenic animal technology; strategies for the production of transgenic animals and their importance in biotechnology; stem cell cultures in the production of transgenic animals.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this subject the student will be able to

- Understand the animal cell culture, animal diseases and its diagnosis
- Gain the knowledge for therapy of animal infections
- Know the concepts of micromanipulation technology and transgenic animal technology
- Use the knowledge gained in this section to apply in the field of clinical research

TEXT BOOKS:

1. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002
2. Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997.

REFERENCE:

1. Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press.2000

BI8001

BIOREACTOR DESIGN

L T P C
3 0 0 3

COURSE OBJECTIVES

- To provide an understanding about the basic principles of design of reactors for bioprocesses
- To develop mathematical descriptions of reaction kinetics
- To provide relationships between reactor design and use them to analyze their behavior, and
- To understand the basic introduction about scale-up and scale-down concepts. To understand the concept of ideal and non-ideal behaviour of the reactor

UNIT I OVERVIEW OF BIOREACTORS & BIOCHEMICAL ASPECTS 9

Classification of bioreactors, major components of a typical stirred tank bioreactor with functions, basic features of special purpose bioreactors. Stoichiometry of bioreactions, mass balances for bioreactors, yield factors, application of yield factors to arrive at single-carbon and energy yielding substrate, biomass and product formation, and nitrogen and oxygen requirements.

UNIT II DESIGN OF BIOREACTORS 9

Process and mechanical design of fermenters, volume, sparger, agitator-type, size and motor power, heat transfer calculations for coil and jacket, sterilization system.

UNIT III ANALYSIS OF BIOREACTOR 9

Development of performance equations for ideal reactors, non-ideal behaviour in bioreactors, models for non-ideal reactors, prediction of conversion in non-ideal chemostat,

UNIT IV BIOREACTOR PERFORMANCE 9

Transient Behaviour in bioreactors, stability of bioreactors, phase-plane analysis, bifurcation analysis.

UNIT V SCALE-UP AND SCALE-DOWN OF BIOREACTORS 9
Strategies and methods for scale-up, similarity criteria, Hubbard method, method of Wang et al., Ettler's method, dimensionless numbers and scale up and the scale-down bioreactor.

TOTAL : 45 PERIODS

COURSE OUTCOMES

- CO1 : To select a suitable bioreactor and mode of operation for a bioprocess.
CO2 : To apply mass/energy balances and reaction kinetics for the design
CO3 : To analyse bioreactors and use scale-up and scale-down considerations for bioprocess intensification
CO4: To analyse the similarity criteria in scale up of reactor
CO5: To understand the methods for scale up techniques

TEXT BOOKS

1. Tapobrata Panda, Bioreactors -Analysis and Design,2011, Tata McGraw-Hill Education.

REFERENCES

1. Michael L. Shuler, FikretKargı, Bioprocess Engineering: Basic Concepts (2nd Edn),2017 Prentice Hall.
2. James Edwin Bailey, Biochemical Engineering Fundamentals,2nd Edn,2011, McGraw-Hill.
3. Ghasem D Najafpour,Biochemical Engineering and biotechnology,2nd Edn,2011,Elsevier

CH8076 PIPING AND INSTRUMENTATION L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on piping technology and instrumentation on pipelines.

UNIT I FUNDAMENTALS OF PIPING ENGINEERING 9
Definitions, Piping Components their introduction, applications. Piping MOC, Budget Codes and Standards, Fabrication and Installations of piping.

UNIT II PIPE HYDRAULICS AND SIZING 9
Pipe sizing based on velocity and pressure drop consideration cost, least annual cost approach, pipe drawing basics, development of piping general arrangement drawing, dimensions and drawing of piping.

UNIT III PLOT PLAN 9
Development of plot plan for different types of fluid storage, equipment layout, process piping layout, utility piping layout. Stress analysis -Different types of stresses and its impact on piping, methods of calculation, dynamic analysis, flexibility analysis.

UNIT IV PIPING SUPPORT 9
Different types of support based on requirement and its calculation.

UNIT V INSTRUMENTATION**9**

Final Control Elements; measuring devices, instrumentation symbols introduction to process flow diagram (PFD) and piping & instrumentation diagram (P&ID)

TOTAL: 45 PERIODS**OUTCOME:**

- Students gain knowledge on fundamentals of piping engineering, pipe hydraulics, piping supports and instrumentation.

