ANNA UNIVERSITY, CHENNAI

UNDERGRADUATE CURRICULUM (UNIVERSITY DEPARTMENTS)

Campus: Alagappa College of Technology

Department: Biotechnology

Programme: B. Tech. Industrial Biotechnology

Regulations: 2023 (Revised 2024), with effect from the AY 2024 – 25 to all the students of UG Programme.

OVERVIEW OF CREDITS

Sem	PCC	PEC	ESC	HSMC	ETC	OEC	SDC	UC	SLC	Total
I	0	0	0	14	0	0	7	1	0	**22**
II	0	0	10	11	0	0	0	1	0	**22**
III	9	0	8	4	0	0	0	2	0	**23**
IV	14	0	3	4	0	0	2	1	0	**24**
V	14	0	0	0	3	0	3	3	1	**24**
VI	0	9	0	0	3	3	3	3	0	**21**
VII	11	9	0	0	0	3	1	0	0	**24**
VIII	0	0	0	0	0	0	8	0	0	**8**
Total	**48**	**18**	**21**	**33**	**6**	**6**	**24**	**11**	**1**	**166**
% of Category	**29**	**11**	**12**	**20**	**3.5**	**3.5**	**15**	**6.5**	**0.5**	**100**

CATEGORY OF COURSES

PCC – Professional Core Course
PEC – Professional Elective Course
ETC – Emerging Technology Course
OEC – Open Elective Course
SLC – Self Learning Course
ESC – Engineering Science Course
HSMC – Humanities Science and Management Course
SDC – Skill Development Course
UC – University Course

For Honours & Minor Degree, please refer the Regulations 2023 (Revised 2024).

SEMESTER – I							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	PH23C01	Engineering Physics	LIT	3-0-2	5	4	HSMC
2.	EN23C01	Foundation English	LIT	2-0-2	4	3	HSMC
3.	ME23C04	Makerspace	LIT	1-0-4	5	3	SDC
4.	ME23C01	Engineering Drawing and 3D Modelling	LIT	2-0-4	6	4	SDC
5.	MA23C01	Matrices and Calculus	T	3-1-0	4	4	HSMC
6.	IB23C02	Bioorganic chemistry	T	3-0-0	3	3	HSMC
7.	UC23H01	*தமிழர் மரபு* / Heritage of Tamils	T	1-0-0	1	1	UC
8.	-	Audit Course I	-	-	-	-	UC
9.	-	NCC / NSS / NSO / YRC	-	0-0-2	2	-	UC
TOTAL CREDITS						**22**	

SEMESTER – II							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	EN23C02	Professional Communication	LIT	2-0-2	4	3	HSMC
2.	CS23C02	Computer Programming in Python	LIT	3-0-2	5	4	ESC
3.	CY23C01	Engineering Chemistry	LIT	3-0-2	5	4	HSMC
4.	MA23C02	Ordinary Differential Equations and Transform Techniques	T	3-1-0	4	4	HSMC
5.	EE23C03	Basics of Electrical and Electronics Engineering	T	2-0-2	4	3	ESC
6.	IB23201	Introduction to Human Physiology	T	3-0-0	3	3	ESC
7.	UC23H02	*தமிழரும் தொழில்நுட்பமும்* / Tamils and Technology	T	1-0-0	1	1	UC
TOTAL CREDITS						**22**	

SEMESTER – III							
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	MA23C06	Partial Differential Equations and Complex Functions	T	3-1-0	4	4	HSMC
2.	IB23301	Chemical Engineering Principles	LIT	3-0-4	7	5	ESC
3.	IB23302	Thermodynamics for Biotechnologists	T	3-0-0	3	3	ESC
4.	IB23C03	Biochemistry	LIT	3-0-4	7	5	PCC
5.	IB23303	Industrial Microbiology	LIT	3-0-2	5	4	PCC
6.	-	Audit Course II	-	-	-	-	UC
TOTAL CREDITS						21	

SEMESTER – IV							
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	IB23401	Cell and Molecular Biology	LIT	3-0-4	7	5	PCC
2	IB23402	Instrumental Methods of Analysis	LIT	3-0-2	5	4	PCC
3	IB23403	Bioprocess Engineering - I	LIT	3-0-4	7	5	PCC
4	UC23U01	Universal Human Values	LIT	1-0-2	3	0	UC
5	MA23C05	Probability and Statistics	T	3-1-0	4	4	HSMC
5	IB23404	Mass Transfer Operations	T	2-1-0	3	3	ESC
6	IB23U01	Standards – Industrial Biotechnology	T	1-0-0	1	1	UC
7	-	Skill Development Course - I	-	-	-	2	SDC
TOTAL CREDITS						24	

SEMESTER – V (PREFERENCE FOR FOREIGN EXCHANGE)							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1	IB23501	Genetic Engineering	LIT	3-0-4	7	5	PCC
2	IB23502	Bioprocess Engineering – II	LIT	3-0-4	7	5	PCC
3	IB23503	Immunology	LIT	3-0-2	5	4	PCC
4	-	Emerging Technology Course - I	-	-	-	3	ETC
5	-	Industry Oriented Course - I	T	1-0-0	1	1	SDC
6	-	Skill Development Course - II	-	-	-	2	SDC
7	IB23U02	Perspectives of sustainable development – Biotechnology	T	3-0-0	3	3	UC
8	IB23L01	Self-Learning Course# (Minimum Duration 15 h)	T	0-0-0	0	1	SLC
			TOTAL CREDITS			**24**	
COURSES FOR HONOURS DEGREE							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	IB23D01	Capstone Design Project – Level I	CDP	0-0-12	12	6	SDC
(OR)							
1.	-	Honours Elective – I	T	3-0-0	3	3	PEC
2.	-	Honours Elective – II	T	3-0-0	3	3	PEC
COURSES FOR MINOR DEGREE							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	-	Minor Elective – I	T	3-0-0	3	3	PEC
2.	-	Minor Elective – II	T	3-0-0	3	3	PEC

SEMESTER – VI (PREFERENCE FOR FOREIGN EXCHANGE)							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1	-	Professional Elective I	T	3-0-0	3	3	PEC
2	-	Professional Elective II	T	3-0-0	3	3	PEC
3	-	Professional Elective III	T	3-0-0	3	3	PEC
4	-	Emerging Technology Course - II	-	-	-	3	ETC
5	-	Industry Oriented Course - II	T	1-0-0	1	1	SDC
6	-	Skill Development Course - III	-	-	-	2	SDC
7	UC23E01	Engineering Entrepreneurship Development	LIT	2-0-2	4	3	UC
8	-	Open Elective - I	T	3-0-0	3	3	OEC
			TOTAL CREDITS			**21**	
COURSES FOR HONOURS DEGREE							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	IB23D02	Capstone Design Project – Level II	CDP	0-0-12	12	6	SDC
(OR)							
1.	-	Honours Elective – III	T	3-0-0	3	3	PEC
2.	-	Honours Elective – IV	T	3-0-0	3	3	PEC
COURSES FOR MINOR DEGREE							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	-	Minor Elective – III	T	3-0-0	3	3	PEC
2.	-	Minor Elective – IV	T	3-0-0	3	3	PEC

SEMESTER – VII							
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	IB23701	Downstream Processing	LIT	3-0-4	7	5	PCC
2	IB23702	Bioinformatics	LIT	3-0-2	5	4	PCC
3	IB23703	Industrial Biosafety and Hazard Management	T	2-0-0	2	2	PCC
4	-	Professional Elective IV	T	3-0-0	3	3	PEC
5	-	Professional Elective V	T	3-0-0	3	3	PEC
6	-	Professional Elective VI	T	3-0-0	3	3	PEC
7	-	Open elective – II	T	3-0-0	3	3	OEC
8	-	Industry Oriented Course - III	T	1-0-0	1	1	SDC
				TOTAL CREDITS		**24**	
COURSES FOR HONOURS DEGREE							
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	IB23D03	Capstone Design Project – Level III	CDP	0-0-12	12	6	SDC
(OR)							
1.	-	Honours Elective – V	T	3-0-0	3	3	PEC
2.	-	Honours Elective – VI	T	3-0-0	3	3	PEC
COURSES FOR MINOR DEGREE							
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	-	Minor Elective – V	T	3-0-0	3	3	PEC
2.	-	Minor Elective – VI	T	3-0-0	3	3	PEC

SEMESTER – VIII							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	IB23801	Project Work / Internship cum Project Work	IPW	0-0-16	16	8	SDC
TOTAL CREDITS						**8**	

PROFESSIONAL ELECTIVE COURSES (PEC)

I	II	III	IV	V
BIOLOGICAL SCIENCES	**BIOMOLECULAR ENGINEERING**	**MEDICAL BIOTECHNOLOGY**	**BIOCHEMICAL ENGINEERING**	**COMPUTATIONAL BIOLOGY**
Animal Biotechnology	Biophysics	Genetics	Chemical Reaction Engineering	Basic programming in computational Biology
Plant Biotechnology	Biological Spectroscopy	Cancer Biology	Instrumentation and Process Control	Algorithms in biomolecular analysis
Marine Biotechnology	Protein Structure and Function	Tissue Engineering and Biomaterials	Process Equipment and Plant Design	Computational protein structure predictions
Developmental Biology	Bio-conjugate Technology and Applications	Fundamentals of Nanoscience	Transport Phenomena	Molecular modelling
Systems Biology	Molecular modelling	Biopharmaceutical Technology	Foundation Skills in integrated Product Development	Molecular simulations in biotechnology
Neurobiology and Cognitive Sciences	Genomics and proteomics	Biosimilars and Monoclonal Antibody Production	Bio-industrial Entrepreneurship and IPR	Computational analysis in Genomes, Evolution and Networks
Bioethics	Fundamentals in Metabolic Engineering	Molecular Basis of Diseases and Therapeutics		

PROFESSIONAL ELECTIVE COURSE (PEC) VERTICALS – REGULATION 2023

VERTICAL I – BIOLOGICAL SCIENCES

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1.	IB23C01	Animal Biotechnology	T	3-0-0	3	3
2.	IB23001	Plant Biotechnology	T	3-0-0	3	3
3.	IB23002	Marine Biotechnology	T	3-0-0	3	3
4.	IB23003	Developmental Biology	T	3-0-0	3	3
5.	IB23004	Systems Biology	T	3-0-0	3	3
6.	IB23005	Neurobiology and Cognitive Sciences	T	3-0-0	3	3
7.	IB23006	Bioethics	T	3-0-0	3	3

VERTICAL II – BIOMOLECULAR ENGINEERING

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1.	IB23007	Biophysics	T	3-0-0	3	3
2.	IB23008	Biological Spectroscopy	T	3-0-0	3	3
3.	IB23009	Protein Structure and Function	T	3-0-0	3	3
4.	IB23010	Bio-conjugate Technology and Applications	T	3-0-0	3	3
5.	IB23011	Genomics and Proteomics	T	3-0-0	3	3
6.	IB23012	Fundamentals in Metabolic Engineering	T	3-0-0	3	3

VERTICAL III – MEDICAL BIOTECHNOLOGY

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	IB23013	Genetics	T	3-0-0	3	3
2	IB23014	Cancer Biology	T	3-0-0	3	3
3	IB23015	Tissue Engineering and Biomaterials	T	3-0-0	3	3
4	IB23016	Fundamentals of Nanoscience	T	3-0-0	3	3
5	IB23017	Biopharmaceutical Technology	T	3-0-0	3	3
6	IB23018	Biosimilars and Monoclonal Antibody Production	T	3-0-0	3	3
7	IB23019	Molecular Basis of Diseases and Therapeutics	T	3-0-0	3	3

VERTICAL IV – BIOCHEMICAL ENGINEERING

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1.	IB23020	Chemical Reaction Engineering	T	3-0-0	3	3
2.	IB23021	Instrumentation and Process Control	T	3-0-0	3	3
3.	IB23022	Process Equipment and Plant Design	T	3-0-0	3	3
4.	IB23023	Transport Phenomena	T	3-0-0	3	3
5.	IB23024	Foundation Skills in integrated Product Development	T	3-0-0	3	3
6.	IB23025	Bio-industrial Entrepreneurship and IPR	T	3-0-0	3	3

VERTICAL V – COMPUTATIONAL BIOLOGY

S. No.	Course Code	Course Name	Course Type#	Periods / Week		Credits
				L-T-P	TCP*	
1	IB23026	Basic programming in computational Biology	T	3-0-0	3	3
2	IB23027	Algorithms in biomolecular analysis	T	3-0-0	3	3
3	IB23028	Computational protein structure predictions	T	3-0-0	3	3
4	IB23029	Molecular modelling	T	3-0-0	3	3
5	IB23030	Molecular simulations in biotechnology	T	3-0-0	3	3
6	IB23031	Computational analysis in Genomes, Evolution and Networks	T	3-0-0	3	3

EMERGING TECHNOLOGY COURSES (ETC)

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	IB23E01	Artificial Intelligence and Machine Learning Fundamentals	T	2-0-2	4	3
2	IB23E02	IoT Concepts and Applications	T	2-0-2	4	3
3	IB23E03	Data Science Fundamentals	T	2-0-2	4	3
4	IB23E04	Augmented Reality /Virtual Reality	T	2-0-2	4	3
5	IB23E05	Immunotherapy and Immuno-informatics	T	3-0-0	3	3
6	IB23E06	Methods in Molecular diagnostics	T	3-0-0	3	3

LIST OF SKILL DEVELOPMENT COURSES (SDC)

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	IB23S01	Professional development	T	2-0-0	2	2
2	IB23S02	Computer aided drug design	T	2-0-0	2	2
3	IB23S03	High-throughput data analysis	T	2-0-0	2	2
4	IB23S04	Good Manufacturing Process & Validation	T	2-0-0	2	2

OPEN ELECTIVE TO OTHER DEPARTMENTS (OEC)

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	IB23901	Introduction to Biotechnology	T	3-0-0	3	3
2	IB23902	Introduction to Enzymes	T	3-0-0	3	3

COURSES TO BE STUDIED BY DIPLOMA LATERAL ENTRY STUDENTS

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	IB23C02	Bioorganic chemistry	T	3-0-0	3	3
2	IB23201	Introduction to Human Physiology	T	3-0-0	3	3

COURSES TO BE STUDIED BY B. SC. LATERAL ENTRY STUDENTS

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	IB23C02	Bioorganic chemistry	T	3-0-0	3	3
2	IB23201	Introduction to Human Physiology	T	3-0-0	3	3

EN23C01 **FOUNDATION ENGLISH** **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To develop students' foundational skills in reading, writing, grammar and vocabulary to enable them to understand and produce various forms of communication.
- To enhance students' proficiency in reading comprehension, narrative and comparative writing.
- To comprehend and analyse descriptive texts and visual images
- To articulate similarities and differences in oral and written forms.
- To improve students' proficiency in reading and writing formal letters and emails.

UNIT I BASICS OF COMMUNICATION **6**

Reading - Telephone message, bio-note; Writing – Personal profile; Grammar – Simple present tense, Present continuous tense, wh-questions, indirect questions; Vocabulary – Word formation (Prefix and Suffix).

LAB ACTIVITY: **6**

Listening – Telephone conversation; Speaking Self-introduction; Telephone conversation – Video conferencing etiquette

UNIT II NARRATION **6**

Reading – Comprehension strategies - Newspaper Report, An excerpt from an autobiography; Writing – Narrative Paragraph writing (Event, personal experience etc.); Grammar – Subject-verb agreement, Simple past, Past continuous Tenses; Vocabulary – One-word substitution

LAB ACTIVITY: **6**

Listening – Travel podcast; Speaking – Narrating and sharing personal experiences through a podcast

UNIT III DESCRIPTION **6**

Reading – A tourist brochure, Travel blogs, descriptive article/excerpt from literature, visual images; Writing –Descriptive Paragraph writing, Grammar – Future tense, Perfect tenses, Preposition; Vocabulary – Descriptive vocabulary

LAB ACTIVITY: **6**

Listening – Railway / Airport Announcements, Travel Vlogs; Speaking – Describing a place or picture description

UNIT IV COMPARE AND CONTRAST **6**

Reading – Reading and comparing different product specifications - Writing – Compare and Contrast Essay, Coherence and cohesion; Grammar – Degrees of Comparison; Vocabulary – Transition words (relevant to compare and contrast)

LAB ACTIVITY: **6**

Listening – Product reviews, Speaking – Product comparison based on product reviews - similarities and differences

UNIT V EXPRESSION OF VIEWS 6

Reading – Formal letters, Letters to Editor ; Writing – Letter writing/ Email writing (Enquiry / Permission, Letter to Editor); Grammar – Compound nouns, Vocabulary – Synonyms, Antonyms

LAB ACTIVITY: 6

Listening – Short speeches; Speaking – Making short presentations (JAM)

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment
- Written assessments
- Assignment

Lab assessment
- Listening
- Speaking

External Assessment
- End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- Use appropriate grammar and vocabulary to read different types of text and converse appropriately.
- Write coherent and engaging descriptive and comparative essay writing.
- Comprehend and interpret different kinds of texts and audio visual materials
- Critically evaluate reviews and articulate similarities and differences
- Write formal letters and emails using appropriate language structure and format

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume I by Orient Blackswan, 2022
2. “English for Science & Technology - I” by Cambridge University Press, 2023

REFERENCES

1. “Interchange” by Jack C.Richards, Fifth Edition, Cambridge University Press, 2017.
2. “English for Academic Correspondence and Socializing” by Adrian Wallwork, Springer, 2011.
3. “The Study Skills Handbook” by Stella Cortrell, Red Globe Press, 2019
4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		
CO3										√		√
CO4										√		
CO5										√		√

MA23C01	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To develop the use of matrix algebra techniques in solving practical problems.
- To familiarize the student with functions of several variables.
- To solve integrals by using Beta and Gamma functions.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals.
- To acquaint the students with the concepts of vector calculus which naturally arise in many engineering problems.

UNIT I MATRICES **9+3**

Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors- Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

UNIT II FUNCTIONS OF SEVERAL VARIABLES **9+3**

Limit, continuity, partial derivatives – Homogeneous functions and Euler's theorem - Total derivative – Differentiation of implicit functions – Jacobians -Taylor's formula for two variables - Errors and approximations – Maxima and Minima of functions of two variables – Lagrange's method of undermined multipliers.

UNIT III INTEGRAL CALCULUS **9+3**

Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions-Properties – Evaluation of single integrals by using Beta and Gamma functions..

UNIT IV MULTIPLE INTEGRALS **9+3**

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-
Evaluation of double and triple integrals by using Beta and Gamma functions.

UNIT V VECTOR CALCULUS **9+3**

Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green's theorem, Stoke's and Gauss divergence theorems (without proofs)– Verification and applications in evaluating line, surface and volume integrals.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students wherever applicable from the content of the course.

General engineering applications / branch specific applications from the content of each units wherever possible will be introduced to students.

Suggested Laboratory based exercises / assignments / assessments :

Matrices

1. Finding eigenvalues and eigenvectors
2. Verification of Cayley-Hamilton theorem
3. Eigenvalues and Eigenvectors of similar matrices
4. Eigenvalues and Eigenvectors of a symmetric matrix
5. Finding the powers of a matrix
6. Quadratic forms

Functions of Several Variables

1. Plotting of curves and surfaces
2. Symbolic computation of partial and total derivatives of functions

Integral Calculus

1. Evaluation of beta and gamma functions
2. Computation of error function and its complement

Multiple Integrals

1. Plotting of 3D surfaces in Cartesian and Polar forms

Vector Calculus

1. Computation of Directional derivatives
2. Computation of normal and tangent to the given surface

OUTCOMES:

CO 1 :Use the matrix algebra methods for solving practical problems.
CO 2 :Use differential calculus ideas on several variable functions.
CO 3 :Apply different methods of integration in solving practical problems by using Beta and Gamma functions.
CO 4 :Apply multiple integral ideas in solving areas and volumes problems.
CO 5 :Apply the concept of vectors in solving practical problems.

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir "'Thomas' Calculus", Pearson Education., New Delhi, 2018.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 45th Edition, New Delhi, 2020.
3. James Stewart, Daniel K Clegg & Saleem Watson "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2023.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.
4. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
6. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

PH23C01	ENGINEERING PHYSICS	L	T	P	C
	(Common to all branches of B.E/B.Tech Programmes)	3	0	2	4

COURSE OBJECTIVES

- To familiarize with crystal structure, bonding and crystal growth.
- To impart knowledge on Mechanics of Materials.
- To impart knowledge of oscillations, sound and Thermal Physics
- To facilitate understanding of optics and its applications, different types of Lasers and fiber optics.
- To introduce the basics of Quantum Mechanics and its importance.

UNIT I CRYSTAL PHYSICS 9+6

Crystal Bonding – Ionic – covalent – metallic and van der Walls's/ molecular bonding. Crystal systems - unit cell, Bravais lattices, Miller indices - Crystal structures - atomic packing density of BCC, FCC and HCP structures. NaCl, Diamond, Graphite, Graphene, Zincblende and Wurtzite structures - crystal imperfections- point defects - edge and screw dislocations – grain boundaries. Crystal Growth – Czocharalski method – vapor phase epitaxy – Molecular beam epitaxy- Introduction to X-Ray Diffractometer.

1. Determination of Lattice parameters for crystal systems.
2. Crystal Growth – Slow Evaporation method
3. Crystal Growth Sol – Gel Method

UNIT II MECHANICS OF MATERIALS 9+6

Rigid Body – Centre of mass – Rotational Energy - Moment of inertia (M.I)- Moment of Inertia for uniform objects with various geometrical shapes. Elasticity –Hooke's law - Poisson's ratio - stress-strain diagram for ductile and brittle materials – uses- Bending of beams – Cantilever - Simply supported beams - uniform and non-uniform bending - Young's modulus determination - I shaped girders –Twisting couple – Shafts. Viscosity – Viscous drag – Surface Tension.

4. Non-uniform bending -Determination of Young's modulus of the material of the beam.
5. Uniform bending -Determination of Young's modulus of the material of the beam
6. Viscosity – Determination of Viscosity of liquids.

UNIT III OSCILLATIONS, SOUND AND THERMAL PHYSICS 9+6

Simple harmonic motion - Torsional pendulum –- Damped oscillations –Shock Absorber - Forced oscillations and Resonance –Applications of resonance.- Waves and Energy Transport –Sound waves – Intensity level – Standing Waves - Doppler effect and its applications - Speed of blood flow. Ultrasound – applications - Echolocation and Medical Imaging. Thermal Expansion – Expansion joints – Bimetallic strip – Seebeck effect – thermocouple -Heat Transfer Rate – Conduction – Convection and Radiation.

7. Torsional pendulum-Determination of rigidity modulus of wire and moment of inertia of the disc
8. Melde's string experiment - Standing waves.
9. Ultrasonic interferometer – determination of sound velocity and liquids compressibility

UNIT IV OPTICS AND LASERS 9+6

Interference - Thin film interference - Air wedge- Applications -Interferometers–Michelson

Interferometer -– Diffraction - CD as diffraction grating – Diffraction by crystals -Polarization - polarizers -– Laser – characteristics – Spontaneous and Stimulated emission- population – inversion - Metastable states - optical feedback - Nd-YAG laser, CO_2 laser, Semiconductor laser - Industrial and medical applications - Optical Fibers – Total internal reflection – Numerical aperture and acceptance angle – Fiber optic communication – Fiber sensors – Fiber lasers.

10. Laser - Determination of the width of the groove of the compact disc using laser.
    Laser Parameters
    -Determination of the wavelength of the laser using grating
11. Air wedge -Determination of the thickness of a thin sheet/wire
12. Optical fibre -Determination of Numerical Aperture and acceptance angle
    -Determination of bending loss of fibre.
13. Michelson Interferometer (Demonstration)

UNIT V QUANTUM MECHANICS 9+6

Black body radiation (Qualitative) – Planck's hypothesis – Einstein's theory of Radiation - Matter waves–de Broglie hypothesis - Electron microscope – Uncertainty Principle – The Schrodinger Wave equation (time-independent and time-dependent) – Meaning and Physical significance of wave function - Normalization - Particle in an infinite potential well-particle in a three-dimensional box - Degenerate energy states - Barrier penetration and quantum tunneling - Tunneling microscope.

14. Photoelectric effect – Determination of Planck's constant.
15. Black Body Radiation (Demonstration)
16. Electron Microscope (Demonstration)

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the significance of crystal structure and bonding. Learn to grow crystals.
CO2: Obtain knowledge on important mechanical and thermal properties of materials and determine them through experiments.
CO3: Conceptualize and visualize the oscillations and sound.
CO4: Grasp optical phenomenon and their applications in real life.
CO5: Appreciate and evaluate the quantum phenomenon.
CO6 Develop skill set to solve engineering problems and design experiments.

TEXT BOOKS:

1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 10th Edition, 2015.
3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.
4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.

REFERENCES:

1. R. Wolfson, Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D. Kleppner and R. Kolenkow. An Introduction to Mechanics, McGraw Hill Education, 2017.
3. K. Thyagarajan and A. Ghatak. Lasers: Fundamentals and Applications. Springer, 2012

CO – PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1		1							
CO2	3	2	1	1								
CO3	3	2	1	1								
CO4	3	2	1	1	1							
CO5	3	2	1	1	1							
CO6	3	2	1	2								

ME23C01	ENGINEERING DRAWING AND 3D MODELLING	L	T	P	C
		2	0	4	4

COURSE OBJECTIVES

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

1. Understand and use the engineering curves in engineering applications and projection techniques to construct conic curves, points and lines.
2. Develop skills in projecting surfaces and solids and create 2D models using CAD software.
3. Develop skills in 3D projection and 3D modeling of simple parts manually as well as using CAD software.
4. Understand and apply sectioning techniques to solids and assemble components.
5. Develop skills in lateral surface development and sheet metal design.

INTRODUCTION

Manual drawing tools (Mini Drafter, Set Squares, Protractor, Compass, and different grades of pencil). **'**BIS' specifications and rules of Engineering Drawing – Arrows (2H thin line body, HB Filled head and L:W = 3:1 ratio), lettering (Digital fonts, font sizes pertaining to usage and representation), types of line and their syntax (Drawing based – Continuous thin & thick, dashed, dashed dotted and Application based – extension, dimensioning, construction, projection, reference, axis, section, hatching, and break lines), scaling (up, down and equal), and dimensioning. Placing and positioning the 'A3' size drawing sheet over the drawing table. Principal planes and projection, Division of line and circle in to equal parts, and construction of polygons

UNIT i: ENGINEERING CURVES, PROJECTION OF POINTS AND LINES 6+12

Construction of conic curves with their tangent and normal – ellipse, parabola, and hyperbola by eccentricity method

Construction of special curves with their tangent and normal – cycloid, epicycloid, and involute

Projection of points and I angle projection of lines inclined to both principal planes by rotating line method and trapezoidal rule – marking their traces.

Lab exercises: Study exercise – Introduction to Sketching (or) Drawing, and modification tools in CAD software (AutoCAD, CREO, CATIA, Solid Works, Inventor, Fusion 360)

Activities based learning: Identification of the curves used in the application given in the flash card, demonstration of the instantaneous centre of rotation of governors with respect to angle of inclination of the arms of the governors

UNIT II PROJECTION OF SURFACES & SOLIDS, AND 2D MODELING 6+12

Projection of surfaces inclined to both the principal planes – polygonal, trapezoidal, rhomboidal and circular

Projection of solids – prisms, pyramids, and axisymmetric solids when the axis inclined to both the principal planes – freely hanging – contour resting condition on either of the planes by rotating object method

Lab exercises: Construction of basic sketches – lines, circle, polygon, spline curves, coils, along with dimensioning. Familiarizing with geometric constraints and their types

Activities based learning: Making the solids using cardboards, shadow mapping and contour drawing at different orientation of the solids using torches,

UNIT III 3D PROJECTION OF SOLIDS AND 3D MODELING OF SIMPLE PARTS 6+12

Free hand sketching – I & III angle projections of engineering parts and components

Isometric projection of combination of solids – prisms, pyramids, axisymmetric solids, frustum

Perspective projection of prisms, pyramids and axisymmetric solids by visual ray method

Lab exercises: 3D Modeling and 2D drafting of machine parts

Activities based learning: Flipped classroom for Free hand sketching, Jig saw activity for Isometric projection, arts and crafts for perspective view

UNIT IV SECTION OF SOLIDS AND SECTIONED DRAFTING OF ASSEMBLED COMPONENTS 6+12

Section of simple and hollow solids – prisms, pyramids and axisymmetric solids, solids with holes/ slots when the section plane perpendicular to one principal plane and inclined to other principal plane ('On the axis' and 'from the axis' conditions)

Application based – section of beams (I, T, L, and C), section of pipe bracket, wood joints, composite walls, shells, flange of a coupling and other similar applications

Lab exercises: Assembly of parts with respect to engineering constraints, and sectioned drafting of assembled components

Activities based learning: Making of mitered joint in wood, sectioning the beams in different angles of orientation and identifying the true shape

UNIT V LATERAL SURFACE DEVELOPMENT AND SHEET METAL DESIGN 6+12

Lateral surface development of sectioned solids when the section plane perpendicular to VP and inclined to HP.

Application based – construction of funnel, chimney, dish antenna, door latch, trays, AC vents, lamp shade, commercial packaging boxes with respect to sectioning conditions and other similar applications

Lab exercises: Sheet metal design and drafting, drafting of coils, springs and screw threads

Activities based learning: Fabrication of funnels, chimney, lamp shade, boxes using card boards, ply woods, acrylics

TOTAL: 90 HOURS

Note: Activities based learning should not be covered in the regular class hours. It should be given as assignments to the group of maximum 3 members

Question pattern suggestion: Part – A (Either or type) (5 × 16 = 80) & Part – B (Compulsory) (1 × 20 = 20)

COURSE OUTCOME:-

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

CO1: Construct and identify different types of conic curves and special curves, and project the points and lines pertaining to engineering applications

CO2: Project and visualize surfaces and solids in different orientations and utilize the CAD tools for designing.

CO3: Create and draft accurate 3D models and 2D drawings of machine parts manually as well as using CAD softwares

CO4: Determine the true shape of a sectioned solid and draft the assemble parts accordingly

CO5: Develop lateral surfaces of sectioned solids and design sheet metal components

TEXTBOOKS:

1. Engineering Drawing" by N S Parthasarathy and Vela Murali
2. Engineering Drawing and Graphics with Auto CAD" by Venugopal K

REFERENCE BOOKS:

1. "Basic Engineering Drawing: Mechanical Semester Pattern" by Mehta and Gupta
2. "Engineering Drawing" by Basant Agrawal and C M Agrawal
3. "Engineering Drawing With Auto CAD" by B V R Gupta
4. "Engineering Drawing" by P S Gill
5. "Engineering Drawing with an Introduction to AutoCAD" by Dhananjay Jolhe
6. "Engineering Drawing" by M B Shah
7. "Fundamentals of Engineering Drawing" by Imtiaz Hashmi
8. "Computer Aided Engineering Drawing" by S Trymbaka Murthy
9. "CAED : Computer Aided Engineering Drawing for I/II Semester BE/Btech Courses" by Reddy K B
10. "Computer-Aided Engineering Drawing" by Subrata Pal

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2		1				3	1		3	3	3	2
2	3	3	2		2				3	2		3	3	3	2
3	3	3	3	1	2				3	3		3	3	3	2
4	3	3	3	1	3				3	3		3	3	3	2
5	3	3	3	1	3				3	3		3	3	3	2

ME23C04	MAKERSPACE	L	T	P	C
		1	0	4	3

COURSE OBJECTIVES:

1. To practice the usage of various tools towards assembly and dis-assembly of different items / equipment.
2. To make simple part / component using welding processes.
3. To train on the basic wiring practices of boards, machines, etc.
4. To provide a hands-on experience on the use of electronic components, equipment, sensors and actuators.
5. To expose to modern computer tools and advanced manufacturing / fabrication processes.