TEXT BOOKS:

1. Piping Handbook, 6 th edition, M.L. Nayyar, P.E., Mc Graw-Hill, Inc
2. Piping Design Handbook edited by Johan J McKetta, CRC Press, 1992.
3. Luyben, W. L., " Process Modeling Simulation and Control for Chemical Engineers, McGraw Hill, 1990.

BT8024**BIOSAFETY AND HAZARD MANAGEMENT****L T P C
3 0 0 3****AIM:**

- To introduce awareness on the importance of plant safety and risk analysis

OBJECTIVE:

- Students learn about implementation of safety procedures, risk analysis and assessment, hazard identification

UNIT I INTRODUCTION**9**

Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling

UNIT II QUALITY CHECKS**9**

Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety

UNIT III RISK ANALYSIS**9**

Overall risk analysis--emergency planning-on site &off site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment – rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

UNIT IV SAFETY AUDITS**9**

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras- Vizag Bopal analysis.

UNIT V HAZARDOUS OPERATIONS**9**

Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965.
2. Marcel, V.C., Major Chemical Hazard- Ellis Harwood Ltd., Chi Chester, UK, 1987.
3. Skeleton, B., Process Safety Analysis: An introduction, Institution of chemical Engineers, U.K., 1997.
4. Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis, Dyadem Press, 2004.

REFERENCES:

1. Handley, W., "Industrial Safety Hand Book ", 2ndEdn., McGraw-Hill Book Company, 1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., "Industrial Accident Prevention", McGraw-Hill Book Co., 1980.
3. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prentice Hall, NJ, 1990.
4. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994

BT8016**GENOMICS AND PROTEOMICS****L T P C****3 0 0 3****OBJECTIVE:**

- To provide the students a broader knowledge on the structure and function of genomes, the technologies developed for genomics, functional genomics and proteomics.

UNIT I INTRODUCTION**9**

Introduction to genome, transcriptome, and proteome; Overview of genomes of bacteria, archae, and eukaryote; Genomes of organelles.

UNIT II GENOME MAPPING AND SEQUENCING**9**

Genetic and physical mapping, Linkage analysis, RFLP, SNP, SSLP, Restriction mapping, STS mapping, FISH, Top-down and bottom-up sequencing strategies, Whole genome sequencing, Gap closure, Pooling strategies.

UNIT III FUNCTIONAL GENOMICS**9**

Genome annotation, ORF and functional prediction, Gene finding, Subtractive DNA library screening, Differential display and Representational difference analysis, SAGE, TOGA, Introduction to DNA microarray.

UNIT IV TECHNIQUES IN PROTEOMICS**9**

In-vitro and in vivo-labeling of proteins, One and two-dimensional gel electrophoresis, Detection of proteins on SDS gels, Protein cleavage, Edman protein microsequencing, Mass spectrometry-principles of MALDI-TOF, Peptide mass fingerprinting.

UNIT V PROTEIN PROFILING**9**

Large-scale protein profiling using proteomics, Post-translational modifications, Phosphoprotein and glycoprotein analyses; Analysis of protein-protein interactions, Protein microarrays.

TOTAL: 45 PERIODS**OUTCOMES:**

- The students would have gained a better understanding of the organization of genomes in multiple levels of taxa, and the methodologies and approaches used for the study of structural and functional genomics. The students would have also acquired knowledge on various genome mapping and sequencing methods, genomic markers, microarray technology and methods for proteomics.

TEXT BOOKS:

1. Suhai, Sandor "Genomics and Proteomics: Functional and Computational Aspects". Springer, 2000
2. Pennington, S.R. and M.J. Dunn "Proteomics: From Protein Sequence to Function". VivaBooksPvt. Ltd., 2002.
3. O'Connor, C.D. and B.D.Hames. "Proteomics". Scion Publishing, 2008.
4. Primrose, S.B. and Twyman. "Principles of Genome Analysis and Genomics". 7th Edition, Blackwell Publishing, 2006

REFERENCES:

1. Cantor, Charles R. and Cassandra L. Smith. "Genomics: The Science and Technology Behind the Human Genome Project". John Wiley & Sons, 1999.
2. Liebler, R.C. "Introduction to Proteomics". Humana Press, 2002.
3. Hunt, Stephen P. and Frederick J. Livesey. "Functional Genomics". Oxford University Press, 2000.
4. Conard, Edward. "Genomics". Apple Academics, 2010

BT8503**PROTEIN ENGINEERING****L T P C****3 0 0 3****OBJECTIVES:**

To enable the students

- To identify the importance of protein biomolecules.
- To realize the structure-function relationships in proteins

UNIT I BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS**9**

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure. Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

UNIT II PROTEIN ARCHITECTURE 9

Primary structure: peptide mapping, peptide sequencing - automated Edman method & mass spec. High-throughput protein sequencing setup Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structure: Alpha-turn-alpha, beta-turn-beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites.

UNIT III TERTIARY STRUCTURE 9

Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures. Quaternary structure: Modular nature, formation of complexes. Computer exercise on the above aspects

UNIT IV STRUCTURE-FUNCTION RELATIONSHIP 9

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp Repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers. Membrane proteins: General characteristics, Transmembrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications. Computer exercise on the above aspects

UNIT V PROTEOMICS 9

Introduction to the concept of proteome, components of proteomics, proteomic analysis, importance of proteomics in biological functions, protein-protein interactions and methods to study it: protein arrays, cross linking methods, affinity methods, yeast hybrid systems and protein arrays. Computer exercise on the above aspects

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, students will be able:

- To analyze the various interactions in protein makeup.
- To be familiar with different levels of protein structure.
- To know the role of functional proteins in various field of study.
- To practice the latest application of protein science in their research.

TEXT BOOKS:

1. Branden C. and Tooze J., "Introduction to Protein Structure" 2nd Edition, Garland Publishing, 1999.
2. Creighton T.E. "Proteins" 2nd Edition. W.H. Freeman, 1993.
3. Pennington, S.R and M.J. Dunn, "Proteomics: Protein Sequence to Function". Viva Books, 2002.
4. Liebler, "Introduction to Proteomics" Humana Press, 2002.

REFERENCES:

1. Voet D. and Voet G., "Biochemistry". 3rd Edition. John Wiley and Sons, 2008.
2. Haggerty, Lauren M. "Protein Structure: Protein Science and Engineering". Nova Science Publications, 2011.
3. Williamson, Mike "How Proteins Work". Garland Science, 2012.

OBJECTIVES:

To enable the students to understand

- Basic biology of cancer
- Impact of antibodies against cancer in the human body leading to more effective treatments
- Enhanced immunology based detection methods and imaging techniques
- Development of cell based and cytokine based immunotherapy against cancer.

UNIT I FUNDAMENTALS OF CANCER BIOLOGY 9

Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer. Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer.

UNIT II PRINCIPLES OF CARCINOGENESIS 9

Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis.

UNIT III PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER 9

Signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes. Oncogenes/proto oncogene activity. Growth factors related to transformation. Telomerases.

UNIT IV PRINCIPLES OF CANCER METASTASIS 9

Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion.

UNIT V NEW MOLECULES FOR CANCER THERAPY 9

Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer; Gene therapy.

TOTAL: 45 PERIODS

OUTCOMES:

The course would facilitate the students

- To appreciate the role of immune system in cancer
- To describe self – tolerance machinery and immune surveillance
- To understand the cancer microenvironment and its influence on immune cells
- To have awareness on medical applications of cytokines and immune cells against cancer

TEXT BOOKS:

1. Weinberg, R.A. "The Biology of Cancer" Garland Science, 2007
2. McDonald, F etal., " Molecular Biology of Cancer" IInd Edition. Taylor & Francis, 2004.

REFERENCES:

1. King, Roger J.B. "Cancer Biology" Addison Wesley Longman, 1996.
2. Ruddon, Raymond W. "Cancer Biology" IIIrd Edition . Oxford University Press, 1995.