LIST OF ACTIVITIES **1L,4P**

(A). Dis-assembly & Assembly Practices

i. Tools and its handling techniques.

ii. Dis-assembly and assembly of home appliances – Grinder Mixer Grinder, Ceiling Fan, Table Fan & Washing Machine.

iii. Dis-assembly and assembly of Air-Conditioners & Refrigerators.

iv. Dis-assembly and assembly of a Bicycle.

(B). Welding Practices

i. Welding Procedure, Selection & Safety Measures.

ii. Power source of Arc Welding – Gas Metal Arc Welding & Gas Tungsten Arc Welding processes.

iii. Hands-on session of preparing base material & Joint groove for welding.

iv. Hands-on session of MAW, GMAW, GTAW, on Carbon Steel & Stainless Stell plates / pipes, for fabrication of a simple part.

(C). Electrical Wiring Practices

i. Electrical Installation tools, equipment & safety measures.

ii. Hands-on session of basic electrical connections for Fuses, Miniature Circuit Breakers and Distribution Box,

iii. Hands-on session of electrical connections for Lightings, Fans, Calling Bells.

iv. Hands-on session of electrical connections for Motors & Uninterruptible Power Supply.

(D). Electronics Components / Equipment Practices

i. Electronic components, equipment & safety measures.

ii. Dis-assembly and assembly of Computers.

iii. Hands-on session of Soldering Practices in a Printed Circuit Breaker.

iv. Hands-on session of Bridge Rectifier, Op-Amp and Transimpedance amplifier.

v. Hands-on session of integration of sensors and actuators with a Microcontroller.

vi. Demonstration of Programmable Logic Control Circuit.

(E).Contemporary Systems

i. Demonstration of Solid Modelling of components.

ii. Demonstration of Assembly Modelling of components.

iii. Fabrication of simple components / parts using 3D Printers.

iv. Demonstration of cutting of wood / metal in different complex shapes using Laser Cutting Machine.

TOTAL: 75 Periods (15 Lecture + 60 Practical)

COURSE OUTCOMES:

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

CO1: Assemble and dis-assemble various items / equipment.
CO2: Make simple parts using suitable welding processes.
CO3: Setup wiring of distribution boards, machines, etc.
CO4: Utilise the electronic components to fabricate a simple equipment, aided with sensors and actuators.
CO5: Take advantage of modern manufacturing practices.

REFERENCES:

1. Stephen Christena, Learn to Weld: Beginning MIG Welding and Metal Fabrication Basics, Crestline Books, 2014.
2. H. Lipson, Fabricated - The New World of 3D Printing, Wiley, 1st edition, 2013.
3. Code of Practice for Electrical Wiring Installations (IS 732:2019)
4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Oxford University Press, 7th ed. (Indian edition), 2017.
5. Mazidi, Naimi, Naimi, AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson India, 1st edition 2013.
6. Visualization, Modeling, and Graphics for Engineering Design, D.K. Lieu, S.A. Sorby, Cengage Learning; 2nd edition.

IB23C02	BIOORGANIC CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- enable the students to understand the basics concepts of chemical reactions
- make students understand the kinetics and its reaction mechanism
- make the students understand the mechanism of synthesis of different chemical moieties
- familiarise the students with the isolation of biomolecules from natural sources

UNIT – I: BONDING AND STEREOCHEMISTRY 9

Overview of atoms, electrons, orbitals and octet rule. Covalent and non-covalent bonds in biological systems, Electronegativity, polar and non-polar bonds. Water and its properties. Acid and base equilibria, pH and buffers – Henderson–Hasselbalch equation. Reactions of the most common functional groups in biological systems –OH, $–NH_2$, –COOH, –C=O, –CH=O, $–CH_3$, –SH, and $–PO_4$. Tetrahedral carbon and stereocenters – conformations and configurations of simple sugars and amino acids. Glycosidic and peptide linkages. Optical rotation.

UNIT – II: MECHANISMS OF SUBSTITUTION AND ADDITION REACTIONS 9

SN1and 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

OUTCOMES:

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

- **CO1**: define and appraise Bonding and stereochemistry
- **CO2**: classify and solve Mechanisms of substitution and addition reactions
- **CO3**: discuss and formulate the Thermodynamics, kinetics and mechanism
- **CO4**: describe and demonstrate Catalysis
- **CO5**: classify and analyze Bioorganic reactions & mechanisms

TEXT BOOKS:

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

REFERENCES:

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

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	2	1	1	1	1	-	-	-	2	2	3	1
2	3	2	2	2	3	2	2	1	1	1	-	2	3	2	2
3	3	2	2	2	2	2	-	-	-	1	-	2	2	2	2
4	1	2	2	2	1	2	1	-	1	1	-	1	2	1	1
5	2	2	2	2	2	1	2	2	2	2	-	2	3	2	3
Overall CO	2.2	2	2	2	1.8	1.6	1.5	1.3	1.3	1.3	-	1.8	2.4	2	1.8

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

UC23H01 **தமிழர் மரபு** **L T P C**
1 0 0 1

அலகு I மொழி மற்றும் இலக்கியம் **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H01 **HERITAGE OF TAMILS** **L T P C**
1 0 0 1

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India-Dravidian Languages–Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - TamilEpicsandImpactofBuddhism&JainisminTamilLand-BakthiLiteratureAzhwarsandNayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyarand Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts-Art of temple car making - Massive Terracotta sculptures, Villagedeities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments-Mridhangam,Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, VilluPattu, KaniyanKoothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAICONCEPTOFTAMILS 3

Flora and Fauna of Tamils&AhamandPuramConceptfromTholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import duringSangamAge -Overseas Conquestof Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils toIndian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - RoleofSiddhaMedicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

NCC Credit Course Level 1*

UC23P01	(ARMY WING) NCC Credit Course Level - I	L	T	P	C
		2	0	0	2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour 'Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P02	**(NAVAL WING) NCC Credit Course Level – I**	**L T P C** **2 0 0 2**
NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P03	**(AIR FORCE WING) NCC Credit Course Level – I**	**L T P C** **2 0 0 2**

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

EN23C02	PROFESSIONAL COMMUNICATION	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES

- To read and comprehend different forms of official texts.
- To develop students' writing skills in professional context.
- To actively listen, read and understand written and oral communication in a professional context.
- To comprehend and analyse the visual content in authentic context.
- To write professional documents with clarity and precision

UNIT I CAUSE AND EFFECT 6

Reading – Newspaper articles on Social and Environmental issues; Writing – Instructions, Cause and effect essay; Grammar - Modal verbs; Vocabulary – Cause and effect, Idioms

LAB ACTIVITY: 6

Listening and Speaking – Listen to news reports and summarise in oral form.

UNIT II CLASSIFICATION 6

Reading – An article, social media posts and classifying based on the content; Writing – Definition, Note making, Note taking (Cornell notes etc.) and Summarising; Grammar – Connectives; Vocabulary – Phrasal verbs

LAB ACTIVITY: 6

Listening and speaking: Social interaction (Conversation including small talk)

UNIT III PROBLEM AND SOLUTION 6

Reading – Visual content (Tables/charts/graphs) for comprehension; Writing - Problem and Solution Essay; Grammar – If conditionals; Vocabulary – Sequential words.

LAB ACTIVITY: 6

Listening – Group discussion; Speaking – Participating in a group discussion

UNIT IV REPORT 6

Reading – Formal report on accidents (industrial/engineering); Writing – Industrial Accident report; Grammar – Active and passive voice, Direct and Indirect speech; Vocabulary – Numerical adjectives.

LAB ACTIVITY: 6

Listening / watching – Television documentary and discussing its content, purpose etc.

UNIT V JOB APPLICATION AND INTERVIEW 6

Reading - Job advertisement and company profile; Writing – Job application (cover letter and CV) Grammar – Mixed Tenses; Vocabulary – Collocations related to work environment

LAB ACTIVITY: 6

Listening – Job interview; Speaking – Mock interviews

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment
Written assessments
Assignment
Lab Assessment
Group discussion (Peer assessment)
Listening

External Assessment
End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- To apply appropriate language structure and vocabulary to enhance both spoken and written communication in formal contexts.
- Comprehend different forms of official documents
- Write professional documents coherently and cohesively.
- Interpret verbal and graphic content in authentic context
- Analyse and evaluate verbal and audio visual materials.

TEXT BOOKS

1. “English for Engineers and Technologists” Volume 2 by Orient Blackswan, 2022
2. “English for Science & Technology - II” by Cambridge University Press, 2023.

REFERENCES

1. “Communicative English for Engineers and Professionals” by Bhatnagar Nitin, Pearson India, 2010.
2. ”Take Off – Technical English for Engineering” by David Morgan, Garnet Education, 2008.
3. “Advanced Communication Skills” by Mathew Richardson, Charlie Creative Lab, 2020.
4. www.uefap.com

CO – PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		√
CO3										√		√
CO4										√		√
CO5										√		√

MA23C02	ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORM TECHNIQUES	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To acquaint the students with Differential Equations which are significantly used in engineering problems.
- To make the students to understand the Laplace transforms techniques.
- To develop the analytic solutions for partial differential equations used in engineering by Fourier series.
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic.
- To develop Z- transform techniques in solving difference equations.

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 9+3

Homogeneous linear ordinary differential equations of second order -superposition principle - general solution- Particular integral - Operator method - Solution by variation of parameters - Method of undetermined coefficients - Homogeneous equations of Euler–Cauchy and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

UNIT II LAPLACE TRANSFORMS 9+3

Existence theorem - Transform of standard functions – Transform of Unit step function and Dirac delta function – Basic properties - Shifting theorems - Transforms of derivatives and integrals – Transform of periodic functions - Initial and Final value theorem - Inverse Laplace transforms- Convolution theorem (without proof) – Solving Initial value problems by using Laplace Transform techniques.

UNIT III FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Computation of harmonics.

UNIT IV FOURIER TRANSFORMS 9+3

Fourier integral theorem – Fourier transform pair - Fourier sine and cosine transforms – Properties – Transform of elementary functions – Inverse Fourier Transforms - Convolution theorem (without proof) – Parsevals's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 9+3

Z-transform – Properties of Z-transform – Inverse Z-transform – Convolution theorem – Evaluation of Inverse Z transform using partial fraction method and convolution theorem - Initial and final value theorems – Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

Ordinary differential equations

1. Symbolic computation of linear ordinary differential equations
2. Solving System of simultaneous linear differential equations using ODE SOLVER

Laplace transforms

1. Symbolic computation of Laplace transform and Inverse Laplace transform
2. Plotting Laplace transforms

Fourier Series

1. Symbolic computation of Fourier Coefficients
2. Computation of harmonics
3. Plotting truncated Fourier Series

Fourier Transform

1. Symbolic computation of Fourier Transforms
2. Plotting truncated Fourier Transforms

Z – transform

1. Symbolic computation of Z-Transforms

OUTCOMES:

CO1 :Solve higher order ordinary differential equations which arise in engineering applications.

CO2 :Apply Laplace transform techniques in solving linear differential equations.

CO3 :Apply Fourier series techniques in engineering applications.

CO4 :Understand the Fourier transforms techniques in solving engineering problems.

CO5 :Understand the Z-transforms techniques in solving difference equations.

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 45th Edition, New Delhi, 2020.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.

REFERENCES:

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008
2. Greenberg M.D., “Advanced Engineering Mathematics”, Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”,Narosa Publications, 5 th Edition, New Delhi, 2017.
4. Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
5. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO 1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 5 :	3	3	2	3	1	2	1	1	1	1	1	3

CY23C01 ENGINEERING CHEMISTRY L T P C

3 0 2 4

UNIT I WATER TECHNOLOGY

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD, BOD, and heavy metals. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, Calgon, and carbonate treatment. External conditioning – demineralization. Municipal water treatment (screening, sedimentation, coagulation, filtration, disinfection-ozonolysis, UV treatment, chlorination), Reverse Osmosis – desalination.

PRACTICAL:

- Estimation of HCl using Na_2CO_3 as the primary standard
- Determination of alkalinity in the water sample.
- Determination of hardness of water by EDTA method.
- Determination of DO content of water sample by Winkler's method.

UNIT II NANOCHEMISTRY

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties (optical, electrical, mechanical, magnetic and catalytic). Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro-spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Applications of nanomaterials – medicine including AYUSH, automobiles, electronics, and cosmetics.

PRACTICAL:

- Preparation of nanoparticles by Sol-Gel method/sonication method.
- Preparation of nanowire by Electrospinning.
- Study of morphology of nanomaterials by scanning electron microscopy

UNIT III CORROSION SCIENCE

Introduction to corrosion – chemical and electrochemical corrosions – mechanism of electrochemical and galvanic corrosions – concentration cell corrosion-soil, pitting, inter-granular, water line, stress and microbiological corrosions-galvanic series-factors influencing corrosion- measurement of corrosion rate. Electrochemical protection – sacrificial anodic protection and impressed current cathodic protection. Protective coatings-metallic coatings (galvanizing, tinning), organic coatings (paints). Paints: Constituents and functions.

PRACTICAL:

- Corrosion experiment-weight loss method.
- Salt spray test for corrosion study.
- Corrosion prevention by electroplating.
- Estimation of corroded Iron by Potentiometry/UV-visible spectrophotometer

UNIT IV ENERGY SOURCES

Electrochemical cell, redox reaction, electrode potential – oxidation and reduction potential. Batteries – Characteristics; types of batteries; primary battery (dry cell), secondary battery (lead acid, lithium-ion battery) and their applications. Emerging energy sources – metal hydride battery, hydrogen energy, Fuel cells – H_2-O_2 fuel cell. Supercapacitors –Types and Applications, Renewable Energy: solar heating and solar cells. Recycling and disposal of batteries.

PRACTICAL:

- Study of components of Lead acid battery.
- Measurement of voltage in a photovoltaic cell.
- Working of $H_2 – O_2$ fuel cell

UNIT V POLYMER CHEMISTRY

Introduction: Functionality-degree of polymerization. Classification of polymers (Source, Structure, Synthesis and Intermolecular forces). Mechanism of free radical addition polymerization. Properties of polymers: Tg, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index (Problems). Techniques of polymerization: Bulk, emulsion, solution and suspension. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring. Polyamides, Polycarbonates and Polyurethanes – structure and applications. Recycling of polymers.

PRACTICAL:

- Determination of molecular weight of a polymer using Ostwald viscometer.
- Preparation of a polymer.
- Determination of molecular weight by Gel Permeation Chromatography.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

CO1: To demonstrate knowledge of water quality in various industries and develop skills in analyzing water quality parameters for both domestic and industrial purposes.

CO2: To identify and apply fundamental concepts of nanoscience and nanotechnology for engineering and technology applications, and to develop skills in synthesizing nanomaterials and studying their morphology.

CO3: To apply fundamental knowledge of corrosion protection techniques and develop skills to conduct experiments for measuring and preventing corrosion.

CO4: To study the fundamentals of energy storage devices and develop skills in constructing and experimenting with batteries.

CO5: To recognize and apply basic knowledge of different types of polymeric materials and develop skills in preparing and determining their applications for futuristic material fabrication needs.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., “Engineering Chemistry”, 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. Dara S.S., “A Textbook of Engineering Chemistry”, Chand Publications, 2004.
4. Laboratory Manual - Department of Chemistry, CEGC, Anna University (2023).

REFERENCES:

1. Schdeva M.V., “Basics of Nano Chemistry”, Anmol Publications Pvt Ltd, 2011.
2. Friedrich Emich, “Engineering Chemistry”, Medtech, 2014.
3. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, “Polymer Science” New AGE International Publishers, 2009.
4. Vogel’s Textbook of Quantitative Chemical Analysis (8th edition, 2014).

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	3	-	-	-	-	-
CO2	3	-	2	-	2	-	3	-	-	-	-	-
CO3	3	3	2	-	2	-	3	-	-	-	-	-
CO4	3	3	-	-	-	-	3	-	-	-	-	-
CO5	3	-	-	-	-	-	3	-	-	-	-	-
Avg	3	3	-	-	-	-	3	-	-	-	-	-

1’ = Low; ‘2’ = Medium; ‘3’ = High

EE23C03	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		2	0	2	3

UNIT-I BASIC ELECTRICAL CIRCUITS **6**

Basic Elements: R,L,C- DC Circuits: Ohm's Law - Kirchhoff's Laws –Mesh and Nodal Analysis(Only Independent Sources). AC Circuits: Average Value, RMS Value, Impedance Instantaneous Power, Real Power, Reactive Power and Apparent Power, Power Factor-Steady state Analysis of RL,RC and RLC circuits.

UNIT II AC AND DC MACHINES **6**

Magnetic Circuit Fundamentals -DC Machines - Construction and Working Principle, Types and Application of DC generator and Motor, EMF and Torque Equation.
AC Machines: Principle, Construction, Working and Applications of Transformer -Three phase Alternator - Three Phase Induction Motor.

UNIT III ANALOG AND DIGITAL ELECTRONICS **6**

Operation and Characteristics of electronic devices: PN Junction Diodes, Zener Diode and BJT
Applications: Diode Bridge Rectifier and Shunt Regulator.
Introduction to Digital Electronics: Basics Logic Gates-Flip Flops.

UNIT IV SENSORS AND TRANSDUCERS **6**

Solenoids, electro-pneumatic systems, proximity sensors, limit switches, Strain gauge, LVDT, Piezo electric transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

UNIT V MEASUREMENTS AND INSTRUMENTATION **6**

Functional Elements of an Instrument, Operating Principle of Moving Coil and Moving Iron Instruments,Power Measurement, Energy Meter, Instrument Transformers - CT and PT, Multimeter-DSO - Block Diagram Approach.

TOTAL: 30 PERIODS

LAB COMPONENET:

1. Verification of ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Load test on Single Phase Transformer.
4. Load test on 3 Phase Induction Motor.
5. Uncontrolled diode bridge Rectifiers.
6. Application of Zener diode as shunt regulator.
7. Verification of truth table of logic gates and flip flops.
8. Characteristics of LVDT.
9. Three phase power measurement using two wattmeter method.
10. Study of DSO.

COURSE OUTCOMES:

Students will be able to

- **CO1** Compute the electric circuit parameters for simple circuits.
- **CO2** Understand the working principles and characteristics of electrical machines.
- **CO3** Understand the basic electronic devices.
- **CO4** Understand the basic operating principles of sensors and transducer.
- **CO5** Understand the operating principles measuring devices

TEXT BOOKS:

1. Kotharai DP and Nagarath IJ, “Basic Electrical and Electronics Enigneering”, McGraw Hill Education, Second Edition, 2020.
2. Bhattacharya SK, “Basic Electrical and Electronics Engineering”, Pearson Education, Second Edition, 2017.

REFERENCES:

1. Mehta V.K. & Mehta Rohit, “Principles of Electrical Engineering and Electronics”, McGraw Hill Education, Second Edition, 2020.
2. Mehta V.K. & Mehta Rohit, “Principles of Electrical Machines”, S. Chand Publishing, second edition 2006.
3. Albert Malvino & David Bates, “Electronic principles”, McGraw Hill Education, Seventh Edition, 2017.

Mapping COs and POs:																
COs	**POS**												**PSOs**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	1														
CO2	2	1														
CO3	2	1														
CO4	2	1														
CO5	2	1														
Avg	2	1														

IB23201	INTRODUCTION TO HUMAN PHYSIOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Enable the students to acquire the basic knowledge of structure and function of eukaryotic cells and human tissue
- To develop an understanding about various organ systems of human and its coordinated working patterns.

UNIT – I: FOUNDATIONS OF PHYSIOLOGY, HOMEOSTASIS 9

Organization of the Human Body, Chemical composition of the body - Atoms, Ions, Molecules, Bonds, Solutions, Classes of organic molecules; Homeostasis - feedback mechanism, composition of blood, morphology of nucleus, plasma membrane, structure and function of cell organelles – mitochondria, endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes, cytoskeleton, Elementary tissues of the human body: epithelial, connective, Muscular and nervous tissues-their sub-types and characteristics. Microscopy and staining of tissues.

UNIT – II: CELLULAR TRANSPORT AND CELLULAR COMMUNICATION 9

Protein channels, ion channels, receptors, Transport protein- uniport, symport, antiport, Intracellular movement, Intercellular movement, Movement of molecules across the plasma membrane- active, passive, vesicular transport mechanism, protein sorting, protein isolation, purification and separation methods. Intercellular communication – signal molecules, chemical messengers, role of signal sequence.

UNIT – III: NERVOUS AND MUSCULO-SKELETON SYSTEM 9

Anatomy and physiology of brain, blood-brain barrier, spinal cord, structure and types of the neuron, synapses neurotransmitters, organization of spinal and cranial nerves, central and peripheral nervous system, autonomic nervous system, receptors membrane potentials – graded potentials and action potentials, physiology of vision, physiology of muscle tissue – skeletal, smooth, cardiac, contraction, Osseous system - structure, composition and functions of the Skeleton, classification of joints, types of movements of jointsand their disorders

UNIT – IV: GASTROINTESTINAL AND RENAL SYSTEM 9

Anatomy and physiology of the gastrointestinal tract (secretion, motility, digestion and absorption), structure and function of the liver, spleen, gallbladder, pancreas; the renal system structure – Anatomy and physiology kidney; structure of the nephron, formation of urine, concentration of urine regulation of acid base balance; the chemical acid-base buffer systems of body fluids and disease conditions.

UNIT –V: CARDIOVASCULAR RESPIRATORY AND ENDOCRINE SYSTEM 9

Anatomy and physiology of the heart, lungs, cardiac cycle; circulation of blood, heart rate, blood pressure, ECG and heart sounds, systemic and portal circulation; vascular system – arteries, arterioles, capillaries, venules. Anatomy of the respiratory tract, mechanism and

dynamics of respiration, lung volumes, cyanosis. Endocrine hormones- functions of pituitary, thyroid, parathyroid, adrenal and pancreatic hormones. Pineal and thymus gland

TOTAL: 45 PERIODS

OUTCOMES:

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

- CO1 understand the fundamentals of physiology and morphology of cells and tissues of human body
- CO2 understand the physiology of communication of cells and transport mechanism of molecules in cells.
- CO3 explain the physiological process of nervous and musculo-skeleton system
- CO4 explain the physiological process of gastrointestinal and renal system
- CO5 describe the coordinated functioning patterns of cardiovascular, respiratory and endocrine system.

TEXT BOOKS:

1. Waugh, Anne and Allison Grant, "Ross and Wilson Anatomy and Physiology in Health and Illness", Xth Edition, Churchill – Livingstone / Elsevier), 2006.
2. Ganong, W.F., "Review of Medical Physiology", XXIVth Edition (A Lange Medical book series) McGraw – Hill (International Ed.) 2014.
3. Khurana, Indu, "A Textbook of Medical Physiology" Elsevier, 2006. 4. Johnson, L.R., "Essential Medical Physiology", IIIrd Edition, Academic Press / Elsevier), 2003.

REFERENCES:

1. Guyton, A.C. and Hall, J.E., "Textbook of Medical Physiology", XIth Edition, Saunders,2006.
2. Carola, R., Harley J.P. and Noback C.R., "Human Anatomy & Physiology", II Edition, McGraw– Hill, 1992.
3. Vander, A.J., Sherman J.H. and Luciano D.S., "Human Physiology: The Mechanisms of Body Function", V Edition, McGraw – Hill, 1990.
4. Dr.Frank Netter., "Atlas of Human Anatomy, Professional Edition", 7th Edition – 2018.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	-	2	3	-	-	-	-	-	-	3	-	1	1	3
2	-	-	3	1	-	-	-	-	-	-	3	-	-	-	-
3	-	-		1	-	-	-	-	-	-	3	-	-	-	-
4	3	-			-	-	-	-	-	-	-	-	-	2	-
5	3	-	1		-	-	-	1	-	-	-	-	1	-	-
Overall CO	**3**	**-**	**2**	**1.3**	**-**	**-**	**-**	**1**	**-**	**-**	**3**	**-**	**0.6**	**1.5**	**1**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

CS23C02 COMPUTER PROGRAMMING IN PYTHON

L	T	P	C
3	0	2	4

COURSE OBJECTIVES:

- To understand fundamental structural programming concepts and problem-solving process.
- To solve problems using modular programming and decomposition techniques.
- To solve problems using data structures and abstraction techniques.
- To create programming solutions using libraries and packages.
- To design solutions to domain problems using programming problem-solving techniques.

UNIT I – STRUCTURED PROGRAMMING **9+6**

Problem-Solving Strategies. Basic Problem-Solving Tools: Flowcharts, Pseudocode. Introduction to Programming Languages and Development Environments. Programming. Basic Concepts and Syntax: Variables, Identifiers, Data Types: Primitive Types and Strings, Statements, Operators, Expressions and its evaluation, Operator Precedence, Basic Arithmetic Operations. Principles of Structured Programming – Control Structures: Sequence, Selection, Iteration and Branching.

PRACTICALS:

- Design algorithms for simple computational problems
- Create Pseudo-code and Flow charts for simple computational problems
- Create Python programs using simple and nested selective control statements
- Create Python programs using simple and nested sequence & iterative control statements
- Create Python programs to generate series/patterns using control statements

UNIT II – MODULARITY AND DECOMPOSITION **9+6**

Principles of Modular and Decomposition. Functions: Defining functions –Argument types – Function Name-spaces – Scoping: Global and Non-local. Principles of Recursion: Base case and Recursive cases – Develop and Analyze Recursive functions: Factorial, Fibonacci. Principles of First-Class and Higher-Order functions: Lambda functions – Functions as arguments.

PRACTICALS:

- Create Python programs using functions
- Create python program using recursion
- Create Python programs using lambda functions
- Create Python programs using first-class functions
- Create Python programs using higher-order functions

UNIT III – DATA STRUCTURES AND ABSTRACTIONS **9+6**

Principles of Data Structures and Abstractions. String Methods and Manipulations,.Lists: List Operations and Methods, List comprehensions, Nested List comprehensions, Matrix operations using Lists. Tuples and sequences. Sets and Operations. Dictionaries:

Dictionary operations, Dictionary comprehensions, Nested Dictionary comprehensions. Comparing Data Structures. Search and Sort Data Structures. Principle of Functional Programming and Tools : map, filter, and reduce.

PRACTICALS:

- Create Python programs for strings manipulations.
- Design Python programs using Lists, Nested Lists and Lists comprehensions
- Create Python programs using Tuples, Nested Tuples, and Tuple comprehensions
- Create Python programs creating Sets and performing set operations
- Create Python programs using Dictionary, Nested Dictionary and comprehensions
- Create Python programs by applying functional programming concepts

UNIT IV – LIBRARIES AND MODULES 9+6

Exceptions: Syntax errors, Exceptions, Exception types, Handling exceptions, Raising exceptions. Files: File Path, Type of files, opening modes, Reading and Writing text files, Handling other format Data files. Modules: Creating Modules, import and from statements, Executing modules as scripts, Standard modules. Packages and Importing from packages

PRACTICALS:

- Design Python programs to handle errors and exceptions
- Create, import, and use pre-defined modules and packages
- Create, import, and use user-defined modules and packages
- Create Python programs to perform various operations on text files
- Create Python programs to perform various operations on other data file formats.

UNIT V – SIMPLE PROBLEM SOLVING TECHNIQUES IN PROGRAMMING 9+6

Data Structures for Problem Solving: Stack, Queue. Principles of Divide and Conquer: Binary Search. Principles of Greedy Algorithms: Minimum Coin Change Problem. Case studies on programming application of problem-solving techniques in different fields of engineering.

PRACTICALS:

- Create python programs to implement stack and queue.
- Create python programs to implement binary search.
- Create python programs to solve minimum coin change problem.
- Case study on developing python solution to a domain specific problems.

TOTAL = 45 + 30 = 75 PERIODS

Course Outcomes

1. Understand fundamental structural programming concepts and problem-solving process.
2. Solve problems using modular programming and decomposition techniques.
3. Solve problems using data structures and abstraction techniques.
4. Create programming solutions using libraries and packages.
5. Design solutions to domain problems using programming problem-solving techniques.

TEXT BOOKS

1. Reema Thareja, Python Programming using Problem Solving Approach, Oxford University
Press, First Edition, 2017.
2. S. Sridhar, J. Indumathi, V. M. Hariharan, Python Programming, Pearson Education, First
Edition, 2023

REFERENCE BOOKS

1. Paul Deitel, Harvey Deitel, Python for Programmers, Pearson Education, 2020.
2. John V Guttag. Introduction to Computation and Programming Using Python, With Application to Computational Modeling and Understanding Data. Third Edition, The MIT
Press, 2021
3. Mark Lutz, Learning Python, 5th Edition, O'Reilly Media, Inc.
4. Python official documentation and tutorial, https://docs.python.org/3/
5. Numerical Python official documentation and tutorial, https://numpy.org/

CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2		2		1								1	1	
2	2		2		1								1	1	
3	2	1	2		1								1	1	
4	2	1	2	1	1								1	1	
5	2	1	2	1	1								1	1	
Avg	2	1	2	1	1								1	1	

1 - low, 2 - medium, 3 - high, '-' - no correlation

UC23H02 **தமிழரும் தொழில்நுட்பமும்** **L T P C**
1 0 0 1

அலகு I **நெசவு மற்றும் பானைத் தொழில்நுட்பம்**: **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II **வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்**: **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III **உற்பத்தித் தொழில் நுட்பம்**: **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV **வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்**: **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V **அறிவியல் தமிழ் மற்றும் கணித்தமிழ்**: **3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்
கல்வியியல் பணிகள் கழகம்).

2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H02 TAMILS AND TECHNOLOGY L T P C
1 0 0 1

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age -Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period -Type study (Madurai Meenakshi Temple)- Thirumalai NayakarMahal -ChettiNadu Houses, Indo-Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies -Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stonebeads - Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE ANDIRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of KumizhiThoompuof Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - KnowledgeofSea -Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - KnowledgeSpecificSociety.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்
   கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi – 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

MA23C06	PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX FUNCTIONS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To familiarize the students to solve of partial differential equations.
- To familiarize the students in solving boundary value problems.
- To understand the concepts of Complex functions.
- To familiarize complex mappings and its property.
- To familiarize the students with integration of complex functions.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9+3

Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Lagrange's Linear equation – Solution of linear equations of higher order with constant coefficients – Linear non-homogeneous partial differential equations.

UNIT II APPLICATIONS OF FOURIER SERIES TO PARTIAL DIFFERENTIAL EQUATION 9+3

Classification of partial differential equations- Method of separation of variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two dimensional heat equation – Fourier series solutions in Cartesian coordinates.

UNIT III ANALYTIC FUNCTIONS 9+3

Limit, Continuity and Differentiation of Complex functions - Analytic functions – Necessary and sufficient conditions for analyticity - Properties of analytic functions – Harmonic conjugates – Construction of analytic function – elementary analytic functions (exponential, trigonometric, logarithm) and their properties.

UNIT IV CONFORMAL MAPPING 9+3

Introduction to complex mapping - Conformal mapping – Condition for conformality – Standard mappings: a+z, az, az+b, $\frac{1}{z}, z^2, e^z$ - Bilinear transformations – Physical applications: Fluid flow and heat flow problems.

UNIT V INTEGRATION OF COMPLEX FUNCTIONS 9+3

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

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

1. Symbolic computation of solution to PDE using PDE Solver
2. Conformal mapping can be done by plotting the curves and surfaces

OUTCOMES:

CO1 :Understand the concepts of partial differential equations in practical situations.
CO2 :Obtain the solutions of the partial differential equations using Fourier series.
CO3 :Understand the Concepts of complex functions in practical situations.
CO4 :Understand the conformal mapping and its applications.
CO5 :Apply the complex integrations in engineering problems.

TEXT BOOKS:

1. Erwin Kreyszig "Advanced Engineering Mathematics", John Wiley & Sons., New Delhi, 2015.
2. Wylie C. R. and Barrett L. C "Advanced Engineering Mathematics", Tata McGraw-Hill., New Delhi, 2019.
3. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 44th Edition, New Delhi, 2017.