BI8002**MOLECULAR MODELING AND DRUG DESIGN****L T P C
3 0 0 3****COURSE OBJECTIVES**

- To gain knowledge on modern approaches used in molecular modelling and computer-based technology.
- To identify and design molecules for new medications greatly shortening the discovery phase of drug development by powerful computer-based technology.
- To help the students to be familiar about the concepts of bioinformatics to be implemented in drug design and development
- . To find new targets to treat disease; mechanism of drug designing
- To make the students understand the concept of molecular modeling, mechanics and interactions

UNIT I QUANTUM MECHANICS & CONCEPTS IN MOLECULAR MODELING 9

Introduction – coordinate systems – potential energy surfaces – introduction to quantum mechanics – postulates – Schrodinger wave equation – hydrogen molecule – Born-Oppenheimer approximation, introduction to computer hardware and software.

UNIT II MOLECULAR MECHANICS & ENERGY MINIMIZATION 9

Empirical force field models – Bond stretching – angle bending – torsional term – nonbonding interactions – thermodynamics properties using a forcefield – derived and non derived energy minimization method – simplex – sequential univariate method – steepest descent method – conjugate gradient method- Newton-Rapson method.

UNIT III MOLECULAR DYNAMICS AND MONTE CARLO SIMULATION 9

Introduction – Using single Model – time steps – Multiple steps – Setting up MD – energy conservation in MD Simulation Examples – Monte Carlo – Random number generation – Difference in MD & MC.

UNIT IV HOMOLOGY MODELLING 9

Comparative modeling of proteins – comparison of 3D structure – Homology – steps in homology modeling – tools – databases – side chain modeling – loop modeling.

UNIT V DRUG DESIGN 9

General approach to discovery of new drugs - lead discovery – lead modification – physiochemical principles of drug action – drug stereo chemistry –drug action - 3D database search – computer aided drug design – docking - molecular modeling in drug design – structure based drug design – pharmacophores - QSAR.

TOTAL : 45 PERIODS

COURSE OUTCOMES

CO1 : To describe different types of protein-ligand interactions and characterise binding pockets

CO2 : To use various tools for silico drug designing.

CO3 : To account for and set up molecular dynamics simulations and free energy calculations

CO4 : To analyze and provide solutions to new drug discovery by using modern CADD tools.

CO5: To understand the theory of inhibition and inactivation of enzymes, drug deactivation and susceptibility

TEXT BOOKS:

1. A.R.Leach "Molecular Modeling Principles and Application", 2nd Edn., Longman Publications, 1996.
2. Tamar Schlinck "Molecular Modelling and Simulation", Springer Edn, 2002
3. K Anand Solomon, "Molecular modelling and Drug design", MJP Publications, 2011

REFERENCES

1. Ken Dill and Sarina Bromberg "Molecular Driving Forces", Garland Science, 2nd Edn., 2012
2. Martin J Field "A Practical Introduction to the Simulation of Molecular Systems", Cambridge University Press 2007
3. Rebecca C Wade, Outi M H Salo-Ahen, "Molecular Modeling in Drug Design", MDPI, 2019
4. Cohen Claude N "Guidebook On Molecular Modeling In Drug Design", Elsevier India, 2014

BT8008

MOLECULAR PATHOGENESIS OF INFECTIOUS DISEASES

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OBJECTIVES:

To enable the students

- To understand about the microbial toxins and modern molecular pathogenesis
- To know about the host pathogen interaction and identifying virulence factors
- To control pathogens by modern approaches.

UNIT I OVERVIEW

5

Historical perspective - discovery of microscope, Louis Pasteur's contributions, Robert Koch's postulates, early discoveries of microbial toxins, toxic assays, vaccines, antibiotics and birth of molecular genetics and modern molecular pathogenesis studies, Various pathogen types and modes of entry.

UNIT II HOST-DEFENSE AGAINST PATHOGENS AND PATHOGENIC STRATEGIES

8

Attributes & components of microbial pathogenesis, Host defence: skin, mucosa, cilia, secretions, physical movements, limitation of free iron, antimicrobial compounds, mechanism of killing by humoral and cellular defence mechanisms, complements, inflammation process, general disease symptoms, Pathogenic adaptations to overcome the above defences.