REFERENCES:

1. Mathews J. H. and Howell R. W "Complex Analysis for Mathematics and Engineering", Narosa Publishing House. New Delhi, 2012.
2. Peter V.O Neil "Advanced Engineering Mathematics", Cengage., New Delhi, 2016.
3. Dennis G Zill "Advanced Engineering Mathematics", Jones & Bartlett India P Ltd., New Delhi, 2017.
4. Dean G Duffy "Advanced Engineering Mathematics with MATLAB", CRC., USA, 2010.
5. Spiegel, M.R., Theory and Problems of Complex Variables and its Application (Schaum’s Outline Series), McGraw Hill Book Co., Singapore (1981).

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

IB23301	CHEMICAL ENGINEERING PRINCIPLES	L	T	P	C
		3	0	4	5

OBJECTIVES:

The course aims to,

- learn about various units and dimensions of different physical quantities and to learn about material balance with and without chemical reactions.
- impart knowledge on the fluid statics and dynamics, to incorporate different expressions involved in fluid flow and fluid flowing over immersed solids and to learn the concepts involved in heat transfer by conduction, convection and radiation.
- enhance the understanding of measurement techniques of fluid flows and to impart practical knowledge on various unit operations.

UNIT – I: STOICHIOMETRY **9**

Basic chemical calculations – Dimensions – Conversion from one system to the other – composition of mixtures and solutions – mass fraction, mass %, mole fraction, mole %, mass ratios, molarity, molality, and normality; Ideal and actual gas equations, Application to pure gas & gas mixtures – partial pressure. Humidity, Molar Humidity, Relative Humidity, % Saturation, humid Volume – Humidity chart – wet, Dry bulb, Dew point temperatures, Chemical Reaction-Limiting and excess reactant, Fractional conversion, Percent conversion, Fractional yield in multiple reactions. Simple problems, Combustion Reactions.

UNIT – II: MATERIAL BALANCE AND FLUID PROPERTIES **9+24**

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

Fluid properties, Barometric equations - application for incompressible and compressible fluids; Gauge and absolute pressure – pressure measurement with Bourdon gauge & manometers. Newtonian and non-Newtonian fluids.

PRACTICALS:

- Calibration of Orifice meter
- Calibration of Venturimeter
- Separation of binary mixture using simple and steam distillation
- Batch drying kinetics using Tray Dryer

UNIT – III: FLUID DYNAMICS AND METERING OF FLUIDS **9+24**

Fluid Dynamics – equation of continuity – Bernoulli's equation. Fluid transport -Industrial applications **-** fluid flow through packing- characteristics of packed bed -Laminar flow through the packed bed and turbulent flow-pressure drop experienced by the fluid-equations and applications - problems. Fluidization phenomena-Industrial application and minimum fluidization velocity. Flow measurement - Constant and variable head meters; Velocity measurement techniques; Types and characteristics of valves; Classification and performance characteristics of pumps.

PRACTICALS:

- Pressure drop studies in packed column
- Batch filtration studies using a Leaf filter
- Hydrodynamics of fluidized bed
- Characteristic curves of centrifugal pump

UNIT – IV: CONDUCTION AND CONVECTION HEAT TRANSFER 9

Heat transfer phenomena - Heat conduction – Fourier's equation –steady state conduction in radial systems – Resistance concept – series and resistance in conduction – parallel resistance in conduction; Forced and natural convection – Dimensional analysis, Dimensionless numbers, Convection heat transfer coefficient, condensation phenomena, Film and dropwise condensation over tubes. Boiling of solutions – individual, overall heat transfer coefficients and solving related problems**.**

UNIT – V: RADIATION HEAT TRANSFER AND HEAT TRANSFER EQUIPMENTS 9+12

Electromagnetic waves, energy of radiation, Plank's equation-Blackbody Radiation. Kirchhoff's law, Stefan Boltzmann equation of radiant energy – Wien's law, Radiation exchange between surfaces – black and grey bodies - view factors - sample problems. Heat exchangers - types, boilers, Kettles. Heat exchanger Design concept. Correction Factor Charts and Plate Heat Exchangers. NTU concept- Industrial evaporators, Evaporator components. Elevation in boiling point - Duhring's rule- Factors affecting performance of evaporators, Material and energy balance in single effect evaporator – multiple effect evaporators, types of operation, simple application problems.

PRACTICALS:

- Flow through annular pipe
- Determination of heat transfer coefficient in a heat exchanger

TOTAL: 105 (45+60) HOURS

OUTCOMES:

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

CO1: understand the fundamentals of engineering units, dimensions, unit conversions and stoichiometry

CO2: perform engineering calculations based on material balances and have comprehensive understanding of fluid properties

CO3: learn the rheological behaviour of fluids and metering of fluids

CO4: understand the basic concepts of heat transfer by conduction and convection.

CO5: understand the basic concepts of heat transfer by radiation and basic concepts involved in heat exchangers and evaporators.

TEXT BOOKS:

1. Bhatt B.I & SB Thakore, Stoichiometry - V edition Tata McGraw Hill 2017
2. Richard M. Felder, Ronald W. Rousseau "Elementary Principles of Chemical Process" III Ed. John Wiley & Sons Publisher 2008.

3. David M. Himmelblau and James B. Riggs “Basic Principles and Calculations in Chemical Engineering”, VIII Edition PHI 2015.
4. Mc Cabe, W.L., Smith, J.C. and Harriot, P., ‘Unit Operations in Chemical Engineering’, VII edition., McGraw-Hill, 2017.
5. Noel de Nevers, “Fluid Mechanics for Chemical Engineers “, Second Edition, McGraw-Hill, (1991).
6. White, F.M., “Fluid Mechanics “, IV Edition, McGraw-Hill Inc., 1999.
7. Kern, D.Q., ‘Process Heat Transfer’, McGraw-Hill, 1999.
8. Geankoplis. C.J” Transport Process & separation Process Principles” IV edition Prentice Hall of India 2015.

REFERENCES:

1. Robert W.Fox, Alan T. McDonald & Philip J.Pritchard “Introduction to Fluid Mechanics” VII Ed. John Wiley & Sons 2015.
2. Munson, B. R., Young, D.F., Okiishi, T.H. “Fundamentals of Fluid Mechanics”, 5 thEdition“, John Wiley, 2006
3. Frank Kreith, Raj M. Manglik and Mark S. Bohn “Principles of Heat Transfer” VII edition Cenage Learning Inc 2018.
4. P. K. Nag “Heat & Mass Transfer”, Tata McGraw Hill III Edition 2011

IB23302 THERMODYNAMICS FOR BIOTECHNOLOGISTS

L	T	P	C
3	0	0	3

OBJECTIVES

The course aims to,

- Learn the laws of thermodynamics and to apply them to understand the PVT behaviour of fluids and chemical reaction equilibria

UNIT – 1: FIRST LAW OF THERMODYNAMICS **9**

Concept of heat work and energy-forms of energy- forms of work- first law of thermodynamics-energy balance equation- batch system energy balance – internal energy and enthalpy changes-application problems – enthalpy changes in chemical and biochemical reactions -application problems- effect of temperature on chemical reactions (Kirchoffs law) Open systems-Simple applied problems

UNIT – II: THERMODYNAMIC PROPERTIES OF FLUIDS **9**

PVT behaviour of pure fluids, Equation of state of ideal gases, Equation of state for Real gases, Second law of thermodynamics, Entropy and entropy changes – Applied problems-Concept of Heat Engine – refrigeration- heat pump -fundamental equations relating first law and second law.

UNIT – III: FREE ENERGY **9**

Helmholtz free energy, Gibbs free energy, Reversible process, Maxwell Relations for fundamental properties, Eqns for ΔG, ΔS, ΔH and Cp-Cv relationship for actual gases. Phase equillibria for single component, VLE and clausius clay petroneqn, Latent heat of phase transformation.

UNIT – IV: MOLAR PROPERTY OF SOLUTIONS **9**

Molar property of ideal solutions & actual solutions, concepts of chemical potential and fugacity, concepts and applications of excess properties of mixtures; activity coefficient; Gibbs Duhem equation, Colligative properties, relationship between equilibrium constant and Gibbs free energy change. Applications of Gibbs free energy on biochemical reactions, Thermodynamic properties of ions in solution, Electrochemical cells, measurement of pH and pKa.

UNIT – V: 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. Thermodynamics of microbial growth stoichiometry thermodynamics of maintenance, thermodynamics and stoichiometry of Product Formation.

TOTAL: 45 PERIODS

OUTCOMES:

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

- CO1 have a comprehensive understanding of the principles of work and energy
- CO2 understand principles of entropy and entropy driven processes in biochemical systems
- CO3 have comprehensive understanding of the concept of free energy and phase equilibria
- CO4 have a thorough understanding of concepts and applications of chemical potential, Fugacity and colligative properties
- CO5 have complete knowledge of principles of chemical reaction equilibria as applied to biological systems

TEXT BOOKS:

1. Smith J.M., Van Ness H.C., And Abbot M.M. "Introduction To Chemical Engineering Thermodynamics", VII Edition, Tata McGraw-Hill, 2009.
2. Narayanan K.V. "A Text Book of Chemical Engineering Thermodynamics", II edition, PHI, 2013.
3. Christina Smolke, "The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2009.
4. Urs Von Stockar. "Biothermodynamics: The Role of thermodynamics In Biochemical Engineering " EPFL Press, distributed by CRC Press Taylor & Francis Group, 2013.

REFERENCES:

1. Sandler S.I. "Chemical and Biochemical Thermodynamics", John Wiley,1989.
2. Peter Atkins, Julio de Paula "Physical Chemistry" VII Edition, oxford university press 2002.
3. Donald T.Haynie, "Biological Thermodynamics" II Edition. Cambridge University Press 2013.
4. Sandler S.I. "Chemical, Biochemical, and Engineering Thermodynamics", V Edition, Wiley, 2017
5. Peter Atkins, Julio de Paula and James Keeler "Atkins' Physical Chemistry: Thermodynamics and kinetics" XI Edition Oxford University Press 2018.

PROGRAMME OUTCOMES

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	1	2	1	-	-	-	-	-	-	1	3	3	1
2	3	3	1	3	2	-	-	-	-	-	-	2	3	3	1
3	3	3	1	3	3	-	-	-	-	-	-	3	3	3	1
4	3	3	1	2	2	-	-	1	-	-	-	1	3	3	-
5	3	2	1	3	2	-	-	1	-	-	-	1	3	3	-
Overall CO	**3**	**2.8**	**1**	**2.6**	**2**	**-**	**-**	**1**		**-**	**-**	**1.6**	**3**	**3**	**1**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23C03	BIOCHEMISTRY	L	T	P	C
		3	0	4	5

OBJECTIVES

The course aims to,

- understand the chemistry of biomolecules and their metabolism with reference to cellular physiology and clinical relevance.
- understand and perform numerous methods to detect and quantify the levels of biomolecules

UNIT – I: BIOMOLECULES – I **9+12**

Carbohydrates: Classification. Structure and properties of simple sugars. Reactions of sugar in biological systems – Redox reactions, Acetal formation and its hydrolysis, Enzymatic (*O*- and *N*-linked glycosylation) and non-enzymatic glycosylation (HbA1c). Modified monosaccharides in biological systems. Carbohydrate derivatives and their significance – Proteoglycans, Glycosaminoglycans and glycoproteins. Glycan binding proteins and their significance. **Lipids:**Classification.Structure and properties of Triglycerides, Fatty acids, Sterols, Phospholipids, Sphingolipids and Glycolipids. Role of lipids in biology – Energy production, membrane biogenesis and cell signalling. Alcohol and ester groups in lipids. Reactions of lipids – Hydrolysis, Saponification, Halogenation, Hydrogenation, and Rancidity.

PRACTICAL:

1. Qualitative tests for carbohydrates: (i) Aldose Vs. Ketose, (ii) Reducing Vs. Non-reducing and (iii) Hexose Vs. Pentose
2. Extraction of lipids and its analysis using Thin Layer Chromatography (TLC).

UNIT – II: BIOMOLECULES – II **11+24**

Nucleic acids: Composition, structure and properties of nucleic acids. Significance of differences between DNA and RNA. Structure of DNA – Phosphodiester bond, Chargaff's rule, X–ray diffraction analysis and Watson & Crick model of double helix, Forces stabilizing the DNA structure. Conformational variants of double helical DNA (*A-, B*- and *Z*- DNA). Hoogsteen base pairing – Triple and Quadruple helix. DNA supercoiling and its significance. Reversible denaturation and hyperchromic effect. Different types of RNA and their biological functions. **Amino acids and protein:** Single and three letter amino acid codes, Classification of amino acids, Optical and Stereochemical properties of amino acids, pI and Zwitterionic characteristics of amino acids and their physiological relevance. Hierarchical structure of protein and stabilizing forces, Ramachandran Plot and its significance. Protein denaturation and renaturation. Protein solubility – Salting in and salting out.

PRACTICAL:

3. Determination of DNA quality and quantity using UV-spectroscopy and assessment of its denaturation.
4. Titration curve for an amino acid.
5. Quantification of amino acids and differentiation of amino acids from imino acids using ninhydrin.
6. Estimation of protein levels using Bradford's, Lowry's and Bicinchoninic acid assay methods.

UNIT – III: INTERMEDIARY METABOLISM 11

Basic concepts of intermediary metabolism and its design: Exergonic Vs. Endergonic reactions, Favourable Vs. Unfavourable reactions, Overview of Enzymes and their Coenzymes/Cofactors, Rate-limiting enzymes, General regulation of metabolism – Enzyme/Co-enzyme concentrations, Allosteric regulations, Enzyme modifications, Substrate concentrations, Compartmentalization, etc. *Metabolism and its regulation:* Glycolysis and gluconeogenesis, HMP pathway, Glycogenesis, β-oxidation of fatty acids and the role of carnitine, Biosynthesis of fatty acids and cholesterol. Pharmacological regulation of carbohydrate and lipid metabolism.

UNIT – IV: BIOENERGETICS 9+6

Overview of mitochondria. High energy compounds, Substrate level phosphorylation, TCA cycle and its amphibolic nature, Shuttle systems (Malate-Aspartate and Glycerol phosphate shuttle), Mitochondrial Electron transport chain (ETC) and redox potential, Chemiosmotic theory and Oxidative phosphorylation (OXPHOS), Adenine nucleotide translocase, Coupled Vs. Uncoupled respiration (Thermogenesis), Inhibitors of respiratory chain, Bioenergetics of glucose and fatty acid oxidation.

PRACTICAL:

7. Determination of glycolytic and OXPHOS capacity of a cell – Study design and data analysis.

UNIT – V: CLINICAL BIOCHEMISTRY 5+18

Organ function tests – Marker enzymes and Metabolites (Creatinine, Bilirubin, etc.). **Disorders of carbohydrate metabolism:** Diabetes mellitus, Glycosylated haemoglobin, Keto-acidosis, Glycogen storage disorder. **Disorders of lipid metabolism:** Niemaan Pick disease, Gaucher disease and Tay-Sachs disease, Lipoproteins (HDL, LDL, IDL, VLDL and Chylomicrons) in health and disease – Dyslipidemia and atherosclerosis.

PRACTICAL:

8. Determination of blood glucose levels using GOD-POD assay.
9. Determination of triglycerides levels in blood using coupled enzymatic assay.
10. Determination of plasma cholesterol levels.

TOTAL: 105 PERIODS

OUTCOMES:

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

- CO1 Gain knowledge about the chemistry of carbohydrates and lipids
- CO2 Gain knowledge about the chemistry of nucleic acids and proteins
- CO3 Understand and analyse the relationship between various metabolic pathways
- CO4 Understand the molecular mechanism of cellular energy production
- CO5 Understand and anlysethe basis of major diseases/disorders associated metabolic dysfunction

TEXT BOOKS:

1. Lehninger Principles of Biochemistry 7th Edition by David L. Nelson, Michael M. Cox W.H. Freeman and Company 2017.

2. Schaum's Outline of Biochemistry, 3rd Edition (Schaum's Outline Series) Philip Kuchel,3rd Edition 2009
3. Lippincott Illustrated Reviews: Biochemistry 7th edition Denise R. Ferrier 2017
4. Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.
5. Outlines of biochemistry, 5th Edition: By E E Cohn, P K Stumpf, G Bruening and R Y Doi. pp 693. John Wiley and Sons, New York. 1987.
6. Biochemistry 9th edition by LubertStryer. Jeremy Berg, John Tymoczko, Gregory Gatto,2015. WH Freeman Publisher 2019
7. Zubay's Principles of Biochemistry Rastogi, Aneja. Meditech publisher, 5th edition 1995
8. Practical Biochemistry by R.C. Gupta and S. Bhargavan. 5th edition, 2013.
9. Introduction of Practical Biochemistry by David T. Phummer. (2nd Edition), 1978.

REFERENCES:

1. Berg, Jeremy M. et al. "Biochemistry", 6th Edition, W.H. Freeman & Co., 2006.
2. Voet, D. and Voet, J.G., "Biochemistry", 3rd Edition, John Wiley & Sons Inc.,2004.
3. Murray, R.K., et al., "Harper's Illustrated Biochemistry", 27th Edition, McGraw-Hill, 2006.
4. Harpers Biochemistry Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell, Appleton and Lange, Stanford, Connecticut, 24th edition,1996.
5. Textbook of Biochemistry with clinical correlations. Ed. Thomas M. Devlin. Wiley Liss Publishers, 6th edition, 2006.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	1	-	-	-	-	-	-	-	2	2	2	1
2	3	2	2	2	2	-	-	-	-	-	-	2	2	3	1
3	2	2	2	2	2	-	-	-	-	-	-	2	2	3	2
4	3	2	2	1	2	1	-	-	-	-	-	2	2	2	1
5	3	2	2	2	-	1	-	-	-	-	-	2	3	3	1
Overall CO	2.6	2	1.8	1.6	2	1	-	-		-	-	2	2.2	2.6	1.2

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23303	INDUSTRIAL MICROBIOLOGY	L	T	P	C
		3	0	2	4

OBJECTIVES

The course aims to,

- provide the students the knowledge of how to identify different microbes
- impart knowledge on how to culture organisms and how to control their growth
- enable the students to apply the basic knowledge to design industrial processes for applications
- make the student aware of the various lab protocols, the safety measures involved while doing experiments
- make the students learn about the principles of microscopy and sterilization techniques
- equip them in handling microbes confidently
- train the students about different staining methods

UNIT – I: INTRODUCTION TO MICROBIOLOGY 9+6

History (scientists and discoveries), classification and nomenclature of microorganisms, basics of microscopy: light, phase contrast, and electron microscopy. Stains and staining techniques – Definition of auxochrome, chromophores, dyes, Classification of stains, Theories of staining, Mechanism of gram staining, acid fast staining, negative staining, capsule staining.

PRACTICAL:

(i) To perform Staining methods – (a) Simple and (b) Gram's staining

UNIT – II: MICROBIAL NUTRITION, GROWTH AND METABOLISM 9+6

Nutritional classification of microorganisms based on carbon, energy and electron sources Definition of growth, balanced and unbalanced growth, growth curve and different methods to quantify bacterial growth:(counting chamber, viable count method), different media used for bacterial culture (defined, complex, selective, differential, enriched), Biochemical test for identification (catalase, coagulase, IMViC), Mathematics of growth-generation time, specific growth rate.

PRACTICAL:

(i) To prepare nutrient agar for microbial culture: Pour plates, streak plates, slants, stabs.

UNIT – III: CONTROL OF MICROORGANISM 9+6

Sterilization, Physical control of micro-organisms dry and moist heat, pasteurization, tyndalization, radiation and chemical control of microorganisms (phenolics, alcohols, halogens, heavy metals, quaternary ammonium compounds) Disinfection, antiseptics and fumigation. Determination of phenol coefficient of disinfectant. Host- microbe interactions (types of interaction, host defense and pathogen defense); anti- bacterial (class I, II, III), anti-fungal and anti-viral agents; mode of action and resistance to antibiotics.

PRACTICAL:

(i) To assay antibiotic sensitivity

UNIT – IV: INTRODUCTION TO INDUSTRIAL BIOPROCESS 9+6

Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Types of media, Basic concepts of upstream and downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation. Bioprocess strategies in Plant Cell and Animal Cell culture, monitoring contamination.

PRACTICAL:

(i) To determine the effect UV radiation on bacterial growth

UNIT – V: PRODUCTION OF METABOLITES AND RECOMBINANT PROTEINS 9+6

Production processes of citric acid, ethanol, biosynthetic pathways and feedback inhibition, Production processes for various classes of secondary metabolites: Penicillin, β-Carotene, Single cell proteins, Economic Aspects Production of recombinant proteins having therapeutic and diagnostic applications, Monoclonal antibodies, Insulin.

PRACTICAL:

(i) To prepare nutrient broth and determine the effect of pH and temperature on bacterial growth

TOTAL: 75 PERIODS

OUTCOMES

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

- CO1 Identify different microorganisms.
- CO2 Design a medium for microbial growth
- CO3 Learn about various physical and chemical agents control microbial growth and also gain knowledge about the interaction of drugs with the microbial metabolism
- CO4 Understand the basic principles of fermentation
- CO5 Know about the applications of microbial metabolism and their primary and secondary metabolites in various fields.

TEXT BOOKS:

1. Prescott. Harley, Klein. “Microbiology “: Authored by Wiley, Sherwood, Woolverton, Prescott 10th edition (2017) McGraw-Hill Higher Education,
2. Cruger, Wulf and AnnelieseCrueger, “Biotechnology: A Textbook of Industrial Microbiology”, IInd Edition, Panima Publishing, 2000.
3. Cappuccino, J.G. and N. Sherman “Microbiology: A Laboratory Manual”, 4th Edition, Addison- Wesley, 1999.
4. Collee, J.G. et al., “Mackie & McCartney Practical Medical Microbiology” 4th Edition, Churchill Livingstone, 1996

REFERENCES:

1. Jeremy. W. Dale Understanding Microbes: An Introduction to a Small World". February 2013 Wiley-Blackwell
2. Pelczar, M.J. "Microbiology", 5th Edition, Tata McGraw-Hill, 2001.
3. Ananthanarayanan, R.andJayaramPaniker C.K., "Textbook of Microbiology",10th Edition, 2017 Orient Longman
4. Casida, L.E. "Industrial Microbiology", New Age International (P) Ltd, 1968.
5. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology", IInd Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995.
6. C.F.A Bryce and EL. Mansi, Fermentation microbiology & Biotechnology, 1999

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	-	1	-	-	-	1	-	-	1	2	2	1	1
2	2	2	1	-	-	-	-	1	2	-	-	2	2	2	2
3	3	2	3	1	1	2	1	1	2	1	1	2	2	3	3
4	1	2	1	1	1	1	2	2	1	-	-	1	2	2	1
5	2	1	2	2	1	1	1	2	-	-	-	2	2	3	3
Overall CO	**2**	**1.8**	**2**	**1.3**	**1**	**1.3**	**1.3**	**1.4**	**1.7**	**1**	**1**	**1.8**	**2**	**2.2**	**2**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

UC23U01 UNIVERSAL HUMAN VALUES L T P C
1 0 2 2

COURSE OBJECTIVE:

The objective of the course is four-fold:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Module I: Introduction (3L,6P)

Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self-Exploration– Its content and process; 'Natural acceptance' and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practical Session: *Include sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking*

Module II: Harmony in the Human Being (3L,6P)

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

Practical Session: *Include sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.*

Module III: Harmony in the Family and Society (3L,6P)

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

Practical Session*: Include sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives*

Module IV: Harmony in the Nature and Existence (3L,6P)

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

Practical Session: *Include sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.*

Module V: Implications of Harmony on Professional Ethics (3L,6P)

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations, Sum up.

Practical Session: *Include Exercises and Case Studies will be taken up in Sessions E.g. To discuss the conduct as an engineer or scientist etc.*

TOTAL: 45 (15 Lectures + 30 Practicals) PERIODS

COURSE OUTCOME:

By the end of the course, the students will be able to:

1. Become more aware of themselves, and their surroundings (family, society, nature);
2. Have more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. Have better critical ability.
4. Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

REFERENCES:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 3rd revised edition, 2023.
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews.
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj - PanditSunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

Web URLs:

1. Class preparations: https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php
2. Lecture presentations: https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php
3. Practice and Tutorial Sessions: https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						1	1	1	3			3
CO2						1	1	1	3			3
CO3						3	3	2	3		1	3
CO4						3	3	2	3		1	3
CO5						3	3	3	3		2	3

IB23401	CELL AND MOLECULAR BIOLOGY	L	T	P	C
		3	0	2	5

OBJECTIVES

The course aims to,

- Understand the basic principle and significance of Central dogma of life
- Apply the molecular biology concepts for better understanding of genetic manipulation and disease biology
- Understand the principle, steps and methods involved in DNA and protein isolation and its separation using gel electrophoresis

UNIT – 1: MEMBRANE BIOLOGY 9+12

Overview about prokaryotic and eukaryotic cells and cellular organelles. Lipid bilayer and its properties – membrane fluidity and asymmetry. Lipid rafts and its significance. Membrane proteins: Peripheral and various transmembrane proteins with examples. Hydropathy plots. Membrane solubilization and purification: micelle formation. Membrane dynamics: flip-flop, rotational and lateral diffusion. Techniques to assess membrane dynamics: Hybrid cells, FRAP and FLIP techniques. Cell-Cell junctions: Anchoring, gap- and tight-junctions.

PRACTICAL

(i) Fixation and H & E staining
(ii) Tissue homogenization and subcellular fractionation (Differential centrifugation)

UNIT – II: CELL DIVISION AND CELL DEATH 9+12

Cell division – Mitosis, Meiosis and Cytokinesis. Cell cycle: Methods in cell cycle analysis. Regulation of cell cycle – Cell cycle check points, molecules and mechanisms of cell cycle regulation. Cell cycle modulators. Cell death – Apoptosis, necrosis and autophagy. Intrinsic and extrinsic pathways of apoptosis. Techniques in cell cycle and cell death analysis – Flow cytometry, TUNEL assay, Caspase assay and Viability assays.

PRACTICAL

(i) Microscopic evaluation of the effect of Colchicine on mitotic cell division
(ii) Flow cytometry – Cell cycle study design and data analysis

UNIT – III: DNA REPLICATION 9+12

Central dogma. Prokaryotic Vs. Eukaryotic chromosomes – Organization and structure. Key characteristics of genomic DNA replication – (i) Semi conservative mechanism, (ii) Starts at origin, (iii) bi-directional and (iv) Semi-discontinuous synthesis. Proteomics of DNA replication. Fidelity and processivity of DNA replication. Inhibitors of DNA replication. Telomere synthesis and shortening and its role in aging and cancer. Mutation: Substitution (Transition and transversion), Insertion, Deletion and inversion. DNA repair – Mismatch repair, Base-excision repair, Nucleotide excision repair, Direct repair.

PRACTICAL

(i) Isolation of DNA
(ii) Agarose gel electrophoresis of DNA

UNIT – IV: TRANSCRIPTION 9+12

Coding Vs. Non-coding strand. Transcriptional elements – Promoters, Enhancers, Operators and Silencers. DNA foot printing and reporter assay. Mechanism of transcription and its fidelity. Inhibitors of transcription. Differences between prokaryotic and eukaryotic transcription. Overview about Ribozymes, RNA processing, Introduction to non-coding RNAs (lncRNA and miRNA).

PRACTICAL

(i) Isolation of total RNA
(ii) Formaldehyde gel electrophoresis of RNA

UNIT – V: TRANSLATION 9+12

Genetic code – Elucidation and characteristics (Universality and degeneracy). Wobble hypothesis and its importance. Silent, missense, nonsense and frameshift mutations. Ribosomes and their role in translation. Free (cytosolic) Vs. bound (Rough ER) ribosomes. Mechanism of protein synthesis and its fidelity. Inhibitors of protein synthesis. Regulation of *lac* and *trp*operons. Post-translational modifications and their importance – Folding (Chaperones), degradation (Proteasomes), protein sorting, Phosphorylation, Acetylation, Hydroxylation, Carboxylation, Glycosylation, Lipidation, Sumoylation, Sulfation, etc.

PRACTICAL

(i) Separation of proteins using SDS-PAGE
(ii) Detection of a post-translational modification using western blot

TOTAL: 105 (45+60) PERIODS

OUTCOMES:

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

- CO1 Understand the key characteristics of biomembranes
- CO2 Understand the basis of cell cycle and cell death and its association with disease pathology
- CO3 Understand the basic concepts and mechanism of genetic inheritance and its role in understanding proliferative and degenerative disorders
- CO4 Understand the basic principle and mechanism of gene expression and its regulation to achieve homeostasis
- CO5 Understand the basic principle and mechanism of protein synthesis and its regulation.

TEXT BOOKS:

1. Nancy Craig, Rachel Green, Carol Greider, Gisela Storz, and Cynthia Wolberger. "Molecular Biology - Principles of Genome Function" 3rd Edition, Oxford University Press, 2021
2. JordankaZlatanova, Kensal E. van Holde. "Molecular Biology – Structure and Dynamics of Genomes and Proteomes" 2nd Edition, CRC Press, 2023.
3. Bruce Alberts et al., "Molecular Biology of the Cell" 7th Edition, WW Norton & Co, 2022
4. Gerald Karp, Janet Iwasa, Wallace Marshall, "Karp's Cell and Molecular Biology", 9th Edition, Wiley, 2019

REFERENCES:

1. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, "Lewin's Essential GENES" 4th Edition, Jones &Bartlet, 2021
2. Green MR and Sambrook J. "Molecular Cloning: A Laboratory Manual". 4th Edition, CSHL press, 2012.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	2	1	2	1	-	1	-	-	-	1	2	2	2
2	1	1	3	3	1	2	-	1	-	-	-	3	2	2	3
3	1	1	3	3	2	2	-	1	-	-	-	3	3	3	3
4	1	1	3	3	2	1	-	1	-	-	-	3	3	3	3
5	1	1	3	3	2	2	-	1	-	-	-	3	3	2	2
Over all CO	**1**	**1**	**2.8**	**2.6**	**1.8**	**1.6**	**-**	**1**	**-**	**-**	**-**	**2.6**	**2.6**	**2.4**	**2.6**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23404	MASS TRANSFER OPERATIONS	L	T	P	C
		2	1	0	3

OBJECTIVES

The course aims to.

- To introduce the principles of Mass Transfer Operations in order to impart knowledge about various mass transfer operations equipment and its design concepts

UNIT – I: DIFFUSION AND MASS TRANSFER 9

Eddy Diffusion - Molecular diffusion in fluids and solids; Interphase Mass Transfer; Mass Transfer coefficients; Mass Transfer Theories & Analogies. Co current and counter current operations**.**

UNIT – II: GAS LIQUID OPERATIONS 9

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

UNIT – III: VAPOUR LIQUID OPERATIONS 9

V-L Equilibria; Simple, Steam and Flash Distillation; Continuous distillation; McCabe-Thiele &Ponchon-Savarit Principles – design of distillation columns – solving design problems ; Industrial distillation equipments, HETP, HTU and NTU concepts.

UNIT – IV: EXTRACTION OPERATIONS 9

L-L equilibria, Solvent characteristics **–** Staged and continuous extraction – Spray, packed and mechanically agitated contactors- Pulsed and centrifugal extractors – supercritical extraction – solving problems - Solid-liquid equilibria, Leaching Principles – leaching equipment

UNIT – V: SOLID FLUID OPERATIONS 9

Adsorption equilibria – Nature of adsorbents; Batch and fixed bed adsorption – Adsorbers – steady state moving bed adsorber and unsteady state moving adsorbers – break through curves. Drying- Mechanism-Drying curves- Time of Drying; Batch and continuous dryers.

TOTAL: 45 PERIODS

OUTCOMES:

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

- CO1 Demonstrate and classify the use of accurate engineering correlations of diffusion and mass transfer coefficient to model a separation process
- CO2 Perceive knowledge about gas absorption principle
- CO3 Understand the principle of vapour liquid operations
- CO4 Perceive knowledge about crystallization, adsorption and drying
- CO5 Obtain a basic knowledge to design and develop different equipment.

TEXT BOOKS:

1. Treybal R.E. “Mass Transfer Operations” III edition. Mcgraw Hill, 2017.
2. Geankoplis C.J. “Transport Processes and Unit Operations” IV edition, Prentice Hall of India, 2015.

REFERENCES:

1. J. M. Coulson and J. F. Richardson with J. R. Backhurst and J. H. Harker “Coulson and Richardson’s chemical engineering. Vol i”, vi edition butterworth-heinemann, 1999.
2. J. M. Coulson and J. F. Richardson with J. R. Backhurst and J. H. Harker “Coulson and Richardson’s Chemical Engineering. Vol II”, V edition Butterworth-Heinemann, 2013.

PROGRAMME OUTCOMES															
CO’s	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	2	2	2	-	-	-	-	-	2	3	2	1
2	2	2	2	2	2	2	-	-	-	-	-	2	3	3	2
3	3	3	3	3	3	3	-	-	-	-	-	1	3	2	3
4	1	1	1	1	1	1	-	-	-	-	-	2	3	3	2
5	2	2	2	2	2	2	-	-	-	-	-	3	3	3	1
Overall CO	**2**	**2**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2.6**	**1.8**

Course 1-low, 2-medium, 3-high, ‘-“- no correlation

Note: The average value of this course to be used for program articulation matrix

MA23C05	PROBABILITY AND STATISTICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
- To understand the basic probability concepts with respect to two dimensional random variables along with the relationship between the random variables and the significance of the Central Limit theorem.
- To understand the basic concepts of sampling distributions and statistical properties of point and interval estimators.
- To apply the small/ large sample tests through Tests of hypothesis.
- To understand the concept of analysis of variance and use it to investigate factorial dependence.

UNIT I ONE-DIMENSIONAL RANDOM VARIABLES 9+3

Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a random variable.

UNIT II TWO-DIMENSIONAL RANDOM VARIABLES 9+3

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 ESTIMATION THEORY 9+3

Sampling distributions – Characteristics of good estimators – Method of Moments – Maximum Likelihood Estimation – Interval estimates for mean, variance and proportions.

UNIT IV TESTS OF SIGNIFICANCE 9+3

Type I and Type II errors – Tests for single mean, proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances –χ^2 test for goodness of fit – Independence of attributes.

UNIT V DESIGN OF EXPERIMENTS 9+3

Completely Randomized Design – Randomized Block Design – Latin Square Design – 2^2 factorial design.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

SUGGESTED LAB EXERCISES

1. Data exploration using R
2. Visualizing Probability distributions graphically
3. Evaluation of correlation coefficient
4. Creating a Linear regression model in R
5. Maximum Likelihood Estimation in R
6. Hypothesis testing in R programming
7. Chi square goodness of fit test in R
8. Design and Analysis of experiments with R

OUTCOMES:

CO1: Can analyze the performance in terms of probabilities and distributions achieved by the determined solutions.
CO2: Will be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis.
CO3: Provides an estimate or a range of values for the population parameter from random samples of population.
CO4: Helps to evaluate the strength of the claim/assumption on a sample data using hypothesis testing.
CO5: Equips to study the influence of several input variables on the key output variable.

TEXT BOOKS:

1. Irwin Miller and Marylees Miller, "John E. Freund's Mathematical Statistics with applications", Pearson India Education, Asia, 8th Edition, 2014.
2. Walpole, R.E., Myers R.H., Myres S.L., and Ye, K. "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2024.

REFERENCES:

1. Richard A. Johnson, Irwin Miller, John Freund "Miller & Freund's Probability and Statistics for Engineers", Person Education, 8th Edition, 2015.
2. Ross, S.M. "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier,
   New Delhi, 5th Edition, 2014.
3. Spiegel, M.R., Schiller, J., Srinivasan, R.A. and Goswami, D. "Schaum's Outline of Theory and Problems for Probability and Statistics", McGraw Hill Education, 3rd Edition, Reprint, 2017.
4. Devore, J.L. "Probability and Statistics for Engineering and the Sciences", Cengage Learning, 9th Edition, 2016.

CO – PO Mapping:

COURSE OUTCOMES	PROGRAMME OUTCOMES											
	PO 1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO8	PO9	P10	P11	P12
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

IB23402	INSTRUMENTAL METHODS OF ANALYSIS	L	T	P	C
		3	0	2	4

OBJECTIVES

The course aims to.

- Enable the students understand the basics of analytical techniques and to learn the principle and handling of various spectroscopic instruments
- To impart hands on experimental training using absorption spectroscopy. Fluorimetry and Chromatography

UNIT – I: INTRODUCTION TO SPECTROMETRY 9+10

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.

PRACTICAL:

(i) To validate Beer-Lambert's law using KMnO4
(ii) To find the molar absorptivity and stoichiometry of the Fe (1,10-phenanthroline) using absorption spectrometry

UNIT – II: MOLECULAR SPECTROSCOPY 9+15

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.

PRACTICAL:

(i) To find the pKa of 4-nitrophenol using absorption spectroscopy
(ii) To determine chemical actinometry using potassium ferrioxalate.
(iii) To estimate of Al^{3+} by Fluorimetry

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+5

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.

PRACTICAL:

(i) To perform column chromatography

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: 75 (45+30) PERIODS

OUTCOMES:

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

- CO1 Understand the basics of spectrometry
- CO2 Understand the mechanisms and instrumentation involved in molecular spectroscopy
- CO3 Understand the basics of magnetic resonance and mass spectroscopy
- CO4 understand the purpose and theories of chromatographic and application for purification of samples.
- CO5 understand the principle and applications of electrochemical and study of surfaces.

TEXT BOOKS:

1. Skoog, D.A. F. James Holler, and Stanky, R.Crouch “Instrumental Methods of Analysis”.. Cengage Learning, 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
5. Skoog, D.A. etal. “Principles of Instrumental Analysis”, Vth Edition, Thomson / Brooks – Cole,1998.
6. Braun, R.D. “Introduction to Instrumental Analysis”, Pharma Book Syndicate, 1987.
7. Willard, H.H. etal. “Instrumental Methods of Analysis”, VIth Edition, CBS, 1986.
8. 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., et al., “Laboratory Instrumentation “. IVth Edition, John Wiley, 1995.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	1	1	-	-	1	2	-	-	1	2	3	3
2	2	3	2	2	2	-	-	1	2	-	-	2	3	2	3
3	2	2	1	1	2	-	-	-	2	-	-	1	2	2	2
4	2	3	2	2	1	-	-	1	2	-	-	2	2	3	3
5	2	3	1	1	1	1	-	-	2	-	-	1	2	2	3
Overall CO	**2**	**2.6**	**1.4**	**1.4**	**1.4**	**1**	**-**	**1**	**2**	**-**	**-**	**1.4**	**2.2**	**2.4**	**2.8**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23403	BIOPROCESS ENGINEERING – I	L	T	P	C
		3	0	4	5

OBJECTIVES

The course aims to,

- Impart knowledge on the mechanism of enzyme
- Develop an understanding of thevarious operations in biotechnology industry
- Study the quantitative relationships in input raw materials and output product

UNIT – I: INTRODUCTION TO ENZYMES 9+12

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. Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc.

PRACTICAL:

1. To Determination of Michaelis-Menten parameters
2. To find the effect of Temperature and pH on enzyme activity

UNIT – II: KINETICS OF ENZYME ACTION 9+12

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.

PRACTICAL:

3. To study the Enzyme inhibition kinetics
4. To study enzyme immobilization – Gel entrapment/ Cross linking

UNIT – III: OVERVIEW OF FERMENTATIONPROCESSES 9+12

Overview of fermentation industry, general requirements offermentation processes, basic configuration of fermenter and ancillaries, main parameters to be monitored and controlled in fermentation processes.

PRACTICAL

5. To analyzemultienzyme one pot conversion
6. To study the Enzymatic conversion in Packed bed Column/Fluidized bed Column

UNIT–IV: RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS 9+12

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.

PRACTICAL:

7. To optimize conditions using – Plackett Burman Design (Design expert software)
8. To optimize conditions using – Response Surface Methodology (Design expert software)

UNIT – V STERILIZATION KINETICS 9+12

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.

PRACTICAL:

9. Overview of Bioreactor and Probes in Bioreactor
10. To perform batch Sterilization kinetics

TOTAL: 105 PERIODS

OUTCOMES:

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

CO1 define the mechanism of enzyme action
CO2 explain as well as apply the kinetics of enzyme action
CO3 understand the configuration of bioreactor with its sensors and controls
CO4 understand the various components in the medium and its design
CO5 study the death kinetics of the microorganism and design of sterlization process

TEXT BOOKS:

1. Michael L. Shuler and FikretKargi , "Bioprocess Engineering" 2nd Edition, Pearson,2015.
2. Pauline M Doran"Bioprocess Engineering Principles" 2nd Edition Academic Press2012

REFERENCES:

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

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	1	1	-	-	-	-	-	-	3	3	2	2
2	2	2	1	-	-	1	-	-	-	1	-	2	2	2	2
3	2	2	2	3	1	1	-	-	-	-	-	3	2	3	3
4	2	2	2	2	3	2	1	1	-	1	-	2	3	3	3
5	3	3	3	3	2	2	1	1	-	-	-	2	3	3	3
Overall CO	**2.2**	**2.2**	**1.8**	**2.2**	**1.7**	**1.5**	**1**	**1**	**-**	**1**	**-**	**2.4**	**2.6**	**2.6**	**2.6**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23U01	STANDARDS - INDUSTRIAL - BIOTECHNOLOGY	L	T	P	C
		1	0	0	1

MODULE I – OVERVIEW OF STANDARDS **6**

Basic concepts of standardization; Purpose of Standardization, marking and certification of articles and processes; Importance of standards to industry, policy makers, trade, sustainability and innovation. Objectives, roles and functions of BIS, Bureau of Indian Standards Act, ISO/IEC Directives; WTO Good Practices for Standardization. Important Indian and International Standards.

MODULE II **9**

NABL guidelines, RCGM guidelines for recombinant DNA research, GMP guidelines in Biotech industries, Guidelines for Stem Cell Research and Clinical Translation, ICMR ethical guidelines.

IB23501	GENETIC ENGINEERING	L	T	P	C
		3	0	4	5

OBJECTIVES

The course aims to,

- Impart knowledge on basic and advanced concepts in genetic engineering to design and develop robust organisms and to evolve high-throughput cutting edge screening/diagnostic methods for industrial, health, agricultural and environmental sectors.

UNIT – I: INTRODUCTION TO RECOMBINANT DNA TECHNOLOGY 9+18

Overview of recombinant DNA technology and its applications. Recombinant DNA technology tools. Restriction and Modifying systems: Biological importance, Classification, Nomenclature, Applications in recombinant DNA technology - Cohesive ends, blunt ends, Isoschizomers, Neoschizomers, Star activity, Compatible cohesive ends, DNA polymerase, DNA ligase, Alkaline phosphatase – Inter and intra molecular ligation, Polynucleotide kinase, Terminal transferase and Exonuclease, Linkers and adaptors

PRACTICAL:

(i) Isolation of plasmid DNA
(ii) Generation of rDNA by Restriction-digestion and ligation
(iii) Restriction mapping

UNIT – II: CLONING VECTORS 9+12

Cloning vector Vs. expression vector.Principle and differences between Transformation, Transfection and Transduction. Plasmid vector – MCS, Selection and Screening markers, copy number regulation, Plasmid compatibility and Host range. Shuttle vectors. TA cloning. T7 expression system and its derivatives. Bacteriophage vector: λDNA vectors – Insertional and replacement vectors, *in vitro* packaging, Size based selection and Spi^- selection. Combinatorial vectors: Cosmid and Phagemid. Introduction to artificial chromosomes – BAC and YAC.

PRACTICAL:

(i) Competent cell preparation and transformation
(ii) Blue-White screening

UNIT – III: DNA LIBRARIES 9

Construction of genomic and cDNA library: Methods, Chromosomal walking, Limitations in cDNA library construction and full-length cDNA library construction. Screening of DNA libraries: Nucleic acid hybridization and PCR – degenerate probes and primers, Southwestern and Northwestern strategies, Immunochemical, protein-protein/ligand interaction, functional complementation/gain of function approaches. Differential cDNA library: Differential expression analysis and screening, subtracted cDNA library, PCR based differential display analysis and difference cloning.

UNIT – IV: PCR AND DNA SEQUENCING 9+18

Polymerase Chain reaction: Principle and Steps in PCR. End-point Vs. Real-time PCR. qPCR and qRT-PCR – SYBR green (melting curve analysis), Taqman and Molecular beacon methods. Digital PCR. *Sequencing:* Conventional Vs. next generation DNA sequencing (NGS). Maxam Gilbert's and Sanger's methods of DNA sequencing. Pyrosequencing. NGS platforms – Illumina, Roche 454 and Ion-torrent platforms.

PRACTICAL:

(i) Primer design and validation and DNA amplification using PCR
(ii) qPCR – Relative quantitation study design, data analysis (ΔCt and ΔΔCt)
(iii) Assembly PCR – Primer and experimental design

UNIT – V: APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY 9+12

Site directed mutagenesis: Primer extension method, Kunkel's method and PCR based site-directed mutagenesis. High level expression of proteins. Gene editing – Zinc finger nuclease, TALEN, meganucleases, CRISPR-Cas systems. Ti Plasmids and transgenic plant.

PRACTICAL:

(i) Optimization of inducer concentration for high level expression of proteins.
(ii) Design and validation of target specific CRISPR/Cas guide RNA

TOTAL: 105 (45+60) PERIODS

OUTCOMES:

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

- CO1 Understand strength and limitations of tools and techniques used in rDNA technology
- CO2 Understand the various vector systems used in rDNA technology
- CO3 Know the strategies to generate DNA libraries and techniques to screen them for various genetic engineering applications.
- CO4 Understand the different types of PCR and sequencing systems for better understanding of genomics field
- CO5 Understand the current techniques involved in gene editing to generate appropriate genetically modified organisms

TEXT BOOKS:

1. Old RW, Primrose SB, "Principles of Gene Manipulation and Genomics", 7th Edition Wiley-Blackwell Publications, 2006.
2. Keya Chaudhuri, "Recombinant DNA technology" The Energy and Resources Institute (TERI), 2013.
3. Green MR and Sambrook J. "Molecular Cloning: A Laboratory Manual". 4th Edition, CSHL press, 2012.

REFERENCES:

1. Sarah Maddocks, Rowena Jenkins, “Understanding PCR A Practical Bench-Top Guide” 1st Edition, Elsevier, 2016
2. Melanie Kappelmann-Fenzl, "Next Generation Sequencing and Data Analysis" Springer, 2021
3. Green MR and Sambrook J. “Molecular Cloning: A Laboratory Manual”. 4th Edition, CSHL press, 2012.
4. Brown TA. “Gene Cloning and DNA analysis: An introduction”. 6th Edition, Wiley-Blackwell, 2010.

PROGRAMME OUTCOMES															
CO’s	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	3	3	2	2	3	-	-	-	-	3	3	3	3
2	1	2	3	3	3	3	3	-	-	-	-	3	3	3	3
3	2	2	3	3	3	3	3	-	-	-	-	3	3	3	3
4	1	2	3	3	3	3	3	1	-	-	-	3	3	3	3
5	1	2	3	3	3	3	3	1	2	1	-	3	3	3	3
Overall CO	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**-**	**3**	**3**	**3**	**3**

Course 1-low, 2-medium, 3-high, ‘-“- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23502	BIOPROCESS ENGINEERING – II	L	T	P	C
		3	0	4	5

OBJECTIVES

The course aims to,

- Develop an understanding of the concepts involved in the design of different bioreactors and its operation mechanism.
- Learn about the recombinant cell cultivation process and their simulation process
- Design and evaluate the performance of bioreactors by analyzing the mass transfer, heat transfer and mixing capabilities in bioreactors.
- Design and set up various recombinant cell cultivation process

UNIT – I: OPERATIONAL MODES OF BIOREACTORS 9+12

Fed batch cultivation, Cell recycle cultivation, Cell recycle cultivation in waste water treatment, two stage cultivation Packed bed reactor, airlift reactor, fluidized bed reactor bubble column reactors.

PRACTICAL:

(i) To perform batch cultivation using exhaust gas analysis
(ii) To perform fed batch cultivation

UNIT – II: BIOREACTOR SCALE – UP 9+6

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.

PRACTICAL:

(i) To estimate missing time in reactor

UNIT – III: BIOREACTOR CONSIDERATION IN ENZYME SYSTEMS 9+36

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.

PRACTICAL:

(i) To estimate KLa – Dynamic Gassing-out method
(ii) To estimate KLa – Sulphite oxidation method
(iii) To estimate KLa – Power correlation method
(iv) To determine residence time distribution
(v) To estimate overall heat transfer coefficient
(vi) To estimate the kinetic parameters in immobilized enzyme packed bed reactor

UNIT – IV: MODELLING AND SIMULATION OF BIOPROCESSES 9+6

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.

PRACTICAL:

(i) To perform total cell retention cultivation.

UNIT – V: RECOMBINANT CELL CULTIVATION 9

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

TOTAL: 105 (45+60) PERIODS

OUTCOMES:

At the end of the course the student will be able to:

- CO1 understand the different operational modes of bioreactor
- CO2 understand the fundamentals of bioreactor scale up process
- CO3 understand the design of reactors for enzyme immobilization processes
- CO4 understand the various modelling and simulations in bioprocess engineering
- CO5 understand the existing strategies for the cultivation of recombinant cells

REFERENCES:

1. Anton Moser, "Bioprocess Technology, Kinetics and Reactors", Springer Verlag.1988, digitalized 2007
2. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, 2nd edition McGraw Hill. 1986
3. Atkinson, Handbook of Bioreactors Atkinson, B. &Mavituna. F., Biochemical Engineering and Biotechnology Handbook, McGraw Hill (2nd Edition) (1993).
4. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Decker Inc. 1997
5. Shuler and Kargi, "Bioprocess Engineering ", Prentice Hall, 1992.
6. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications.2009

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	2	1	1	-	-	-	-	-	-	3	1	1	2
2	2	2	2	2	2	-	-	-	-	-	-	2	2	1	2
3	2	2	2	1	2	1	1	1	-	1	-	2	2	2	1
4	2	2	2	2	2	2	1	1	1	-	-	2	1	2	2
5	3	2	2	1	3	2	3	3	1	2	-	3	3	3	3
Overall CO	**2.2**	**1.8**	**2**	**1.4**	**2**	**1.6**	**1.6**	**1.6**	**1**	**1.5**	-	**2.4**	**1.8**	**1.8**	**2**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23503	IMMUNOLOGY	L	T	P	C
		3	0	2	4

OBJECTIVES

The course aims to,

- discuss the structure, function, integration of immune system, and staining techniques
- explain antigen-antibody interactions and the mechanism of protection of body from foreign pathogens/germs by the immune system.
- explain various techniques of monoclonal and engineered antibodies (important therapeutic molecules) production, for treating most of the human diseases

UNIT – I: INTRODUCTION TO IMMUNE SYSTEM 9+6

Organisation and classification of immune system – immune cells and organs; innate and acquired immunity; Toll receptors and responses, classification of antigens – chemical and molecular nature; haptens, adjuvants; cytokines; complement pathway, antigen presenting cells; major histocompatibility complex

PRACTICAL:

1. To identify leukocytes from blood smear by differential staining (Geimsa stain)
2. To enumerate RBCs/leukocytes by Neubar chamber for cell culture studies.

UNIT – II: HUMORAL AND CELLULAR IMMUNITY 9+6

Development, maturation, activation, regulation, differentiation and classification of T-cells and B- cells, antigen processing and presentation, theory of clonal selection, TCR; Immunoglobulin - Structure and functions; Immunoglobulin – genes and generation of diversity; antigen-antibody reactions: precipitation, Agglutination, complement fixation, IFT, RIA, ELISA.

PRACTICAL:

1. To separate Peripheral Blood Mononuclear Cells (PBMC) by Ficoll –Hypaque
2. To determine agglutination reaction – Blood grouping antigens

UNIT – III: IMMUNITY AGAINST PATHOGENS AND TUMORS 9+6

Inflammation; protective immune responses to virus, bacteria, fungi and parasites; tumor antigens, tumor immune response, tumor diagnosis, tumor immunotherapy (Cytokines and CAR-T cell therapy)

PRACTICAL:

1. To demonstrate immunoprecipitaion reaction – Immunodiffusion/ immunoelectrophoresis
2. To evaluate antibody titre by ELISA method

UNIT – IV: IMMUNE TOLERANCE AND HYPERSENSITIVITY 9+6

Immune tolerance, Immunodeficiencies; Transplantation – genetics of transplantation; laws of transplantation; Allergy and hypersensitivity – Types of hypersensitivity, Autoimmunity, Auto immune disorders and diagnosis

PRACTICAL:

1. To determine agglutination: Diagnostic Widal test
2. To perform rapid diagnostic tests – Immunochromatographic test strips

UNIT – V: APPLIED IMMUNOLOGY 9+6

Monoclonal antibodies, engineering of antibodies; Classification of Vaccines, methods of vaccine development, immunodiagnostic methods (Immunodiffusion ELISA, FACS), immunomodulatory drugs.

PRACTICAL DEMONSTRATION FOR:

1. laboratory animal handling and selection of animals (mice/rat)
2. determining various routes of immunization
3. different bleeding methods, serum separation and storage.
4. Preparation of antigens for immunization schedule to raise antisera.

TOTAL: 75 (45+30) PERIODS

OUTCOMES:

At the end of the course the student will be able to

- **CO1** Understand about the immune system, morphology of immune cells and its functions.
- **CO2** learn and classify different types of immune cells and the techniques
- **CO3** evaluate the basis of immunity to various pathogens and tools to tumor diagnosis
- **CO4** Learn about the concepts and mechanism behind tissue transplantation, allergy and hypersensivity reactions.
- **CO5** apply and evaluate the mechanism of action and production of therapeutic/diagnostic molecules.

TEXT BOOKS:

1. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, "Roitt's Essential Immunology", 13th Edition, Wiley 2017.
2. Jenni Punt; Sharon Stranford; Patricia Jones; Judy Owen, "Kuby Immunology", 8th Edition, Macmillan 2019.

REFERENCES:

1. Coico, Richard “Immunology: A Short Course” 8th Edition. John Wiley, 2021.
2. Khan, Fahim Halim “Elements of Immunology” Pearson Education, 2009.
3. Abbas, Lichtman, Shiv Pillai Cellular and Molecular Immunology 6th edition Elsevier 2017.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1	1	-	1	1	1	-	-	-	2	2	2	2
2	2	2	3	2	2	1	2	1	-	-	-	2	2	2	3
3	2	2	2	2	2	1	1	-	-	-	-	3	3	2	2
4	3	2	2	2	2	-	1	2	-	-	-	3	3	2	3
5	2	2	2	2	2	1	2	2	-	2	-	2	2	2	3
Overall CO	**2**	**1.8**	**2**	**1.8**	**2**	**1**	**1.4**	**1.5**	**-**	**2**	**-**	**2.4**	**2.4**	**2**	**2.6**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23U02	PERSPECTIVES OF SUSTAINABLE DEVELOPMENT – BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Deliver perspectives about the possible sustainable developments in biotechnology

Unit I – INTRODUCTION **6**

Principles & Historical perspectives, Importance and need for sustainability in engineering and technology, impact and implications. United Nations Sustainability Development Goals (SDG), UN summit – Rio & outcome, Sustainability and development indicators.

Unit II - ENVIRONMENTAL SUSTAINABILITY **6**

Climate change, Biodiversity loss, Pollution and waste management, Renewable vs. non-renewable resources, Water and energy conservation, Sustainable agriculture and forestry. National and international policies, Environmental regulations and compliance, Ecological Footprint Analysis

Unit III – SOCIAL & ECONOMIC SUSTAINABILITY **6**

Equity and justice, Community development, Smart cities and sustainable infrastructure, Cultural heritage and sustainability, Ethical considerations in sustainable development. Triple bottom line approach, Sustainable economic growth, Corporate social responsibility (CSR), Green marketing and sustainable product design, Circular economy and waste minimization, Green accounting and sustainability reporting.

Unit IV: Sustainable development goals in Biotechnology **6**

Zero hunger. Good health and well-being – Personalized and precision medicine, Advanced therapies, Development of innovative medicine. Clean water and sanitation. Affordable and clean energy. Climate action.

Unit V: SUSTAINABILITY PRACTICES **6**

Suggested Practices not limited to

- Energy efficiency – how to save energy (energy efficient equipment, energy saving behaviours).
- Chemical use and storage - the choice of chemicals being procured, the safe disposal of leftover chemicals, the impact of chemicals on the environment and long-term health impacts on humans.
- Green building, green building materials, green building certification and rating: green rating for integrated habitat assessment (GRIHA), leadership in energy and environmental design (LEED)
- Tools for Sustainability - Environmental Management System (EMS), ISO14000, life cycle assessment (LCA)
- Ecological footprint assessment using the Global Footprint Network spreadsheet calculator
- National/Sub national Status of Sustainable Development Goals

TOTAL: 30 PERIODS

OUTCOMES:

At the end of the course the student will be able to

- Understand the importance of sustainability and to develop potential novel strategies

TEXT BOOKS:

1. Allen, D., &Shonnard, D. R. (2011). Sustainable engineering: Concepts, design and case studies. Prentice Hall.
2. Munier, N. (2005). Introduction to sustainability (pp. 3558-6). Amsterdam, The Netherlands: Springer.
3. Blackburn, W. R. (2012). The sustainability handbook: The complete management guide to achieving social, economic and environmental responsibility. Routledge.
4. Clini, C., Musu, I., &Gullino, M. L. (2008). Sustainable development and environmental management. Published by Springer, PO Box, 17, 3300.
5. Bennett, M., James, P., &Klinkers, L. (Eds.). (2017). Sustainable measures: Evaluation and reporting of environmental and social performance. Routledge.
6. Seliger, G. (2012). Sustainable manufacturing for global value creation (pp. 3-8). Springer Berlin Heidelberg.
7. Stark, R., Seliger, G., & Bonvoisin, J. (2017). Sustainable manufacturing: Challenges, solutions and implementation perspectives. Springer Nature.
8. Davim, J. P. (Ed.). (2013). Sustainable manufacturing. John Wiley & Sons.

UC23E01 ENGINEERING ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship
2. Apply process of problem - opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects
3. Analyse market types, conduct market estimation, identify customers, create customer persona, develop the skills to create a compelling value proposition and build a Minimum Viable Product
4. Explore business models, create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture ideas & solutions built with domain expertise
5. Prepare and present an investible pitch deck of their practice venture to attract stakeholders

MODULE – I: ENTREPRENEURIAL MINDSET **4L,8P**

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economies – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Case Analysis: Study cases of successful & failed engineering entrepreneurs - Foster Creative Thinking: Engage in a series of Problem-Identification and Problem-Solving tasks

MODULE – II: OPPORTUNITIES **4L,8P**

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

MODULE – III: PROTOTYPING & ITERATION **4L,8P**

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques.

Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

MODULE – IV: BUSINESS MODELS & PITCHING **4L,8P**

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest Assumptions in Business Model Design – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback

MODULE – V: ENTREPRENEURIAL ECOSYSTEM **4L,8P**

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Develop an Entrepreneurial Mind-set and Understand the Entrepreneurial Ecosystem Components and Funding types

CO2: Comprehend the process of opportunity identification through design thinking, identify market potential and customers

CO3: Generate and develop creative ideas through ideation techniques

CO4: Create prototypes to materialize design concepts and conduct testing to gather feedback and refine prototypes to build a validated MVP

CO5: Analyse and refine business models to ensure sustainability and profitability Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

REFERENCES:

1 Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition

2. Bill Aulet (2024). Disciplined Entrepreneurship: 24 Steps to a Successful Startup. John Wiley & Sons.

3. Bill Aulet (2017). Disciplined Entrepreneurship Workbook. John Wiley & Sons.

4. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business

5. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch

6. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons

7. Marc Gruber & Sharon Tal (2019). Where to Play: 3 Steps for Discovering Your Most Valuable Market Opportunities. Pearson.

IB23701	DOWNSTREAM PROCESSING	L	T	P	C
		3	0	4	5

OBJECTIVES

The course aims to,

- understand the fundamentals of biological product recovery, isolation separation purification and formulation
- acquire in depth knowledge and hands on training on design and optimization of Downstream process operations and equipment
- understand the principles behind various separation of biomolecules in Biotechnology industry
- have a hands-on experience in developing purification process for biomolecules produced in biotechnology industry

UNIT – I: DOWNSTREAM PROCESSING 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.

PRACTICAL:

(i) Cell disruption techniques – dynomill – batch and continuous

UNIT – II: PHYSICAL METHODS OF SEPARATION 9

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

PRACTICAL:

(i) Solid liquid separation – centrifugation, filtration

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.

PRACTICAL:

(i) Cell disruption techniques – ultrasonication, French pressurecell
(ii) Precipitation – ammonium sulphateprecipitation
(iii) Ultra filtration, Microfiltration, and dialysis
(iv) Aqueous two phase extraction ofbiologicals

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.

PRACTICAL:

(i) High resolution purification – affinitychromatography
(ii) High resolution purification – ion exchangechromatography

UNIT – V: FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS 9

Crystallization, drying and lyophilization in final product formulation

PRACTICAL:

(i) Product polishing – spray drying, freezedrying
(ii) Stability evaluation of BSA

TOTAL: 90 PERIODS

OUTCOMES:

At the end of the course, the students will be able to:
CO1 have a comprehensive understanding of the physicochemical properties of biotechnological products and economics of downstream processing
CO2 be capable of equipment selection and design of mechanical separation process for recovery of biotechnological products
CO3 be able to identify and optimize the suitable bio product isolation process at laboratory and pilot scale
CO4 have a thorough understanding of chromatographic separation processes and equipment selection
CO5 have complete knowledge of stability of biotechnology products and should be capable of formulation and stabilization for enhanced shelf-life

TEXT BOOKS:

1. Belter, P.A., E.L. Cussler and Wei-Houhu “Bioseparations – Downstream Processing for Biotechnology”, John Wiley, 1988
2. Ghosh, Raja “Principles of Bioseparations Engineering”. World Scientific, 2006
3. Roger G. Harrison, Paul W. Todd, Scott R. Rudge, and Demetri P. Petrides “Bioseparations Science and Engineering “ Oxford University Press 2006
4. Belter, P.A., E.L. Cussler and Wei-Shouhu “Bioseparations – Downstream Processing for Biotechnology”, John Wiley, 1988
5. Juan A. Asenjo - “Separation Processes in Biotechnology”, CRC Press, 2020
6. R.O. Jenkins, (Ed.) – Product Recovery in Bioprocess Technology – Biotechnology by Open Learning Series, Butterworth-Heinemann, 2004.
7. J.C. Janson And L. Ryden, (Ed.) – “Protein Purification – Principles, High Resolution Methods And Applications”, VCH Pub. 1989

REFERENCES:

1. Michael C Flickinger “Encyclopedia of Industrial Biotechnology: Bioprocess, Bioseparation, and Cell Technology” John Wiley & Sons 2010
2. Michael R Ladisch “Bioseparations Engineering” John Wiley & Sons 2001

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	1	1	-	-	-	-	-	-	3	3	2	2
2	2	3	1	-	-	1	-	-	-	1	-	2	2	2	2
3	2	2	2	3	1	1	-	-	-	-	-	3	2	3	3
4	2	2	2	2	3	2	1	1	-	1	-	2	3	3	3
5	3	3	3	3	2	2	1	1	-	-	-	2	3	3	3
Overall CO	**2.2**	**2.4**	**1.8**	**2.3**	**1.8**	**1.5**	**1**	**1**	**-**	**1**	**-**	**2.4**	**2.6**	**2.6**	**2.6**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23702	BIOINFORMATICS	L	T	P	C
		3	0	2	4

OBJECTIVES

The course aims to,

- To introduce the student to biological data resources, algorithms and alignment tools and understand about machine learning techniques and neural networks in the analysis of biological data

UNIT – I: BIOLOGICAL DATABASES AND SEQUENCE ANALYSIS 9+6

Introduction to Bioinformatics and Computational Biology, Biological databases, Data formats, Sequence Analysis, Dynamic programming algorithms for computing,Needleman and Wunsch algorithm, Smith Waterman algorithm, Local and Global alignment.