UNIT III MOLECULAR PATHOGENESIS (WITH SPECIFIC EXAMPLES)

16

Virulence, virulence factors, virulence-associated factors and virulence lifestyle factors, molecular genetics and gene regulation in virulence of pathogens, Vibrio Cholerae: Cholera toxin, co-

regulated pili, filamentous phage, survival E.coli pathogens: Enterotoxigenic E.coli (ETEC), labile & stable toxins, Entero- pathogenic E.coli (EPEC), type III secretion, cytoskeletal changes, intimate attachment; Enterohaemorrhagic E.coli (EHEC), mechanism of bloody diarrhoea and Hemolytic Uremic Syndrome, Enteroaggregative E.coli (EAEC). Shigella: Entry, macrophage apoptosis, induction of macropinocytosis, uptake by epithelial cells, intracellular spread, inflammatory response, tissue damage Plasmodium: Life cycle, erythrocyte stages, transport mechanism and processes to support the rapidly growing schizont, parasitiparous vacuoles, and knob protein transport, Antimalarials based on transport processes. Influenza virus: Intracellular stages, Neuraminidase & Haemagglutinin in entry, M1 & M2 proteins in assembly and disassembly, action of amantidine.

UNIT IV EXPERIMENTAL STUDIES ON HOST-PATHOGEN INTERACTIONS 8

Virulence assays: adherence, invasion, cytopathic, cytotoxic effects. Criteria & tests in identifying virulence factors, attenuated mutants, molecular characterization of virulence factors, signal transduction & host responses

UNIT V APPROACHES TO CONTROL PATHOGENS 8

Classical approaches based on serotyping. Modern diagnosis based on highly conserved virulence factors, immuno& DNA-based techniques. New therapeutic strategies based on recent findings on molecular pathogenesis of a variety of pathogens, Vaccines - DNA, subunit and cocktail vaccines.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the student will be able to understand the

- Host pathogen interactions at the level of cellular and molecular networks.
- Diagnosis of diseases through the examination of molecules.
- Modern therapeutic strategies on various pathogens.

REFERENCES:

1. Iglewski B.H and Clark V.L “Molecular basis of Bacterial Pathogenesis“, Academic Press, 1990.
2. Peter Williams, Julian Ketley& George Salmond, “Methods in Microbiology: Bacterial Pathogenesis, Vol. 27”, Academic Press, 1998.
3. Recent reviews in Infect. Immun., Mol. Microbiol., Biochem. J., EMBO etc
4. Nester, Anderson, Roberts, Pearsall, Nester, “Microbiology: A Human Perspective”, McGraw Hill, 3rd Edition, 2001.
5. Eduardo A. Groisman, Principles of Bacterial Pathogenesis, Academic Press, 2001.

OBJECTIVE:

- The course objectives are imparting the basic knowledge of students about stem cell, culturing and its clinical applications.

UNIT I STEM CELLS AND TYPES 9

Stem cells: Definition, Classification, Sources and Properties –Types of stem cells: methods of isolation, study of stem cells and their viability IPSC, embryonic stem cells, cancer stem cells. – Preservations of Stem cell. Embryonic stem cell: Isolation, Culturing, Differentiation, Properties – Adult stem cell: Isolation, Culturing, Differentiation, Trans-differentiation, Plasticity, and Properties

UNIT II STEM CELLS IN PLANTS AND ANIMALS 9

Stem cell and founder zones in plants –particulary their roots – stem cells of shoot meristems of higher plants. Skeletal muscle stem cell – Mammary stem cells – intestinal stem cells – keratinocyte stem cells of cornea – skin and hair follicles –tumour stem cells.

UNIT III STEM CELLS DIFFERENTIATION 9

Factors influencing proliferation, physical, chemical and molecular methods for differentiation of stem cells – hormonal role in differentiation.

UNIT IV REGENERATION AND EXPERIMENTAL METHODS 9

Germ cells, hematopoietic organs, and kidney, cord blood transplantation, donor selection, HLA matching, patient selection, peripheral blood and bone marrow transplantation, - Stem cell Techniques: fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging

UNIT V APPLICATION AND ETHICAL ISSUES 9

Stem cell Therapy for neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns, skin ulcers, muscular dystrophy and orthopaedic applications. Stem cell policy and ethics, stem cell research: Hype, hope and controversy.

TEXT BOOKS:

- Stem cells by C.S Potten., Elsevier, 2006.
- Essentials of Stem Cell Biology by Robert Lanza., fourth edition. Elsevier 2014.

REFERENCES:

- Stem cell biology and Gene Therapy by Peter Quesenberry., First Edition, Wiley-Liss, 1998.
- Embryonic Stem cells – Protocols by KursadTurksen., Second Edition Humana Press, 2002.
- Stem Cells: From Bench to Bedside by AriffBongso, EngHinLee., World Scientific Publishing Company, 2005.
- Stem cells in clinic and Research by Ali Gholamrezanezhad., Intech, 2013

COURSE OBJECTIVES

- To give the students a working knowledge on design principles as applied in chemical engineering processes and operations.
- To learn how to design major equipment used in most chemical processes.
- To learn how unit operations fit together and interact in these processes and the basic procedure in process engineering design.
- To learn the impact of engineering solution on the environment.
- To provide comprehensive knowledge of various process parameters and economics involved in the development of process and plant design

UNIT I PROCESS DESIGN ASPECTS 9

Basic consideration in chem.engg. plant design, project identification, preliminary techno-economic feasibility, Selection of process, factors affecting process selection, types of flow diagrams. Standard versus special equipment, materials of construction, selection criteria

UNIT II PROCESS AUXILIARIES & UTILITIES 9

Piping design, layout, support for piping insulation, types of valves, process control & instrumentation control system design, Process water, boiler feed water, water treatment & disposal, steam, oil heating system, chilling plant, compressed air and vacuum system.

UNIT III COST ESTIMATION 9

Factors involved in project cost estimation, total fixed & working capital, types & methods of estimation of total capital investment, estimation of total product cost, factors involved.

UNIT IV DEPRECIATION & PROFITABILITY 9

Types and methods of determination, evaluation, Alternative investment & replacement methods for profitability evaluation, economic consideration in process and equipment design, inventory control

UNIT V OPTIMUM DESIGN & SCHEDULING AND CONTROL 9

General products rates in plant operation, optimum conditions; Introduction- PERTS & CPM.

TOTAL:45 PERIODS**COURSE OUTCOMES**

- CO1 : To apply various algorithms to synthesize a process flow sheet.
 CO2 : To calculate different costs involved in a process plant.
 CO3 : To calculate interest and time value of investments.
 CO4 : To measure profitability on investments.
 CO5 : To perform breakeven analysis and optimum design of a process

TEXT BOOKS

1. Peters M.S., Timmerhaus, K.D., "Plant Design and Economics for Chemical Engineers", 4th Edn., McGraw-Hill, Singapore,1991.

REFERENCES:

1. VilbrantF.C.,Dryden, C.E., "Chemical Engineering and Plant Design", 4thEdn., McGraw-Hill, NewYork, 1959.
2. Pant J.C. "CPM and PERT with Linear Programming", Jain Brothers, New Delhi, 1986.

3. Davis, G.S, "Chemical Engineering Economics and Decision Analysis", CENDC, I.I.T.,Madras, 1981
4. Holland, F.A., Watson, F.A and Wilkinson, J.K., "Introduction to Process Economics", Wiley,New York, 1974

BT8017

BIOFUEL

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UNIT I OVERVIEW OF BIOFUELS 9

Generation of biofuels – Development of biological conversion technologies – Integration of biofuels into biorefineries – Energy security and supply – Environmental sustainability of biofuels – Economic sustainability of biofuels.

UNIT II BIODIESEL 9

Biodiesel – Microorganisms and raw materials used for microbial Oil production – Treatment of the feedstocks prior to production of the Biodiesel – Current technologies of biodiesel production – Purification of biodiesel; Industrial production of biodiesel – Biodiesel production from single cell oil.

UNIT III BIOETHANOL 9

Bioethanol – Properties – Feedstocks – Process technology – Pilot plant for ethanol production from lignocellulosic feedstock – Environmental aspects of ethanol as a biofuel.

UNIT IV BIOMETHANE AND BIOHYDROGEN 9

Biomethanol – Principles, materials and feedstocks – Process technologies and techniques – Advantages and limitations – Biological hydrogen production methods – Fermentative hydrogen production – Hydrogen economy – Advantages and limitations.

UNIT V OTHER BIOFUELS 9

Biobutanol production – Principles, materials and feedstocks – Process technologies – Biopropanol – Bioglycerol – Production of bio-oils via catalytic pyrolysis – Life-Cycle environmental impacts of biofuels and Co-products.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Luque, R., Campelo, J.and Clark, J. Handbook of biofuels production, Woodhead Publishing Limited 2011
2. Gupta, V, K. and Tuohy, M, G. Biofuel Technologies, Springer, 2013
3. Moheimani, N. R., Boer, M, P, M, K, Parisa A. and Bahri, Biofuel and Biorefinery Technologies, Volume 2, Springer, 2015

REFERENCES:

1. Eckert, C, A. and Trinh, C, T. Biotechnology for Biofuel Production and Optimization, Elsevier, 2016
2. Bernardes, M, A, D, S. Biofuel production – recent developments and prospects, InTech, 2011

COURSE OBJECTIVES

- To provide a working knowledge of a variety of computational techniques that can be used for solving engineering problems
- To develop a capability to write computer programs.
- To develop the ability for result presentations and data visualization of engineering problems
- To Understand the basic concepts of Finite Difference and Finite Volume Methods.
Comprehend the methodology and algorithms of CFD analysis.

UNIT I INTRODUCTION 9

Illustration of the CFD approach, CFD as an engineering analysis tool, Review of governing equations, Modelling in engineering, Partial differential equations-Parabolic, Hyperbolic and Elliptic equation, CFD application in Chemical Engineering, CFD software packages and tools.

UNIT II PRINCIPLES OF SOLUTION OF THE GOVERNING EQUATIONS 9

Finite difference and Finite volume Methods, Convergence, Consistency, Error and Stability, Accuracy, Boundary conditions, CFD model formulation.

UNIT III MESH GENERATION 9

Overview of mesh generation, Structured and Unstructured mesh, Guideline on mesh quality and design, Mesh refinement and adaptation.

UNIT IV SOLUTION ALGORITHMS 9

Discretization schemes for pressure, momentum and energy equations -Explicit and implicit Schemes, Firstorder upwind scheme, second order upwind scheme, QUICK scheme, SIMPLE, SIMPLER and MAC algorithm, pressure-velocity coupling algorithms, velocity-stream function approach, solution of Navier-Stokes equations

UNIT V CFD SOLUTION PROCEDURE 9

Problem setup –creation of geometry, mesh generation, selection of physics and fluid properties, initialization, solution control and convergence monitoring, results reports and visualization

TOTAL : 45 PERIODS**COURSE OUTCOMES**

Upon completion of the course, the students shall be able to

CO1 : Solve PDE.

CO2 : Use Finite Difference and Finite Volume methods in CFD modelling

CO3 : Generate and optimize the numerical mesh

CO4 : Simulate simple CFD models and analyze its results

TEXT BOOKS

1. JiyuanTu, Guan Heng Yeoh, Chaoqun Liu, A Computational Fluid Dynamics, 3rd Edn, ELSEVIER, 2018
2. Sundararajan T, Muralidhar K. Computational Fluid Flow and Heat Transfer, Narosa Publishing. House, 2003.
3. Dale A. Anderson, Joha C. Tannehill, Richard H. Pletcher, Munipalli Ramakanth, Vijaya Shakar, 4th Edn, 2020
4. P.S. Ghoshadastidar, Computational Fluid Dynamics and Heat Transfer, 1st Edn, 2017

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1. Niyogi, P. Chakrabarty, S.K. and Laha, M.K., Introduction to computational fluid dynamics, Pearson education ,200).
2. R.S.Amano,B.Sunden, Computer Simulation of Flow and Heat Transfer, Emerging Topics, WIT press,2011
3. Suhas V. Patankar. Numerical Heat Transfer and Fluid Flow, CRC Press,2018.
4. S K Gupta. Numerical Methods for Engineers, New Age Publishers,2015.
5. Anderson John.D. Computational Fluid Dynamics,3rd Edition, Mc-Graw Hills,2003.
6. Guan Heng Yeoh,Jiyuan Tu, Computational Techniques for multiphase flows, Elsevier Science 2010.
7. Joel H Ferziger, Milovan Peric,Robert L.Street Computational Methods for Fluid Dynamics, Springer International Publishing,2019.