PRACTICAL:

(i) Biological Databases: Data formats and Data retrieval
(ii) Pairwise Sequence Alignment: Global and Local

UNIT – II: ALGORITHMS FOR SEQUENCE ALIGNMENT 9+6

Multiple sequence alignment, Algorithms for Multiple sequence alignment, Substitution matrices, BLAST family of programs, Motifs and Profiles, Functional annotation.

PRACTICAL:

(i) Multiple Sequence alignment: ClustalW, Muscle
(ii) Homology search using BLAST family of programs: BLASTp, BLASTn

UNIT – III: NEXT GENERATION SEQUENCING, DATA ANALYSIS AND APPLICATIONS 9+6

Next Generation Sequencing techniques, Data formats, Whole genome sequencing, exome sequencing, RNA-seq and its applications.

PRACTICAL:

(i) NGS data resources: SRA and GEO
(ii) Tools for basic analysis of NGS data

UNIT – IV: PHYLOGENETICS, MOLECULAR MODELLING AND DOCKING 9+6

Phylogenetics: Introduction, Distance based trees, Character-based trees, Bootstrapping. Protein Structure: Tertiary structure prediction methods, Homology modeling, Molecular docking principles and applications.

PRACTICAL:

(i) Generating Phylogenetic trees and Bootstrapping
(ii) 2. Homology Modeling and assessing the quality of models

UNIT – V: MACHINE LEARNING, OTHER BIOINFORMATICS APPLICATIONS 9+6

Machine learning techniques: ANN for prediction of protein secondary structures and Hidden markov models for gene finding. Introduction to Systems Biology, Bioinformatics approaches for drug discovery.

PRACTICAL:

(i) Generating and understanding Protein-Protein Interaction networks
(ii) 2. Understanding drug-protein interaction through molecular docking

TOTAL: 75 (45+30) PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

- **CO1** Acquainted with bioinformatics databases and sequence analysis techniques and understand how to retrieve biological data and use bioinformatics tools
- **CO2** Acquainted with algorithms for sequence alignment and BLAST and use it for analysis
- **CO3**Analyze next generation sequencing data, interpret results and know how to use NGS resources
- **CO4** Acquire skills to understand and perform phylogenetic studies and homology modelling
- **CO5** List and demonstrate bioinformatics applications and molecular docking

TEXT BOOKS:

1. Arthur K. Lesk, “Introduction to Bioinformatics”, Oxford University Press, 4 th edition, 2014 166 166.
2. Dan Gusfield, Algorithms on Strings, Trees and Sequences”, Cambridge University Press, 1999..

REFERENCES:

1. R.Durbin, S.Eddy, A.Krogh and G.Mitchison, “Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids”, Cambridge University Press, 2013.
2. David W. Mount, “Bioinformatics Sequence and Genome Analysis”,Cold Spring Harbor Laboratory Press, 2 nd Edition, 2004.
3. Pierre Baldi and Soren Brunak, “Bioinformatics The Machine Learning Approach”, Cambridge University Press, 2001.
4. EijaKorpelainen, JarnoTuimala, PanuSomervuo, Mikael Huss and Garry Wong, “RNA-seq Data Analysis: A Practical Approach”, CRC Press, 2014.
5. Xinkun Wang “Next Generation Sequencing Data Analysis”, CRC Press, 2016.

IB23703 INDUSTRIAL BIOSAFETY AND HAZARD MANAGEMENT

L	T	P	C
2	0	0	2

OBJECTIVES

- make the students aware of safety guidelines in industry
- learn about risk analysis and implementation procedures
- learn about concepts in hazard analysis and its applications

UNIT – I: SAFETY REQUIREMENTS **9**

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

UNIT – II: IMPLEMENTATION AND ASSESSMENT OF SAFETY **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: GUIDELINES **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: REGULATIONS AND CASE STUDY ANALYSIS **9**

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

TOTAL: 45 PERIODS

OUTCOMES:

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

- CO1: understand the statutory requirements for an Industry on registration, license and its renewal
- CO2: identify and construct a GLP accredited laboratory and their standards
- CO3: Understand and prepare for the prevention of fire hazards and critical hazard risk management in the work place
- CO4: Learn and understand the rules and guidelines on risk assessment and management
- CO5: familiarize and apply the concept of Biosafety

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. Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis,Dyadem Press, 2004

REFERENCES:

1. Handley, W., "Industrial Safety Hand Book ", 2nd Edn., 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.

Programme Outocmes															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1	1	1	1	1	1	2	-	-	-	1	1	1
2	2	2	2	2	1	2	2	2	2	-	-	-	1	2	2
3	3	3	3	3	1	2	2	2	2	-	-	-	2	3	2
4	2	2	3	3	2	3	3	2	2	-	-	-	2	3	3
5	2	2	2	2	2	3	3	2	2	-	-	-	2	3	3
Overall CO	**2.0**	**2.0**	**2.2**	**2.2**	**1.4**	**2.2**	**2.2**	**1.8**	**2.0**	**1**	**-**	**2.4**	**1.6**	**2.4**	**2.2**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23801 PROJECT WORK / INTERNSHIP CUM PROJECT WORK

L	T	P	C
0	0	16	8

OBJECTIVES

The course aims to,

- train students to analyze a problem
- make them understand how to find solutions innovatively
- enable them to acquire technical and experimental skills to validate the solution, analyze the results and communicate.

OUTCOMES:

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

- CO1 Formulate and analyze a problem
- CO2 Plan experiments to find solutions in a logical manner
- CO3 Analyze the results, interpret and communicate

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	1	1	1	1	2	2	2	1	2	2	2	2
2	2	1	2	2	2	1	2	3	3	2	2	3	3	2	2
3	3	2	3	3	2	2	2	3	3	3	2	3	3	3	2
Overall CO	**2.3**	**1.7**	**2**	**2**	**1.7**	**1.3**	**1.7**	**2.7**	**2.7**	**2.3**	**1.7**	**2.7**	**2.7**	**2.3**	**2**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

PROFESSIONAL ELECTIVE COURSES (PEC)

IB23C01	ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course aims to,

- Impart knowledge on basic to advanced concepts and strategies involved in the generation of 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:

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

- CO1 Gain the knowledge about animal cell culturing methods and its various applications.
- CO2 Understanding the diagnosis of disease and develop different strategies of treatment
- CO3 Understanding existing therapeutic strategies for animal diseases
- CO4 Imparting knowledge on embryo manipulation towards transgenic animal generation

- CO5 Gain knowledge about the methodologies to generate transgenic animals technology

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
3. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition R. Ian Freshney 2010

REFERENCES:

1. Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press.2000
2. Animal Cell Biotechnology: Methods and Protocols. Author(s): Ralf Pörtner Series: Methods in Biotechnology, Publisher: Humana Press, Year: 2007
3. Animal cells as bioreactors. Terence Cartwright Series: Cambridge Studies in Biotechnology Publisher: Cambridge University Press, Year: 2008
4. Animal Biotechnology. Models in Discovery and Translation Author(s): Ashish Verma and Anchal Singh (Eds.) Publisher: Academic Press, Year: 2014

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	-	-	-	-	-	-	-	-	1	3	3	-
2	3	3	2	2	2	-	-	-	-	-	-	2	3	3	2
3	3	3	3	3	2	-	-	-	-	-	-	3	3	3	2
4	3	3	3	2	2	2	2	1	-	-	-	1	3	3	2
5	3	2	3	3	2	3	2	1	-	-	-	1	3	3	2
Overall CO	**2.8**	**2.6**	**2.4**	**2.5**	**2.0**	**2.5**	**2**	**1**	**-**	**-**	**-**	**1.6**	**3**	**3**	**2**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23001	PLANT BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course aims to,

- Impart knowledge on basic to advanced concepts and strategies involved in the generation of transgenic plants

UNIT – I: PLANT PHYSIOLOGY AND BASIC ORGANIZATION OF GENETIC MATERIAL **9**

Photosynthesis, respiration, phyto-hormones, photoperiodism and flowering, plant signaling and behavior [plant communication] Nuclear, chloroplast and mitochondrial genome. Gene structure and regulation of gene expression.

UNIT – II: PLANT TISSUE CULTURE **9**

Introduction to cell and tissue culture, media, aseptic techniques, initiation and maintenance of callus and suspension cultures protoplast isolation and fusion, section and regeneration of hybrid plants (somatic embryogenesis and organogenesis), Embryo culture, Anther, pollen and ovary culture for production of haploid plants. Cryopreservation, slow growth for germplasm conservation and encapsidation. Applications of tissue culture

UNIT – III: PLANT TRANSFORMATION **9**

Direct (particle bombardment, PEG mediated transformation, electroporation, silicon carbide fibre) and indirect gene transformation (Agrobacterium and viral mediated transformation,), Vectors, Promoters, Markers and reporters used for plant transformation. Chloroplast transformation

UNIT – IV: APPLICATIONS OF TRANSGENIC PLANT TECHNOLOGY **9**

Production of genetically modified plants for herbicide resistant (phosphoinothricin, glyphosate) insect resistance (Bt genes) biotic and abiotic stress tolerance and improvement of quality traits [Golden Rice, Fortified rice], technology protection system [Terminator gene technology),), viral resistant (coat protein or replicase or movement protein mediated).

UNIT – V: BIOPHARMING **9**

Therapeutic proteins in transgenic plants: Various single-chain Fv antibody fragments (antibody_ non Hodgkins lymphoma), Caro RX, E.coli heat labile toxin, Cyanoverin-N ,Insulin, Lysozyme, Lactoferrin, Norwalk virus capsid protein, Gastric lipase. Metabolic engineering of plants for secondary metabolite production/overproduction. Different plant cell culture platforms for the production of recombinant proteins

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

CO1: Understanding the basics of plant genome and its physiology

CO2: Acquire knowledge on plant tissue culture methods

CO3: Understanding the tools available in plant biotechnology

CO4:Understanding the significance of plant biotechnology in various industrial applications

CO5: Imparting knowledge on the use of plant biotechnology to produce pharmaceuticals

TEXT BOOKS:

1. Adrian Slater, N W Scott, M Fowler, Plant Biotechnology: The Genetic Manipulation of Plants, second Edition 2014, Oxford University Press.
2. Heldt HW. Plant Biochemistry & Molecular Biology, Oxford University Press. 1997.
3. H.S. Chawla. 2015. Plant biotechnology: A practical approach. Oxford and IBH Publishing Co. Pvt. Ltd., India.
4. Bhojwani, Sant Saran, Dantu, Prem Kumar, Plant Tissue Culture: An Introductory Text 2013; Springer India.
5. Plant derived pharmaceuticals: principles and applications fo developing countries Ed. Kathleen Hefferson CABI international. 2014

REFERENCES:

1. M.K. Razdan. 2014. Introduction to Plant Tissue Culture. 2nd Edition, Oxford and IBH Publishing Company, India
2. Wang, Aiming and Ma, Shengwu. 2014. Molecular Farming in Plants: Recent Advances and Future Prospects. Springer, New York, USA.
3. Edwin F. George, Michael A. Hall and Geert-Jan De Klerk 2014. Plant propagation by tissue culture. 3rd Edition. Springer, The Netherlands.
4. Hammond PM and Yusibov V. Plant Biotechnology New Products and Applications. Springer International Edition. 1999
5. Roberta Smith. 2013. Plant tissue culture: Techniques and experiments. Third edition. Academic Press, Elsevier Inc., USA
6. Gerard J. Tortora, Sandra. R. Grabowski, Principles of Anatomy and Physiology, 10th Edition, 2002, Wiley Publishers.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	-	-	-	-	-	-	-	-	1	3	3	-
2	3	3	2	2	1	-	-	-	-	-	-	2	3	3	-
3	3	3	3	3	2	-	-	-	-	-	-	3	3	3	-
4	3	3	3	2	2	2	2	1	-	-	-	1	3	3	2
5	3	2	3	3	2	3	2	1	-	-	-	1	3	3	2
Overall CO	**3**	**2.6**	**2.4**	**2.5**	**1.7**	**2.5**	**2**	**1**	**-**	**-**	**-**	**-**	**3**	**3**	**2**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23002	MARINE BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Impart knowledge about the abiotic and biotic components of the marine ecosystem, and active compounds obtained from the marine environment and their applications as well as to understand various techniques used in aquaculture.

UNIT – I: INTRODUCTION TO MARINE ENVIRONMENT9

Introduction to Marine Biotechnology: The marine ecosystem and its functioning: intertidal, estuarine, salt marsh, mangrove, coral reef, coastal &deep sea ecosystems. Hydrothermal vents. Bioprospecting, Marine Microbial Habitats and their Biotechnologically relevant microorganisms; Methods for Microbial Bioprospecting in Marine Environments - Biotechnological Potential of Marine Microbes. Bioactive compounds from other Marine Organisms: fungi, Microalgae, Seaweeds, Actinomycetes, sponges.

UNIT – II: IMPORTANT MARINE ORGANISMS9

Phytoplanktons – zoo planktons – nektons – benthos — marine algae – mangroves – coral reefs — intertidal zone – fauna and flora.

UNIT – III: MICROALGAL TECHNOLOGY9

Micro-algae- indoor and mass-culture methods, Biotechnological approaches for production of important microalgae. Single cell protein from Spirulina; vitamins, minerals and Omega-3 fatty acids from micro-algae; enrichment of micro-algae with micro-nutrients; cell wall polysaccharides of micro-algae; micro algae biomass for removal of heavy metals; Biofuel production from microalgae; metabolic engineering of microalgae for biofuel production

UNIT – IV: MARINE DRUGS AND ENZYMES9

Drugs from Marine organisms: Pharmaceutical compounds from marine flora and fauna - marine toxins, antiviral and antimicrobial agents -; Approved Marine Drugs as Pharmaceuticals -; Marine Natural products and its Challenges -; Marine Microbial Enzymes Marine Extremozymes and Their Significance, Current Use of Marine Microbial Enzymes.

UNIT – V: INDUSTRIAL APPLICATIONS9

Green fluorescent protein (GFP) & red fluorescent protein (RFP) characteristics and their applications; Green mussel adhesive protein; Chitosan and its applications; ornamental fishes. Marine Functional Foods: Marine Sources as Healthy Foods or Reservoirs of Functional Ingredients. Marine Bioactives as Potential Nutraceuticals. Cosmetics from Marine Sources: Scenario of Marine Sources in the Cosmetic Industry, Cosmetics: Definition and Regulations Cosmeceuticals, Target Organs and Cosmetics Delivery Systems, Components of Cosmetics, Major Functions of Some Marine Components in Cosmetics and Cosmeceuticals

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:
CO1 Understandthe physical and biological nature of the marine environment.
CO2 Understand and emphasizing the role of marine organisms
CO3 Understand the existing therapeutic strategies for animal diseases
CO4 Know about the active ingredients present in the marine system and their application
CO5 explore the potential knowledge about marine resources and techniques utilized for its mass cultivation

TEXT BOOKS:

1. Kim, S.K. Springer Handbook of Marine Biotechnology; Springer: Berlin, Germany; Heidelberg, Germany, 2015.
2. Nollet, Leo M. L- Marine microorganisms- extraction and analysis of bioactive compounds-CRC Press_Taylor& Francis (2017)

REFERENCES:

1. Recent advances in marine biotechnology volume 3 – M.Fingerman , R . Nagabhushanam Mary–Frances Thomson. Science Publishers Inc, USA 1999
2. Recent advances marine biotechnology volume 7 – M.Fingerman , R .Nagabhushanam Mary – Frances Thomson Science Publishers Inc, USA 2002
3. Barsanti L. & P. Gualtieri. Algae-Anatomy, Biochemistry and biotechnology, Taylor & Francis, 2006.
4. Blanca Hernández-Ledesma, Miguel Herrero-Bioactive Compounds from Marine Foods-Plant and Animal Sources-Wiley-Blackwell (2013)
5. BECKER, E.W. 1994 Microalgae-Biotechnology and microbiology. Cambridge University Press. 3. Bryant D.A., Molecular Biology of Cyanobacteria, Kluwer Academic Publisher, 1995.
6. Chácon-Lee, T.L. & González-Mariño, G.E. 2010. Microalgae for “healthy” foods–possibilities and challenges. Comprehensive reviews in food science & food safety
7. Felix, S., (2010) Handbook of Marine and Aquaculture Biotechnology, AGROBIOS INDIA

PROGRAMME OUTCOMES															
CO’s	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	-	-	-	-	-	-	-	-	1	-	2	-
2	3	3	2	2	2	-	-	-	-	-	-	2	2	2	2
3	3	3	3	3	2	-	-	-	-	-	-	3	3	3	2
4	3	3	3	2	2	2	2	1	-	-	-	1	3	3	2
5	3	2	3	3	2	3	2	1	-	-	-	1	3	3	3
Overall CO	**2.8**	**2.6**	**2.4**	**2.5**	**2.0**	**2.5**	**2**	**1**	**-**	**-**	**-**	**1.6**	**2.7**	**2.6**	**2.2**

Course 1-low, 2-medium, 3-high, ‘-“- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23003	DEVELOPMENTAL BIOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- understand the basics of developmental stages and pathways of different organisms as well as their regulation by biotic and abiotic factors

UNIT – I: HISTORY & BASIC CONCEPTS OF DEVELOPMENT 9

Overview of how the modern era of developmental biology emerged through multidisciplinary approaches, stages of development- zygote, blastula, gastrula, neurula. Cell fate & commitment – potency- concept of embryonic stem cells, differential gene expression, terminal differentiation lineages of three germ layers, fate map. Mechanisms of differentiation- cytoplasmic determinants, embryonic induction, mosaic and regulative development. Pattern formation-- axis specification, positional identification (regional specification). Morphogenetic movements Model organisms in Developmental biology

UNIT – II: EARLY DEVELOPMENT IN INVERTEBRATE /VERTEBRATE MODELS 9

Drosophila, *C.elegans*, Xenopus, Mouse/ Human. Cleavage, gastrulation, Axis specification (Dorsoventral, anterior posterior), & body plan patterning, left right asymmetry in vertebrates

UNIT – III: LATE DEVELOPMENT IN INVERTEBRATE /VERTEBRATE MODELS 9

Organogenesis- development of central nervous system in vertebrates, vulval formation in *C.elegans*

UNIT – IV: GERM CELL SPECIFICATION& MIGRATION 9

Germplasm and determination of primordial germ cells, germ cell migration (Drosophila, vertebrates), Gamete maturation (amphibians, mammal) Medical aspects in developmental biology (genetic errors in human development, teratogenesis) developmental therapies

UNIT – V: APPLICATIONS OF DEVELOPMENTAL BIOLOGY 9

Overview of plant development, Medical implications of developmental biology - genetic errors/ teratogenesis/ stem cell therapy, etc.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

CO1 Gain knowledge on the basics of developmental biology
CO2 Understanding the early developmental stages/pathways
CO3 Understanding the late developmental stages/pathways
CO4 Understanding the influence of the biotic and abiotic factors on developmental pathways
CO5 Knowing about the significance and applications of developmental biology

TEXT BOOKS:

1. Developmental Biology, 10th edition by Scott F. Gilbert (Sinauer Associates, Inc.) 2013
2. Principles of Development - Lewis Wolpert 4th edition, Oxford University Press 2011

REFERENCES:

1. Essential Developmental Biology by Jonathan Slack, 3rd edition, Wiley Blackwell 2012
2. Developmental Biology, Werner A Muller: 1997 edition (6 December 2012)

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	1	2	1	1	-	1	-	-	-	1	1	2	1
2	2	2	1	2	-	1	-	1	-	-	-	2	3	3	1
3	2	2	2	2	1	2	-	1	-	-	-	2	3	2	2
4	3	2	3	2	2	2	-	2	-	-	-	2	3	3	2
5	3	3	3	2	2	2	-	2	-	-	-	2	3	3	2
Overall CO	**2.2**	**2.2**	**2.0**	**2.0**	**1.5**	**1.6**	**-**	**1.4**	**-**	**-**	**-**	**1.8**	**2.6**	**2.6**	**1.6**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23004	SYSTEMS BIOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Familiarize the students with the concepts of system biology.
- Make them aware of the kinetic modelling and flux balance analysis
- Make them familiarize tools and databases for modelling

UNIT – I: INTRODUCTION **9**

Introduction to Systems Biology, Systems level understanding of biological systems. Basic concepts in Systems modeling: Model Scope, Model Statements, System state, Variables, parameters and constants, Model behavior, classification and steady state. Merits of computational modeling.

UNIT – II: KINETIC MODELLING **9**

Kinetic modeling of biochemical reactions, describing dynamics with ODEs, rate equations, deriving a rate equation, incorporating regulation of enzyme activity by effectors, E-cell platform and erythrocyte modeling.

UNIT – III: FLUX BALANCE ANALYSIS **9**

Introduction to Flux balance analysis, Construction of stoichiometric matrices, Constraint based models. Network basics, examples of mathematical reconstruction of transcriptional networks and signal transduction networks

UNIT – IV: NETWORK MOTIFS **9**

Network motifs, Feed forward loop network motif. Gene circuits, robustness of models, Chemotaxis model, Integration of data from multiple sources: Building genome scale models

UNIT – V: TOOLS AND DATABASES FOR MODELING **9**

Tools and databases for modeling: Pathway databases KEGG, EMP, Metacyc, Enzyme kinetics database BRENDA, Gene expression databases, Biomodels database, Basics of Systems Biology Markup Language (SBML), SBML editors.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: understand System Biology Concepts
CO2: identify and develop simple kinetic models
CO3: discuss and describe flux balance model
CO4: identify and construct models from sources
CO5: analyze and learn basics of SBML

TEXT BOOKS:

1. Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Systems Biology a Textbook by Wiley-BlackWell Publications (2009 Edition).
2. Uri Alon, An introduction to Systems Biology: Design Principles of Biological Circuits, (Chapman and Hall / CRC 2007 Edition)
3. Edda Klipp, Ralf Herwig, Axel kowald, Christoph Wierling, Hans Lehrach, Systems Biology in practice: concepts, implementation and application. (Wiley – VCH 2005)

REFERENCES:

1. Foundations of Systems Biology Edited by Hiroaki Kitano (MIT Press) 2001
2. Systems Biology: Definitions and perspectives by Lilia Albhergina (Springer Publications 2008)
3. GROMACS. www.gromacs.org
4. AUTODOCK autodock.scripps.edu
5. NEXT generation sequencing https:// usegalaxy.org

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	1	2	-	-	-	-	-	-	1	1	1	1
2	2	2	2	1	3	1	-	-	1	1	-	2	3	3	2
3	3	2	2	3	2	-	-	-	1	1	-	1	3	3	1
4	3	2	2	2	3	1	-	-	1	1	-	2	3	3	2
5	3	2	2	2	3	-	-	-	1	1	-	2	3	3	2
Overall CO	**2.6**	**2**	**2**	**1.8**	**2.6**	**1**	**-**	**-**	**1**	**1**	**-**	**1.6**	**2.6**	**2.6**	**1.6**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23005	NEUROBIOLOGY AND COGNITIVE SCIENCES	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Inculcate the fundamentals of neuronal cell development, structure, function, and the signal transduction mechanism as well as to dissipate knowledge on neuronal disorders, drug interactions, and cognitive behaviors.

UNIT – I: NEUROANATOMY **9**

Classification of central and peripheral nervous systems; Structure and function of neurons; types of neurons; cranial nerves, spinal nerves, glial cells; myelination; Brief anatomy of Brain and Spinal cord Blood Brain barrier; Meninges and Cerebrospinal fluid; Spinal Cord.

UNIT – II: NEUROPHYSIOLOGY **9**

Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; Chemical and electrical synaptic transmission; information representation and coding by neurons, classification of neurotransmitters; neuropeptides; adrenergic and cholinergic transmission; hormones and their effect on neuronal function.

UNIT – III: NEUROPHARMACOLOGY **9**

Overview of drug mechanism of action and classification – parasympathetic and sympathetic drugs, neuroleptics, thymoleptics, analeptics, drugs used in Alzheimer's and Parkinson disease, drug addiction

UNIT – IV: APPLIED NEUROBIOLOGY **9**

Basic neurologic mechanism of sense organs; research models for study and investigation in neurosciences and neuropharmacologic drug development

UNIT – V: BEHAVIOUR AND COGNITIVE SCIENC **9**

Basic mechanisms associated with motivation; behavioural studies – interpersonal interaction models, Transactional Analysis, neurology of memory; disorders associated with the nervous system.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

- CO1 Gain knowledge about the principles and implications of neuroscience.
- CO2 Understand the mechanism of neurophysiology and being able to analyze various processes of signal transduction.
- CO3 Analyze various facts about brain function and experimental approaches, theories, and models to integrate neuroscience information cross their biotech discipline
- CO4 Understanding, applying and analyzing the interaction of drugs with the neuronal system.
- CO5 Understanding of the behavior and cognitive ability of living systems and being able to create a solution for the neurological and psychological disorder.

TEXT BOOKS:

1. Ross and Wilson Anatomy and Physiology in Health and Illness: 11th edition, Anne Waugh 2010
2. Principles of Neural Science, Fifth Edition by Eric R. Kandel (Editor), James H. Schwartz (Editor), Thomas M. Jessell (Editor), Steven A. Siegelbaum (Editor), A. J. Hudspeth 2012
3. Neuroscience by Dale Purves, George J. Augustine, David Fitzpatrick, William C. Hall, Anthony-Samuel LaMantia, Leonard E. White 6 edition (October 12, 2017)
4. Lippincott Illustrated Reviews: Pharmacology 6th edition, Karen Whalen 2014

REFERENCES:

1. Neuroscience: Exploring the Brain 4th Edition, by Mark F. Bear, Barry W. Connors, Michael A. Paradiso Wolters Kluwer Health; 4th edition 2015
2. Mathews G.G. Neurobiology: molecules, cells and systems/Gary G. Mathews 2nd edition, Blackwell Science, UK, 2000.
3. The Brain That Changes Itself: Stories of Personal Triumph from the Frontiers of Brain Science, Norman Doidge Penguin USA 2007

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	1	1	1	-	-	-	-	-	1	2	2	1
2	2	3	2	2	1	1	-	-	-	-	-	1	3	3	2
3	2	1	2	2	1	1	-	-	-	-	-	2	2	2	2
4	3	2	2	2	2	2	-	-	-	-	-	2	3	3	2
5	3	3	3	3	2	3	-	-	-	-	-	3	3	3	2
Overall CO	**2.4**	**2.2**	**2.0**	**2.0**	**1.4**	**1.6**	**-**	**-**	**-**	**-**	**-**	**1.8**	**2.6**	**2.6**	**1.8**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23006	BIOETHICS	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- enlighten the students about the ethical issues and the responsibilities and to discuss about the safety and risk assessment in various industrial process

UNIT – I: ENGINEERING ETHICS **9**

Cardinal virtues and their development, concept of morality, ordinal virtues, Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Professions and Professionalism – Professional Ideals and Virtues – Uses of Ethical Theories

UNIT – II: ENGINEERING AS SOCIAL EXPERIMENTATION **9**

Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – The Challenger Case Study

UNIT – III: ENGINEER'S RESPONSIBILITY FOR SAFETY **9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk - Chernobyl and Bhopal Case Studies.

UNIT – IV: RESPONSIBILITIES AND RIGHTS **9**

Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

UNIT – V: GLOBAL ISSUES **9**

Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

- CO1 learn the basics of work ethics.
- CO2 Acquire knowledge on social experimentation and ethics
- CO3 Acquire knowledge on responsibility of an engineer towards safety
- CO4 Acquire knowledge on social responsibility
- CO5 Understand the global issues in ethics

TEXT BOOKS:

1. Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw Hill, New York (2005).
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Thompson Learning, (2000).

REFERENCES:

1. Charles D Fleddermann, “Engineering Ethics”, Prentice Hall, New Mexico, (1999).
2. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, (2003)
3. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, (2001)
4. Prof. (Col) P S Bajaj and Dr. Raj Agrawal, “Business Ethics – An Indian Perspective”, Biztantra, New Delhi, (2004)
5. David Ermann and Michele S Shauf, “Computers, Ethics and Society”, Oxford University Press, (2003)

PROGRAMME OUTCOMES															
CO’s	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1	1	-	1	1	2	1	1	1	2	1	1	1
2	1	1	1	1	-	2	1	3	1	1	1	2	1	2	2
3	1	1	1	1	-	2	1	3	1	1	1	3	1	2	2
4	1	1	1	1	-	2	1	3	1	1	1	3	1	1	2
5	1	1	1	1	1	3	1	3	1	1	1	3	1	1	1
Overall CO	1	1	1	1	1	2.0	1	2.8	1	1	1	2.6	1	1.4	1.6

Course 1-low, 2-medium, 3-high, ‘-“- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23007	BIOPHYICS	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Learn the physical basis of biological processes.
- Understand the complex biological world based on physics and physical chemistry in an analytical, rational and quantitative manner.

UNIT – I: MOLECULAR STRUCTURE OF BIOLOGICAL SYSTEMS 9

Intramolecular bonds – covalent – ionic and hydrogen bonds –Inter-atomic interactions - Molecular dynamic simulation - biological structures –general features – water structure – hydration – interfacial phenomena and membranes – self-assembly and molecular structure of membranes.

UNIT – II: CONFORMATION OF NUCLEIC ACIDS 9

Primary structure – the bases – sugars and the phosphodiester bonds- double helical Structure – a b and z forms – triple helix – G-Quartet - properties of circular DNA – topology – polymorphism and flexibility of DNA – DNA condensation - structure of ribonucleic acids – riboswitches –hydration of nucleic acids - nucleic acid dynamics related to function.

UNIT – III CONFORMATION OF PROTEINS 9

Conformation of the peptide bond – secondary structures – Ramachandran plots – use of potential functions – tertiary structure – folding – hydration of proteins – hydropathy index – protein dynamics – structural motifs – contact map – membrane proteins – protein structure prediction – Intrinsically Disordered Proteins (IDP) – Protein folding mechanisms – protein aggregation and neurotoxicity.

UNIT – IV CELLULAR PERMEABILITY AND ION – TRANSPORT 9

Ionic conductivity – transport across ion channels – mechanism - ion pumps- classification of transport mechanisms – passive and active transport kinetic models - proton transfer – Mitchel's Chemiosmotic Theory of energy transduction - nerve conduction theory and models– techniques of studying ion transport.

UNIT – V ENERGETICS & DYNAMICS OF BIOLOGICAL SYSTEMS 9

Concepts in thermodynamics – force and motion – entropy and stability – analyses of fluxes – diffusion potential – basic properties of fluids and biomaterials – laminar and turbulent flows – Electron transfer theories – Electron transfer in mitochondria and chloroplast.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Understand the physicochemical properties of biomolecules

CO2 Understand structural dynamics of biomolecules and their role in cellular functions such as transport and DNA organization

CO3 Analyze how the protein interaction and dynamics influence metabolic activity of the cell

CO4 Describe and analyze how ion transport influences cellular metabolism

CO5 Develop basic knowledge on bio thermodynamics to assess the strength and limitations of biological systems

TEXT BOOKS:

1. Biophysical Chemistry of Nucleic Acids and Proteins, Thomas E. Creighton 2010
2. Biophysics: Molecules in Motion; R. Duane. Academic Press, 1999

REFERENCES:

1. Cantor, Charles R. and Paul R. Schimmel "Biophysical Chemistry". 1-3 Vols. W.H.Freeman& Co.,1980.
2. Physical Biology of the Cell, R. Phillips et al 2013.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	1	2	1	-	-	-	-	-	-	1	3	3	1
2	3	3	2	3	3	-	-	-	-	-	-	2	3	3	1
3	3	3	2	3	3	-	-	-	-	-	-	3	3	3	1
4	3	3	2	2	2	-	-	1	-	-	-	1	3	3	-
5	3	2	2	3	3	-	-	1	-	-	-	1	3	3	-
Overall CO	**3.0**	**2.8**	**1.8**	**2.6**	**2.4**	**-**	**-**	**1**		**-**	**-**	**1.6**	**3**	**3**	**1**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23008	BIOLOGICAL SPECTROSCOPY	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Instruct the students various spectroscopic and microscopic techniques that are used in research and practice in biotechnology
- Impart knowledge on most of the current and novel spectroscopic techniques.

UNIT – I: CIRCULAR DICHROISM (CD) AND OPTICAL ROTATORY DISPERSION (ORD) 9

Polarized light – optical rotation – circular dichroism – circular dichroism of nucleic acids and proteins

UNIT – II: FLUORESCENCE AND RAMAN SPECTROSCOPY 9

Molecular energy level diagrams – principles of fluorescence and Raman – parameters for measurement – excited state processes - fluorescence polarization – Forster Resonance Energy Transfer – fluorescence quenching – single molecule spectroscopy - application to proteins and nucleic acids.

UNIT – III NUCLEAR MAGNETIC RESONANCE 9

Chemical shifts – spin – spin coupling – relaxation mechanisms – nuclear over Hauser effect – multidimensional NMR spectroscopy – determination of macromolecular structure by NMR – magnetic resonance imaging.

UNIT – IV MASS SPECTROMETRY and X-RAY DIFFRACTION9

Ion sources sample introduction – mass analyzers and ion detectors – biomolecule mass spectrometry – peptide and protein analysis – carbohydrates and small molecules – specific applications. Scattering by x- rays – diffraction by a crystal – measuring diffraction pattern – Bragg reflection – unit cell – phase problem – anomalous diffraction – determination of crystal structure – electron and neutron diffraction.

UNIT V SPECIAL TOPICS 9

Electron microscopy – transmission and scanning electron microscopy; Cryo Electron Microscopy – scanning tunneling and atomic force microscopy (AFM); Fluorescence Correlation Spectroscopy (FCS); FRAP; Two-photon Microscopy; STED and STORM microscopies.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 understand the principle and applications of circular dichroism and optical rotatory dispersion

CO2 understand the theory and applications of IR and Raman spectroscopy

CO3 understand the principle and applications of NMR
CO4 Apply and analyze using Mass spectrometry and X ray diffraction.
CO5 comprehend the high-resolution imaging techniques to assess surface and intracellular complexity.

TEXT BOOKS:

1. Banwell, Colin N. and E.M. McCash. "Fundamentals of Molecular Spectroscopy" 4th Edition, Tata McGraw-Hill, 1994.
2. Aruldas, G. "Molecular Structure and Spectroscopy". IIndEdition, Prentice Hall of India, 2007.

REFERENCES:

1. Pavia, D.L., G.M. Lampman and G.S. Kriz. "Introduction to Spectroscopy:" IIIrdEdition, Thomson, Brooks/ Cole, 2001.
2. Williams, Dudley H. and Ian Fleming." Spectroscopic Methods in Organic Chemistry". VthEdition, Tata McGraw-Hill, 1995.
3. Siuzdak, Gary. "Mass Spectrometry for Biotechnology". Academic Press / Elsevier,1996.
4. Hammes, Gordon G. "Spectroscopy for the Biological Sciences". John Wiley, 2005.
5. Campbell I.D and Dwek R.A., "Biological Spectroscopy ", Benjamin Cummins and Company, 1986.
6. Atkins P.W., "Physical Chemistry ", Oxford IV Edition, 1990.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	2	1	-	-	-	1	-	-	1	1	2	1
2	2	2	1	3	3	-	-	-	1	-	-	2	2	2	1
3	2	3	2	3	3	-	-	-	1	-	-	3	2	2	1
4	3	3	2	2	2	-	-	-	1	-	-	1	2	2	-
5	3	3	3	3	3	-	-	-	1	-	1	1	2	2	-
Overall CO	**2.4**	**2.6**	**1.8**	**2.6**	**2.4**	**-**	**-**	**-**	**1**	**-**	**1**	**1.6**	**1.8**	**2**	**1**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23009	PROTEIN STRUCTURE AND FUNCTION	L	T	P	C
		3	0	0	3

OBJECTIVES

This course aims to,

- provide fundamental knowledge on the existence of various structures of proteins
- impart knowledge on how these structures relate to their functions.

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, Trans-membrane 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.

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:

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

CO 1: classify amino acids and their properties
CO 2 :understand and analyze the existence of basic levels of protein structure
CO 3: illustrate and analyze the tertiary structure of proteins
CO 4: how these protein structures relate to protein functions
CO5: have knowledge on basic tools to study protein – protein interaction

TEXT BOOKS:

1. Branden C. and Tooze J., "Introduction to Protein Structured" 2nd Edition, Garland Publishing, 1999.
2. Creighton T.E. "Proteins" 2nd Edition. W.H. Freeman, 1993.

REFERENCES:

1. Pennington, S.R and M.J. Dunn, "Proteomics: Protein Sequence to Function". Viva Books, 2002
2. Liebler, "Introduction to Proteomics" Humana Press, 2002.
3. Voet D. and Voet G., "Biochemistry". 3rd Edition. John Wiley and Sons, 2008.
4. Haggerty, Lauren M."Protein Structure : Protein Science and Engineering".Nova Science Publications, 2011.
5. Williamson, Mike "How Proteins Work". Garland Science, 2012.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	-	-	2	2	-	-	-	-	-	-	-	1	2	-
2	2	2	1	3	3	-	-	-	-	-	-	1	2	2	-
3	3	3	2	3	3	-	-	-	-	-	-	1	2	2	-
4	3	3	2	2	3	2	2	-	-	-	-	3	2	2	2
5	3	3	2	3	1	2	1	-	-	-	1	3	2	2	2
Overall CO	**2.4**	**2.7**	**1.7**	**2.6**	**2.6**	**2**	**1.5**	**-**	**-**	**-**	**1**	**2.0**	**1.8**	**2**	**2**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23010 BIOCONJUGATE TECHNOLOGY AND APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVES

The course aims to,

- To impart knowledge about the principles involved in the different functional targets and its modification
- To enable the students to learn study about the applications of conjugate technology in Immunology and enzyme technology

UNIT – I: FUNCTIONAL TARGETS **9**

Modification of Amino Acids, Peptides and Proteins – Modification of sugars, polysaccharides and glycoconjugates – modification of nucleic acids and oligonucleotides.

UNIT – II: CHEMISTRY OF ACTIVE GROUPS **9**

Amine reactive chemical reactions – Thiol reactive chemical reactions – carboxylate reactive chemical reactions – hydroxyl reactive chemical reactions – aldehyde and ketone reactive chemical reactions – Photoreactive chemical reactions.

UNIT – III BIOCONJUGATE REAGENTS **9**

Zero length cross linkers – Homobifunctional cross linkers – Heterobifunctional cross linkers – Trifunctional cross linkers – Cleavable reagent systems – tags and probes.

UNIT – IV ENZYME AND NUCLEIC ACID MODIFICATION AND CONJUGATION **9**

Properties of common enzymes – Activated enzymes for conjugation – biotinylated enzymes – chemical modification of nucleic acids – biotin labeling of DNA- enzyme conjugation to DNA – Fluorescent of DNA.

UNIT – V: BIOCONJUGATE APPLICATIONS **9**

Preparation of Hapten-carrier Immunogen conjugates - antibody modification and conjugation – immunotoxin conjugation techniques – liposome conjugated and derivatives- Colloidal – gold- labeled proteins – modification with synthetic polymers.

TOTAL: 45 PERIODS

OUTCOMES:

After the completion of the course the student will be able to:
CO1 to recognize and explain various modifications in biological molecules
CO2 to analyse the interactions of chemical groups
CO3 familiarize the students with the various conjugates available in the pharmaceuticaland biotechnological industry
CO4 enable the students to design and develop efficient conjugates
CO5 apply and evaluate the knowledge gained about bioconjugates in various fields

TEXT BOOKS:

1. Bioconjugate Techniques, G.T. Hermanson, Academic Press, 1999.
2. Chemistry of Bioconjugates: synthesis, characterization and biomedical applications 1st edition RavinNarain 2013

REFERENCES:

1. Principles of Biochemistry. Lehninger 7th edition 2017
2. Antibody drug conjugates: fundamentals of drug development and clinical outcomes to target cancer 1st edition Kenneth J Oliver, Sara A Hurvitz ,2016.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	1	1	-	-	-	-	-	-	-	1	-	-	-
2	3	2	2	1	2	-	-	-	-	-	-	2	2	2	-
3	3	3	3	3	2	-	-	-	-	-	-	3	3	3	2
4	3	3	3	2	2	2	2	-	-	-	-	1	3	3	2
5	3	2	3	3	2	3	2	-	-	-	-	1	3	3	3
Overall CO	**2.6**	**2.4**	**2.4**	**2.0**	**2.0**	**2.5**	**2**	**-**	**-**	**-**	**-**	**1.6**	**2.7**	**2.7**	**1.7**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23029	MOLECULAR MODELLING	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Impart knowledge on the molecular behaviour of proteins, nucleic acids and small molecules in the biological system.
- Enable the students to understand the principles involved in molecular modelling.

UNIT – I: INTRODUCTION TO CLASSICAL MECHANICS 9

Newtons laws of motion – time intervals- algorithms

UNIT – II: INTRODUCTION TO STATISTICAL MECHANICS 9

Boltzman's Equation – Ensembles – Distribution law for non-interacting molecules – Statistical mechanics of fluids.

UNIT – III QUANTUM MECHANICS 9

Photoelectric effect – De Broglies hypothesis – Uncertainity principle – Schrodingers time independent equation – particle in a one -dimensional box.

UNIT – IV GROMOS, GROMACS, AMBER & DOCK 9

Various forcefields for proteins and nucleic acids – Molecular mechanics – Molecular dynamics– Molecular dynamics simulations in water and organic solvents.

UNIT V GAUSSIAN 9

Preparing input files – job types – model chemistries – basis sets – molecule specifications running Gaussian – examples

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the students would be able to:
CO1 understandthebehaviourofSmallandmacromoleculesinbiologicalsystem
CO2 apply laws of statistics to the behaviour of molecules
CO3 apply the principles of quantum mechanics to particle bahaviour
CO4 simulate the biomolecules using molecular modelling software.
CO5 assess and utilize various software and tools which utilizes quantum and molecular mechanics principles

TEXT BOOKS:

1. Leach, Andrew R. "Molecular Modelling: Principles and Applications" IInd Edition, Pearson, 2010.
2. Cohen, N.C. "Guide Book on Molecular Modeling in Drug Design" Academic Press/ Elsevier, 1996.

REFERENCES:

1. Statistical Mechanics; D. McQuarrie, Narosa, University Science Books; 1st edition 2000
2. Quantum Mechanics; D. McQuarrie, Narosa, 1999.
3. GROMOS Handbook www.gromacs.org

PROGRAMME OUTCOMES

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	1	2	-	-	-	-	-	-	1	2	1	1
2	2	2	2	2	3	1	-	-	-	-	-	2	2	3	1
3	3	2	3	2	2	-	-	-	-	-	-	1	3	3	2
4	3	3	2	2	3	1	-	-	-	-	-	2	3	3	1
5	3	2	2	2	3	-	-	-	-	-	-	2	3	3	3
Overall CO	**2.6**	**2**	**2**	**1.8**	**2.6**	**1**	**-**	**-**	**-**	**-**	**-**	**1.6**	**2.6**	**2.6**	**1.6**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23011	GENOMICS AND PROTEOMICS	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Provide the students a broader knowledge on the structure and function of genomes.
- Understand and learn about different protein characterization and profiling techniques.

UNIT – I: FUNDAMENTALS OF OMICS IN BIOLOGY 9

Introduction to Omics sciences and the technologies; Genome, Transcriptome, and Proteome; Overview of genomes of bacteria, archaea, and eukaryota; Evolution of genomics and the emergence of Human genome project.

UNIT – II: GENOME MAPPING AND SEQUENCING 9

Restriction mapping, RFLP, SSLP, STS mapping, RAPD, Top-down and bottom-up sequencing strategies, Chemical degradation and Chain-termination sequencing, Whole genome sequencing, Gap closure, Pooling strategies.

UNIT – III FUNCTIONAL GENOMICS 9

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

UNIT – IV TECHNIQUES IN PROTEOMICS 9

Protein isolation and separation of proteins through One and two-dimensional gel electrophoresis, Detection of proteins on SDS PAGE, labelling of proteins, Protein cleavage, Edman protein micro sequencing, 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:

At the end of the course, the student would be able to

- CO1 understand about the multiple Omics sciences and the technologies
- CO2 understand genomics through different mapping and sequencing strategies
- CO3 learn about functional genomics through multiple approaches
- CO4 understand the methods of isolation and characterization of proteins through proteomics

- CO5 Learn about large-scale protein profiling strategies in 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

PROGRAMME OUTCOMES															
CO’s	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	-	2	-	-	-	-	-	-	1	-	2	-
2	3	3	2	2	2	-	-	-	-	-	-	2	2	2	2
3	3	3	3	3	2	-	-	-	-	-	-	3	3	3	2
4	3	3	3	2	2	2	2	1	1	-	-	1	3	3	2
5	3	2	3	3	2	3	2	1	1	-	-	1	3	3	3
Overall CO	**2.8**	**2.6**	**2.4**	**2.5**	**2.0**	**2.5**	**2**	**1**	**1**	**-**	**-**	**1.6**	**2.7**	**2.6**	**2.2**

Course 1-low, 2-medium, 3-high, ‘-“- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23012 FUNDAMENTALS IN METABOLIC ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES

The course aims to,

1. To Impart the knowledge, techniques and tool-sets for metabolic design and pathway analysis.
2. To make rational decisions for genetically modifying the cells leading to improved productivity of products or cellular properties

UNIT – I: BASICS OF METABOLIC DESIGN AND PATHWAY **9**

Basic principles of metabolic design, thermodynamics of pathway, redox balancing, transport of substrates and product, changes to be adopted at systems level to enhance committing metabolite, Identifying rate limiting steps in the pathways, choice of appropriate genetic strategies.

UNIT – II: MATERIAL BALANCES AND DATA CONSISTENCY **9**

Solving black box model by applying matrix algebra, Theory of determined, over-determined systems, Analysis of over determined systems using black box model- identification of gross measurement errors, Introduction to MATLAB®

UNIT – III: METABOLIC FLUX ANALYSIS **9**

Comprehensive models of cellular reactions; stoichiometry of cellular reactions, lumping of reaction rates, metabolic flux analysis for exactly determined systems. - linear programming, introduction to genome scale metabolic modelling, methods for the experimental determination of metabolic fluxes by isotope labelling in simple branched pathways.

UNIT – IV: METABOLIC CONTROL ANALYSIS **9**

Fundamentals of Metabolic Control Analysis, control coefficients and the summation theorems, Experimental determination of flux control coefficients and other coefficients. Theory of large deviations, introduction to kinetic model

UNIT – V: ANALYSIS OF METABOLIC NETWORKS **9**

Stoichiometric Network Analysis. Elementary mode analysis, Control of flux distribution at a single branch point, Grouping of reactions, optimization of flux amplifications.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the student would be able to:

CO1 To impart the basics of metabolic design and pathway analysis

CO2 Learn pathway analysis by understanding material balances and stoichiometry

CO3 Understanding the basics of metabolic flux analysis

CO4 To impart knowledge of identifying and quantifying the extent of rate limitation.

CO5 To perform theoretical analysis of metabolic networks and experimental validation

TEXT BOOKS:

1. Gregory N. Stephanopoulos, Aristos A. Aristidou, Jens Nielsen, Metabolic Engineering: Principles and Methodologies, Academic Press. First edition,2005
2. Herbert M. Sauro, Introduction to Metabolic Control Analysis**,**Ambrosius Publishing,2013.

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
4. Sang Yup Lee E. Terry Papoutsakis Marcel Dekker, Metabolic Engineering.inc 1998
5. Nielsen J and Villadsen J. (1994) Bioreaction Engineering Principles. New york:Plenum Press

PROGRAMME OUTCOMES

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	-	2	-	-	-	-	-	-	1	-	2	-
2	3	3	2	2	2	-	-	-	-	-	-	2	2	2	2
3	3	3	3	3	2	-	-	-	-	-	-	3	3	3	2
4	3	3	3	2	2	2	2	1	1	-	-	2	3	3	3
5	3	2	3	3	2	3	2	1	1	-	-	2	3	3	3
Overall CO	**2.8**	**2.6**	**2.4**	**2.5**	**2.0**	**2.5**	**2**	**1**	**1**	**-**	**-**	**2.0**	**2.7**	**2.6**	**2.5**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23013	GENETICS	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Understand the fundamentals of inheritance
- Understand the role of inheritance in evolution and disease

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, nonrandom 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

OUTCOMES:

At the end of the course, the student will be able to:

CO1 understanding the basic concepts of inheritance of genes
CO2 enable the students to understand Mendelian inheritance

CO3 apply the knowledge in different systems

CO4 study the structure of population and the concept of gene pool, its effect on genotype frequencies

CO5 Imparting knowledge in the treatment of Human diseases

TEXT BOOKS:

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

REFERENCES:

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

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	1	2	1	1	-	-	-	-	-	1	-	1	1
2	2	2	1	2	-	1	-	-	-	-	-	2	2	3	1
3	2	2	2	2	1	2	-	-	-	-	-	2	3	3	1
4	3	2	3	2	2	2	-	-	-	1	-	2	2	-	2
5	3	3	3	2	2	2	-	-	-	1	-	2	3	3	2
Overall CO	**2.2**	**2.2**	**2.0**	**2.0**	**1.5**	**1.6**	**-**	**-**	**-**	**1**	**-**	**1.8**	**2.5**	**2.5**	**1.4**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23014	CANCER BIOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Understand the basic principles of cancer development and pathology
- Familiar with basic facets of carcinogenesis and methods to study the process
- Familiar with basic principles and applications of cancer therapies

UNIT – I: FUNDAMENTALS OF CANCER BIOLOGY 9

Cancer Epidemiology, Etiology and causes, diet and cancer, different forms of cancers, Regulation and modulation of cell cycle in cancer, DNA damage and check points, Cancer symtoms and Tumor Staging, Epigenetic modifications. Cell death pathways, Autophagy mechanisms, Autophagy in tumorogenesis. Apoptosis, tumour suppressor genes, p53 mediated apotosis,Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogens, principles of physical carcinogenesis, x-ray radiation- mechanisms of radiation carcinogenesis.

UNIT – II: MOLECULAR MECHANISMS 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 and oncogenes, Growth factors related to transformation. Telomerases, Clinical significances of invasion, metastatic cascade, Intravasation and extravasation, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion, Cancer Stem Cells, tumor microenvironment.

UNIT – III: SIGNALLING AND METABOLIC PATHWAYS IN CANCER 9

Metabolic reprogramming, Pathways that contribute to the altered cancer cell metabolism, Warburg effect. Cell signaling pathways, GPCR signaling, Jak-STAT signaling, Integrin Signaling, WntSignaling, TGF-B signaling, NF-Kb signaling, Notch signaling, Hedgehog and RasSignaling pathways, mTOR pathway. Tumor Angiogenesis, Angiogenic switches, targeting tumor angiogenesis.

UNIT – IV: DETECTION OF CANCER 9

Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer. Prediction of aggressiveness of cancer, Tumor staging, Endoscopy, Ultrasound, Use of cancer antigens in cancer detection/classification, Monoclonal antibodies in cancer diagnosis, Cancer imaging Technologies -Mammography, MRI, CT and PET scans, genetic testing and genomic medicine.

UNIT – V: MECHANISMS OF CANCER THERAPY 9

Different forms of therapy, chemotherapy, PIPAC, radiation therapy, Immunotherapy, CAR-T therapy, Use of signal targets towards therapy of cancer; Gene therapy. Cancer antigen based vaccines, cell based therapy against cancer, Targeted therapy, Hormone Therapy,

Anti-angiogenic therapy.Proton therapy, Exploiting Artificial intelligence and Machine learning in Oncology.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

CO1 understanding the basic facts and the process of carcinogenesis

CO2 Impart knowledge on molecular mechanisms and oncogenesis

CO3 learn about the signalling pathways in cancer

CO4 understand the molecular tools and applications of cancer detection and diagnosis

CO5 understand the fundamental principles and applications of cancer therapies

TEXT BOOKS:

1. Weinberg, R.A. “The Biology of Cancer” Garland Science, 2007
2. McDonald, F *et al*., “Molecular Biology of Cancer” 2nd Edition. Taylor & Francis, 2004

REFERENCES:

1. King, Roger J.B. “Cancer Biology” Addison Wesley Longman, 1996.
2. Ruddon, Raymond W. “Cancer Biology” 3rd Edition. Oxford University Press, 1995

PROGRAMME OUTCOMES															
CO’s	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	1	1	1	-	1	-	-	-	1	2	2	1
2	2	3	2	2	1	1	-	1	-	-	-	1	3	3	2
3	2	1	2	2	1	1	-	1	-	-	-	2	2	2	2
4	2	2	2	2	2	2	-		-	-	-	2	3	3	2
5	3	3	3	3	2	3	-	2	-	-	-	3	3	3	2
Overall CO	**2.2**	**2.2**	**2.0**	**2.0**	**1.4**	**1.6**	**-**	**1.2**	**-**	**-**	**-**	**1.8**	**2.6**	**2.6**	**1.8**

Course 1-low, 2-medium, 3-high, ‘-“- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23015	TISSUE ENGINEERING AND BIOMATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- learn principles of tissue engineering and tissue repair
- learn the major components of tissue engineered scaffolds, including polymeric constructs and its applications to diseases worldwide

UNIT – I: FUNDAMENTALS OF TISSUE ENGINEERING 9

Introduction to tissue engineering: Basic definition; current scope of development; use in therapeutics, cellular therapies, Tissue therapies, cell numbers and growth rates, measurement of cell characteristics morphology, number viability, motility and functions. Measurement of tissue characteristics, appearance, cellular components, Cell adhesion, ECM component, mechanical measurements and physical properties

UNIT – II: TISSUE ARCHITECTURE 9

Tissue types and Tissue components, Tissue repair, Engineering wound healing and sequence of events. Basic wound healing ,Applications of growth factors: VEGF/angiogenesis, Cell-Matrix& Cell-Cell Interactions, Microenvironment, Control of cell migration in tissue engineering. Cells micro-mechanisms for regeneration and repair, neo-vascularisation, Role of Bioreactors in shaping the shape and functions of the tissue.

UNIT – III: BIOMATERIALS 9

Biomaterials: Properties of biomaterials, Surface, bulk, mechanical and biological properties. Scaffolds , Types of biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials, Modifications of Biomaterials, Role of Nanotechnology. 3DPrinting, controlled bioactive factor release mechanisms, ink-jet based bioprinting, electrospinning, Three dimensional constructs. Artificial intelligence in Tissue engineering enhancing biomaterial design, cell-culture optimisation and personalised medicine.

UNIT – IV: BASIC BIOLOGY OF STEM CELLS 9

Stem Cells: Introduction, hematopoietic differentiation pathway, Potency and plasticity of stem cells, Stem Cell markers, FACS analysis, Types & sources of stem cells with characteristics: embryonic, adult, haematopoetic, Mesenchymal stem cells, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells, Induced pluripotent stem cells

UNIT – V: CLINICAL APPLICATIONS 9

Applications of Tissue engineering - Therapies, artificial meats, Pharmaceutical screening and testing. Stem cell therapy, Molecular therapy, Stem cell therapy for Neurodegenerative diseases, spinalcord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, Orthopedic applications, Stem cells and Gene therapy ,Tissue engineering for skin transplantation, cartilage, bone, Neural tissue engineering, Tissue engineered products characterization, safety, efficacy. Cryobiology, Vitrification technology, Preservation – freezing and drying. Patent protection and regulation of tissue- engineered products, Ethical issues

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Understand the basic utility and potential of Tissue Engineering principles

CO2 learn the major components of tissue engineered scaffolds, including polymeric constructs and cellular populations

CO3 understand design considerations for tissue engineering focusing on the stem cells, biomaterials and its applications

CO4 impart knowledge on regulatory, ethical and commercial considerations for tissue engineering

CO5 understand the biological processes and apply this knowledge to tissue engineering and regenerative medicine

TEXT BOOKS:

1. Clemens Van Blitterswijk, Tissue Engineeering.Elseiver,2nd edition,2014
2. Bernhard O.Palsson, SangeetaN.Bhatia, "Tissue Engineering" Pearson Publishers 2009
3. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. Fundamentals of Tissue Engineering and Regenerative Medicine.2009
4. The molecular and cellular biology of wound repair. Clark, Plenum Press.1988
5. Biomaterials Science. Ratner, Hoffman, Schoen, Academic Press.3rd edition 2012
6. Cell and Molecular Biology, Gerald Karp, John Wiley & Sons, Inc.2015

REFERENCES:

1. Raphael Gorodetsky, Richard Schäfer..Stem cell-based tissue repair. RSC Publishing,2011.
2. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult &Fetal Stem Cells,Academic Press, 2004.
3. R. Lanza, J. Gearhart etal (Eds), Essential of Stem Cell Biology, Elsevier Academicpress,2006.
4. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches InTissueEngineering&Regenrative Medicine" Artech House, INC Publications, 2008.
5. Naggy N. Habib, M.Y. Levicar,, L. G. Jiao,.and N. Fisk, Stem Cell Repair and Regeneration, volume-2, Imperial College Press,2007
6. Bernard N. Kennedy (editor). Stem cell transplantation, tissue engineering, and cancer applications, Nova Science Publishers, 2008

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	1	2	1	-	-	-	-	-	-	1	1	1	-
2	3	3	1	3	2	-	-	-	-	-	-	2	3	2	1
3	3	3	1	3	3	2	1		-	-	-	3	3	3	1
4	3	3	1	2	2	2	1	1	1	-	-	1	3	3	-
5	3	2	1	3	2	2	-	1	1	-	-	1	3	3	2
Overall CO	**3**	**2.8**	**1**	**2.6**	**2**	**2**	**1**	**1**	**1**	**-**	**-**	**1.6**	**24**	**2.6**	**1.3**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23016	FUNDAMENTALS OF NANOSCIENCE	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- learn about basis of nanomaterial and its preparation
- learn about characterization and applications in other fields

UNIT – I: INTRODUCTION **9**

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires- ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only)

UNIT – II: GENERAL METHODS OF PREPARATION **9**

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE

UNIT – III: NANOMATERIALS **9**

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, 92 Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MW CNT)- methods of synthesis (arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays- functionalization and applications-Quantum wires, Quantum dots preparation, properties and applications

UNIT – IV: CHARACTERIZATION TECHNIQUES **9**

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation

UNIT – V: APPLICATIONS **9**

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nano biotechology: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 familiarize about the science of nanomaterials
CO2 understand various top-down and bottom-up approaches for nanomaterial synthesis
CO3 demonstrate the preparation of nanomaterials
CO4 develop knowledge in characteristics of nanomaterial and familiarize with various spectroscopic techniques
CO5 Synthesise and deposit nanomaterials by various methods and acquire the knowledge of mechanisms in MESM/NEMS

TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, "Nanoscale characterization of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000

REFERENCES:

1. G Timp (Editor), "Nanotechnology", AIP press/Springer, 1999
2. AkhleshLakhtakia (Editor),"The Hand Book of Nano Technology, Nanometer Structure, Theory Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	1	1	1	-	-	-	-	-	-	1	-	-	-
2	2	2	2	1	1	2	2	-	-	-	-	2	2	2	2
3	3	3	2	3	1	2	2	-	-	-	-	3	3	3	2
4	3	2	3	2	3	2	2	-	-	-	-	1	3	3	3
5	3	2	3	3	2	2	2	1	1	-	-	1	3	3	3
Overall CO	**2.4**	**2.2**	**2.2**	**2.0**	**1.6**	**2.0**	**2.0**	**1**	**1**	**-**	**-**	**1.6**	**2.7**	**2.7**	**2.4**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23017	BIOPHARMACEUTICAL TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Explain about the various types of drugs and their mode of action
- Explain about various drug formulations and their applications

UNIT – I: INTRODUCTION **9**

Pharmaceutical industry & development of drugs; types of therapeutic agents and their uses; economics and regulatory aspects

UNIT – II: DRUG ACTION, METABOLISM AND PHARMACOKINETICS **9**

Absorption, distribution, metabolism and excretion of drugs, principle of drug action various receptors theory: GPCR. Ion channel receptor, enzyme receptors, intracellular receptors

UNIT – III: MANUFACTURE OF DRUGS, PROCESS AND APPLICATIONS **9**

Types of reaction process and special requirements for bulk drug manufacture. Unit operations in drug manufacture and safety hazard in pharma industry

UNIT – IV: PRINCIPLES OF DRUG MANUFACTURE **9**

Compressed tablets; dry and wet granulation; slugging or direct compression; tablet presses; coating of tablets; capsule preparation and evaluation; oral liquids preparation: solvents and solubility; preservation of drugs. Parenterals : manufacture , evaluation of parenterals like sterility testing, particulate testing, pyrogen testing, etc.

UNIT – V: THERAPEUTICS **9**

Various categories of therapeutics like vitamins, antiulcer, analgesics, contraceptives, antibiotics, anticancer, hormones and vaccines , biopharmaceuticals like insulin, erythropoietin, GMCSF

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 understand the process of drug discovery, development of new drugs, and biopharmaceuticals

CO2 understand pharmacokinetic parameters of drug action

CO3 learn about different dosage forms and their manufacture

CO4 learn about the principles of drug manufacture

CO5 appreciate the importance of pharmacology as a basis of therapeutics

TEXT BOOKS:

1. Lachman/Liebermanns textbook of The theory and practice of Industrial Pharmacy:,CBS Publishers and Distributors,2014
2. Ansel's Pharmaceutical Dosage forms and Drug delivery systems;Wolter Kluwer publishers,2014
3. Gilbert S Banker, Modern Pharmaceutics, CRC press,1996
4. DM Brahmanker, S Jaiswal Biopharmaceutics and Pharmacokinetics,Vallabh Publications,2014
5. Janeway, C.A. etal., "Immunology : The Immune Systems in Health and Diseases", VIthEdition, Garland Science, 2005

REFERENCES:

1. N.K .Jain Pharmaceutical product development. 2006. CBS Publishers &Distributors.
2. Gareth Thomas. Medicinal Chemistry. An introduction. John Wiley. 2000.
3. Katzung B.G. Basic and Clinical Pharmacology, Prentice Hall of Intl. 1995.
4. Abbas, A.K. etal., "The Cellular and Molecular Immunology", VIth Edition, Sanders / Elsevier, 2007.
5. Weir, D.M. and Stewart, John "Immunology", VIIIth Edition, Churchill Pvt. Ltd., 2000
6. Finkle Richard, etal., "Lippincott's Illustrated Reviews Pharmacology" IV thEdition.Wolters Kluwer / Lippincott Williams & Wilkins, 2009.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	1	1	-	-	-	-	-	-	-	1	-	-	-
2	3	2	2	1	2	-	-	-	-	-	-	2	2	2	2
3	3	3	3	3	2	-	-	-	-	-	-	3	3	3	2
4	3	3	3	2	2	2	2	1	1	-	-	1	3	3	3
5	3	2	3	3	2	3	2	1	1	-	-	1	3	3	3
Overall CO	**2.6**	**2.4**	**2.4**	**2.0**	**2.0**	**2.5**	**2**	**1**	**1**	**-**	**-**	**1.6**	**2.7**	**2.7**	**2.4**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23018	BIOSIMILARS AND MONOCLONAL ANTIBODY PRODUCTION	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Impart knowledge on the development of biosimilars
- Enable the students to develop biosimilar mABs as well as know how to increase their efficacy

UNIT – I: INTRODUCTION TO THERAPEUTIC MONOCLONAL ANTIBODIES 9

Introduction, Antibody Engineering: A New Approach to the Treatment of Disease, Antibody Design, Antibody Production, Recombinant Antibodies

UNIT – II: MECHANISM OF ACTION FOR THERAPEUTIC ANTIBODIES 9

Blockade of Ligand–Receptor Interaction, Target Depletion via ADCC and CDC, Engaging Cytotoxic T Cell Through the Use of Bispecific Abs, Receptor Downregulation by Enhanced Internalization and Degradation, Targeted Drug Delivery

UNIT – III: THERAPEUTIC MONOCLONAL ANTIBODIES AND THEIR TARGETS 9

Monoclonal Antibody Therapies for Infectious Diseases, Monoclonal Antibody Therapies for Autoimmune Diseases, Therapeutic Monoclonal Antibodies Against Neoplastic Diseases

UNIT – IV: MANUFACTURE OF RECOMBINANT THERAPEUTIC PROTEINS USING CHINESE HAMSTER OVARY CELLS IN LARGE-SCALE BIOREACTORS 9

Process and Cells, Choices for Manufacturing: Host Cells for Production and Suitable Selection Systems Methods for Rapid Generation of High-Producing Cell Lines, Silencing: Stability of Expression, Facilitators for High-Level Productivity, High-Throughput Bioprocess Development, Disposable Bioreactors

UNIT – V: REGULATORY ISSUES AND LEGAL CONSIDERATIONS 9

Existing Regulatory Pathways, challenges, Overview of the Biologics Price Competition and Innovation Act of 2009 (“BPCIA”), Patent Litigation and the BPCIA, Patenting Your Biosimilar

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

CO1 design and develop recombinant antibodies

CO2 explain the various targets of antibodies and apply the knowledge to target the receptor

CO3 identify therapeutic monoclonal antibodies for different diseases and design their synthesis

CO4 choose suitable host cells for mAB production and evaluate conditions for large scale production in bioreactors

CO5 discuss the regulatory issues involved in biosimilar/mAB production and evaluating the risks involved

TEXT BOOKS:

1. Biosimilars Of Monoclonal Antibodies: A Practical Guide To Manufacturing, Preclinical And Clinical Development Cheng Liu, PhD, and K. John Morrow, Jr., PhD, Wiley-Interscience, Year: 2017
2. Biosimilars: Regulatory, Clinical And Biopharmaceutical Development Hiten J. Gutka, Harry Yang, ShefaliKakar AAPS Advances in the Pharmaceutical Sciences Series 34, Springer International Publishing, Year: 2018

REFERENCES:

1. Nonclinical Development Of Novel Biologics, Biosimilars, Vaccines And Specialty Biologics Lisa M. Plitnick, MS, PhD and Danuta J. Herzyk, PhD (ed) 2013 Elsevier Inc.
2. Biologics, Biosimilars And Biobetters, An Introduction To Pharmacists, Physicians And Health Practitioners (ed) Iqbal Ramzan, WILEY 2021

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	-	-	-	-	-	-	-	-	1	1	3	-
2	3	3	2	2	2	-	-	-	-	-	-	2	3	3	2
3	3	3	3	3	2	-	-	1	-	-	-	3	3	3	2
4	3	3	3	2	2	2	2	1	1	-	-	1	3	3	2
5	3	2	3	3	2	3	2	1	1	-	1	1	1	3	-
Overall CO	**2.8**	**2.6**	**2.4**	**2.5**	**2.0**	**2.5**	**2**	**1**	**1**	**-**	**1**	**1.6**	**2.4**	**3**	**2**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23019	MOLECULAR BASIS OF DISEASES AND THERAPEUTICS	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Impart basic knowledge about disease diagnosis and detection
- Enable the students to know basics of pathogen control

UNIT – I: INTRODUCTION TO BASICS OF DISEASES AND DIAGNOSTICS 9

Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases- bacterial, viral, fungal, protozoans and other parasites; Attributes & components of microbial pathogenesis, Virulence, virulence factors, virulence-associated factors and virulence lifestyle factors. general approach to clinical specimens Sample collection- method of collection, transport and processing of samples

UNIT – II: TRADITIONAL DISEASE DIAGNOSIS METHODS AND TOOLS 9

Diagnosis of infection caused by Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium.
Diagnosis of major fungal infections: Dermetophytoses, Candidiosis and Aspergillosis.
Diagnosis of DNA and RNA viruses- Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis

UNIT – III: DIAGNOSIS AND TREATMENT OF COMMON DISEASES 9

Atherosclerosis, ischemic heart disease and cerebrovascular disease; coagulation system and hypertension; metabolic syndrome and diabetes mellitus; asthma, allergy and inflammatory diseases of the lung; gastrointestinal system, including inflammatory bowel diseases

UNIT – IV: MOLECULAR PATHOGENESIS (WITH SPECIFIC EXAMPLES) 9

Molecular genetics and gene regulation in virulence of pathogens: Vibrio Cholerae: Cholera toxin, co-regulated pili, filamentous phage, survival. Tuberculosis: clinical manifestation, molecular biology of infection - early events, late events, lipid metabolism, iron uptake and models (macrophage and animal) in studying tuberculosis - Leptospirosis: epidemiology and pathogenesis 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.

UNIT – V: CLINICAL DIAGNOSTICS AND PATHOGEN CONTROL 9

Classical approaches based on serotyping - Modern diagnosis based on highly conserved virulence factors, immune & DNA-based techniques; Antibiotics and antibiotics resistance: Principles of antibiotic mechanisms - Mechanisms of the origin of antibiotics resistance;

Vaccines - DNA, subunit and cocktail vaccines - approaches behind success story of small pox eradication across the world and polio in India. clinical diagnostic technologies: flow cytometry, medical cytogenetics, fluorescence in situ hybridization, immunohistochemistry and laser capture microdissection (FFPE)

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 recognise and explain the mode as well as factors controlling infections
CO2 choose and compare different diagnostic methods
CO3 apply techniques learnt to diagnose common diseases
CO4 analyse the different modes of pathogenesis employed by various pathogens
CO5 evaluate and apply the knowledge for pathogen diagnostics and control

TEXT BOOKS:

1. Molecular Diagnostics by Harald Seitz Sarah Schumacher, Springer 2013 Ed.
2. Iglewski B.H. and Clark V.L "Molecular Basis of Bacterial Pathogenesis", Academic Press, 1st Edition, 1990.

REFERENCES:

1. Williams, P.H., Ketley, J. and Salmond, G., "Methods in Microbiology: Bacterial Pathogenesis-Volume 27", Academic Press, 1st Edition, 1998.
2. Nester E.W., Anderson D.G., Roberts C.E., Pearsall N.N. and Nester M.T., "Microbiology: A Human Perspective", McGraw Hill, 4th revised Edition, 2003.
3. Molecular Diagnostics: Fundamentals, Methods and Clinical Applications by Lela Buckingham, F. A. Davis Company 2019
4. Molecular and Cellular Therapeutics by David Whitehouse, Ralph Rapley, Wiley & Sons, Ltd. 2012.
5. Williams, P.H., Ketley, J. and Salmond, G., "Methods in Microbiology: Bacterial Pathogenesis-Volume 27", Academic Press, 1st Edition, 1998.
6. Nester E.W., Anderson D.G., Roberts C.E., Pearsall N.N. and Nester M.T., "Microbiology: A Human Perspective", McGraw Hill, 4th revised Edition, 2003.

PROGRAMME OUTCOMES

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1	1	-	-	-	-	-	-	-	2	1	-	1
2	1	2	2	2	1	1	-	-	-	-	-	2	2	3	1
3	3	2	2	2	1	2	-	-	-	-	-	2	3	3	2
4	3	3	2	2	2	2	-	-	-	-	-	2	2	1	2
5	3	3	3	3	2	2	-	-	-	-	-	2	3	3	2
Overall CO	**2.2**	**2.2**	**2.0**	**2.0**	**1.5**	**1.7**	**-**	**-**	**-**	**-**	**-**	**2.0**	**2.2**	**2.5**	**1.6**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23020	CHEMICAL REACTION ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- To provide the basics of reaction types, variable affecting the reaction rate and evaluation of rate equations for different types of reactions
- To provide the information about different reactor systems and deriving the performance equations of various reaction system

UNIT – I: SCOPE OF CHEMICAL KINETICS & CHEMICAL REACTION ENGINEERING **9**

Broad outline of chemical reactors; rate equations; concentration and temperature dependence; development of rate equations for different homogeneous reactions. Industrial scale reactors

UNIT – II: DEAL REACTORS **9**

Isothermal batch, flow, semi-batch reactors; performance equations for single reactors; multiple reactor systems; multiple reactions.

UNIT – III: IDEAL FLOW AND NON IDEAL FLOW **9**

RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow

UNIT – IV: GAS-SOLID, GAS-LIQUID REACTIONS **9**

Resistances and rate equations; heterogeneous catalysis; reactions step; resistances and rate equations

UNIT – V: FIXED BED AND FLUID BED REACTORS **9**

G/L reactions on solid catalysis; trickle bed, slurry reactors; three phase-fluidized beds; reactors for fluid-fluid reactions; tank reactors

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: write the rate equation for any type of reaction
CO2: design reactors for heterogeneous reactions and optimize operating conditions
CO3: relate and calculate the conversions, concentrations and rates in a reaction and identify, formulate and solve chemical engineering problems
CO4: analyze the resistance and rate equations
CO5: identify and design Reactors for different type of reactions

TEXT BOOKS:

1. Levenspiel O. “Chemical Reaction Engineering”, III Edition, John W iley, 1999.
2. Fogler H.S. “Elements Of Chemical Reaction Engineering”,IV edition, Pearson Education India, 2015.

REFERENCES:

1. Missen R.W., Mims C.A., and Saville B.A. “Introduction to Chemical Reaction Engineering and Kinetics”, John Wiley & sons, 1999.
2. Dawande, S.D., “Principles of Reaction Engineering”, I edition, Central Techno Publications, 2001.

PROGRAMME OUTCOMES															
CO’s	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	1	2	-	-	-	-	-	-	1	1	1	2
2	2	2	2	2	3	1	1	-	1	1	-	2	3	3	2
3	3	2	3	3	2	-	1	-	1	1	-	1	3	3	2
4	3	3	3	2	2	1	1	-	1	1	-	2	3	3	2
5	3	3	3	2	2	-	1	-	1	1	-	2	3	3	2
Overall CO	**2.6**	**2.4**	**2.6**	**2.2**	**2.2**	**1**	**1**	**-**	**1**	**1**	**-**	**1.6**	**2.6**	**2.6**	**2.0**

Course 1-low, 2-medium, 3-high, ‘-“- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23021	INSTRUMENTATION AND PROCESS CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Introduce dynamic response of open and closed loop systems
- Make the students learn about the control loop components and stability of control systems along with instrumentation

UNIT – I: INSTRUMENTATION 9

Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, Volumetric Flow Rate and mass flow rate (for liquids and solids), viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

UNIT – II: OPEN LOOP SYSTEMS 9

Laplace transformation, application to solve ODEs. Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

UNIT – III: CLOSED LOOP SYSTEMS 9

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability

UNIT – IV: FREQUENCY RESPONSE 9

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings

UNIT – V: ADVANCED CONTROL SYSTEMS 9

Introduction to advanced control systems, cascade control, feed forward control, Smith predictor controller, control of distillation towers and heat exchangers, introduction to computer control of chemical processes

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: learn about the construction and working principles of instruments in bio-process industries

CO2: control the process parameters in optimized conditions at bioprocess industries

CO3:.Explain and evaluate the importance of process control loops for process engineering plants

CO4: classify and define the required instrumentation and frequency response

CO5: understand and design the modern hardware and instrumentation needed to implement in process control

TEXT BOOKS:

1. Stephanopoulos, G., “Chemical Process Control “, Prentice Hall of India, 2003.
2. Coughnowr, D., “Process Systems Analysis and Control “, IIndEdn., McGraw Hill, New York, 1991

REFERENCES:

1. Marlin, T. E., “Process Control “, IIndEdn, McGraw Hill, New York, 2000.
2. Smith, C. A. and Corripio, A. B., “Principles and Practice of Automatic Process Control”, IIndEdn., John Wiley, New York, 1997

PROGRAMME OUTCOMES															
CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	1	1	1	-	-	-	-	-	1	-	1	1
2	2	2	2	2	1	1	-	-	-	-	-	1	1	1	1
3	2	2	2	2	3	2	1	-	-	-	-	1	1	1	2
4	2	3	3	2	2	2	-	-	1	-	-	2	2	2	2
5	2	2	3	3	2	2	1	-	-	1	-	2	2	2	2
Overall CO	**2.0**	**2.2**	**2.2**	**2.0**	**2.0**	**1.6**	**1**	**-**	**1**	**1**	**-**	**1.4**	**1.5**	**1.4**	**1.6**

Course 1-low, 2-medium, 3-high, ‘-“- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23022	PROCESS EQUIPMENTS AND PLANT DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- explain about the designing aspects of various equipment used in biotech industry
- discuss about the process involved in the construction of an Industrial Plant

UNIT – I: HEAT EXCHANGERS, CONDENSERS, EVAPORATORS 9

Single and multi-process exchangers, double pipe, U tube heat exchangers, combustion details supporting structure. Single and vertical tube evaporation, Single and multi-effect evaporators, forced circulation evaporators.

UNIT–II: STORAGE VESSEL FOR VOLATILE AND NON VOLATILE FLUIDS PRESSURE VESSEL STRUCTURE 9

Design of the following equipment as per ASME, ISI codes, drawing according to scale; monoblock and multiplayer vessels, combustion details and supporting structure

UNIT – III: EXTRACTOR, DISTILLATION AND ABSORPTION TOWER 9

Construction details and assembly drawing; Plate and Packed Extraction Towers; Plate and Packed Absorption Towers; Plate and Packed Distillation Towers

UNIT – IV: PUMPS, MECHANICAL SEALS, VALVES AND SWITCHES 9

Various types of pumps, Principle of working, construction, usages, advantages and disadvantages; Various types of seals, effectiveness, usages; Pneumatic Seals; Gate, Globe and Butterfly Valves, their material of construction; Pneumatically Controlled Valves

UNIT – V: PIPING, PLANT LAY OUT AND DESIGN 9

Various types of Piping, material of construction, their usage; Pipe lay out; Modern Plant Design and case Studies.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: design the heat exchangers and evaporators
CO2: design the pressure and storage vessels
CO3: design the distillation column, absorption column, and extractors
CO4: understand the usage of different pumps, mechanical seals, valves and switches
CO5: design layout of industrial plants

TEXT BOOKS:

1. Brownell, L.E. and Young, E.H., “Process Equipment Design”, Wiley Eastern India Limited 2009.
2. Ray Sinnott& Gavin Towler “Chemical engineering design” V edition, Butterworth-Heinemann, 2015

REFERENCES:

1. Kern, D.Q., ‘Process Heat Transfer’, McGraw-Hill, 1999.
2. McCabe, W.L., J.C. Smith and P. Harriott “Unit Operations of Chemical Engineering”, VIth
   Edition, McGraw-Hill, 2001.

PROGRAMME OUTCOMES															
CO’s	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	1	2	-	-	-	-	-	-	1	1	1	2
2	2	2	2	2	3	1	1	-	1	1	-	2	3	3	2
3	2	2	3	3	2	-	1	-	1	1	-	1	3	3	2
4	3	3	3	2	2	1	1	-	1	1	-	2	2	3	2
5	3	3	2	2	2	-	1	-	1	1	-	2	2	2	1
Overall CO	**2.4**	**2.4**	**2.4**	**2.2**	**2.2**	**1**	**1**	**-**	**1**	**1**	**-**	**1.6**	**2.2**	**2.4**	**1.8**

Course 1-low, 2-medium, 3-high, ‘-“- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23023	TRANSPORT PHENOMENA	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- introduce the concept of simultaneous mass, momentum and energy transport
- develop velocity, temperature and concentration profiles for various systems involving turbulent flow

UNIT – I: MOMENTUM TRANSPORT 9

Viscosity, temperature effect on viscosity of gases and liquids, Newton's law, mechanism of momentum transport, shell balance method, pressure and velocity distributions in falling film, circular tube, annulus, slit.

UNIT – II: EQUATIONS OF CHANGE AND TURBULENT FLOW 9

Equation of continuity, motion, mechanical energy, use of equations of change to solve flow problems, dimensional analysis of equations of change, comparison of laminar and turbulent flows, time-smoothed equation of change, empirical expressions.

UNIT – III: ENERGY TRANSPORT 9

Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier's law, mechanism of energy transport, shell energy balance, temperature distribution in solids and laminar flow, with electrical, nuclear, viscous, chemical heat source, heat conduction through composite walls, cylinders, spheres, fins, slits.

UNIT – IV: EQUATIONS OF CHANGE FOR NON ISOTHERMAL SYSTEM AND TEMPERATURE DISTRIBUTION IN TURBULENT FLOWS 9

Energy equations, special forms, use of equations of change, dimensional analysis of equations of change, time-smoothed equations of change, empirical expressions, temperature distribution for turbulent flow in tubes, jets.

UNIT – V: MASS TRANSPORT, EQUATIONS OF CHANGE FOR MULTICOMPONENTSYSTEMS AND CONCENTRATION DISTRIBUTION IN TURBULENT FLOWS 9

Diffusivity, temperature and pressure effect, Fick's law, mechanism of mass transport, theory of diffusion in gases and liquids, shell mass balances, concentration distribution in solids and in laminar flow: stagnant gas film, heterogeneous and homogeneous chemical reaction systems, falling film, porous catalyst. The equation of continuity, summary of equations of change and fluxes, use of equations of change, dimensional analysis, time smoothed equations of change, empirical expressions for turbulent mass flux.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: understand and analyze the fundamental connections between the conservation laws in heat, mass, and momentum in terms of vector and tensor fluxes
CO2: define and classify the mechanism of fluids in motion under different conditions
CO3: understand and classify energy transport
CO4: study and describe the non-isothermal system and temperature distribution in turbulent flows
CO5: analyze and appraise various transport processes with understanding of solution approximation methods and their limitations

TEXT BOOKS:

1. Bird, R. B., Stewart, W. E. and Lighfoot, E. N., "Transport Phenomena", II edition, John Wiley, 2006
2. Brodkey, R. S., and Hershey, H. C., "Transport Phenomena", McGraw-Hill, 1987.
3. Brodkey, R. S., and Hershey, H. C., "Transport Phenomena: A unified approach", Volume I & II Brodkey publishing, 2003.

REFERENCES:

1. W elty, J. R., Wilson, R. E., Wicks, C. E., and Rorer,G. L., "Fundamentals of Momentum, Heat and Mass Transfer ", V edition, John Wiley & sons Inc., 2010.
2. Slattery , J. S., "Advanced Transport Phenomena", Cambridge University Press, London, 1999

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	-	-	-	-	-	-	-	-	1	3	3	-
2	2	3	3	2	2	-	-	-	1	-	-	1	3	3	-
3	3	2	3	1	1	-	-	-	1	1	-	1	3	3	-
4	3	3	3	2	1	-	-	-	1	1	-	1	3	3	-
5	3	3	3	2	1	-	-	-	1	1	-	1	3	3	-
Overall CO	**2.6**	**2.6**	**2.6**	**1.8**	**1.2**	**-**	**-**	**-**	**1**	**1**	**-**	**1.0**	**3.0**	**3.0**	**-**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23024	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- understand the global trends and development methodologies of various types of products and services
- conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT – I: FUNDAMENTALS OF PRODUCT DEVELOPMENT 9

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - **Introduction to Product Development Methodologies and Management** - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies- Product Life Cycle – Product Development Planning and Management.

UNIT – II: REQUIREMENTS AND SYSTEM DESIGN 9

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - **System Design & Modelling** -Introduction to System Modelling - System Optimization - System Specification - Sub-System Design - Interface Design.

UNIT – III: DESIGN AND TESTING 9

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – **Challenges in Integration of Engineering Disciplines** – Concept Screening& Evaluation - **Detailed Design** - Component Design and Verification – **Mechanical, Electronics and Software Subsystems** - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – **Prototyping** - Introduction to Rapid Prototyping and Rapid Manufacturing- System Integration, Testing, Certification and Documentation.

UNIT – IV: SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation- **Sustenance** -Maintenance and Repair – Enhancements - **Product EoL** – Obsolescence Management – Configuration Management - EoL Disposal.

UNIT – V: BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9

The Industry - Engineering Services Industry - Product Development in Industry versus Academia–**The IPD Essentials** - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Define, formulate and analyse a problem
CO2: Solve specific problems independently or as part of a team
CO3: Gain knowledge of the Innovation & Product Development process in the Business Context
CO4: Work independently as well as in teams
CO5: Manage a project from start to finish

TEXT BOOKS:

1. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", TataMcGrawHill, Fifth Edition, 2011.
2. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

REFERENCES:

1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford,2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013

PROGRAMME OUTCOMES															
CO’s	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1	1	2	-	-	-	1	1	-	1	1	1	1
2	1	1	1	1	2	-	-	-	1	1	-	2	1	1	1
3	3	2	2	1	3	-	-	-	1	1	-	2	1	1	1
4	2	2	2	2	2	1	-	-	1	1	2	2	1	1	2
5	2	2	3	3	3	2	-	2	2	2	3	3	1	1	2
Overall CO	**1.8**	**1.6**	**1.8**	**1.6**	**2.4**	**1.5**	**-**	**2.0**	**1.2**	**1.2**	**2.5**	**2.0**	**1**	**1**	**1.4**

Course 1-low, 2-medium, 3-high, ‘-“- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23025	BIO-INDUSTRIAL ENTREPRENEURSHIP & IPR	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Discuss about the factors for the development of Entrepreneurship skills and to explain the process involved in IPR.

UNIT – I: **9**

- Should You Become an Entrepreneur? What Skills Do Entrepreneurs Need?
- Entrepreneurship and intrapreurship
- Identify and Meet a Market Need
- Entrepreneurs in a Market Economy
- Select a Type of Ownership

UNIT – II: **9**

- Choose Your Location and Set Up for Business
- Market Your Business
- Hire and Manage a Staff
- Develop a Business Plan

UNIT – III: **9**

- Finance, Protect and Insure Your Business
- Record Keeping and Accounting
- Financial Management

UNIT – IV: **9**

- Types of Intellectual property (IP): Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology.
- Indian Patent Act 1970 & recent amendments

UNIT – V: **9**

- Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition
- Specifications: Provisional and complete Specifications: Provisional and complete; Forms and fees Invention in context of “prior art
- National and PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for. Patent licensing and agreement Patent infringement-meaning, scope, litigation, case studies.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

- CO1 know the basic requirement for being an entrepreneur
- CO2 Know the basics of a business plan
- CO3 Know the fundamentals of finance and its management to set up a business
- CO4 know how to design and implement a successful commercial venture
- CO5 know how to safeguard his innovation/idea via patenting

TEXT BOOKS:

1. Entrepreneurship Ideas in Action—South-W estern, 2000.
2. Business Idea the Early Stages of Entrepreneurship Soren Hougaard Publisher: Springer, Year: 2004

REFERENCES:

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
2. Pharmaceutical Substances. Syntheses, Patents, Applications Kleemann Publisher: Thieme, Year 2001

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	1	1	1	1	1	1	2	2	-	-	2	1	1	2
2	-	1	1	2	2	2	1	3	2	2	-	2	1	2	2
3	-	1	1	1	1	2	1	3	2	2	3	2	1	2	2
4	1	1	2	1	2	2	1	3	2	2	-	2	1	1	2
5	1	1	2	2	2	3	1	3	2	2	3	2	1	1	2
Overall CO	1	1	1.4	1.4	1.6	2.0	1	2.8	2.0	2	3	2.0	1	1.4	2.0

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23026	BASIC PROGRAMMING IN COMPUTATIONAL BIOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

To introduce the student to the role of programming and database management in analyzing and interpreting biological data

UNIT I INTRODUCTION TO COMPUTATIONAL BIOLOGY AND PROGRAMMING BASICS **9**

Introduction to computational biology, Importance of programming in biological research, Applications in genomics, proteomics, and systems biology, Overview of R programming language, Introduction to relational databases and MySQL, Key differences and complementary use of R and MySQL

UNIT II DATA MANAGEMENT AND ANALYSIS WITH R **9**

Basic commands and navigating the environment, Variables, data types, and operators, Vectors, matrices, data frames, and lists, Importing and exporting data, Control structures: loops and conditionals, Writing and using functions, Subsetting, filtering, and arranging data, Creating and customizing plots for biological data

UNIT III INTRODUCTION TO MYSQL AND DATABASE MANAGEMENT **9**

Overview of relational databases and SQL, Database design principles, Understanding tables, relationships, and keys, Creating and managing databases, Designing tables and setting up schemas, Inserting, updating, and deleting data, Basic SQL syntax and commands, Data retrieval with SELECT statements.

UNIT IV ADVANCED MYSQL AND INTEGRATING WITH R **9**

Filtering and sorting data using WHERE, ORDER BY, and GROUP BY clauses, Joining tables and complex queries, Subqueries and nested queries, Introduction to views and indexes, Setting up R-MySQL connection using RMySQL package, Performing basic SQL queries from R, Importing data from MySQL to R for analysis

UNIT V APPLICATIONS OF R AND MYSQL IN COMPUTATIONAL BIOLOGY **9**

Best practices for data storage and retrieval using MySQL, Designing a workflow for biological data analysis, Visualizing results of SQL queries in R, Creating comprehensive reports integrating R and MySQL outputs, Application of statistical methods to a real-world biological dataset, Visualization and interpretation of results

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

- **CO1** get acquainted with basics of biological data and fundamentals of R and MySQL
- **CO2** Use R to manipulate, analyze, and visualize biological data
- **CO3** Understand and implement relational databases in MySQL, and execute SQL queries
- **CO4** Combine R and MySQL to build efficient data pipelines for analyzing large-scale biological datasets
- **CO5** Design a workflow using R and MySQL for organizing and analyzing biological data

TEXT BOOKS:

1. R Programming for Bioinformatics by Robert Gentleman, *ISBN:* 978-1420063677, Chapman and Hall/CRC; 1st edition
2. Building Bioinformatics Solutions: With Perl, R And Mysql by Bessant Conrad, ISBN-10 : 019958690X, Oxford University Press
3. Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python by Peter Bruce and Andrew Bruce, ISBN: 978-1491952962, O'Reilly Media; 1st edition
4. Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools by Vince Buffalo, *ISBN:* 978-1449367374, O'Reilly Media; 1st edition

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
2	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
3	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
4	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
5	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
Overall CO	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**1**	**3**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23030 MOLECULAR SIMULATIONS IN BIOTECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES

The course aims to

- To impart knowledge on the molecular behaviour of biomolecules proteins, nucleic acids and small molecules in the biological system.
- To enable the students to understand the principles involved in molecular simulation
-

UNIT – 1: INTRODUCTION **9**

Overview of Biomolecular Structure Introduction-Molecular Modeling, Statistical Mechanics, Introduction to Quantum Mechanics- Schrodinger equation

UNIT – II: MOLECULAR MECHANICS **9**

Force Fields, General features of Molecular Mechanics Force Fields, Types of Force Fields, Components of Force Fields, Introduction – Monte Carlo

UNIT – III INTRODUCTION TO MOLECULAR DYNAMICS SIMULATION **9**

Molecular Dynamics Simulation-Introduction, Molecular units and timescales, Energies, Equations of motion, Newtons laws of motion – time intervals- trajectories, phase space, Temperature, velocity distributions, elements of an MD simulation.

UNIT – IV MOLECULAR DYNAMICS SIMULATION METHODS **9**

Setting up and Running a Molecular Dynamics Simulation Various forcefields for proteins and nucleic acids –Molecular dynamics simulations in water and organic solvents. Preparing input files and setting up parameters

UNIT V MOLECULAR DYNAMICS SIMULATION SOFTWARE **9**

Introduction to Various MD Software- GROMACS-AMBER- examples and case studies, Analysis of MD Simulation results and interpretation

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the students would be able to

- CO1 to understand the behaviour of Small and macro molecules in biological system
- CO2 to understand the Force Fields and its features
- CO3 Understand and apply Molecular Dynamics Simulation to biomolecules
- CO4 simulate the biomolecules using molecular modelling software.
- CO5 assess and utilize various software and tools which utilizes Molecular dynamics simulations methods

TEXT BOOKS:

3. Leach, Andrew R. “Molecular Modelling: Principles and Applications” IInd Edition, Pearson, 2010.
4. Ramachandran, Deepa and Namboori,” Computational Chemistry and Molecular
   Modeling-Principles and Applications”, Springer, 2008
5. Alan Hinchliffe, “MolecularModelling for Beginners”, (2nd Edition) John Wiley & Sons
   Ltd. 2008

REFERENCES:

1. Cohen, N.C. “Guide Book on Molecular Modeling in Drug Design” Academic Press/ Elsevier, 1996
2. Tamar Schlick “Molecular Modeling and Simulation – An interdisciplinary Guide” Springer, 2010

Course Articulation Matrix															
CO’s	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	1	2	-	-	-	-	-	-	1	2	1	1
2	2	2	2	2	3	1	-	-	-	-	-	2	2	3	1
3	3	2	3	2	2	-	-	-	-	-	-	1	3	3	2
4	3	3	2	2	3	1	-	-	-	-	-	2	3	3	1
5	3	2	2	2	3	-	-	-	-	-	-	2	3	3	3
Overall CO	**2.**	**2**	**2**	**1.**	**2.**	**1**	**-**	**-**	**-**	**-**	**-**	**1.**	**2.**	**2.**	**1.**

Course 1-low, 2-medium, 3-high, ‘-“- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23027	ALGORITHMS IN BIOMOLECULAR ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to

- To explain protein and nucleotide sequence related algorithms
- To impart knowledge to understand and apply DP and sequence-based algorithms
-

UNIT – 1: INTRODUCTION TO ALGORITHM **9**

Algorithms-Complexity of algorithms and running time, Polynomial, NP complete problems, Exhaustive search, Branch and Bound, divide and conquer algorithms, sorting

UNIT – II: EXACT MATCH AND HIDDEN MARKOV MODELS **9**

Boyer-Moore algorithm for exact match, Hidden Markov Model: Forward and Backward Algorithms, Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA.

UNIT – III DNA AND RNA RELATED ALGORITHMS **9**

Finding regulatory motifs in DNA, Suffix Trees, RNA secondary structure prediction: Base pair maximization and the Nussinov folding algorithm, Energy minimization algorithm, Application of RNA Fold.

UNIT – IV DYNAMIC PROGRAMMING AND SEQUENCE BASED ALGORITHMS **9**

Dynamic programming Principles and its uses. Local and Global alignment principles, finding longest common subsequences, Models of evolution.

UNIT V SEQUENCE ASSEMBLY AND PROTEIN STRUCTURE **9**

DNA sequencing, shortest super-string problem, sequencing by Hybridization as a Hamiltonian Path Problem, Randomized algorithms: Gibbs Sampling, Protein sequencing and identification, spectral graphs and spectral alignment, Protein structure prediction- Secondary structure prediction algorithms.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the students would be able to

- CO1 Understand the design and implementation of algorithms used in Biology
- CO2 Understand and illustrate DNA and RNA related algorithms
- CO3 Understand and apply dynamic programming and sequence based algorithms for sequence alignment.
- CO4 Formulate simple algorithms for user defined problems
- CO5 Apply the tools based on these algorithms to make meaningful interpretations

TEXT BOOKS:

1. Neil C. Jones and Pavel .A Pevzner An introduction to Bioinformatics Algorthims.(computational Molecular Biology) (2004) MIT press. ISBN-10: 0262101068
2. R. Durbin, S.Eddy, A.Krogh, G.Mitchison Biological sequence analysis : Probabilistic
   models of Proteins and Nucleic acids (2013) Cambridge University Press 0521540798
3. Dan GusfieldAlgorthims on Strings, Trees and Sequences: Computer Science and
   Computational Biology (1997) Cambridge University Press. ISBN-10: 0521585198

REFERENCES:

1. Michael.S.Waterman Introduction to Computational Biology: Maps, Sequences and Genomes. Waterman. reprint(2018) Chapman and Hall/ CRC Press ISBN: 1439861315
2. Horowitz, S. Sahini, and Rajasekharan: Fundamentals of Computer Algorithms (2004)
   Galgotia Publications. ISBN-10: 81-7515-257-5.

Course Articulation Matrix															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	1	2	-	-	-	-	-	-	1	2	1	1
2	2	2	2	2	3	1	-	-	-	-	-	2	2	3	1
3	3	2	3	2	2	-	-	-	-	-	-	1	3	3	2
4	3	3	2	2	3	1	-	-	-	-	-	2	3	3	1
5	3	2	2	2	3	-	-	-	-	-	-	2	3	3	3
Overall CO	**2.**	**2**	**2**	**1.**	**2.**	**1**	**-**	**-**	**-**	**-**	**-**	**1.**	**2.**	**2.**	**1.**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23031	COMPUTATIONAL ANALYSIS OF GENOMES, EVOLUTION, AND NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES

To provide a comprehensive understanding of computational methods for analyzing genomic data, evolutionary processes, and biological networks

UNIT I INTRODUCTION TO GENOMIC DATA AND COMPUTATIONAL TOOLS **9**

Introduction to genomic data and its biological significance, Basic principles of DNA sequencing and genome assembly, Genome types and their characteristics, Introduction to genomic databases, genome alignment, Gene prediction and annotation tools, Basic scripting for genomic data analysis

UNIT II EVOLUTIONARY ANALYSIS OF GENOMES **9**

Molecular evolution and phylogenetics, Comparative analysis of genomes across species, Orthologs and paralogs: identification and significance, Evolutionary conservation and divergence, Constructing phylogenetic trees using computational tools, Interpreting phylogenies and understanding evolutionary relationships, Molecular clocks and evolutionary rates

UNIT III NETWORK THEORY AND BIOLOGICAL NETWORKS **9**

Basics of network theory: nodes, edges, paths, and cycles, Types of networks: random, scale-free, small-world, Introduction to biological networks: protein-protein interaction networks, metabolic networks, gene regulatory networks, Properties of biological networks, Tools and software for analyzing biological networks, Network visualization techniques

UNIT IV INTEGRATIVE ANALYSIS OF GENOMES, EVOLUTION, AND NETWORKS **9**

Combining phylogenetic data with genomic features, Evolutionary constraints on gene networks, Applying network theory to identify key genes and pathways, Predicting gene function through network analysis, Integrative analysis of transcriptomics, proteomics, and metabolomics data.

Examples of successful integration of genomics, evolution, and network analysis in biological research

UNIT V PRACTICAL APPLICATIONS AND EMERGING TRENDS **9**

Genomic medicine: personalized genomics, pharmacogenomics, Biotechnology applications: synthetic biology, CRISPR-based genome editing, Handling large-scale genomic and network data, Current research and future directions in computational genomics and network biology, Artificial intelligence and machine learning applications in genomics and networks

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

- **CO1** Demonstrate proficiency in using computational tools to analyze and interpret genomic data
- **CO2** Use evolutionary biology concepts to perform comparative genomics and construct phylogenetic trees.
- **CO3** Apply network theory to study the structure and dynamics of biological networks.

- **CO4** Combine data from various sources to do comprehensive analyses and generate biological insights
- **CO5** Apply the knowledge gained to real-world and present findings effectively.

TEXT BOOKS:

5. Bioinformatics and Functional Genomics by Jonathan Pevsner, *ISBN:* 978-1118581780, Wiley-Blackwell.
6. Phylogenetics: Theory and Practice of Phylogenetic Systematics by E.O. Wiley and Bruce S. Lieberman, *ISBN:* 978-0470905968, Wiley-Blackwell.
7. Networks, Crowds, and Markets: Reasoning About a Highly Connected World by David Easley and Jon Kleinberg, *ISBN:* 978-1107606649, Cambridge University Press
8. Evolutionary Genomics and Systems Biology edited by Gustavo Caetano-Anollés, *ISBN:* 978-1118210710, Wiley-Blackwell

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
2	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
3	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
4	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
5	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
Overall CO	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23028	COMPUTATIONAL PROTEIN STRUCTURE PREDICTION	L	T	P	C
		3	0	0	3

OBJECTIVES

To introduce the student to fundaments of protein structures, experimental methods to determine protein structures, modes of secondary and tertiary structure prediction using *in silico* methods and the applications of protein structure prediction

UNIT I: INTRODUCTION TO PROTEIN STRUCTURE **9**

Principles of protein design, Amino acid properties and their impact on protein structure, Overview of protein structure: primary, secondary, tertiary, quaternary, Ramachandran map, Types of interactions in proteins, Protein folding and stability

UNIT-II: PROTEIN STRUCTURAL HIERARCHY **9**

Structural Hierarchy, Motifs and domains: domain structures, Multi-domain proteins, Study of prototype protein under each category - alpha, beta, alpha-beta structures, lysozyme, immunoglobulins, membrane proteins, structure of viruses, Protein visualization tools – Pymol and Chimera

UNIT-III: Experimental protein structure determination **9**

X-ray crystallography: Crystals to protein structure, Nuclear Magnetic Resonance (NMR) spectroscopy in protein structure determination, Cryo-Electron Microscopy (Cryo-EM) for large protein complexes, Comparison of experimental methods, Structural genomics

UNIT – IV: PROTEIN STRUCTURE PREDICTION **9**

Methods for predicting secondary structures: Chou-Fasman, GOR, machine, Multiple sequence alignment method, Evaluating the accuracy of secondary structure predictions, prediction of protein tertiary Structure, Threading, *ab initio* and Homology Modeling methods, Structure validation techniques, Critical Assessment of Structure Prediction

UNIT – V Applications in Drug Discovery and Recent advances **9**

Protein structure analysis, Protein-protein and Protein-DNA Interactions, Protein structure comparison, Molecular Docking, Structure-based drug designing approaches, Tools and Molecular docking programs: AutoDock, HEX, Deep learning approaches in protein structure prediction and analysis

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

- CO1 get acquainted with overview of protein structure and principles of protein folding
- CO2 acquire knowledge on protein structure-function correlation
- CO3 acquaint with the experimental techniques for protein structure determination
- CO4 utilize computational tools and techniques for protein structure prediction
- CO5 apply and understand protein-structure in interactions and drug designing

TEXT BOOKS:

1. Branden, Carl, and Tooze, John. Introduction to Protein Structure. 2nd ed., Garland Science, 1999.
2. Höltje, Hans-Dieter, Sippl, Wolfgang, Rognan, Didier, and Folkers, Gerd.

Molecular Modeling: Basic Principles and Applications. 3rd ed., Wiley-VCH, 2008.
3. Mount, David W. Bioinformatics: Sequence and Genome Analysis. 2nd ed., Cold Spring Harbor Laboratory Press, 2004.
4. Gu, Jenny, and Bourne, Philip E., editors. Structural Bioinformatics. 2nd ed., Wiley-Blackwell, 2009.
5. Zaki, Mohammed, and Bystroff, Chris, editors. Protein Structure Prediction: Methods and Protocols. Humana Press, 2007.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
2	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
3	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
4	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
5	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3
Overall CO	3	2	3	2	3	3	3	2	2	2	3	2	2	1	3

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

OPEN ELECTIVE II (OFFERED TO OTHER DEPARTMENTS)

IB23901	INTRODUCTION TO BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- provide an introduction to biotechnology
- make the students aware of the basic principles and techniques in biotechnology
- make the students aware of the interdisciplinary potentials of biotechnology

UNIT – I: INTRODUCTION TO BIOTECHNOLOGY & IT'S SCOPE 9

Definition of biotechnology, mile stones in biotechnology – Who can be a biotechnologist? Applications of biotechnology in interdisciplinary (Mathematics, Chemistry, Microbiology, Aquaculture etc) and engineering (Fermentation Technology, Electronics, Plastic Technology etc) specialties, Future prospects of biotechnology industries – GM crops, animals, microbes, etc.

UNIT – II: PROTEINS AS PRODUCTS 9

Definition of Proteins: Amino Acids – Structure, Functions and Uses; Structure, Function and Importance of Proteins. Uses of Proteins: Therapeutic proteins eg. used for treatment of irritable bowel syndrome, Branch Chain Amino Acids; A protein from the industry using microbes: Corynebacterium sp. – A case study, recombinant proteins, enzymes: Streptokinase, amylase, lipase etc., Production of recombinant human insulin.

UNIT – III: DNA, GENES, GENOMES & RDNA TECHNOLOGY 9

DNA: Structure – Gene: One gene one Enzyme concept, One Gene many enzymes concept, one gene many polypeptides concept, Genomes, what is genomics? – Transgenic animals and their applications, DNA Vaccines, Edible vaccines, what is recombinant DNA Technology? – A Case study

UNIT – IV: MEDICAL BIOTECHNOLOGY 9

Gene testing – identification of protein and genetic disorders, Gene screening – a tool for phenotypic screening e.g., Cancer identification & Gene therapy e.g., Cystic Fibrosis as a case study, Transgenic Pigs as an artificial organ donor.

UNIT – V: DNA FINGERPRINTING,FORENSIC SCIENCE & ETHICS IN BIOTECHNOLOGY 9

Case study – Homicide, Disputed parentage, Immigration issues, Ethics in Biotechnology – GM crops – Ethical issues; Golden Rice – Eradication of Blindness

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: make the students aware of the basic principles of biotechnology

CO2: be aware of the various techniques in biotechnology

CO3:make the students aware of the applications of biotechnology in the field of pharmaceuticals and medicine

CO4: make the students understand the importance of biotechnological techniques in the detections and early intervention against diseases

CO5: make the students aware of the prospects of biotechnology in crime detection and also make them aware of the ethic and regulations involved

TEXT BOOKS:

1. "Essential Cell Biology", third edition, Alberts, Bray et al, Garland Science,2010.
2. "An Introduction to Genetic Engineering", third edition Desmond S T Nicholl Cambridge University Press 2008

REFERENCES:

1. "An Introduction to human molecular genetics -mechanisms of inherited diseases", second edition Jack J Pasternak, Wiley-LSS,2005.
2. " Diagnostic tests in Genetics ", ed Jean Louis Serre, John Wiley & Sons,2006.

PROGRAMME OUTCOMES												
CO's	**PO's**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	3	-	-	-	-	-	-	-	-	1	-	1
2	3	-	-	-	-	-	-	-	-	1	-	1
3	3	-	-	-	1	2	-	-	-	1	-	1
4	3	-	-	-	1	2	-	-	-	1	-	1
5	3	3	3	3	1	-	-	2	-	1	-	1
Overall CO	**3**	**3**	**3**	**3**	**1**	**2**	**-**	**2**	**-**	**1**	**-**	**1**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix

IB23902	INTRODUCTION TO ENZYMES	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to

- To learn the basics of the various aspects in enzyme technology
- To apply the enzyme technology in their respective disciplines.

UNIT – I: CLASSIFICATION, MECHANISM AND REGULATION OF ENZYME ACTIVITY 9

Introduction to enzymes, Interaction between enzyme and substrates, lock and key model, induced fit model features of active sites, activation energy. Nomenclature and classification of enzymes; mechanism and regulation of enzyme activity.

UNIT – II: OPTIMIZATION OF ENZYME ACTIVITY BY VARIOUS PHYSICO-CHEMICAL METHODS 9

Basic kinetics of enzymatic reactions, MichaelisMenten kinetics, Estimation of kinetic constants, Kcat, turnover number, specific activity, Factors affecting enzyme activity; pH, temperature, substrate and product, concentration. Substrate, product and allosteric inhibition.

UNIT – III: IMMOBILIZED ENZYMES AND BIOTRANSFORMATION 9

Various methods of Stabilizing enzymes, immobilization of enzymes, various methods of immobilization methods, adsorption, chemical methods, covalent, ion exchange, Basic mass transfer limitations in immobilized enzymes. Application of immobilized enzymes in various biotransformations

UNIT – IV: PRODUCTION OF ENZYMES FROM VARIOUS SOURCES 9

Isolation and extraction of enzymes from plant,animal and microbial sources, Enzyme production from native strains for proteases, cellulases and other enzymes, Enzyme production form recombinant strains such as *E. coli, Pichia pastoris, Aspergillus niger*etc.

UNIT – V: APPLICATION OF ENZYMES FOR INDUSTRIAL APPLICATIONS 9

Application of enzymes for commercial biotransformation processes such synthesis of fine chemicals, food, textiles and leather industries. Application enzymes in energy and environment. Biomedical application of enzymes such as biosensors etc.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

CO1 : Explain the mechanism and function of enzymes and its classification
CO2 : Learning to optimize the function of enzymes
CO3 : Immobilized enzymes and biotransformation
CO4 : Production of enzymes from various sources
CO5 : Understand the industrial application of enzymes

TEXT BOOKS:

1. Enzymes Biocatalysis: Principles and Applications byAndrés Illanes (2008) ISBN 978-1-4020-8361-7.

2. Enzyme: Catalysis, kinetics and mechanisms by N.S. Punekar (2018). ISBN 978-981-13-0784-3.

REFERENCES:

1. Fundamentals of Enzymology: The cell and molecular Biology of Catalytic Proteins by Nicholas C. Price, Lewis Stevens, and Lewis stevens, Oxford University Press, USA
2. Enzymes in Industry: Production And Applications by Aehle W (2007) John Wiley & Sons Inc
3. Nelson, D.L et al., "Lehninger's Principles of Biochemistry" Stryer, Lubert. "Biochemistry". IV Edition, W.H Freeman & Co., 2000.
4. Voet, D.J and J.G. Voet and C.W. Pratt "Principles of Biochemistry" IIIrd Edition, John Wiley & Sons Inc., 2008.
5. Murray, R.K., et al., "Harper's Illustrated Biochemistry". XXVIIth Edition. McGraw-Hill, 2006.

PROGRAMME OUTCOMES												
CO's	**PO's**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	3	-	-	-	-	-	-	-	-	1	-	1
2	3	3	3	3	-	-	-	-	-	1	-	1
3	3	3	3	3	1	2	-	-	-	1	-	1
4	3	-	-	-	1	3	-	-	-	1	-	1
5	3	-	-	-	1	-	2	2	-	1	-	1
Overall CO	**3**	**3**	**3**	**3**	**1**	**2.5**	**2.0**	**2**	**-**	**1**	**-**	**1**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

EMERGING TECHNOLOGY COURSES (ETC)

IB23E06	METHODS IN MOLECULAR DIAGNOSTICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To impart knowledge on key and recent techniques involved in molecular diagnostics.

UNIT – 1: PCR based diagnostics **9**

Polymerase chain reaction – Primer designing and validation, Optimization of PCR – Gradient PCR, Touchdown PCR, Hot Start PCR and Nested PCR. Multiplexing, Absolute Vs. Relative quantitation, Normalization methods in qPCR (ΔCt and ΔΔCt). Types and applications of PCR in diagnostics with examples.

UNIT – II: Isothermal amplification based diagnostics **9**

Loop mediated amplification (LAMP), Strand displacement amplification (SDA), Nucleic acid sequence based amplification (NASBA), Recombinase polymerase amplification (RPA) and Helicase dependent amplification (HDI). Applications of isothermal amplification in diagnostics with examples. Advantages and limitations of isothermal amplification.

UNIT – III: Sequencing based diagnostics **9**

Preparation of templates for sequencing – Fragmentation Vs. Tagmentation, Library preparation, Suppression PCR, Overview about next generation DNA sequencing (NGS). Thrid generation sequencing – Nanopore and PacBio SMRT sequencing. Applications of probe based diagnostics with examples.

UNIT – IV: Probe based diagnostics **9**

Basic principles of array techniques. Solid- and liquid-phase array technologies. Array assays – Expression arrays, Array CGH, Resequencing arrays, SNP arrays, Arrays for multiplexed PCR assays. Fluorescence *in-situ* hybridization (FISH). Applications of probe based diagnostics with examples.

UNIT – V: CRISPR/Cas based diagnostics **9**

Overview about CRISPR/Cas system. Pre-amplification and amplification-free diagnostics. Toehold sensor and collateral cleavage based signal detection. Canonical Vs. Non-canonical crRNAs. Multiplexing with CRISPR/Cas systems – LEOPARD and CARMEN. Optimization of assay for applications at the Point-of-care (POC). Examples of CRISPR/Cas based diagnostic methods – NASBACC, DETECTR, HOLMES and HOLEMSv2, SHERLOCK and SHERLOCKv2.

TOTAL: 30 PERIODS

OUTCOMES:

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

- CO1 Understand the strength and limitations of PCR tools in diagnostics
- CO2 Understand the role of isothermal amplification in molecular diagnostics

- CO3 Understand the advanced sequencing technologies in molecular diagnostics.
- CO4 Understand the nucleic acid probe based molecular diagnostics
- CO5 Understand the advancement in CRISPR based molecular diagnostics
-

TEXT BOOKS:

1. Nader Rifai, A. Rita Horvath, Carl T. Wittwer, Jason Park, "Principle and Applications of molecular diagnostics" 2018
2. Patricia Marques, "Molecular Diagnostics", 2017.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	3	3	2	2	3	-	-	-	-	3	3	3	3
2	1	2	3	3	3	3	3	-	-	-	-	3	3	3	3
3	2	2	3	3	3	3	3	-	-	-	-	3	3	3	3
4	1	2	3	3	3	3	3	1	-	-	-	3	3	3	3
5	1	2	3	3	3	3	3	1	2	1	-	3	3	3	3
Overall CO	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**-**	**3**	**3**	**3**	**3**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23E05	IMMUNOTHERAPY AND IMMUNOINFORMATICS	L	T	P	C
		3	0	0	3

OBJECTIVES

The course aims to,

- Make understanding the concepts and computational aspects of immunology
- Inculcate the tools and databases related to immunoinformatics studies.

UNIT I: Introduction - Types of immunity - innate and adaptive; Cells and organs of the immune system; Antigens - epitopes, antigenicity, factors influencing antigenicity, antigen processing and presentation; Antibodies - structure and function, haptens, adjuvants, mitogens; Major Histocompatability Complex (MHC); Applications of immunoinformatics. Immunoglobulins- Structure and function-- Monoclonal antibodies. B Cell generation and differentiation: BCR--Antibody diversity: Genetic basis—T- dependent activation of B cells- B lymphocyte signal transduction. Cytokines. Complement system. **9**

UNIT II: Antigen- antibody interaction: antibody affinity and activity- Isolation of lymphoid cells from blood and lymphoid organs-- precipitation reaction, agglutination reaction --Radioimmunoassay, ELISA, Western Blot, Immunoprecipitation, Immun-fluoresence, flow cytometry. Cell cultures and Experimental animal models. Analysis of gene expressions. **9**

UNIT III: Sequence analysis- Alignments- DNA alignments- Molecular evolution and phylogeny viral evolution and escape- prediction of functions. Methods applied in Immunological Bioinformatics- starting from sequence weighing methods to cluster analysis- Gibbs Sampling, HMM- Neural network- microarray and its applications. **9**

UNIT IV: MHC- I prediction- Prediction of Cytotoxic T Cell (MHC Class I) Epitopes- Antigen Processing in the MHC Class I Pathway. MHC-II prediction - Prediction of Helper T Cell (MHC Class II) Epitopes- Processing of MHC Class II Epitopes; B cell epitope prediction and web sources - Recognition of Antigen by B Cells vaccine design - Web-Based Tools for Vaccine Design. The IMGT Immunoinformatics page- Databases associated with Immunoglobulins (or Antibodies) (IG), T cell receptors (TR), Major histocompatibility (MH), Antigens, Allergens, Peptides binding to MHC. **9**

UNIT V: Hybridoma technology for mass production-Chimeric antibodies, antibody engineering via computational tools, large scale manufacture of antibodies. CAR-T cells therapy, immunotherapy – antibody therapies, Vaccine development and Immunoinformatics; Recombinant vaccines, combined vaccines, polyvalent vaccines. Immunoinformatics, databases in immunology, DNA, Plant and protein based recombinant antigens as vaccines. **9**

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

- CO1 Familiarize with the basic cellular machinery of immune system.
- CO2 Design vaccines by understanding the mechanism of the recognition of pathogen and its antigens.
- CO3 Evaluate individual differences in disease susceptibility through Immunoinformatics tools.
- CO4 Analyze and predict the epitopes and antigen-antibody interactions by acquainting the principles of immunology and Immunoinformatics database and

tools.

- CO5 Vaccine development and modelling using immunoinformatics tools.

TEXT BOOKS:

1. Immunological Bioinformatics‖ Ole Lund Darren Flower, MIT press, Springer September 2005, 2006.
2. Immunoinformatics: Predicting Immunogenicity in Silico‖ Darren R Flower Humana Press 2007

REFERENCES:

1. ImmunoinformaticsBioinformatics Strategies for Better Understanding of Immune Function‖ Rammensee Wiley 2003
2. Computational Immunology: Basics ShyamasreeGhosh CRC Press 2020
3. Kuby Immunology Thomas J. Kindt , Richard A. Goldsby, Barbara A borne W. H. Freeman & Company 2006

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	2	1	2	1	-	1	-	-	-	1	2	2	2
2	1	1	3	3	1	2	-	1	-	-	-	3	2	2	3
3	1	1	3	3	2	2	-	1	-	-	-	3	3	3	3
4	1	1	3	3	2	1	-	1	-	-	-	3	3	3	3
5	1	1	3	3	2	2	-	1	-	-	-	3	3	2	2
Over all CO	**1**	**1**	**2.8**	**2.6**	**1.8**	**1.6**	**-**	**1**	**-**	**-**	**-**	**2.6**	**2.6**	**2.4**	**2.6**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

SKILL DEVELOPMENT COURSES (SDC)

IB23S02	COMPUTER AIDED DRUG DESIGN	L	T	P	C
		2	0	0	2

OBJECTIVES

The course aims to,

- learn about modern techniques of drug design, which include quantitative structure activity relationship (QSAR)
- learn about prodrug concept, combinatorial chemistry and Computer aided drug design (CADD)
- learn about planning and selection of In-silco approaches and tools

UNIT I STEREOCHEMISTRY AND DRUG DESIGN **6**

Structurally Rigid Groups – Conformation – Configuration, Introduction to Drug Discovery and Development: Stages of drug discovery and development, Drug properties and Databases, Introduction to Virtual Screening.

UNIT II STRUCTURE ACTIVITY RELATIONSHIP **6**

Changing size and shape – degree of unsaturation, Addition and removal of ring system – New substitutions – methyl – halogen. Basic groups – changing existing substituents for a lead compound, Structure and property - Drug likeness, ADME.

UNIT III QUANTITATIVE STRUCTURE – ACTIVITY RELATIONSHIP **6**

QSAR- Pharmacophore based approach, Scaffold hopping ,Target based design, Partitional parameters – partition coefficients – hepo substituent constants – electronic parameters – Hammet constant steric parameters – Hansch analysis.

UNIT IV: DOCKING **6**

Docking ligands to macromolecules – Structure based and ligand based approaches, Scoring functions, Docking algorithms – Introduction to AUTODOCK.

UNIT V: MOLECULAR SIMULATIONS **6**

Introduction to Molecular Dynamic Simulations – Force Field, Energy Minimisation, Introduction to GROMACS – Setup, run MD Simulation of a Protein and Analyse the results.

TOTAL: 30 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

- CO 1: understand various stereo chemical aspects of drug binding
- CO 2: understand Quantitative Structure Activity Relationship
- CO 3: perform and analyse various in-silico docking and MD Simulations experiments in drug research

TEXT BOOKS:

1. Patrick Bultinck , Hans De Winter , Wilfried Langenaeker, Jan P. Tollenare, Computational Medicinal Chemistry for Drug Discovery 1st Edition Marcel Dekker Inc. , 2004
2. Andrew R. Leach Molecular Modeling Principles and Applications (2nd Ed.). Prentice Hall ,2009

3. Cohen, N.C. “Guide Book on Molecular Modeling in Drug Design”, Academic Press / Elsevier, 2006
4. Eliel, E.L. “StereoChemistry of Organic Compounds”, John Wiley, 1994.

REFERENCES:

1. Frenkel, Dean and Berend Smith “Understanding Molecular Simulation: From Algorithms to Applications”, 2nd Edition Academic Press, 2002.
2. Lee, Mike S. “Integrated Strategies for Drug Discovery using Mass Spectrometry” John Wiley – Interscience, 2005.
3.

PROGRAMME OUTCOMES															
CO’s	**PO’s**												**PSO’s**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	-	-	-	-	-	-	-	-	1	1	3	-
2	3	3	2	2	2	-	-	-	-	-	-	2	3	3	2
3	3	3	3	3	2	-	-	1	-	-	-	3	3	3	2
4	3	3	3	2	2	2	2	1	1	-	-	1	3	3	2
5	3	2	3	3	2	3	2	1	1	-	1	1	1	3	-
Overall CO	**2.8**	**2.6**	**2.4**	**2.5**	**2.0**	**2.5**	**2**	**1**	**1**	**-**	**1**	**1.6**	**2.4**	**3**	**2**

Course 1-low, 2-medium, 3-high, ‘-“- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23S03	HIGH THROUGHPUT DATA ANALYSIS	L	T	P	C
		2	0	0	2

OBJECTIVES

The course aims to,

- Develop competence in quantitative methods for the analysis of high-throughput data in molecular biology.
- Impart knowledge on how to think about issues that will come up in high-throughput data, *viz.* systematic and correlated technical errors, normalization of data, correlated variability due to similar biological function, approximate significance estimation, and biologically meaningful testing.

UNIT I: Analysis of Array-Based Assays **6**

Comparative genomic hybridization arrays – Models for oligo probe sets, normalization and segmentation, Normalization of immuno-precipitation (IP) arrays, Chromatin IP and Methylated DNA IP arrays -- estimation by moving average, Biological issues in moving average techniques.

UNIT II: High-throughput sequencing data analysis **6**

Overview of NGS and its data analysis. Problems in mapping reads, Variations in representation of sequences, Normalization of raw count data, ChIP-Seq analysis, RNASeq analysis, Metagenomic data analysis

UNIT III: Quality assessment and normalization of arrays data **6**

Comparison of normalization strategies for expression data, Advantages and limitations of quantile normalization, Systematic errors and correlated differences, Approaches to normalization by estimating technical distortion, Normalization by singular value decomposition.

UNIT IV: Determination of significance and multiple comparisons **6**

Simes' Lemma and FDR theory, Permutation procedures for FDR, Stein's Theorem and shrinkage procedures for reducing overall error, SAM and Empirical Bayes procedures
Power Calculations

UNIT V: Multivariate analysis of pathways and Gene Ontology functional groups **6**

Tests for systematic (but modest) changes in groups of genes, Comparison of pathway configurations between control and disease/treatment groups.

TOTAL: 30 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

- CO 1: Understand the basis of nucleic acid array based analysis.
- CO 2: Understand the basis of sequencing data analysis.
- CO 3: Gain knowledge about various normalization strategies used in array assays
- CO 4: Understand the numerous methods to determine significance and multiple comparisons
- CO 5: Understand the basis of pathways analysis and Gene ontology

TEXT BOOKS:

1. Patrick McConnell, Simon M. Lin, Patrick Hurban, "Methods of Microarray Data

Analysis V" 2007
2. Xinkun Wang, "Next-Generation Sequencing Data Analysis" 2016
3. Kuo Ping Chiu, "Next-Generation Sequencing and Sequence Data Analysis" 2015
4. Giuseppe Agapito, " Microarray data analysis" 2022.

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	3	3	2	2	3	-	-	-	-	3	3	3	3
2	1	2	3	3	3	3	3	-	-	-	-	3	3	3	3
3	2	2	3	3	3	3	3	-	-	-	-	3	3	3	3
4	1	2	3	3	3	3	3	1	-	-	-	3	3	3	3
5	1	2	3	3	3	3	3	1	2	1	-	3	3	3	3
Overall CO	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**-**	**3**	**3**	**3**	**3**

Course 1-low, 2-medium, 3-high, '-"- no correlation
Note: The average value of this course to be used for program articulation matrix

IB23S04 GOOD MANUFACTURING PROCESS & VALIDATION

L	**T**	**P**	**C**
2	**0**	**0**	**2**

OBJECTIVES

The course aims to provide knowledge on current validation practices across the bioprocess industries

UNIT I TRENDS FOR VALIDATING BIOLOGICAL PROCESSES **6**

Importance of process validation for manufacturing drugs and medical devices, Definitions, Process validation, Prospective Validation, Concurrent Validation, Retrospective Validation, Critical Process Parameters, Critical Quality Attributes, Scaled-down model, Worst-case, FDA Guidelines

UNIT II PROCESS VALIDATION: GENERAL PRINCIPLES AND PRACTICES **6**

General Considerations for Process Validation, Concept of Bioprocess in Bulk Drug Manufacturing, Concept of Biotechniques in industrial validation, Integration of various biotechniques to maintain quality in downstream processing, CGMP regulations for validating biopharmaceutical (drug) manufacturing

UNIT III GOOD MANUFACTURING PRACTICE FOR BIOPROCESS ENGINEERING **6**

Statutory and regulatory requirements for process validation, Production Methods and Considerations, Automation and control issues, System functionality, Principles for Layout of Bulk Production Facilities, Green Field Development, Brown Field Development, cross- contamination from other sources and linked systems, Clean In Place techniques, interactions with shared systems.

UNIT IV: APPROACH TO PROCESS VALIDATION **6**

Process Design, Process Qualification, Continued Process Verification, attributes relating to identity, strength, quality, purity, and potency; Information and data organization from laboratory-, pilot-, and/or commercial-scale studies, validation of computerized systems.

UNIT V: CASE STUDIES IN PROCESS VALIDATION **6**

Process validation for recombinant therapeutic proteins like erythropoetin, insulin, GMCSF, viral, bacterial vaccines.

TOTAL: 30 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

- CO 1: understand the implications of validation for process development
- CO2: Describe the general principles and practices of process validation of biopharmaceutical manufacturing processes.
- CO 3: explain regulatory requirements for process validation
- CO 4: design, verify and validate process using case studies
- CO 5: analyse the case studies and draw results to the problems.

TEXT BOOKS:

1. Process Validation in Manufacturing of Biopharmaceuticals, Third Edition, Anurag S. Rathore, Gail Sofer, CRC Press, 2012
2. Encyclopedia of Industrial Biotechnology: Bioprocess, Bioseparation, and Cell Technology Phamaceutical Process Validation, Nash, R.A., 2003.
3. Handbook of pharmaceutical analysis. CRC Press, Ohannesian, L. and Streeter, A. eds., 2001
4. Pharmaceutical equipment validation: The ultimate qualification guidebook,Cloud, P., 1998, CRC Press

PROGRAMME OUTCOMES															
CO's	**PO's**												**PSO's**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	1	2	-	-	-	-	-	-	1	1	1	2
2	2	2	2	2	3	1	1	-	1	1	-	2	3	3	2
3	2	2	3	3	2	-	1	-	1	1	-	1	3	3	2
4	3	3	3	2	2	1	1	-	1	1	-	2	2	3	2
5	3	3	2	2	2	-	1	-	1	1	-	2	2	2	1
Overall CO	**2.4**	**2.4**	**2.4**	**2.2**	**2.2**	**1**	**1**	**-**	**1**	**1**	**-**	**1.6**	**2.2**	**2.4**	**1.8**

Course 1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix