DEPARTMENT OF BIOTECHNOLOGY

B.TECH

CURRICULUM AND SYLLABUS

REGULATION 2013-2014

KALASALINGAM UNIVERSITY
(*KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION)*
Anand Nagar, Krishnankoil - 626 126

Institute Vision	**Institute Mission**
To be a Center of Excellence of International Repute in Education and Research	To Produce Technically Competent, Socially Committed Technocrats and Administrators through Quality Education and Research
Department Vision	**Department Mission**
Building an undisputed reputation as a frontrunner in teaching and research at the National and International levels	To provide well-crafted curricula in the various branches of biotechnology and to inculcate the requisite technical and research skills in students so as to render them employable in academia, and industries in the service of society

Program Educational Objectives (B.Tech - Biotechnology)

1. Graduates would have attained a general level of competence in order to pursue advanced courses and / or acquire specialized training and skills relevant to their professions.
2. Graduates would be ready to take up responsible positions in Public and Private sector undertakings to serve society through Academics, Industry and Law.
3. Graduates would have learnt to uphold ethical conduct in their professions, have effective communication and managerial skills, and possess the urge to learn and update themselves lifelong.

Program Outcomes

Graduates will be able to

1. **Understand the fundamental principles** of molecular biology, biochemistry, genetics, gene manipulation, gene transfer, chemical engineering and bioinformatics.
2. **Analyze the problems** in the production of biopharmaceuticals and agricultural products as well as optimizing bioprocesses.
3. Recognize the importance of **cleaning up the environment**, preventing pollution and optimizing the use of resources for **sustainable** development.
4. Identify, analyze and **address complex biological and engineering** problems associated with biotechnology.
5. **Design a method and apply** the techniques of biotechnology towards the prevention, diagnosis and treatment of hereditary and infectious diseases in humans, plants and animals.
6. **Communicate effectively** in oral and written language with their peers, teachers and the outside world.
7. **Work individually** and / or as part of a **team** towards the successful execution of their individual and / or collective responsibilities.
8. Keep **them updated on the modern trends and developments** in the theory and practice of biotechnology.
9. Grasp the essentials of **managing** various projects.
10. Perceive the importance of **learning throughout their lives** about developments in their respective fields.
11. Recognize engineers as **responsible technocrats** who impact **society** through their knowledge and actions.
12. Realize the importance of **ethics and ethical behavior** in their professional lives.

B. Tech. BIOTECHNOLOGY CURRICULUM

Semester I

Code No.	Subject	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
HSS101	English for Technical Communication I	1,3	6,7,10	2	0	0	2
MAT103	Mathematics I	1,2	1,2,4	3	0	0	3
PHY131	Engineering physics I	1	1,2,3,4	3	0	0	3
CHY106	Engineering Chemistry	1,2	1,3,4	3	0	0	3
CSE102/ MEC101	Programming Languages/Engineering Drawing	1/1	1,7,11/ 4,7,10,11	2	0	0	2
EEE101/ CIV101	Basic Electrical and Electronics Engineering/ Basic Civil and Mechanical Engineering	1/1	3,4,10,11/ 6,7,9,10,11	4	0	0	4
PHY183/ CHY182	Physics Laboratory/ Chemistry Laboratory	1/1	1,3,4,11/ 1,2,3	0	0	3	1
CSE181/ MEC181	Programming Language Laboratory/ Workshop	1/1	1,4/7	0	0	3	1
	Total			17	0	6	19

Semester II

Code No.	Subject	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
HSS102	English for Technical Communication II	1,3	6,8,9,10,11	2	0	0	2
MAT104	Mathematics II	1,2	1,4	3	0	0	3
PHY112	Engineering Physics II	1	1,3,4	3	0	0	3
CIV101/ EEE101	Basic Civil and Mechanical Engineering/ Basic Electrical and Electronics Engineering	1/1	6,7,9,10,11/ 3,4,10,11	4	0	0	4
CHY102	Environmental Sciences	1	3,4,9,12	2	0	0	2
MEC101/ CSE102	Engineering Drawing/ Programming Languages	1/1	4,7,10,11/ 1,7,11	1	0	3	2
BIT103	Cell Biology and Genetics	1	1,4,5,6,8, 10,11	3	0	0	3
MEC181/ CSE 181	Workshop/ Programming Language Laboratory	1/1	7/1,4	0	0	3	1
CHY182/ PHY181	Chemistry Laboratory/ Physics Laboratory	1/1	1,2,3/1,3,4 ,11	0	0	3	1
HSS036	Soft Skills-I	1,3	6,7,10	1	0	0	1
	Total			19	0	9	22

Semester III

Code No.	Subject	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
MAT202	Mathematics III	1,2	5	3	0	0	3
CHE253	Bioprocess Calculations	1,2	1,2	3	1	0	4
BIT204	Microbiology	1,2	1,2,3,5,6,7, 8,9,10,12	3	0	0	3
BIT209	Molecular Biology	1,2,3	1,4,5,6,7,8,9 ,10,12	3	0	0	3
BIT214	Analytical Techniques in Biotechnology	1,2	1,2,3,4,5,8, 10	3	0	0	3
BIT211	Principles of Biochemistry	1,2	1,3,11	3	0	0	3
BIT281	Biochemistry Laboratory	1,2,3	1,2,3	0	0	3	2
BIT283	Microbiology Laboratory	1,2,3	1,6,7	0	0	3	2
BIT286	Cell and Molecular Biology Laboratory	1,2,3	3,5	0	0	3	2
HSS037	Soft Skills-II	1,3	6,7,10	1	0	0	1
	Total			19	1	9	26

Semester IV

Code No.	Subject	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
HSSXXX	Humanities Elective I			3	0	0	3
CHE252	Unit Operations	1,2	1,4	3	1	0	4
BIT203	Bioenergetics and Metabolism	1,2	1,2	3	1	0	4
BIT205	Industrial Biotechnology	1,2,3	1,2,6,7,8,9, 10,12	3	0	0	3
BIT215	Bioinformatics and Computational Biology	1,2,3	1,8	3	1	0	4
BIT216	Protein Science and Engineering	1,2	1,4,5,8,12	3	0	0	3
BIT288	Computational Biology Laboratory	1,2,3	1,8	0	0	3	2
CHE291	Chemical Engineering Laboratory	1,2,3	1,7	0	0	3	2
HSS037	Soft Skills-III	1,3	6,7,10	1	0	0	1
	Total			19	3	6	26

Semester V

Code No.	Subject	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
BITXXX	Major Elective I			3	0	0	3
	Minor Elective I			3	0	0	3
BIT303	Bioprocess Principles	1,2	2,11	3	1	0	4
BIT304	Genetic Engineering	1,2,3	1,2,3,5,6,7,8 ,9,11,12	3	1	0	4
BIT322	Enzyme Technology	1,2	1,3,5	3	1	0	4
CHE357	Reaction Engineering for Biotechnologists	1,2	1,2,4	3	0	0	3
BIT387	Bioprocess Laboratory	1,2,3	1,2,3,4,7,8, 10,11,12	0	0	4	2
BIT388	Genetic Engineering Laboratory	1,2,3	1,6,9	0	0	4	2
BIT398	Community Service Project Phase I	1,2,3	1,2,5,6,7,8, 9,10,11,12	0	2	0	1
	Total			18	5	8	26

Semester VI

Code No.	Subject	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
BITXXX	Major Elective II			3	0	0	3
HSSXXX	Humanities Elective II			3	0	0	3
	Free Elective I			3	0	0	3
	Minor Elective II			3	0	0	3
BIT305	Biochemical Engineering	1,2	1	3	1	0	4
BIT306	Immunology	1,2,3	1,2,5,8	3	1	0	4
BIT389	Immunology Laboratory	1,2,3	1,4,5,6,7, 11,12	0	0	3	2
BIT390	Biochemical Engineering Laboratory	1,2,3	1,2	0	0	6	2
BIT399	Community Service Project Phase II	1,2,3	1,2,5,6,7,8, 9,10,11,12	0	3	0	2
	Total			18	5	9	26

Semester VII

Code No.	Subject	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
HSSXXX	Humanities Elective III			3	0	0	3
	Free Elective II			3	0	0	3
BITXXX	Major Elective III			3	0	0	3
BITXXX	Major Elective IV			3	0	0	3
BIT401	Animal Biotechnology	1,2	1,2,5,8	4	0	0	4
BIT402	Plant Biotechnology	1,2	1,2,4,511	3	0	0	3
BIT403	Downstream Processing	1,2	1,2,4	3	1	0	4
BIT491	Downstream Processing Laboratory	1,2,3	1,2,4,5	0	0	6	2
	Total			21	1	6	25

Semester VIII

Code No.	Subject	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
BITXXX	Self study Elective			3	0	0	3
BIT499	Project Work	1,2,3	1,2,5,6,7,8, 9,10,11,12	0	0	26	10
	Total			3	0	26	13

Total Credits (from 1st semester to 8th semester = 183)

LIST OF MAJOR ELECTIVES FOR III YEAR

Code No.	Subject	L	T	P	C
BIT307	Environmental Biotechnology	3	0	0	3
BIT308	Spectroscopic Methods For Structure Determination	3	0	0	3
BIT309	Food Processing and Technology	3	0	0	3
BIT310	Pharmaceutical Biotechnology	3	0	0	3
BIT311	Healthcare Biotechnology	3	0	0	3
BIT313	Metabolic Engineering	3	0	0	3
BIT314	Drug Design and Development	3	0	0	3
BIT323	Exploring the microbial world	3	0	0	3
CHE352	Bioprocess Instrumentation and Control	3	0	0	3
CHE358	Transport Phenomena in Biological Systems	3	0	0	3

LIST OF MAJOR ELECTIVES FOR IV YEAR

Code No.	Subject	L	T	P	C
BIT405	Nanobiotechnology	3	0	0	3
BIT406	IPR in Biotechnology	3	0	0	3
BIT407	Bioreactor Design and Analysis	3	0	0	3
B1T409	Cancer Biology	3	0	0	3
BIT410	Biomedical Engineering	3	0	0	3
BIT411	Bioresource Technology	3	0	0	3
BIT412	RNAi Technology	3	0	0	3
BIT413	Vaccinology	3	0	0	3
BIT417	Biosensors	3	0	0	3
BIT418	Molecular pathogenesis	3	0	0	3
BIT419	Molecular diagnostics and therapeutics	3	0	0	3
BIT420	Signal transduction	3	0	0	3
BIT421	Functional genomics	3	0	0	3
BIT422	Radiation biology	3	0	0	3
BIT423	Recombinant protein production	3	0	0	3
BIT424	Clinical trials and management	3	0	0	3

LIST OF MINOR ELECTIVES

Code No.	Subject	L	T	P	C
CHE354	Mass Transfer	3	0	0	3
CHE355	Bioprocess Plant Design Economics	3	0	0	3
CHE356	Chemical and Bio-thermodynamics	3	0	0	3
CHE314	Colloids & Surface Science	3	0	0	3
CIV369	Environmental Impact Assessment	3	0	0	3
CIV463	Solid Waste Management	3	0	0	3
CIV416	Industrial Wastewater Management	3	0	0	3
CSE103	Data Structures	3	0	0	3
EIE409	Biomedical Instrumentation	3	0	0	3
EIE416	Optimization Techniques	3	0	0	3
INT 303	Database Management systems	3	0	0	3

LIST OF HUMANITIES ELECTIVES

Code No.	Subject	L	T	P	C
HSS001	Total Quality Management	3	0	0	3
HSS002	Engineering Management	3	0	0	3
HSS004	Industrial Psychology	3	0	0	3
HSS005	Consumer Psychology	3	0	0	3
HSS006	Professional Ethics	3	0	0	3
HSS007	Operations Management	3	0	0	3
HSS008	Introduction to Economics	3	0	0	3
HSS010	International Trade and Finance	3	0	0	3
HSS011	Information Systems for Managerial Decision Making	3	0	0	3
HSS013	Cost Analysis and Control	3	0	0	3
HSS014	Introduction to Marketing Management	3	0	0	3
HSS016	Organizational Psychology	3	0	0	3
HSS017	International Economics	3	0	0	3
HSS018	Communication Skills	3	0	0	3
HSS022	Banking Theory and Practice	3	0	0	3
HSS023	Entrepreneurship Development	3	0	0	3
HSS025	Science Fiction: An Appreciation	3	0	0	3
HSS026	German - I	3	0	0	3
HSS028	French - I	3	0	0	3
HSS030	Science Technology and Medicine in India: A Historical Perspective	3	0	0	3
HSS033	Modern Science in India	3	0	0	3
HSS035	History of Science and Technology	3	0	0	3

SEMESTER I

HSS101	**ENGLISH FOR TECHNICAL COMMUNICATION I (Common to all branches)**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

Course Outcomes:

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

CO1: Participate in Non-verbal communication

CO2: Enjoy Cloze reading€ skimming and scanning

CO3: Frame simple sentences to express daily activities

CO4: Take notes when reading and listening lectures and media events

CO5: Frame Instructions, Recommendations and Short Speeches

CO6: Remember nuances of Note-making, the template of Notices, Advertisements, Graphs and Charts

CO7: Write Short stories, anecdotes, process description, etc..

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						H	M			H		
CO2						H	M			H		M
CO3						H						
CO4						H						
CO5						H	M					
CO6						H						
CO7						H						

FOCUS ON LANGUAGE

Parts of speech - nominal compounds, noun phrases - relative pronoun - adjective - numerical, comparison and contrast, collocation and word combinations - verb - preposition and relative - conjunction- connectives, expressions of purpose and function, cause and effect - articles - adjectives - sentence pattern - tenses - voice - rewriting the sentences in impersonal/abbreviated passive grammatical structures - concord - sentence level verb noun agreement - gerund - rewriting infinitive into gerund - imperative - rewriting imperative into recommendation using should - word formation - varied grammatical function of the same word - affixes - prefix and suffix, number prefix, negative prefix - reported speech - editing strategies - conditional structures - real, unreal, no possibility, zero condition - writing formal definition - abbreviation and acronym - idioms and phrases - varieties of English - British versus American.

LISTENING SKILLS

Comprehension practice - vocabulary development - familiarity to varied types of spoken English and accents - developing ability to understand audio and video media - aiming at overcoming barriers to listening - listening to documentaries, radio news broadcasts, TV

news telecasts - active listening in discussions and to lectures - taking notes while listening - extracting information from listening.

SPEAKING SKILLS

Oral practice - role play - interplay - seminar - transcoding visual into oral - participating in short and longer conversation - voice record, replay, correction of intonation, pronunciation and flow of speech - phonemes - vowels, consonants, stress, rhythm, intonation - group discussion - participative learning - acquiring proficiency, fluency, accuracy in oral communication - speaking practice - developing confidence - extempore speech - learning professional/conversational etiquette.

READING SKILLS

Vocabulary extension - improving vocabulary - intensive reading - reading strategies - identifying topic sentence - guessing meaning from content - picking out specific information - professional reading - reading practice - predicting the content, critical and analytical reading - reading articles in English newspapers, sports magazines, encyclopedias - reading aloud, use of stress and intonation - reading and comprehending technical materials - cloze reading.

WRITING SKILLS

Discourse cohesion - improving writing skills, avoiding common grammatical errors in academic writing - extending the hints - writing shorter sentences - punctuation - dialogue writing - paragraph writing, problems and solutions, achieving coherence, transition words, sequence words - essays of descriptive and argumentative - writing instructions, use of imperatives - jumbled sentences into sequential paragraph using linguistic clues - report writing - technical reports, industry visit reports, events reports - writing recommendations - letter writing - formal and informal letters - job application and resume, permission for in-plant training, business correspondence letters, calling for quotation, placing order, lodging complaint, persuasive letters - assignment writing - mini-project - transcoding - transferring of information from text to pictorial/graphical representation and vice versa.

TEXT BOOK

1. Rizvi M Ashraf, Effective Technical Communication, Tata McGraw-Hill, 2005

REFERENCES

1. Daniel Jones, English Pronouncing Dictionary, Universal Book Stall, New Delhi, 17th Edition, 2000
2. Geoffrey Leech, Fan Svartvik, A Communicative Grammar of English, Pearson Education Asia, 1994
3. Hornby, AS, Oxford Advanced Learner•s Dictionary of Current English, OUP, 7th Edition, 2005
4. Manivannan G, English for Engineers - A Book on Scientific and Technical Writing, Govi Publications, 2005

MAT103	MATHEMATICS I (Common to all Branches)	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Find the Eigen values of a matrix and to use Cayley-Hamilton theorem for finding the inverse of a matrix.

CO2: Explain the concept of curvature and to find envelope of a curve.

CO3: Apply partial derivatives to find maxima and minima.

CO4: Solve second order linear differential equations with constant coefficients, Cauchy•s equation and Legendre•s equation .

CO5: Understand the geometry of sphere, plane and straight line in the three dimensional space

Course Outcomes Vs Program Outcomes Mapping:

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

MATRICES

Review of linear algebra - Matrix operations - Addition, scalar multiplication, multiplication, transpose, adjoint and their properties - Special types of matrices - Null, identity, diagonal, triangular, symmetric, Skew-symmetric, Hermitian, Skew-Hermitian, orthogonal, unitary, normal - Rank - Consistency of a system of linear equations - Solution of the matrix equation $Ax = b$, Row - Reduced echelon form

EIGEN VALUE PROBLEMS

Eigen value and eigen vector of real matrix - properties of eigen values and eigen vectors - Cayley - Hamilton theorem - Orthogonal transformation of a real symmetric matrix to diagonal form - Reduction of quadratic form to canonical form by orthogonal transformation - Index, signature and nature of quadratic form

DIFFERENTIAL CALCULUS

Review of limits - Continuity and differentiability - Curvature - Cartesian and Parametric co-ordinates - Centre and radius of curvature - Circle of curvature - Evolutes - Involutes - Envelopes - Partial differentiation - Euler•s theorem for homogeneous functions -Total differential - Taylor•s expansion (two variables) - Maxima and Minima for functions of two variables - Method of Lagrangian multiplier - Jacobians

THREE DIMENSIONAL ANALYTICAL GEOMETRY

Direction cosines and ratios - Angle between two lines - Equations of a plane - Equations of straight line - Coplanar lines - Shortest distance between two skew lines - Sphere - Tangent plane - Plane section of a sphere - Orthogonal spheres

ORDINARY DIFFERENTIAL EQUATIONS

Solutions of second and higher order linear ODE with constant coefficients - Cauchy•s and Legendre•s linear equations - Simultaneous first order linear equations with constant coefficients - Method of variation of parameters

TEXT BOOKS

1. Kreyszig, E, Advanced Engineering Mathematics, John Wiley and Sons (Asia) Limited, Singapore , 8th Edn., 2001
2. Arumugam, S., Thangapandi Isaac, A., Somasundaram, A., Engineering Mathematics Volume I, Scitech Publications (India) Pvt. Ltd., Chennai, 2nd Edn., Reprint 2000, 1999

REFERENCES

1. Grewal , B.S., Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 37th Edition., 5th Reprint 2004, 2003
2. Venkataraman, M. K., Engineering Mathematics First Year, The National Publishing Company, Chennai, 2nd Edition., Reprint 2001, 2000

PHY 131	ENGINEERING PHYSICS I (Common to all Branches)	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Understand the different types of sound waves and production & application of ultrasonics.

CO2: Understand the basic concepts, production & applications of different types of laser sources.

CO3: Know the general ideas about optical fibres and their applications in various fields.

CO4: Learn the basic knowledge of crystallography and it•s preparation techniques.

CO5: Gain the knowledge about the fundamentals, theory of quantum physics

CO6: Gain the knowledge about various mechanical properties & thermal properties of matters.

Course Outcomes Vs Program Outcomes Mapping:

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

ACOUSTICS AND STRUCTURE OF SOLIDS

Classification of sound , reverberation , Sabine•s formula , common acoustical defects and remedies , classification of solids , crystal structures , X-ray diffraction , crystal growth , crystal defects

LASER AND FIBRE OPTICS

Interaction of radiation with matter , quantum mechanical view , three and four Level laser system , Holography , construction and reconstruction of hologram , Engineering and medical applications , introduction of fibre optics , classification of fibre , Engineering and medical applications

QUANTUM PHYSICS

Inadequacy of classical mechanics , Black body radiation , Planck•s law , Photo electric effect , Compton effect , Einstein•s photoelectric equation , Schrödinger wave equation , particle in one , three dimensional box.

NON-DESTRUCTIVE TESTING

Liquid penetrant , magnetic particle and eddy current methods , X-ray radiography , fluoroscopy , Gamma ray radiography , ultrasonic scanning methods , ultrasonic flaw detector , thermography.

RELATIVITY

Frame of reference , Newtonian relativity , Galilean Transformation equations , Ether hypothesis , Michelson-Morley experiment , special theory of relativity , Lorentz transformation equations , length contraction , time dilation , relativity of simultaneity , addition of velocities , variation of mass with velocity , mass-energy equivalence , Minkowski•s four dimensional space , time continuum.

TEXT BOOKS

1. P.K. Palanisamy, *f*Engineering Physics,„ Scitech Publications (India), Pvt Ltd., Chennai, 2009.
2. S.O. Pillai and D.N. Sankar, A text book of Engineering Physics. New Age International Publication, New Delhi, 2008.

REFERENCES

1. Murthy V.S.R., Jena AK, Gupta K.P. and Murthy G.S., Structures and Properties of Engineering Materials, Tata McGraw , Hill Publishing Company Limited, New Delhi, 2003.
2. Gaur R.K. & Gupta S.L., Engineering Physics, Dhanpat Rai publications (P) Ltd., New Delhi, 2001.
3. Ali Omar. M, Elementary Solid State Physics, Pearson Education (Singapore), Indian Branch, New Delhi.
4. William F. Smith, Foundations of materials science and Engineering, 3rd Edition, Tata McGraw-Hill, New York, 2003.

5. Rajput B.S Pragati Prakashan, Advanced Quantum Mechanics, New Market, Begum Bridge, Meerut.
6. Hand book of Electronics, Gupta S.L. Kumar V Pragati Prakashan, New Market, Begum Bridge, Meerut.
7. Arthur Beiser, Concepts of Modern Physics - Tata McGraw , Hill Publishing Company Limited, New Delhi, 5th Edition, 2000.

CHY 106	ENGINEERING CHEMISTRY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Know the water quality parameters to assess the quality of water

CO2: Learn the techniques of purification of water

CO3: Gather the knowledge in basic concepts of thermodynamics

CO4: Explain the principles of chemical & electrochemical reactions and prevention of corrosion of materials

CO5: Explain the principles and generation of energy in batteries, solar cells and fuel cells

CO6: Explain the preparation, properties and applications of polymers and nano-materials

CO7: Discuss the principles, instrumentations and applications of analytical techniques

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			H	M								
CO2			H									
CO3	M											
CO4			M									
CO5				M								
CO6				M								
CO7	M		M	M								

MACROSCOPIC PROPERTIES OF SYSTEMS IN EQUILIBRIUM

Basic concepts of thermodynamics- Mathematical form of First law and its limitations- Enthalpy- Applications of first law (relation between C_p and C_v only) - Second law of thermodynamics (Clausius and Kelvin statement) - Entropy changes for reversible and isothermal processes - Problems-Entropy of phase transitions-Problems- Free energy and work function, Gibbs-Helmholtz equation- Applications-Problems-Van•t Hoff isotherm and isochore-Applications-Problems- Phase equilibria- Application to one component systems, two component systems (eutectic and compound formation).

ELECTRODICS

Electrochemical series and its applications -Reference electrodes (H_2 and calomel electrodes)- Determination of single electrode potential by using reference electrodes - -EMF measurements and its applications- problems- Nernst equation-Problems- Electrochemical energy systems: primary and secondary batteries, fuel cells, solar cell- Chemical structure, electronic behaviours and applications of conducting polymers.-Principles of chemical and

electrochemical corrosion - Corrosion control (Sacrificial anode and impressed current methods).

DYNAMICS OF CHEMICAL PROCESSES

Basic concepts- Kinetics of parallel, opposing and consecutive reactions with examples- Temperature dependence of rate of reactions-Problems -Techniques and methods for fast reactions, flow techniques, relaxation methods and flash photolysis - Thermodynamic formulation of reaction rates - Enzyme kinetics (Michaelis-Menten equation).

WATER TECHNOLOGY

Water quality parameters - Definition and expression - Importance and determination of Dissolved oxygen (DO) content in water-Estimation of hardness (EDTA method)- Problems-Determination of alkalinity- Water softening (zeolite) - Demineralisation (Ion- exchangers) and desalination , Boiler feed water-Domestic water treatment.

INSTRUMENTAL METHODS OF ANALYSIS

Fundamental principles, theory, instrumentation and applications of UV-Visible spectroscopy, Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), Thermogravimetric analysis (TGA), Differential Thermal Analysis (DTA), Scanning Electron Microscopy (SEM), Tranmission Electron Microscopy (TEM), Refractometry and Nephelometry.

TEXT BOOKS

1. Atkins P. W., Physical Chemistry, Sixth Edition, Oxford University Press, 1998.
2. Jain P.C. and Monica J., " Engineering Chemistry ", Dhanpat Rai Publications Co.,(P) Ltd., New Delhi, 14th Edition 2002.
3. Sharma, B.K., "Instrumental Methods of Analysis ", Goel publishing House, 12th Edition, 2001.

REFERENCES

1. Puri B. R., Sharma L. R., and Pathania M.S., *f*Principles of Physical Chemistry,„ Vishal Publishing Co., 2008.
2. Kuriakose, J.C. and Rajaram J., " Chemistry in Engineering and Technology ", Vol. I and II, Tata McGraw-Hill Publications Co.Ltd, New Delhi ,1996.
3. Kund and Jain, " Physical Chemistry ", S. Chand and Company, Delhi, 1996.
4. Gordon M.Barrow, " Physical Chemistry ", Sixth Edition, Tata McGraw Hill, 1998.
5. Willard, H.H., Merritt. I.I., Dean J.A., and Settle, F.A., "Instrumental methods of analysis", Sixth Edition, CBS publishers, 1986.
6. Vogel A.I., " Quantitative Inorganic Chemical Analysis ", V. Edition, 1989.
7. 7. Rouessac, F., " Chemical Analysis-Modern instrumental methods and techniques ", Wiley- Publishers, 1999.

CSE 102	PROGRAMMING LANGUAGES (Common to all Branches)	L	T	P	C
		2	0	0	2

Course Outcomes:

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

CO1: Learn the basics of computer programming concepts using C programming language

CO2: Design programs involving decision structures, and loops

CO3: Understand how to include functions and structure as part of the solution

CO4:Utilize pointers & arrays to efficiently solve problems and understand the dynamics of memory

CO5: Understand the file system and operations on files

CO6: Develop algorithms to solve basic programming problems & able to learnhands-on experience in designing and implementing some selected types of team oriented projects

CO7: Understand the UNIX basics and also the concept of Shell Programming

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H						M					
CO2											M	
CO3											M	
CO4											M	
CO5	H											
CO6	M											
CO7	M											

BASIC ELEMENTS OF C & CONTROL STATMENTS

Introduction to C programming , C character set , Identifiers, keywords, data types, constants, variable, declarations, expressions, statements, symbolic constants, Operators and Expressions-Operator precedence and associativity of operators -Input and Output Functions-Library Functions - Header Files - Simple Computational problems. Decision Making: if statement - if-else statement - else-if ladder , Looping statements , While , do- while- Still more looping-For statement, Nested control statements- switch statement , the break statement - ? : Operator - Continue statement - goto statement , Problems using Control Structures.

USER DEFINED FUNCTION FUNCTIONS & STORAGE CLASSES

Need for User defined functions, a multifunction program- Elements of user defined functions- Definition of Functions- Return values and their Types- Function Calls-Function declaration-Category of functions- Nesting of functions , Recursion- Problems on functions & recursion functions. Storage Classes -Automatic Variables -External Variables , Static and Register Variables.

ARRAYS AND POINTERS

Defining and Processing an Array - Passing Arrays to Functions - Multidimensional Arrays - Arrays and Strings - Enumerated data types-Programs using sorting, searching and merging

of arrays. Pointer Fundaments - Pointer Declarations - Passing Pointers to Functions - Arrays and Pointers - Pointers and One-Dimensional Arrays - Pointers and Multidimensional Arrays - Operations on Pointers-Programs using Pointers with Functions.

DYNAMIC MEMORY MANAGEMENT, STRUCTURES & UNIONS

Dynamic Memory Allocation , Allocating a Block of memory, multiple blocks, releasing used space, altering the size of block. , Defining a Structure - Processing a Structure , User defined Data Types , Nested structure - Structures and Pointers - Passing Structures to Functions - Self Referential Structures- Arrays and & Structures Union.

DATA FILES AND UNIX OS

Opening and Closing a Data File - Creating a Data File , Reading & writing a data file. Processing and Updating of Data Files - Unformatted Data Files - Programs using merging, searching of data file contents. Introduction to Operating System. Shell fundamentals- shell commands , File commands- Directory commands-Miscellaneous commands

TEXT BOOK

1. Byron S. Gottfried, Programming with C, Second Edition, Tata McGraw Hill, 2006

REFERENCES

1. Brian W. Kerninghan and Dennis M.Richie, *f*The C Programming language,,, Pearson Education,2005.
2. Johnsonbaugh R.and Kalin M, *f*Applications Programming in ANSI C,,, Third Edition, Pearson Education, 2003.
3. E. Balagurusamy *f* Programming in ANSI C,, fourth edition TMH 2008
4. V.Rajaraman *f*Computer Basics and C Programming,, PHI 2008
5. Stephen Kochan and Patrick Wood, UNIX Shell Programming, Third Edition, Pearson education, 2003

		L	**T**	**P**	**C**
EEE101	**BASIC ELECTRICAL AND ELECTRONICS ENGINEERING (Common to Non-circuit Branches)**	**4**	**0**	**0**	**4**

Course Outcomes:

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

CO1: Do the basic estimation of electrical quantities

CO2: Interpret the basic electrical and electronics circuits

CO3: Understand the DC and AC single phase and three phase fundamentals

CO4: Understand the working principle of various Electrical AC and DC machines

CO5: Get the knowledge about various Analog type measuring instruments and house wiring.

CO6: Get the knowledge about basic semiconductor devices.

CO7: Get the knowledge about the application of basic Electronics devices for domestic and industries

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										M		
CO2										M		
CO3										M	M	
CO4										M	M	
CO5										M	M	
CO6			M							M		
CO7			M	M						M		

MAGNETIC CIRCUITS

Magnetic circuits - definition of MMF, flux and reluctance - reluctance in series and parallel - electromagnetic induction - Fleming•s rule - Lenz•s Law - Faraday•s laws - statically and dynamically induced EMF - self and mutual inductance - coefficient of coupling - hysteresis - eddy currents - analogy of electric and magnetic circuits - simple problems.

DC CIRCUITS AND AC CIRCUITS

Electrical quantities - resistors - inductors - capacitors - Ohm•s Law - Kirchoff•s Laws - series and parallel circuits - analysis of DC circuits - mesh, nodal - simple problems.
Sinusoidal functions - phasor representation - RMS Effective values - form and peak factors - RLC circuits - power and power factor - analysis of 3 phase AC circuits - simple problems.

ELECTRICAL MACHINES

Construction and principle of operation of DC machines - generator, motor - single phase transformers - alternators - three phase and single phase induction motors.

MEASURING INSTRUMENTS AND WIRING CIRCUITS

Moving coil and moving iron instruments - dynamometer type wattmeter - induction type energy meter.
Domestic wiring - accessories - types - staircase wiring - fluorescent tube circuits - simple layout - earthing.

ELECTRONIC DEVICES

Basic concepts of PN junction diodes - zener diode - bipolar junction transistor - uni polar devices - FET, MOSFET, UJT - thyristor - photoelectric devices.

ELECTRONIC CIRCUITS

Half wave and full wave rectifier - amplifier - oscillator - RC integrator and differentiator circuits - diode clampers and clippers - multivibrators - schmitt trigger.

TEXT BOOKS

1. V.K. Mehta, *f*Principles of Electrical Engineering and Electronics,„ S. Chand & Company Ltd, 2008.
2. Kothari D P and Nagrath I J, "Basic Electrical Engineering", Tata McGraw Hill, 1991.
3. Mithal G K, Electronic Devices & Circuits, Khanna Publications, 1997.

REFERENCES

1. T. Thyagarajan, ƒFundamentals of Electrical and Electronics Engineering,„ SciTech publications (Ind.) Pvt. Ltd., 3rd Edition, October 2000.
2. Muraleedharan K.A, Muthususbramanian R and Salivahanan S, "Basic Electrical, Electronics and Computer Engineering" Tata McGraw Hill, 1999.

PHY 183	PHYSICS LABORATORY (Common to all Branches)	L	P	T	C
		0	0	3	1

Course Outcomes:

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

CO1: Learn the practical understanding of the mechanical properties such as modulus, moment of inertia, gravitational force, stress, strain, etc

CO2: Understand and apply the optical phenomena like diffraction, interference, etc.

CO3: Understand the thermal conductivity and also thermal behavior of the specimen

CO4: Acquire practical skill to analyze the fluid state mechanism

CO5: Find thickness of very very thin objects

CO6: Learn the knowledge of generating ultrasonic waves and finding the velocity of it in Liquid.

CO7: Determine the bandgap of semiconductor.

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				M								
CO2	H											
CO3	H		M	M								
CO4	H											
CO5											M	
CO6	M											
CO7			M									

List of Experiments:

1. To determine the acceleration due to gravity using Compound Pendulum
2. To determine the Rigidity Modulus of wire using Torsional Pendulum
3. To find thickness of the given two glass plates using single optic lever.
4. To determine the thermal conductivity of a bad conductor
5. To determine the refractive index of the material of the prism.
6. To find the number of rulings per cm length of the given transmission grating.
7. To determine the particle Size Using Laser
8. To determine the coefficient of viscosity of the liquid by Poiseuille•s method
9. To determine the young•s modulus of given material using Uniform Bending
10. To Determine the thickness of a given material using Air wedge method
11. To determine the focal length of a biconvex lens using Newton•s Rings method
12. To determine the velocity of ultrasonic waves in the given medium using ultrasonic Interferometer.

CSE 181	PROGRAMMING LANGUAGE LABORATORY	L	T	P	C
		0	0	3	1

Course Outcomes:

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

CO1: Understand problem analysis, algorithm design, and program implementation

CO2: Write modular, efficient and readable C programs

CO3: Design modular programs with structured programming constructs

CO4: Formulate problems and implement algorithms in C and work in a team to develop projects

Course Outcomes Vs Program Outcomes Mapping:

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

List of Experiments:

APPLICATION PACKAGES

1. Word Processing
2. Spreadsheet
3. Powerpoint
4. Database Management

C PROGRAMMING

1. Basics
2. Operators and Expressions
3. I/O formatting
4. Control Statements

ARRAYS AND FUNCTIONS

1. Arrays
2. String Manipulation
3. Functions

POINTERS, STRUCTURES AND FILES

1. Pointers
2. Structures and Unions
3. File Handling

UNIX PROGRAMMING

1. Basic Unix Commands
2. Basic Shell Programming

SEMESTER II

HSS102	ENGLISH FOR TECHNICAL COMMUNICATION II (Common to all Branches)	L	T	P	C
		2	0	0	2

Course Outcomes:

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

CO1: Identify the errors in sentence structures

CO2: Construct grammatically correct sentences

CO3: Frame conversations

CO4: Effectively construct utterances for a Dialogue

CO5: Prepare various components of official communication like Memos, Circulars, Notices and Agendas

CO6: Recall Mechanics of Manuscript Preparation

CO7: Write reviews of a text, that the students read or a movie that they watch.

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										M		
CO2						H						
CO3						H						
CO4						H				M	M	
CO5								M		M		
CO6						M			M			
CO7						M		M		M		

GRAMMAR AND VOCABULARY

Grammar and Vocabulary - Introduction to grammatical models - Proper use of tenses, concord, voice, articles, punctuation, and modal auxiliaries.

RECEPTION SKILLS

Listening and Language Development - Improving listening skills - comprehension practice - Comprehend classroom lectures, simple technically oriented passages - Listening to news bulletins, pre-recorded talks, different speech styles, comprehending the essential meaning - Physical and psychological barriers to listening - Steps to overcome the barriers - Practice in note-taking while listening.

SPEAKING TECHNIQUES

Speaking practice - Improving conversing skills - Improving self-expression - Developing confidence and fluency in oral communication - Physical and psychological barriers to speaking - Steps to overcome the barriers - Formal and public speaking practice - Extemporary talk practice - Speech process - fluency and accuracy in speech - Developing persuasive speaking skills - Conversation in a given milieu, social and cultural surroundings - Practice in giving small talks on local topics for a minute or two - Goal oriented group discussion - Participating in seminars - Independent and effective communication.

READING STRATEGIES

Reading comprehension - Vocabulary extension methods - Speed reading practice - technical and non-technical materials - Practice in various reading techniques - skimming, scanning, eye reading - Looking for specific information - Comprehending the given passages, technical information.

WRITTEN COMMUNICATION

Basic grammatical structures - Alphabet of other languages - Paragraph writing - Expressing the idea in writing - Avoiding and correcting common errors - Effective writing techniques - brevity, clarity, objectivity and simplicity - Discourse writing - definition, description, instruction - Note-making - Proof reading - Mechanics of writing - Writing formal, informal letters, Technical reports - Reference skills - using dictionary better.

TEXT BOOKS

1. Rizvi M Ashraf, Effective Technical Communication, Tata McGraw-Hill, 2005.
2. Rutherfoord Andrea J, Basic Communication Skills for Technology, Pearson Education, 2002.

REFERENCES

1. Deborah C Andrews, Margaret D Bickle, Technical Writing - Principles and Forms, Macmillan, 1978.
2. Manivannan G, English for Engineers - A Book on Scientific and Technical Writing, Govi Publications, 2005.
3. Sarah Freeman, Written Communication in English, Orient Longman, 2000.
4. Thomson A J & AV Martinet, A Practical English Grammar, OUP, 4th Edition, 1986.
5. Tom Hutchinson, Alan Waters, English for Specific Purpose, Cambridge University Press, 1987.

MAT104	MATHEMATICS II (Common to all Branches)	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1 : Explain the concept of double integral and triple integral.

CO2 : Explain the concept of Gradient, divergence and curl.

CO3 : Explain the concept of line, volume and surface integrals.

CO4 : Construct conformal mappings between regions.

CO5 : Evaluate certain real integrals using residue theorem.

CO6: Apply differential equations for Physical problems.

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M			M								
CO2	M	H										

CO3		H		M								
CO4				M								
CO5	M											
CO6	M			M								

SEQUENCES AND SERIES

Convergence and divergence of infinite series , series of positive terms , comparison, D•Alembert•s ratio, Raabe•s and Cauchy•s root tests , Convergence of alternating series , Leibnitz•s test (proof of theorems and tests not included) , elementary notions of absolute and conditional convergence - Power series , Taylor•s theorem(one variable)

ANALYTIC FUNCTION AND CONFORMAL MAPPING

Function of a complex variable , Analytic function , Necessary conditions , Cauchy , Riemann equations , Sufficient conditions (excluding proof) , Properties of analytic function , Harmonic conjugate , Construction of Analytic functions - Conformal mapping - w = z+a, az, 1/z, e^z , sin z, cos z and bilinear transformation , fixed points , cross ratio

COMPLEX INTEGRATION

Statement and application of Cauchy•s integral theorem and integral formula , Taylor and Laurent expansions , Isolated singularities , Residues - Cauchy•s residue theorem - Contour integration over unit circle and semicircular contours (excluding poles on boundaries)- evaluation of real integrals using contour integration

MULTIPLE INTEGRALS

Review of Riemann integrals - Double integration , Cartesian and polar coordinates , change of order of integration , change of variable between Cartesian and polar , Area as double integral , Triple integration in Cartesian, cylindrical and spherical polar coordinates , volume as triple integral

VECTOR CALCULUS

Gradient, Divergence and Curl , Directional derivative , Irrotational and solenoidal vector fields , Vector integration , Green•s theorem in a plane, Gauss divergence theorem and Stoke•s theorem (excluding proof) , Simple applications

TEXT BOOKS

1. Kreyszig, E, Advanced Engineering Mathematics, John Wiley and Sons (Asia) Limited, Singapore, 8th Edition, 2001
2. Arumugam, S., Thangapandi Isaac, A., Somasundaram, A., Engineering Mathematics Volume II, Scitech Publications (India) Pvt. Ltd., Chennai, 1st Edition., Reprint 2000, 1999

REFERENCES

1. Grewal , B.S., Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 37th Edition., 5th Reprint 2004, 2003
2. Venkataraman, M. K., Engineering Mathematics First Year, The National Publishing Company, Chennai, 2nd Edition., Reprint 2001, 2000

3. Venkataraman, M. K., Engineering Mathematics , III A, The National Publishing Company, Chennai, 11th Edition., Reprint 2002, 1998

PHY 132	ENGINEERING PHYSICS II (common to all branches)	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Understand the free electron theories, formation of energy bands, energy distribution and also the electron behavior in solids

CO2: Know and understand the cooper pair electron behavior, applications of superconducting materials in developing technologies.

CO3: Learn the importance of semiconducting materials in engineering fields by projecting the view of energy bands.

CO4: Gain the knowledge about various kinds of magnetic materials, their properties and applications in advanced technologies.

CO5: Gain the knowledge about dielectric materials, their properties and significant applications in advanced technologies.

CO6: Learn how to prepare some new materials like metallic glasses, nano-materials, shape memory alloys, nonlinear materials to improve the technology.

CO7: Adapt to new developments of materials in science and technology by characterizing with sophisticated instruments.

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M		M	M								
CO2			M									
CO3			M									
CO4	M		M	M								
CO5			M									
CO6			M									
CO7			M									

CONDUCTING MATERIALS

Conduction in metals , mobility and conductivity , classical free electron theory - electrical conductivity , thermal conductivity , Wiedemann-Franz law , Lorentz number , drawbacks of classical theory.

SEMICONDUCTING AND SUPERCONDUCTING MATERIALS

Introduction semi conducting materials , types of semiconducting materials , carrier concentration , Hall effect , determination of Hall coefficient , superconducting phenomena , properties of superconductors , Type I and Type II superconductors , high Tc superconductors , application of super conductors.

MAGNETIC MATERIALS

Classical theory of magnetism , quantum theory of paramagnetism , ferromagnetism , ferrites , applications of magnetic materials.

DIELECTRIC MATERIALS AND OPTICAL MATERIALS

Electronic, ionic, orientational and space charge polarization , internal field and deduction of Clausius-Mosotti relation , properties of dielectric materials , classification of insulating materials , optical properties of semiconductor , imperfection of crystals , luminescence , fluorescence , phosphorescence , light emitting diode (LED) , liquid crystal displays (LCD).

NEW ENGINEERING MATERIALS

Metallic glasses as transformer core material , nanophase materials , shape memory alloys , Bio materials (metals & alloys, ceramics) , non-linear materials , second harmonic generation , optical mixing - optical phase Conjugation , solitons and IC packaging materials.

TEXT BOOKS

1. P.K. Palanisamy, *f*Material Science,,, Scitech Publications (India), Pvt Ltd., Chennai, 2009.
2. Arumugam, M., Material Science, Anuradha Agencies, Kumbakonam, 3rd Edition, 2003.

REFERENCES

1. Aswani K.G., A Text book of Material Science, S.Chand & Co., Ltd., New Delhi, 2nd Edition, 2001.
2. Raghavan, V., Material Science and engineering, Prentice-Hall of India Pvt. Ltd., India.
3. William F.Smith, Foundations of Materials Science and Engineering, McGraw-Hill, New York, 3rd Edition, 2003.
4. Wahab M.A., Solid State Physics, Narosa Publishing House, New Delhi, 1999.
5. Pillai S.O., Solid State Physics, New Age International Publication, New Delhi, 5th edition, 2003.
6. Ali Omar.M, Elementary Solid State Physics, Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi, 2002.
7. Murthy V.S.R., Jena AK, Gupta K.P. and Murthy G.S., Structure and Properties of Engineering Materials, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2003.

CIV 101	BASIC CIVIL AND MECHANICAL ENGINEERING	L	T	P	C
		4	0	0	4

Course Outcomes:

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

CO1: Describe the scientific terminologies related to construction and mechanical sciences.
CO2: Familiarize with different components, equipments and technical standards
CO3: Know the purpose, procedures, and the materials
CO4: Be aware of the uses and standards adopted in industries.
CO5: Understand the basic laws pertaining towards the subject.
CO6: Understand the procedures for construction of several structures.
CO7: Create working models or prototypes of the components.
CO8: Gain knowledge in surveying, their types and the equipments used.
CO9: Explain the principle, working and application of Engines and Power plants.
CO10: Understand and apply the concepts of manufacturing and the technology related.
CO11: Mention some of the applications of the manufacturing processes.

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									H			
CO2											M	
CO3											M	
CO4									M			
CO5									H	M		
CO6											M	
CO7											M	
CO8							H				M	
CO9											M	
CO10										M	M	
CO11						M					M	

CIVIL ENGINEERING

BUILDINGS

Characteristics of good building materials such as stones, bricks, plywood and ceramic tiles, timber, cement, aggregates and concrete - Basic functions of buildings , Major components of buildings , Foundations - Purpose of a foundation , Bearing capacity of soils , types of foundations. Proper methods of construction of Brick masonry , Stone masonry , Hollow Block masonry. Beams , Lintels , Columns , Flooring , Damp proof course , surface finishes , Doors and windows , Roofing.

TRANSPORTATION ENGINEERING

Principles and Classification of surveying, Chain surveying, Compass surveying and leveling - Importance of roads , Classification of Highways , water bound macadam, bituminous and cement concrete roads , . Railways - Importance of railways , Gauges , Components of a

permanent way. Bridges - Components of Culverts , Causeways, Slab Bridge, T-beam and slab bridge, Suspension bridge

MECHANICAL ENGINEERING

BOILERS AND TURBINES

Boilers - boiler mountings and accessories , Cochran boiler, Locomotive boiler, Babcock and Wilcox boiler, fire and water tube boilers - Steam turbine - single stage impulse turbine, Parson•s reaction turbine, difference between impulse and reaction turbines.

POWER PLANTS AND INTERNAL COMBUSTION (IC) ENGINE

Classification of power plants , steam, nuclear, diesel and hydro power plants - Alternate sources of energy - solar, wind, tidal, geothermal, ocean thermal energy conversion. , IC engine - components, working of four and two stroke petrol and diesel engines.

PRODUCTION TECHNOLOGY

Metal casting and forming process , patterns, moulding, melting of cast iron, casting , forging , rolling , extrusion , drawing - Metal joining process - welding , arc welding, gas welding, brazing and soldering - Metal machining , lathe, drilling machine, milling machine, shaping machine, planing machine, introduction to Computer Numerical Control machining.

TEXT BOOK

1. Shanmugam, G,, and Palanichamy, M.S., Basic Civil and Mechanical Engineering, Tata McGraw Hill Publishing Co., New Delhi, 1996.

REFERENCES

1. Khanna, K., Justo C E G, Highway Engineering, Khanna Publishers, Roorkee, 2001
2. Arora S.P. and Bindra S.P., Building Construction, Planning Techniques and Method of Construction, Dhanpat Rai and Sons, New Delhi, 1997.
3. Venugopal K., Basic Mechanical Engineering, Anuradha Publications,
4. Kumbakonam, 2000.
5. Shanmugam G., Basic Mechanical Engineering, Tata McGraw Hill Publishing Co.,New Delhi, 2001.

CHY 102	ENVIRONMENTAL SCIENCES (Common to all branches)	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Know the importance of environmental studies and methods of conservation of natural resources.

CO2: Describe the structure and function of an ecosystem.

CO3: Identify the values and conservation of bio-diversity.

CO4: Explain the causes, effects and control measures of various types of pollutions.

CO5: Select the appropriate methods for waste management.

CO6: Get knowledge about various disaster management methods

CO7: Recall social issues and legal provision.

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			H	M								
CO2			H	M								
CO3			H	M								
CO4			H	H								
CO5			H	H								
CO6			H	H					M			
CO7			H	M								H

NATURAL RESOURCES

Definitions , Scope of Environmental Sciences - Forest Resource , Food Resource , Land Resource , Water , Mineral resources - Utilization of Natural Resource, Impact on Environment , Conservation of Natural Resources

ECOSYSTEM AND BIODIVERSITY

Concept , Structure and Function , Energy Flow in Ecosystem , Ecological Succession , Food Chain , Food Web, Ecological Pyramids , Biodiversity, Definition, Values, Threats to Biodiversity, Conservation of Biodiversity

ENVIRONMENTAL POLLUTION

Definition, Causes, Effects and Control Measures of Air, Water and Soil Pollution , Thermal and Nuclear Pollution

MANAGEMENT OF ENVIRONMENTAL POLLUTION

Solid Waste Management , Treatment Methods adopted for Municipal Sewage and Industrial Effluent , Hazardous and Biomedical Waste Management

TOOLS FOR ENVIRONMENTAL MANAGEMENT

Environment Impact Assessment , Precautionary and Polluter Pay Principle - Constitutional Provision , (Air, Water and Forest) - Waste Minimization Techniques, Cleaner Technology Options, Bioremediation

TEXT BOOK

1. Dhameja, S.K., Environmental engineering and Management, S. K. Kataria & Sons, New Delhi, 1st Edition, 2004

REFERENCES

1. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad, 1st Edition, 2001.
2. Miller, T.G. Jr., Environmental Science, Wadsworth Publishing Co. USA, 2nd Edition, 2004
3. Trivedi, R.K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media., New Delhi, 2nd Edition, 2004
4. Masters, G. M., Introduction to Environmental Engineering & Science, Prentice Hall, New Delhi, 2nd Edition, 1997
5. Henry, J. G., and Heike, G. W., Environmental Science & Engineering, Prentice Hall International Inc., New Jersey, 1st Edition, 2005

MEC101	ENGINEERING DRAWING (Common to all Branches)	L	T	P	C
		1	0	3	2

Course Outcomes:

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

CO1: Describe the scientific and empirical foundations for engineering design.
CO2: Familiarize with different drawing equipments and technical standards
CO3: Know the purpose, procedures, materials and conventional symbols used
CO4: Be aware of the uses of standard and nominal sizes in industries.
CO5: Understand the basic geometrical relationships; parallelism, perpendicularity, angularity, co-linearity and concentricity.
CO6: Understand the procedures for construction of geometric figures.
CO7: Create and read an engineering drawing using standard views
CO8: Know the principles projection and distinguish the types of projection
CO9: Convert pictorial (3-D) drawings to orthographic (2-D) drawings and vice versa
CO10: Explain the principle and application of sectioning
CO11: Understand and apply the concepts of development of surfaces
CO12: Mention some of the applications of technical drawings

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				H								
CO2										M		
CO3										M	M	
CO4										M	M	
CO5				H								
CO6											M	
CO7							M					

CO8											M	
CO9											M	
CO10											M	
CO11											M	
CO12							M					

INTRODUCTION

Importance of graphics , use of drafting instruments , BIS conventions and specifications , size, layout and folding of drawing sheets , lettering dimensioning and scales - orthographic principles , missing view - free hand sketching in first angle projection from pictorial views.

PROJECTION OF POINTS, STRAIGHT LINES AND PLANES

Projection of points, located in all quadrants - projection of straight lines located in the first quadrant, determination of true lengths and true inclinations, location of traces - projection of polygonal surface and circular lamina located in first quadrant inclined to one or both reference planes.

PROJECTION OF SOLIDS AND SECTION OF SOLIDS

Projection of solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method , types of section , full section and half section -conventional section lines - section of simple solids like prisms, pyramids, cylinder and cone in vertical position by cutting planes inclined to any one of the reference planes, obtaining true shape of section

DEVELOPMENT OF SURFACES

Development of lateral surfaces of simple and truncated solids , prisms, pyramids, cylinders and cones - development of lateral surfaces of combined solids.

ISOMETRIC AND PERSPECTIVE PROJECTION

Principles of isometric projection , isometric view and projections of simple solids, truncated prisms, pyramids, cylinders and cones - Orthographic to isometric view , Introduction to perspective projection.

TEXT BOOK

1. Basant Aggarwal and C. Aggarwal, Engineering Drawing, Tata McGraw-Hill publishing company,New Delhi , 2008

REFERENCES

1. Shah, M.B., and Rana, B.C., Engineering Drawing, Pearson Education, New Delhi, 2005.
2. Nataraajan, K.V., A text book of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 2006.
3. Bhatt, N.D., Engineering Drawing, Charotar publishing House, New Delhi, 46th Edition, 2003.

4. Luzadder and Duff, Fundamentals of Engineering Drawing, Prentice Hall of India Pvt Ltd, New Delhi, XI Edition, 2001.
5. Venugopal, K., Engineering Graphics, New Age International (P) Limited, 2002.

BIT103	CELL BIOLOGY AND GENETICS	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Distinguish prokaryotic cell from eukaryotic cell and describe the structure and function of different parts of a eukaryotic cell

CO2: Explain the mitosis and meiosis cell division and the consequences

CO3: Explain different types of microscopes and their main uses

CO4: Appreciate the discovery of Mendelian laws

CO5: Describe human chromosome and basis of genetic diseases

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	-	-	H	-	M	-	-	-	M	-	-
CO 2	H	-	-	H	M	M	-	-	-	M	-	-
CO 3	H	-	-	H	M	M	-	H	-	H	M	-
CO4	H	-	-	H	-	M	-	-	-	-	-	-
CO5	H	-	-	H	M	M	-	H	-	H	M	-

STRUCTURE AND FUNCTION OF CELL ORGANELLES

History of cell - Development of cell theory - General organization of prokaryotic and eukaryotic cell - comparison - Organization of cell membrane , Cell permeability , Differentiations of the cell membrane -Intercellular communications and Gap junctions , Cytoskeleton and cell motility - Microtubules, microfilaments and intermediate filaments , Endoplasmic reticulum and protein segregation , Golgi complex and cell secretion - Lysosomes, endocytosis, coated vesicles, endosomes and peroxisomes , Mitochondria and Oxidative Phosphorylation , Chloroplast and Photosynthesis- ribosomes- nucleolus, chromatin and chromosomes.

CELL CYCLE AND CELL DIVISION

The cell cycle , Regulation - Role of cyclins and Cdks, Cell cycle check points, , General description and different stages of mitosis and meiosis , Functional role of mitotic apparatus , Consequences of meiosis and types of meiosis , difference between mitosis and meiosis.

TYPES OF MICROSCOPES AND APPLICATIONS

Microscopy , Simple and Compound Microscope, Different types of light microscope and their applications, Confocal microscope, Electron microscopes- Transmission Electron Microscope and Scanning Eelectron Microscope,, - Sample preparation for light microscopy and electron microscopy.

CONCEPTS IN GENETICS

History , Mendelian experiments with pea plants , self pollination and cross pollination- Mendelian Laws of inheritance: dominance and recessive, law of segregation and law of independent assortment -Linkage and Crossing over- Linkage mapping , chromosome mapping- Extra chromosomal inheritance- population and evolutionary genetics

HUMAN GENETICS

The human chromosome, chromosome abnormalities - Genotype and allelic frequencies- Inborn-errors of metabolism - polygenic and multifactorial inheritance , Sex determination - Role of Y chromosome , sex-linked inheritance, sex chromosome anomalies - Mutation - Gene mutation - molecular basis of mutation - Molecular basis of genetic diseases

TEXT BOOKS

1. De Robertis, E.D.P. and De Robertis, E.M.F., Cell and Molecular Biology, Lippincott Williams & Wilkins, Philadelphia, USA, 8th Edition, 2010.
2. Gardner, E.J., Simmons, M.J. Snustad, D.P. Principles of GeneticsWiley-India Ltd, New Delhi , 8th Edition, 2008.
3. Strachan, T., and Read A.P. Human Molecular Genetics, Garland Publishing, 3rd Edition, 2004.

MEC181	WORK SHOP	L	T	P	C
		0	0	3	1

Course Outcomes:

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

CO1: Make Joints and understand their uses in Wooden Products like Table, Frame, etc…

CO2: Perform metal joining with simple saw process

CO3: Make hollow channels, containers using Sheet metal development

CO4: Join Metal using Welding process (Knowledge only)

CO5: Gain knowledge in Casting and Molding of Metals

CO6: Perform various Machining Techniques like Drilling, Tapping, etc…

Course Outcomes Vs Program Outcomes Mapping:

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

CARPENTRY

Carpentry tools - practice in marking, sawing, planing and chiseling , making simple joints: lap joint, T-joint, dovetail joint, mortise and tenon joint.

FITTING

Fitting tools - practice in marking, filing, punching, hacksawing - fitting to size and drilling - making of simple mating profiles: V, square, dovetail, half round joints.

SHEET METAL

Study of press, die and tools - sheet metal layout - development of lateral surfaces -simple exercises: blanking, forming, bending and flanging.

DRILLING

Drilling and tapping in drilling machines

Demonstration on:

(i) Welding operations like butt joint and lap joints in Arc welding

(ii) Foundry operations like mould preparation for split pattern

(iii) Smithy operations like the production of hexagonal bolt

(iv) Preparation of plumbing line sketches , basic pipe connections involving the fittings like valves, taps, couplings, unions, reducers, elbows and other components used in household fittings.

CHY 182	CHEMISTRY LABORATORY	L	T	P	C
		0	0	3	1

Course Outcomes:

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

CO1: Analyze the various water quality parameters.

CO2: Investigate the kinetics of a chemical reaction.

CO3: Determine the amount of fluoride and iron by spectrophotometric methods

CO4: Estimate the amount of acid and base by electrochemical methods.

Course Outcomes Vs Program Outcomes Mapping:

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

List of Experiments:

1. Estimation of hardness of water sample by EDTA method
2. Determination of alkalinity of given water sample
3. Determination of dissolved oxygen in a water sample
4. Determination of rate constant of a reaction (Ester hydrolysis)
5. Estimation of hydrochloric acid by pH titration
6. Estimation of chloride ion in a given water sample
7. Determination of sodium and potassium by flame photometry
8. Estimation of ferrous ion by potentiometric method
9. Estimation of iron by spectrophotometry using 1,10-phenanthroline
10. Determination of strength of mixture of acids using strong base by conductometric titration
11. Estimation of fluoride ion by spectrophotometry
12. Conductometric titration of strong acid with strong base

SEMESTER III

		L	T	P	C
MAT202	**MATHEMATICS III** (Common to Biotechnology, Chemical Engineering, Civil Engineering, CSE, EEE, ICE and Mechanical Engineering)	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Evaluate integrals and solve boundary value problems using Laplace transfoms

CO2: Solve standard type of first order partial differential equations and higher order partial differential equations with constant coefficients.

CO3: Apply the concept of Fourier series to find the sum of certain series.

CO4: Solve difference equations using Z-transform.

CO5: Find Fourier, Sine and Cosine transforms of given functions.

Course Outcomes Vs Program Outcomes Mapping:

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

LAPLACE TRANSFORM

Definition of Laplace transform - Linearity property - condition for existence of Laplace transform - First and second shifting properties - Laplace transform of derivatives and integrals - Unit step functions - Diarc delta-function - Differentiation and integration of transforms - Convolution theorem - Inversion - Periodic functions - Evaluation of integrals by Laplace transform - Solution of boundary value problems

PARTIAL DIFFERENTIAL EQUATIONS

Formation of PDE - Solution of std types of first order PDE - Lagrange•s linear equation - Linear PDE of second and higher order with constant coefficients

FOURIER SERIES

Dirichlet•s conditions - General Fourier series - odd and even functions - Half range sine and cosine series - complex form of Fourier series - Parseval•s identity - Harmonic analysis

Z € TRANSFORM

Z-transform - elementary properties - Inverse Z-transform - Convolution theorem - formation of difference equation - Solution of difference equation using Z-transform.

FOURIER TRANSFORM

Fourier Integral formula - Fourier Transform - Fourier sine and cosine transforms - Linearity, Scaling, frequency shifting and time shifting properties - Self reciprocity of Fourier Transform - Convolution theorem - Application to boundary value problems

TEXT BOOKS

1. Kreyszig, E., Advanced Engineering Mathematics, John Wiley and Sons (Asia) Limited, Singapore, 8th Edition., 2001
2. Arumugam, S., Thangapandi Isaac, A., Somasundaram, A., Engineering Mathematics Volume II, Scitech Publications (India) Pvt. Ltd., Chennai, 1st Edn., Reprint 2000, 1999

REFERENCES

1. Grewal, B.S., Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 37th Edition, 5th Reprint 2004, 2003
2. Venkataraman, M. K., Engineering Mathematics , III A, The National Publishing Company, Chennai, 11th Edition., Reprint 2002, 1998
3. Venkataraman, M. K., Engineering Mathematics - III B, The National Publishing Company, Chennai, 13th Edition., Reprint 1999, 1998

CHE 253	BIOPROCESS CALCULATIONS	L	T	P	C
		3	1	0	4

Course Outcomes:

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

CO1: Analyze the data obtained from an experiment using various analytical and graphical methods

CO2: Solve material balance of physical processes

CO3: Solve material balance of chemical processes

CO4: Solve energy balance of physical and chemical processes

CO5: Solve combined material balance and energy balance for selected bioprocesses

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION

Units and dimensions, Concept of mole and Molecule, Composition of mixtures of Solids, liquids and gases - Composition of mixtures and solutions- Percentage by weight, mole and Volume; normality, molarity, molality, and ppm, pH and pKa Buffer Calculations

MATERIAL BALANCE WITHOUT CHEMICAL REACTIONS:
Material balances in distillation, absorption, extraction, crystallization, psychrometry, drying, mixing and evaporation operations, Material balances involving bypass, recycle and purge.

MATERIAL BALANCE INVOLVING CHEMICAL REACTIONS
Principles of stoichiometry, definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, Selectivity and related problems.

THERMOPHYSICS AND THERMOCHEMISTRY
Thermophysics: Heat-capacity of gases, empirical equations for heat capacities, mean-heat capacities of gases, latent heats, calculation of enthalpy from thermo physical properties.

Thermochemistry: Standard heat of reaction, heat of formation, law of Hess, standard heat of combustion, heats of formation calculated from heats of combustion, calculation of the standard heat of reaction from heats of formation or combustion, effect of temperature on heat of reaction, enthalpy changes in reactions with different temperatures, calculation of theoretical flame temperature.

STOICHIOMETRY OF BIOPROCESS
Material balance: Material balance involved in bioprocess, Stoichiometry of growth and product formation
Energy balance: Heat of reaction for process with biomass production, Thermodynamics of microbial growth, Energy balance for cell culture.

TEXT BOOKS

1. Bhatt, B.I. and Vora, S.M., Stoichiometry, Tata McGraw-Hill Publishing Company, New Delhi, 4th Edition, 2004.
2. Doran, P.M., Bioprocess Engineering Principles, Academic Press (An Imprint of Elsevier), New Delhi, 2nd Edition, 2005

REFERENCES

1. Himmelblau, D.M. Basic Principles and Calculations in Chemical Engineering, Prentice-Hall of India, New Delhi , 7th Edition, 2004.
2. Hougen, O.A., Watson, K.M., and Ragatz, R.A., Chemical Process Principles, Part-I, CBS Publishers and Distributors, New Delhi, 2nd Edition, 1995.

BIT 204	MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:
At the end of the course, students would be able to
CO1: Describe diversity of microorganisms, bacterial cell structure and function, microbial growth and metabolism, and the ways to control their growth by physical and chemical means

CO2: Demonstrate the knowledge as to how microorganisms interact with their environment and interaction between humans and microorganisms

CO3:Explain the cell structure and metabolism and basic genetic systems of bacteria, bacteriophage and plasmids

CO4: Demonstrate practical skills in fundamental microbiological techniques.

CO5: Systematically apply the scientific method of investigation and hypothesis testing including the development of theoretical and practical skills in the design and execution of experiments as well as the development of oral and writing skills necessary for the effective communication of experimental results

Course Outcomes Vs Program Outcomes Mapping:

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

MICROBIAL WORLD

Basic of Microbial existence, History of microbiology, Classification and Nomenclature of microorganisms, Type cultures and culture collections, Principles of Light, Phase contrast and Dark field Microscopy, Electron microscope - Staining Techniques - Gram•s and Acid-fast staining, spore, capsular and flagellar staining , Pure culture techniques.

STRUCTURE AND FUNCTION

Structure of the bacterial cell wall, appendages of bacteria - Pili and flagella, capsule, slime and bacterial endospores, Over view of Viruses, Structure, classification and multiplication of algae and fungi, Life history of yeast and bacteriophages.

BACTERIAL PHYSIOLOGY AND GENETICS

Nutritional requirements of bacteria, Cultivation of bacteria - Different media used for bacterial culture, Bacterial growth curve - measurement, kinetics and generation time, Bacterial growth under aerobic and anaerobic conditions, Utilization of energy for biosynthesis of important molecules. Bacterial reproduction - binary fission - Transformation, conjugation and transduction , mutation and recombination

MEDICAL MICROBIOLOGY

Microorganisms as pathogens- common infectious diseases , cholera, typhoid, tuberculosis, HIV, rabies, pappiloma, hepatitis Antibiosis: assay, common antibiotics , ampicillin and kanamycin and their mode of action

MICROBIAL ECOLOGY

Effect of environmental factors on the growth of microorganisms, Control of microorganisms - antibiotics and disinfectants, Plant associates microorganisms - Rhizosphere, phylloplane micro flora. Mycorrhiza, air and water micro flora, Host-microbe Interaction, Microbes and the environment

TEXT BOOK

1. Pelczar M. J., Chan E.C.S. and Krieg N.R., Microbiology, Tata McGraw Hill, New Delhi, India, 5th Edition, 1998.

REFERENCES

1. Prescott.L. M., Harley J.P. and Klein B.A., Microbiology, Wm. C. Brown Publishers, IOWA. USA, 5th Edition, 2003.
2. Tortora, G.J., Funke, B.R. and Case, C.L., Microbiology: An Introduction, Benjamin Cummings, 10th Edition, 2009.

BIT 209	MOLECULAR BIOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Summarize DNA as a genetic materials, organization and packing of genes in chromosomes of both prokaryotic and eukaryotic systems

CO2: Describe replication, repair and recombination of DNA, in both prokaryotic and eukaryotic organism

CO3: Explain the structure and function of RNA polymerase and how they are involved in transcription with cap formation, splicing and polyadenylation

CO4: Understand genetic code, types of ribosome, RNA and how they are involved in translational machinery of an organism

CO5: Illustrate various molecular biological techniques such as Southern, Northern and western blotting, PCR types, and next generation sequencing

Course Outcomes Vs Program Outcomes Mapping:

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

GENES, GENOMES AND DNA

DNA as the genetic material , Organization of prokaryotic and eukaryotic genomes, supercoiling, repetitive DNA - Levels of DNA packaging in Eukaryotes - Coding and non-coding DNA

DNA REPLICATION

Prokaryotic and eukaryotic DNA replication - mechanisms of DNA replication- fidelity of replication- enzymes and accessory proteins involved in DNA replication - replication inhibitors - DNA Repair and recombination; Gene mutations - types of mutations - Suppression, Transposable genetic elements

TRANSCRIPTION

RNA Polymerase - holoenzyme and apoenzyme - sigma factors , Initiation, elongation, termination mechanism of eukaryotic and prokaryotic transcription - Types of RNA polymerases - Promoter of RNA polymerase II - Enhancers - General and inducible transcription factors - modifications of RNA - 5• cap formation , polyadenylation - splicing of nuclear pre-mRNA, mRNA stability , Run-on Run-off mechanism - transcription inhibitors

TRANSLATION

Genetic code , characteristics -deciphering the code - protein biosynthesis- prokaryotic and eukaryotic translation, the translational machinery, mechanism of initiation, elongation and termination - regulation of expression in eukaryotes - regulation of translation by 3• and 5• UTR motifs , translation inhibitors

TECHNINIQUES IN MOLECULAR BIOLOGY

Blotting and hybridization, DNA sequencing - Sangers method - DNA fingerprinting; PCR, RT-PCR and qPCR, transcriptome analysis , Next generation sequencing

TEXT BOOKS

1. Allison, L.A, Fundamental Molecular Biology , Blackwell publishing group, Malden, MA, USA, 1st Edition, 2007.
2. Friefelder. D., Molecular Biology, McGraw-Hill Companies, New York, USA, 5th Edition, 2013.

REFERENCE

1. Clark, D.P. and Pazdernik, N.J., Molecular Biology, Elsevier Academic Press , 2nd Edition, 2013

BIT214	ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Describe the working principles of pH meter and estimation of macromolecules
CO2: Explain the principles and instrumentation of spectroscopy.
CO3: Describe the principles of centrifugation methods
CO4: Classify separation methods
CO5: Understand the principles of chromatography

Course Outcomes Vs Program Outcomes Mapping:

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

BASIC TECHNIQUES

Measurement of pH: pH Indicators, pH Meter, titration of acids, preparation of buffers. Estimation of macromolecules , carbohydrates, proteins, lipids

COLORIMETRY AND SPECTROSCOPY

Properties of electromagnetic radiation - interaction with matter; Beer-Lambert•s Law - differences between spectrophotometer and colorimeter - Visible light spectroscopy: Principle, instrumentation and applications. Ultraviolet spectroscopy - Atomic absorption spectroscopy, Thermogravimetric analysis, Spectrofluorimetry, FTIR, NMR and mass spectrometry.

CENTRIFUGATION

Basic principles; Types of centrifuge - microfuge, and high-speed and ultracentrifuge; Preparative centrifugation; Differential and density gradient centrifugation; applications (Isolation of cell components); analytical centrifugation; determination of molecular weight by sedimentation velocity and sedimentation equilibrium methods

ELECTROPHORESIS

Theory and applications of electrophoresis; agarose and polyacrylamide Disc- and slab-gel electrophoresis; Gradient electrophoresis - Capillary electrophoresis; 2D Electrophoresis - Isoelectric focusing, pulse-field gel electrophoresis

CHROMATOGRAPHIC METHODS OF SEPARATION

Introduction to chromatography - models, ideal separation, retention parameters Van - Deemter equation , TLC, HP-TLC and Column chromatography , chromatographic separation of proteins , ion-exchange, affinity, hydrophobic interaction and size-exclusion chromatography; gas chromatography (GLC) and high-performance Liquid Chromatography (HPLC)

TEXT BOOK

1. Friefelder. D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, W.H. Freemen and Company, San Francisco, 2nd edition, 1982.

REFERENCES

1. Griffiths, O. M., Techniques of Preparative, Zonal and Continuous Flow Ultracentrifugation, 1983.
2. William, B.L. and Wilson, K., A Biologist•s Guide to Principles and Techniques, 1986.

BIT 211	PRINCIPLES OF BIOCHEMISTRY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Describe the role of biomolecules and their applications

CO2: Calculate the pH of required buffers

CO3: Classify vitamins and their deficiency symptoms

CO4: Compare the structures of amino acids and lipids

CO5: Explain the role of hydrogen bonds in DNA structure

Course Outcomes Vs Program Outcomes Mapping:

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

BASIC PRINCIPLES AND CHEMISTRY OF LIFE

Solution of non electrolytes & Electrolytes: Concentration expressions, ideal solutions, colligative properties. Arrhenius theory, strong electrolytes - Ionic equilibrium, Electromotive force. Bonds: ionic bonding, Ion-dipole. Covalent, H-bonds, Vander Waal•s interaction, Hydrophobic and hydrophilic interactions. Water as a biological solvent and its role in biological processes; Calculation of pH, Henderson-Hasselbalch equation, concept of buffer, strength of buffer, range of buffer, important biological buffers; isotopes and their use in biology.

CARBOHYDRATES AND VITAMINS

Classification, structure and reactions of monosaccharides, and disaccharides, Polysaccharides , structural polysaccharides and storage polysaccharides; Homopolysaccharide and Hetero-polysaccharides; vitamins , Fat soluble and water soluble vitamins; Classification, structures and physiological functions

AMINOACIDS AND PROTEINS

Structure and characteristics of amino acids - Peptide bond stability and formation-Structural organization of proteins - primary, secondary, tertiary, quaternary and subunit structure of protein - Conformation of proteins globular and fibrous proteins

LIPIDS

Structure, and properties classification of lipids, fatty acids, waxes, phospholipids, cerebrosides, lipoproteins and gangliosides- Prostaglandins - prostacyclins, leukotrienes, thromboxanes and physiological implications- Steroids and bile acids.

NUCLEIC ACIDS

Structure of purines, pyrimidine, nucleosides and nucleotides - stability and formation of phosphodiester bond - Watson and Crick model of DNA; calculation of †Tm• for oligonuclotides; Types of RNA- Structure of tRNA

TEXT BOOKS

1. Nelson.D.L, Cox. M. M., Lehninger•s Principle of Biochemistry. 5th ed. Freeman, 2008.
2. Murray. R.K., Granner, D.K., Mayes. P. A. and Rodwell, V.W., Harper•s Biochemistry, McGraw Hill, 27th Edition, 2006.

REFERENCES

1. Berg. J.M., Tymoczko.J.L., Stryer, L., Biochemistry, Freeman, 6th edition, 2006.
2. Zubay , Biochemistry, William C. Brown Publication, 4th Edition, 1998.
3. Voet, D., Voet, G., Biochemistry, John Wiley and Sons, Singapore, 3rdEdition, 2001.

BIT 281	BIOCHEMISTRY LABORATORY	L	T	P	C
		0	0	3	2

Course Outcomes:

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

CO1: Explain the concept of pH

CO2: Perform calibration of pH meter and colorimeter.

CO3: Prepare the required buffers

CO4: Identify unknown amino acids from titration curves

CO5: Analyze carbohydrates, lipids and amino acids qualitatively and quantitatively

Course Outcomes Vs Program Outcomes Mapping:

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

List of Experiments:

1. Preparation of buffers (acidic, basic, neutral, biological)
2. Titration curves for amino acid, determination of pKa and pI
3. Qualitative analysis of lipids, carbohydrates and amino acids
4. Determination of aminoacids by ninhydrin method and Sorensen formal titration(glycine)
5. Estimation of protein (Biuret and Lowry Method)
6. Estimation of total sugars by Anthrone method
7. Estimation of total sugars by DNS method
8. Estimation of aldose and ketose sugars
9. Determination of acid value, saponification value and iodine number of oils
10. Determination of acid value, saponification value and iodine number of fats

BIT 283	MICROBIOLOGY LABORATORY	L	T	P	C
		0	0	3	2

Course Outcomes:

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

CO 1: Prepare nutrient agar media and pour in Petri plates.

CO 2: Stain and differentiate between gram positive and gram negative bacteria.

CO 3: Perform serial dilution and plating

CO4: Perform single colony streaking

CO5: Draw and interpret a growth curve of bacterial culture

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	M				M	H	H		M			
CO 2	H			M	M	H	H	M	M	M		
CO 3	H					H	M					M
CO4	H	M		M	M	H	M					
CO5	H					H	H		M			M

List of Experiments:

1. Sterilization techniques and handling method of glass wares and instruments
2. Microscopy and micrometry
3. Staining techniques - Simple, Gram•s, Capsule and Endospore staining
4. Motility test by hanging drop technique
5. Enumeration of Soil Microorganisms - serial dilution and plating
6. Pure culture technique
7. Biochemical tests - IMViC Test, catalase, oxidase, starch hydrolysis
8. Antimicrobial assay - (Kirby Bauer method)
9. Effect of disinfectants , phenol coefficient.
10. MPN technique.
11. Phage titration.
12. Phage lysis of liquid culture
13. Examination of quality of milk , Methylene blue test
14. Storage of microorganisms.
15. 16s rDNA sequencing.

BIT286	CELL AND MOLECULAR BIOLOGY LABORATORY	L	T	P	C
		0	0	3	2

Course Outcomes:

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

CO1: Observe sub-cellular organelles under the microscope

CO2: Visualize DNA bands in agarose gels

CO3: Isolate plasmid DNA from bacteria

CO4: Isolate genomic DNA from bacteria and plant

CO5: Prepare competent cells for transformation

Course Outcomes Vs Program Outcomes Mapping:

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

List of Experiments:

1. Cell fractionation - isolation of sub cellular organelles such as mitochondria, chloroplast etc.
2. Cell division in Onion root tip
3. Isolation of protoplast from plant leaves
4. Polytene Chromosomes of Dipterans
5. Estimation of nucleic acids
6. Isolation of plasmid DNA from bacteria
7. Agarose gel electrophoresis
8. Preparation of competent cells and transformation
9. Isolation of genomic DNA from bacteria
10. Isolation of genomic DNA from plant and animal cell
11. Restriction enzyme digestion
12. Mutagenesis , UV and chemical
13. Southern and Northern blotting
14. Separation of Proteins - SDS-PAGE

SEMESTER IV

CHE 252	UNIT OPERATIONS	L	T	P	C
		3	1	0	4

Course Outcomes:

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

CO1: Explain the phenomena of fluid statics and dynamics and their applications

CO2: Describe the principles of mixing & agitation and its applications

CO3: Explain the concepts of filtration & sedimentation and its applications

CO4: Describe the mechanism of heat transfer

CO5: Discuss heat exchangers used in process industries

Course Outcomes Vs Program Outcomes Mapping:

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

FUNDAMENTALS OF FLUID MECHANICS AND APPLICATIONS

Properties of fluids - Fluid statics, pressure measurement, forces on submerged bodies - Equation of continuity and motion - Bernoulli•s equation and its applications - Newtonian and non-Newtonian fluids - Laminar and turbulent flows - Pressure drop calculation and friction factor - Principles and operation of variable head meter and variable area meter - Fluid moving machineries such as pumps, blowers, compressors, vacuum system - Application and selection of valves

AGITATION AND MIXING

Dimensional analysis - Power for agitation, Agitation of liquids - Gas-liquid systems -Gas-solid suspensions - Agitator scale up

FILTRATION & SEDIMENTATION

Constant pressure and constant volume batch filtration, continuous filtration - Industrial filters - batch sedimentation test - Centrifugation

MECHANISM OF HEAT TRANSFER

Steady state conduction - Combined resistances - Unsteady state conduction - Combined conduction and convection , Lumped heat capacity - Extended surfaces - Forced and natural convection , Correlations for convective heat transfer coefficient for convection in flow over surfaces and through pipes - Boiling and condensation

HEAT EXCHANGERS AND EVAPORATORS

Heat exchangers - Overall heat transfer coefficients - Design of heat exchangers, NTU concept , Evaporators - single and multiple effects - Mass and enthalpy balances

TEXT BOOKS

1. McCabe, W. L., Smith, J. C., and Harriott, P., Unit Operations of Chemical Engineering, McGraw Hill, New York, 7th Edition, 2005
2. Holman, J. P., Heat Transfer, Mc Graw Hill, New York, 9th Edition, 2002.
3. Geankoplis, C.J., Transport Processes and Unit Operations, Prentice Hall of India, New Delhi, 3rd Edition, 2002

REFERENCES

1. David, M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, Prentice-Hall of India, New Delhi, 7th Edition, 2004.
2. Coulson, J.M., Richardson, J.F, Backhurst J.R. and Harker J.M., Coulson and Richardson•s Chemical Engineering, Volume I, Butter worth Heinemann, Oxford, New York, 5th Edition, 2002.

BIT203	BIOENERGETICS AND METABOLISM	L	T	P	C
		3	1	0	4

Course Outcomes:

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

CO1: Describe the fundamental concepts of biochemistry and their implications for biology.
CO2: Write the pathways involved in the synthesis and regulation of macromolecules
CO3: Explain the role of enzymes in biosynthesis.
CO4: Discuss the metabolic disorders of nucleic acids.
CO5: Summarize the cell metabolism and various reactions

Course Outcomes Vs Program Outcomes Mapping:

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

BIOENERGETICS

Laws of thermodynamics, entropy, enthalpy, free energy and equilibrium constant, Gibbs free energy equation, Biological oxidation and reduction, Redox potential and phosphate potential - Thermodynamic considerations. High energy compounds - Requirements of ATP for synthesis and degradation cycle. - Photosynthesis - Photo systems, light and dark reactions, C3 and C4 pathways

CARBOHYDRATE METABOLISM

Glycolysis, Tricarboxylic acid cycle (TCA),Glyoxylate cycle - Pentose phosphate pathway (HMP) gluconeogenesis and Glycogen metabolism, oxidative phosphorylation, Electron transport chain (ETC), Chemiosmotic theory- oxidative phosphorylation, inhibitors and un-couplers of electron transport chain and function of ATPase (bacterial and mitochondrial), Shuttle systems.

PROTEIN METABOLISM

Urea cycle, Biosynthetic and degradative pathway of amino acids - Protein synthesis and degradation - Different levels of regulation -Allosteric regulation and feedback regulation proteolytic processing.

LIPID METABOLISM

Fatty acids metabolism - Biosynthesis of fatty acids - β-oxidation pathway - Ketone bodies - Control of metabolism - Biosynthesis and degradation of cholesterol.

NUCLEIC ACID METABOLISM

Biosynthesis of purine - Nucleotides (adenine, guanine) - Biosynthesis of pyrimidine - Nucleotides (cytosine, thymine, and uracil) - Catabolism of adenine, guanine, cytosine, thymine, and uracil - Metabolic disorders associated with purine metabolism - Metabolic disorders associated with pyrimidine metabolism

TEXT BOOKS

1. Voet and Voet. Biochemistry. John Wiley and Sons, Singapore, 4th Edition, 2010.
2. Murray. R.K, Granner.D.K, Mayes. P. A, Rodwell. V. W. Harper s Biochemistry. McGraw Hill, 27th Edition, 2006.

REFERENCES

1. Stryer, L.Berg., J.M.Tymoezko., J.L., Biochemistry, W.H. Freeman Co., New York, 5th Edition, 2002.
2. Zubay, G., Biochemistry, McGraw Hill Publishers, New Delhi, 4th Edition, 1999.
3. Lehninger•s, A.L. Nelson., D.L., Cox, M.M., Principles of Biochemistry, Worth Publishers, London,4th Edition, 2000.

BIT205	INDUSTRIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1:Illustrate the screening procedures of microbes of industrial importance

CO2:Explain the medium requirements for fermentation processes

CO3:Compare various types of fermentation processes

CO4:Sketch and describe the production of industrially important products

CO5:Discuss the production of microbial enzymes, vaccines and microbial transformations

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION TO INDUSTRIAL BIOPROCESS

Introduction to fermentation process - definition, scope, history, microorganisms and industrial products - Screening for microbes of industrial importance - Isolation and preservation of industrial microorganisms - Primary screening (screening for amylase, organic acid, antibiotic, amino acid and vitamin producing microorganisms) and secondary screening - Further evaluation of primary isolates - Detection and assay of fermentation products - Physico chemical methods and biological assays - Role of a bioprocess engineer in the biotechnology industry - Outline of the various unit operations involved in an integrated bioprocess - Process flow sheeting

STRAIN IMPROVEMENT AND MEDIA PREPARATION

Environmental factors and genetic factors for improvement , Methods of strain improvement , mutation and rDNA technology, Inoculum media and inoculum preparation - Medium requirements for fermentation process. Examples of simple and complex media, raw materials, saccharides, starchy and cellulosic materials

FERMENTATION PROCESS

Types of fermentation processes - Solid state, surface and submerged fermentations - batch, fed batch, continuous fermentations - Direct-dual or multiple fermentations - Scale up of fermentations

PRODUCTION OF PRIMARY AND SECONDARY METABOLITES

Fermentative production of industrial alcohol, beer - Principles of wine making. Fermentative production of citric acid, vitamin B12, glutamic acid. Antibiotics - commercial production of benzyl penicillin and tetracycline•s.

PRODUCTION OF MODERN BIOTECHNOLOGICAL PRODUCTS

Immobilization - Production and application of microbial enzymes - Amylases, lipases and proteases enzymes in biotransformation - Steroid transformations - Microbial biopesticides and biofertilizers - Principles of vaccine production and types of vaccines - Microbial products from genetically modified (cloned) organisms.

TEXT BOOKS

1. Wulf Cruger and Anneliese Cruger., Biotechnology, (A text book of industrial Microbiology), Panima Publishers, New Delhi, 2nd edition, 2003.
2. A.H.Patel., Industrial microbiology, Macmillan Publishers India, 2nd edition (2012).

REFERENCES

1. Prescott and Dunn, Industrial Microbiology, CBS Publishers, New Delhi, 4th Edition, 1987
2. Young, M.Y., Comprehensive Biotechnology Vol. 1-4, Pergamon Press, Oxford, 1st Edition, 1985
3. Stanbury, P.F., and Whitaker, A., Principles of Fermentation Technology, Pergamon Press, Oxford, 2nd Edition, 2005.

BIT215	BIOINFORMATICS AND COMPUTATIONAL BIOLOGY	L	T	P	C
		3	1	0	4

Course Outcomes:

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

CO1: Describe the use of computers in storing, retrieving and annotating biological information

CO2: Access, search and retrieve information from various biological databases

CO3: Comparatively analyze DNA and Protein sequences.

CO4: Perform phylogenetic analyses and determine the evolutionary relationship between organisms

CO5: Explain the algorithms to predict primary, secondary and tertiary structure of proteins from their sequences

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION

Bioinformatics, Scope and applications of bioinformatics, Computer Hardware, Computer networks, Network Topology, Internet, Internet Protocols, FTP, HTTP, Search engine, Operating systems, Programming languages.

BIOLOGICAL DATABASES

Introduction to databases - Data life cycle, DBMS; Biological databases- Classification of biological databases- Primary and Secondary databases, Sequence and structure databases, Specialized databases- Data submission and Information Retrieval from biological databases.

PATTERN MATCHING

Sequence Homology versus Sequence Similarity, Sequence Similarity versus Sequence Identity, Sequence alignment- Local and global alignment, Pair wise sequence alignment, multiple sequence alignment, Dot Plots, Dynamic programming, Substitution matrices- PAM and BLOSSUM, Database similarity searching -FASTA and BLAST, Protein signatures, Identification of Motifs and Domains in Multiple Sequence Alignment.

PHYLOGENETIC ANALYSIS

Molecular Evolution and Molecular Phylogenetics, Phylogenetic tree, Forms of Tree Representation, Rooted and un-rooted trees, Phylogenetic Tree Construction Methods: Distance based methods- NJ, UPGMA, Character based methods , Maximum Parsimony, Phylogenetic programs

STRUCTURAL BIOINFORMATICS

Protein structure basics, Protein structural visualization and comparison, Secondary structure prediction- Chau-Fasman, GOR, Neural networks, Protein tertiary structure prediction- Homology modeling, Threading and Fold recognition.

TEXT BOOKS

1. Jin Xiong, Essential Bioinformatics, Cambridge University Press, New York, 1st Edition, 2006.
2. Mount, D. W., Bioinformatics Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, 2nd Edition, 2001.
3. Bergeron, B, (2003) Bioinformatics Computing, Eastern Economy Edition, 2nd Edition, Prentice Hall, NewYork,

REFERENCES

1. Lesk, A. M., Introduction to Bioinformatics, Oxford University Press, New York, 1st Edition, 2003.
2. Baldi, P., Brunak, S., Bioinformatics, A Machine Learning Approach, MIT press, USA, 2nd Edition, 1998.
3. Attwood, T.K., Perry smith, D.J., Introduction to Bioinformatics, Oxford University Press, New York, 1st Edition, 2002.

BIT216	PROTEIN SCIENCE AND ENGINEERING	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Explain and compare the different level of protein structure and their interdependence and protein folding

CO2: Describe the regulation of gene expression control and function of proteins with an examples of proton pump and photoreaction centre

CO3: Explain the theoretical knowledge of cloning of a gene on expression vector and purification of proteins with various column

CO4: Describe various bioinformatics tools which are involved in phylogenetic analysis, structure and functional prediction of proteins

CO5: Describe the protein engineering techniques how to utilize in industrial biotechnology

Course Outcomes Vs Program Outcomes Mapping:

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

STRUCTURE OF PROTEINS

Primary structure - Peptide mapping, peptide sequencing, automated Edman method and mass spectrophotometer - high throughput protein sequencing setup - Secondary structure - alpha, beta and loop structures, alpha-turn-alpha, beta-turn-beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down and TIM barrel structures, nucleotide binding folds, prediction of substrate binding sites - Tertiary structure - Domains, folding, denaturation and renaturation - Overview of methods to determine 3D structures - Quaternary structure - Modular nature, formation of complexes

STRUCTURE - FUNCTION RELATIONSHIP

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-Immunoglobulin - 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

STRUCTURE PREDICTION AND MODELING

Structure prediction and modeling proteins - Molecular graphics in protein engineering - Dynamics and mechanics - Drug-protein interactions and design

DATA ANALYSIS METHODS

Methods in protein data base analysis - theory, interactive graphics programme, perturbation

ENGINEERING OF PROTEIN

Protein engineering - Proteins design and engineering , site-directed mutagenesis - strategies to alter catalytic efficiency , stabilization of industrial enzymes - Design of biotechnology applicable yeast carboxypeptidase, ß-glycoside hydrolases - Specificity and stability in glucoamylase - Engineering proteins for degradation of recalcitrant compounds and biosensors

TEXT BOOKS

1. Branden, C. and Tooze, R., Introduction of Protein structure, Garland, 2nd Edition, 1999.
2. Lilia Alberghina., Protein Engineering in Industrial Biotechnology, Harwood Academic publishers, Netherland, Reprint, 2003

REFERENCES

1. Creighton, T.E., Proteins, WH Freeman, New York, 2nd Edition, 1993
2. Donald Voet, Judith G. Voet, Charlotte W. Pratt, Fundamentals of Biochemistry Life at molecular level, New York: John Wiley and sons, Inc, 4th edition, 2011.

BIT288	COMPUTATIONAL BIOLOGY LABORATORY	L	T	P	C
		0	0	3	2

Course Outcomes:

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

CO1: Access,search and retrieve information from various Biological databases

CO2: Perform database similarity search using online tools.

CO3: Use online tools for sequence analysis, alignment and comparison to find out sequence similarity

CO4: Predict primary, secondary and tertiary structure of proteins using online proteomic tools.

CO5: Construct phylogenetic trees form DNA / Protein sequences using specialized software

Course Outcomes Vs Program Outcomes Mapping:

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

List of Experiments:

1. Basic Unix/Linux commands
2. Exploring the integrated database system at NCBI server and querying the PUBMED and GenBank databases using the ENTREZ search engine
3. Exploring & querying UniProt database.
4. Search & retrieval: PDB databases
5. Exploring the integrated database system at EBI server and searching the EMBL Nucleotide database using the SRS search engine
6. Retrieve the database using Sequence Retrieval System (SRS and Expasy)
7. Pair-wise global alignments of protein and DNA sequences using Needleman-Wunsch algorithm & interpretation of results to deduce homology between the sequences, use of scoring matrices
8. Pair-wise local alignments of protein and DNA sequences using Smith-Waterman algorithm and interpretation of results
9. Find the hydrogen bonding interaction using Chem2pac software.
10. Using Mega4 software draw Phylogenetic tree for the given sequences (Protein/DNA).
11. Generate the secondary structural elements from amino acid sequence using various methods.
12. Write any simple program to retrieve the sequence through internet.

CHE291	CHEMICAL ENGINEERING LABORATORY	L	T	P	C
		0	0	3	2

Course Outcomes:

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

CO1: Calibrate Flow meters

CO2: Calculate friction factor in pipes & packed beds

CO3: Demonstrate particle filtration and particle classification studies

CO4: Estimate overall heat transfer coefficient in heat exchangers

CO5: Employ mass transfer operations such as distillation and adsorption

Course Outcomes Vs Program Outcomes Mapping:

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

List of Experiments:

1. Flow measurement - Variable head and variable area meters (Venturi, orifice, rotameter) - Calibration curve and determination of discharge coefficient
2. Pressure drop in straight pipes
3. Pressure drop in annular pipes
4. Pressure drop in packed columns - verification of Ergun equation
5. Fluidization - Calculation of minimum fluidization velocity
6. Filtration - plate and frame Filter, leaf filter and rotary vacuum filter
7. Heat exchanger - shell and tube, double pipe heat exchanger, calculation of effectiveness and efficiency
8. Simple distillation
9. Steam distillation
10. Distillation in packed column
11. Liquid-liquid equilibria in extraction
12. Adsorption equilibrium
13. Transient heat conduction
14. Free and forced convection heat transfer
15. Batch sedimentation Test

SEMESTER V

BIT303	BIOPROCESS PRINCIPLES	L	T	P	C
		3	1	0	4

Course Outcomes:

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

CO1: Explain fermenter design

CO2: List the roles of a bioprocess engineer in the bioprocess industry

CO3: Summarize the role of medium formulation and optimization in fermentation processes

CO4: Describe sterilization kinetics and the various modes of sterilization

CO5: Express microbial growth kinetics in various modes of fermentation

CO6: Apply metabolic stoichiometry and energetics data in assessing and optimizing fermentation process

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		H		M								
CO2		M									H	
CO3		M	M								H	
CO4		M									M	
CO5		H						M		M		
CO6		M	M									

OVERVIEW OF FERMENTATION PROCESS

Overview of fermentation industry - General requirements of fermentation processes, basic configuration of fermenter and ancillaries, main parameters to be monitored and controlled in fermentation processes - Role of bioprocess engineer in the biotechnology industry - Concept of bioprocess outline of an integrated bioprocess and the various unit operations involved in bioprocesses - Generalized process flow sheets - Modern applications of biotechnological processes

MICROBIAL MEDIA AND MEDIUM OPTIMIZATION

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, Plackett-Burman and Response Surface Methodology

STERILIZATION KINETICS

Thermal death kinetics of microorganisms , Types of sterilization process, Batch and continuous heat sterilization of liquid media - Filter sterilization of liquid media - Air sterilization and design of sterilization equipment

METABOLIC STOICHIOMETRY AND ENERGETICS

Stoichiometry of cell growth and product formation - Elemental balances, degrees of reduction of substrate and biomass, available electron balances - Yield coefficients of biomass and product formation, maintenance coefficients, energetic analysis of microbial growth and product formation - Oxygen consumption and heat evolution in aerobic cultures, Thermodynamic efficiency of growth

KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION

Modes of operation - Batch, fed batch and continuous cultivation - Chemostat -Turbidostat - Introduction to unstructured models for growth and product formation - Simple unstructured kinetic models for microbial growth - Monod model - Growth of filamentous organisms - Product formation kinetics - Substrate and product inhibition on cell growth and product formation

TEXT BOOKS

1. Shuler, M.L. and Kargi, F., Bioprocess Engineering-Basic Concepts, Prentice Hall Pvt. Ltd., New Delhi, 2nd Edition, 2004.
2. Peter, F., Stanbury ., Stephen, J., Hall and A. Whitaker., Principles of Fermentation Technology, Elsevier, Science and Technology Books, New Delhi, 2nd Edition, 2005.
3. Doran, P.M., Bioprocess Engineering Principles, 2nd Edition, Academic Press (An Imprint of Elsevier), New Delhi, 2nd Edition, 2013.

REFERENCES

1. Bailey, J.E. and Ollis, D.F., Biochemical Engineering Fundamentals, McGraw Hill Publishers, New Delhi, 2nd Edition, 1986.
2. James Lee, M., Biochemical Engineering, Prentice-Hall Inc Publishers, Delhi. 1st Edition, 1992.

BIT304	GENETIC ENGINEERING	L	T	P	C
		3	1	0	4

Course Outcomes:

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

CO1: Summarize the enzymes involved in cloning and restriction enzymes in recombinant DNA technology

CO2: Describe different types of vectors such as plasmid, cosmid, phage and YAC.

CO3: Explain the cloning of a gene in different types of vectors and its applications

CO4: Illustrate construction and screening of cDNA and genomic libraries.

CO5: Describe cloning and transformation of Ti vectors in plants

Course Outcomes Vs Program Outcomes Mapping:

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

MOLECULAR TOOLS FOR GENE CLONING

Restriction enzymes- Modifying enzymes - DNA and RNA polymerases - Safety guidelines of recombinant DNA research

VECTORS FOR GENE CLONING

Introduction to cloning vectors- plasmid vectors (high copy and low copy)-Phage vectors, cosmid vectors - phasmid vectors - BAC vectors and YAC vectors - Insect, yeast and mammalian vectors

CLONING AND EXPRESSION OF RECOMBINANT PROTEIN

Cloning strategies- restriction digestion - blunt and cohesive end ligation , design of linkers and adaptors - cloning after homopolymer tailing; Strategies for cloning PCR products - creation of restriction sites, Plasmid expression vectors-General features - promoters used in expression vectors -cloning of genes in correct reading frame in expression vector- Strategies for purification of recombinant proteins

CONSTRUCTION & SCREENING OF LIBRARIES

Construction of cDNA library- construction subtractive cDNA library , construction of genomic DNA library , BAC library , YAC library - Screening of libraries with DNA probes and anti-sera - methods of nucleic acid sequencing - Sangers method

APLLICATION OF RECOMBINANT DNA TECHNOLOGY

Cloning in plants - Ti plasmid - Transgenic and knockout animals

TEXT BOOKS

1. Primrose, S., B. and Twyman, R., M., Principles of Gene Manipulation and Genomics, Blackwell Publishing Co., 7th Edition, 2006.
2. Brown, T.A.,Gene Cloning and DNA analysis-An Introduction, BlackwellScience, 2nd Edition, 2001.

REFERENCES

1. Lodge, J., Lund, P., and Minchin, S., Gene Cloning, Taylor & Francis Group ISBN: 0-7487-6534-4, 2007

BIT322	ENZYME TECHNOLOGY	L	T	P	C
		3	1	0	4

Course Outcomes:

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

CO1: Explain the characteristics and catalytic mechanisms of enzymes

CO2: Identify enzyme inhibition patterns and determine kinetics of single substrate enzyme catalyzed reactions

CO3: Characterize enzymes and design enzyme assays

CO4: Describe immobilization techniques,and their principles, advantages and disadvantages

CO5: Suggest a preliminary design for biosensors

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION TO ENZYMES

Classification of enzymes - Mechanisms of enzyme action, concept of active site and energetic of enzyme substrate complex formation - Specificity of enzyme action - Principles of catalysis - Collision theory, transition state theory - Role of entropy in catalysis - Types of enzymes - constitutive enzyme, induced enzymes, intracellular and extracellular enzymes - Application of enzymes in food, pharmaceutical and other industries - Enzymes for analytical and diagnostic applications

KINETICS OF ENZYME ACTION

Kinetics of single substrate reactions - Estimation of Michaelis -Menten parameters, Turnover number , Multi-substrate reactions, Mechanisms and kinetics - Types of inhibition, Kinetic models, Substrate and product inhibition - Allosteric regulation of enzymes, The Monod-Changeux-Wyman model and the Koshland-Nemethy-Filmer model - pH and temperature effect on enzyme activity

PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES

Methods of production of enzymes, Extraction of enzymes from various sources like plant, animal and microbial sources, soluble enzymes, and membrane bound enzymes - Nature of extraction medium - Purification of enzyme - Criteria of purity - Determination of molecular weight of enzymes.

ENZYME IMMOBILIZATION

Physical and chemical techniques for enzyme immobilization - adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding with example - Advantages and disadvantages of different immobilization techniques - Overview of applications of immobilized enzyme systems

BIOSENSORS

Introduction to biosensors , History - Types and design of enzyme electrodes , Biosensors applications in industry, healthcare and environment

TEXT BOOKS

1. Chaplin, M. and Bucke, C. (1990). Enzyme Technology, 1st Edition, Cambridge University Press, London, 1st Edition, 1990.
2. Palmer, T., Enzymes: Biochemistry Biotechnology and Clinical Chemistry, East West Press Pvt Ltd, New Delhi, 5th Edition, 2001.

REFERENCES

1. James Lee, M. (1992). Biochemical Engineering, 1st Edition, Prentice-Hall Inc Publishers, Delhi, 1st Edition, 1992.
2. Blanch, H. W. and Clark, D.S., Biochemical Engineering, CRC Press, USA, 2nd Edition, 1997.
3. Zubay, G., Biochemistry, 4th Edition, McGraw Hill Publishers, New Delhi, 4th Edition, 1999.

CHE357	REACTION ENGINEERING FOR BIOTECHNOLOGISTS	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Describe the kinetics of reactions

CO2: Design equations to determine the performance of ideal reactors

CO3: Create various models for describing non- ideal behavior of reactors

CO4: Analyze performance of combined reactors

CO5: Explain adsorption and desorption phenomena in heterogeneous systems.

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H							M				
CO2				H							M	
CO3				H							M	

CO4		H									M	
CO5	H							M				

REACTION KINETICS

Law of mass action, rate equation, elementary, non-elementary reactions and their mechanisms, theories of reaction rate and temperature dependency, analysis of experimental reactor data, evaluation of rate equation, integral and differential analysis for constant and variable volume system, fitting of data complex reaction mechanism, searching of reaction mechanism

IDEAL REACTORS

Isothermal and non isothermal homogeneous reactor systems, adiabatic reactors, Design of batch and continuous reactors, optimum temperature progression.

NON IDEALITY IN REACTORS

RTD in non-ideal flow; non-ideal flow models, conversion in non-ideal reactors.

HOMOGENEOUS REACTION SYSTEM

General mole balance equation: batch, plug flow, mixed flow reactor (steady & unsteady state condition).Design for homogeneous systems, batch, stirred tank and tubular flow reactor, fluidized bed, fixed bed. Design of reactors for multiple reactions, combination reactor system, size comparison of reactors.

HETEROGENEOUS REACTION SYSTEM

Rate equations for heterogeneous reactions, nature of catalysis, adsorption isotherms and rates of adsorption, desorption and surface reaction analysis of rate equation and rate controlling steps, surface area and pore-volume distribution, catalyst preparation, Diffusion within catalyst particle, effective thermal conductivity mass and heat transfer within catalyst pellets.

TEXT BOOKS

1. Levenspiel, O. (2009) Chemical Reaction Engineering, 3rd Edition, John Wiley.
2. Smith, J.M. (1981) Chemical Engineering Kinetics, 3rd Edition, McGraw-Hill.

REFERENCES

1. Missen, R.W., Mims, C.A. and Saville, B.A. (1998) Introduction to chemical reaction engineering and kinetics, John Wiley & Sons.
2. Fogler. H.S. (2005) Elements of Chemical reaction engineering, 4th edition, Prentice Hall

BIT387	BIOPROCESS LABORATORY	L	T	P	C
		0	0	4	2

Course Outcomes:

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

CO1:Plan an experiment to produce an enzyme using an appropriate microbial strain

CO2:Screen amylase producing bacteria from soil samples

CO3:Optimize the effect of pH, temperature, substrate concentration and reaction time on amylase activity

CO4:Use immobilization techniques

CO5:Study the activity of enzymes and the kinetics of different enzymatic reactions

Course Outcomes Vs Program Outcomes Mapping:

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

List of Experiments:

1. Determination of bacterial growth by turbidity measurement; measurement of biomass by dry weight and wet weight
2. Growth kinetics of bacteria - calculation of specific growth rate, yield coefficient in shake flask culture
3. Growth of yeast - estimation of biomass, calculation of specific growth rate, yield coefficient in shake flask culture
4. Estimation of enzyme activity (amylase, protease) calculation of specific activity
5. Enzyme kinetics , Michaelis-Menton parameters
6. Effect of pH and temperature on enzyme activity
7. Enzyme inhibition kinetics
8. Immobilization of yeast cells
9. Enzyme immobilization - gel entrapment; kinetics of immobilized enzyme reactions
10. Bioconversion studies with immobilized enzyme using packed - bed reactors.
11. Extraction of proteolytic enzyme from papaya latex
12. Extraction of invertase enzyme from yeast cells
13. Estimation of invertase activity

BIT388	GENETIC ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

Course Outcomes:

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

CO 1: Isolate the plasmid DNA from bacterial cells

CO 2: Design the setting up of restriction digestion of DNA

CO 3: Isolate genomic DNA from prokaryotic and eukaryotic cells

CO 4: Demonstrate the Southern blotting technique

CO 5: Formulate PCR reaction conditions

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H			M	M	H	M	M	H		M	
CO 2	H				M	H	M	M	H			
CO 3	H			M	M	H	M	M	H	M		M
CO 4	H					H	M	M	H			
CO 5	H			M	M	H	M	M	H	M	M	

List of Experiments:

1. Isolation of chromosomal DNA from bacteria
2. Sub-cloning of a sucrase gene in *E. coli* , (restriction digestion, gel isolation and ligation, transformation and screening of recombinants)
3. Polymerase Chain Reaction , (identification of microorganisms using 16srRNA sequence)
4. Isolation of RNA
5. Southern blotting
6. Northern blotting
7. Western blotting
8. Colony hybridization
9. Site-directed mutagenesis using sequence specific primers

SEMESTER VI

BIT305	BIOCHEMICAL ENGINEERING	L	T	P	C
		3	1	0	4

Course Outcomes:

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

CO:1 Explain ideal and non-ideal behaviour of reactors.

CO:2 Describe the configurations and applications of various bioreactors.

CO:3 Suggest scale up of design parameters for bioreactors.

CO:4 Illustrate immobilization techniques and their principles advantages and disadvantages.

CO:5 Explain the models of cell growth

Course Outcomes Vs Program Outcomes Mapping:

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

ANALYSIS OF BIOREACTORS

Stirred Tank Reactor- non-ideal behavior, RTD and stability analysis - Tanks-in-series and dispersion models - Application to design of continuous sterilizers - Design and operation of novel bioreactors -airlift reactor, bubble column reactors , Stability analysis of bioreactors

SCALE UP OF BIOREACTORS

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

MODELLING AND SIMULATION OF BIOPROCESSES

Study of structured models for analysis of various bioprocesses - Compartmental models, cybernetic models - Models of cellular energetic and metabolism - Single cell models, plasmid replication and plasmid stability model - Dynamic simulation of batch, fed batch, steady and transient culture metabolism - Model simulation using MATLAB-SIMULINK and ISIM software packages

MODERN BIOTECHNOLOGICAL PROCESSES

Recombinant cell culture processes - Guidelines for choosing host-vector systems, plasmid stability in recombinant cell culture - Limits to over expression - Bioreactor strategies for maximizing product formation - Bioprocess design considerations for plant and animal cell cultures

BIOREACTOR CONSIDERATIONS IN ENZYME SYSTEMS

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

TEXT BOOKS

1. Harvey W. Blanch., Douglas S. Clark, *f*Biochemical Engineering,„ Marcel Decker Inc. 2007.
2. Bailey, J.E., Ollis, D.F., Biochemical Engineering Fundamentals, McGraw Hill Publishers, New Delhi, 2nd Edition, 1986.

REFERENCES

1. Shuler, M.L. and Kargi, F., Bioprocess Engineering-Basic Concepts, Prentice Hall Pvt. Ltd., New Delhi, 2nd Edition, 2004.
2. Doran, P.M., Bioprocess Engineering Principles, Academic Press (An Imprint of Elsevier), New Delhi, 2nd Edition, 2005.
3. James Lee, M., Biochemical Engineering, Version 2.1, PHI, USA, 2002.

BIT306	IMMUNOLOGY	L	T	P	C
		3	1	0	4

Course Outcomes:

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

CO1: Understand the differentiation of hematopoietic stem cell, complementary cascade and anatomy of lymphoid organ

CO2: Explain the structure, function, and genetic regulation of antibody and their development, and activations

CO3: Describe various mechanisms of antigen presenting cells and how to regulate phagocytosis and macrophage

CO4: Explain the different types hypersensitive reactions and cytokine molecules

CO5: Describe molecular mechanism of Graft rejection, immunosuppressive drugs, and autoimmune diseases

Course Outcomes Vs Program Outcomes Mapping:

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

THE IMMUNE SYSTEM

Introduction - Lymphocytes, their origin and differentiation - Antigens, their structure and classification - Complement and their biological functions -Types and regulation of immune responses, anatomy of immune response

HUMORAL IMMUNITY

B-Lymphocytes and their activation - structure and function of immunoglobulin, immunoglobulin classes and subclasses, genetic control of antibody production - Hybridoma technology and diagnosis - Idiotope and antibodies - Major histocompatibility Complex, Production of polyclonal and monoclonal antibody; antigen , antibody interactions-immunostaining , immunocytochemistry , *in situ* hybridization

CELLULLAR IMMUNOLOGY

Thymus derived lymphocytes (T Cells), their classification - Antigen presenting cells (APC), macrophages, langerhans cells, their origin and function - Mechanisms of phagocytosis, identification , antigen processing and presentation

IMMUNITY TO INFECTION

Hypersensitivity reactions - Mechanisms of T cell activation - Cytokines and their role in immune response , Macrophage activation and granuloma formation

TRANSPLANTATION AND AUTOIMMUNITY

Graft versus host reaction, Graft rejection - evidence and mechanisms of graft rejection - Prevention of graft rejection - Immunosuppressive drugs - HLA and disease - Mechanisms of immunity to tumour antigens-Autoantibody in humans - Pathogenic mechanisms - Experimental models of autoimmune disease - Treatment of auto immune disorders

TEXT BOOKS

1. Janes Kuby., Immunology, WH Freeman and Company, Newyork.,6th Edition, 2006.
2. Roitt, I., Essential Immunology, Blackwell Scientific Publications, Oxford, 11th Edition, 2006.

REFERENCES

1. Benjamin, E., Leskowitz, S., Immunology , A Short Course, Wiley Liss, New York, 3rd revised Edition, 1996.
2. Jeneway, C. A Jr. and Travers, P.T., Immunobiology, Blackwell Scientific Publishers, 6th Edition, 2004.

BIT389	IMMUNOLOGY LABORATORY	L	T	P	C
		0	0	3	2

Course Outcomes:

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

CO 1: To identify the blood group of unknown sample by agglutination test

CO 2: To perform radial and double immuno-diffusion

CO 3: To handle animals for bleeding techniques

CO4: To demonstrate rocket immuno-electrophoresis

CO5: Execute clinical tests such as ELISA and Widal test

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H					H	H	M	M	M	H	
CO 2	H			M	M	H	H				M	
CO 3	H		M			H	M	M	M	M		H
CO4	H			M	M	H	H	M			M	
CO5	H			H	H	H	H	M	M	M	H	M

List of Experiments:

1. Identification of blood group
2. Handling of animals and bleeding techniques
3. Testing for typhoid antigens by Widal test
4. Immunoelectrophoresis
5. Rocket Immunoelectrophoresis
6. Outcherlony double diffusion
7. Radial Immunodiffusion
8. Affinity chromatography for antibody purification
9. ELISA-DOT and plate ELISA
10. Sandwich ELISA
11. Quantitative precipitation Assay
12. Latex agglutination Test
13. Western blot

BIT390	BIOCHEMICAL ENGINEERING LABORATORY	L	T	P	C
		0	0	6	2

Course Outcomes:

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

CO:1Compute residence time distribution for PFR and MFR.

CO:2 Determine mixing time in a reactor.

CO:3 Optimize media by Plackett Burman method

CO:4 Simulate batch and fed batch fermentation

CO:5 Study growth and product formation kinetics

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO:1	M		M			M	H					
CO:2			M			H						
CO:3	H		H			M						
CO:4	H		M			M						
CO:5	H	H	H			M	M					

List of Experiments:

1. Demonstration of various bioreactor configurations, parts and integrated process control systems.
2. Batch sterilization design and Thermal death kinetics
3. Medium optimization - Plackett Burman design
4. Medium optimization - Response surface methodology
5. Estimation of K_La by sulphite oxidation method.
6. Estimation of mass transfer coefficient and power number correlation
7. Estimation of mixing time in batch reactor.
8. Residence time distribution analysis.
9. Estimation of overall heat transfer coefficient.
10. Batch cultivation, estimation of K_La , Dynamic gassing method, exhaust gas analysis , carbon balancing, gas balancing.
11. Fed batch cultivation, exhaust gas analysis , carbon balancing, gas balancing
12. Continuous cultivation , x-d diagram, pulse and shift method, exhaust gas analysis , carbon balancing, gas balancing
13. Model simulation using MATLAB-SIMULINK, BMS and ISIM software packages

SEMESTER VII

BIT 401	ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Explain animal cell culture media and animal cell culture techniques

CO2: Describe expression vectors and production of recombinant products using animal cells

CO3: Apply biotechnological methods for basic research

CO4: Apply reproduction methods with particular reference to gamete and embryo manipulation techniques, production of transgenic animals and cloning

CO5: Discuss manipulation strategies to improve livestock production including meat and milk production

Course Outcomes Vs Program Outcomes Mapping:

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

ANIMAL CELL CULTURE

Media for culturing cells and tissues - Chemically defined and serum free media for cell culture; Sterilization of various equipments and apparatus - Cell culture substrates - Animal cell culture; types and methods - Development of cell lines; Development, Maintenance, Preservation and Characterization of animal cells , Scaling up of animal cell cultures - Cell culture as source of valuable products-Protein production by genetically engineered mammalian cell lines, Stem cells and their applications.

GENE TRANSFER METHODS

Gene transfer methods - Virus mediated methods; Biology and Construction of viral vectors like SV40, adenovirus, lentivirus, vaccinia virus, herpes virus, and adeno associated virus, baculovirus , Transfection methods; stable and transient methods

MICROMANIPULATION OF EMBRYO•S AND EMBRYO TRANSFER

Micromanipulation technology; Artificial insemination, Superovulation, Embryo transfer, Invitro fertilization - Pregnancy diagnosis - Sexing of embryos, Embryo splitting; Cryopreservation of embryo - Cloning and SCNT - Breeding of farm animals

TRANSGENIC ANIMALS

Concepts of transgenic animal technology - Various strategies for the production of transgenic animals and their importance in biotechnology; pronuclear microinjection, embryonic stem cells and somatic cell nuclear transfer in the production of transgenic

animals. - Transgenic animals as bioreactors for producing pharmaceutically important compounds and therapeutics etc. Role of gene knock out and gene knock in mice model for studying human genetic disorder

BIOTECHNOLOGY IN ANIMAL PRODUCTION

Manipulation of Growth hormone; Somatotropic hormone and Thyroid hormone - Probiotics as growth promoters; Ideal characteristics of probiotics; Mode of action and uses of probiotics-Manipulation of lactation -Lactogenesis-galactopoiesis, wool growth and rumen microbial digestive system.

TEXT BOOKS

1. Davis, D., Animal Biotechnology, National Academic Press, Washington, 1st Edition, 2002.
2. Ramadoss, P., Animal Biotechnology: Recent Concepts and Developments, MJb Publishers, Chennai, 1st Edition, 2008.

REFERENCES

1. Freshney, R. I., Culture of Animal Cells: A manual of Basic technique, John , Wiley and sons, 6th Edition, 2010.
2. Masters, J.R.W., Animal Cell Culture: Practical Approach, Oxford University Press, New York, 3rd Edition, 2000.
3. Holland, A. and Johnson, A., Animal Biotechnology and Ethics, Springer Verlag, New York, 1st Edition, 1998.

BIT402	PLANT BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO 1: Outline the method of creating transgenic plants in general

CO 2: Explain how to make commercially important compounds using plant tissue culture

CO 3: Describe how micropropagation is carried out and its advantages

CO4: Differentiate plant breeding and genetic engineering approaches

CO5: Report the strategy and advantages of creation of BT cotton

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	M	H		M	H	M		M		M	M	M
CO 2	M	H		M	M	M		M		M	H	
CO 3	M	H		M	M	M		M		M	H	
CO4	H	H		H	H	M		M		M	H	M
CO5	H	H		H	M	M		M		M	H	M

INTRODUCTION TO PLANT BIOLOGY

Photosynthetic bacteria and Blue-green Algae. Autotrophs, heterotrophs and evolution of plants from algae. Special features and organization of plant cells, Chloroplast DNA, photosynthesis, Mitochondrial DNA, and chromatin and chromosome structure.

PLANT TISSUE CULTURE

Plasticity and totipotency, Plant cell culture media, Plant growth regulators, Organogenesis Culture types: Callus, cell-suspension culture, protoplasts, root culture, hairy root culture and production of secondary metabolites, Plant regeneration by somatic embryogenesis: Direct and Indirect. Case study: Cereal regeneration via somatic embryogenesis from immature embryos and Micropropagation

PLANT BREEDING BASICS AND PLANT TRANSFORMATION

Simple and complex inheritance, Value of plant variety depends on many traits, back cross, Molecular Markers: RFLP and PCR based SSR markers, Marker-Assisted selection, Hybrid seeds production. *Agrobacterium* biology and T-DNA transfer, Binary vector system, *Agrobacterium*-mediated plant transformation, Direct DNA transfer methods in plants - particle bombardment method.

APPLICATIONS OF PLANT GENETIC ENGINEERING

Herbicide tolerant plants: Different strategies to achieve, strategy to generate glyphosate tolerant plants and their related problems. Mechanism of insecticidal crystal protein of *Bacillus thuringiensis*, strategy to generate BT cotton transgenic plants; their problems and solutions. Disease resistance: against bacterial, fungal and viral pathogens, gene silencing, applications in virus resistance and golden rice.

MOLECULAR FARMING AND PLANT GENOMICS

Molecular farming of proteins, Plant vaccines, custom-made antibodies, case study: Bioplastics. Genome size and organization, Arabidpsis genome sequencing project technology and applications; Biotechnological implications of Arabidopsis genome initiative, crop plant genome sequencing.

TEXT BOOKS

1. Slater A., Nigel W., Scott, and Fowler MR., Plant biotechnology: The Genetic Manipulation of Plants, Oxford University Press, London, 2nd Edition, 2008.
2. Neal Stewart, Jr., Plant Biotechnology and Genetics: Principles, Techniques, and Applications. John Wiley & Sons Inc. USA, 2008.
3. Chawla HS ., Introduction to Plant Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, 2nd Edition, 2003.

BIT403	DOWNSTREAM PROCESSING	L	T	P	C
		3	1	0	4

Course Outcomes:

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

CO1: Describe the advantages of bioprocesses as well as explain the principles of various separation processes

CO2: Explain the various concepts of centrifugal separation and diffusion-based processes, such as dialysis

CO3: Demonstrate knowledge of the principles of pressure-driven processes, such as reverse osmosis, and adsorption-desorption phenomena

CO4: Explain the principles of aqueous two-phase extraction and the various techniques of protein precipitation.

CO5: Explain the principles of planar chromatography and those of the various finishing operations used for bioproducts

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION TO DOWNSTREAM PROCESSING

Advantages of bioprocesses over chemical processes - Range and characteristics of bioproducts , Importance of downstream processing in biotechnology , Characteristics of fermentation broths , Overview of bioseparations , Case studies.

PHYSICAL METHODS OF SEPARATION

Batch Filtration: Theory, Filter Media and Equipment , Continuous Filtration , Centrifugation: Settling of solids, Centrifugal Sedimentation, Centrifugal Decantation and Centrifugal Filtration , Scale-up of centrifugation , Membrane separation processes: Classification and theoretical considerations, Equipment and types of membrane processes

ISOLATION OF PRODUCTS

Cell disruption: Chemical, Mechanical and Enzymatic methods , Adsorption: Process and Isotherms , Adsorption techniques: Batch, in CSTR and Fixed bed , Analysis and scale-up , Extraction: Solvent extraction principles, Equipment for extraction, Modes of extraction , Aqueous two-phase extraction , Supercritical fluid extraction , Precipitation of proteins by: Isoelectric precipitation, addition of salts, addition of organic solvents, addition of non-ionic polymers and ionic polyelectrolytes - Scale-up of precipitation.

CHROMATOGRAPHIC METHODS

Basic principles and classification , Reversed-phase chromatography , Hydrophobic interaction chromatography - Ion-exchange chromatography , Size-exclusion chromatography , Bioaffinity chromatography.

FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS

Crystallization: Theory, Practice and Equipment for crystallization , Drying: Theoretical considerations and drying equipment , Freeze Drying (Sublimation Drying or Lyophilization) - Formulation

TEXT BOOK

1. B. Sivasankar., Bioseparations, Eastern Economy Edition, Prentice-Hall of India Pvt. Ltd., New Delhi, 2006.

REFERENCES

1. Belter, P.A., Cussler, E.L. and Wei-Houhu., Bioseparations: Downstream Processing for Biotechnology, Wiley Interscience Publications, Singapore, 1st Edition, 1988.
2. P.F. Stanbury, A. Whittaker and S.J. Hall, Principles of Fermentation Technology, Butterworth Heinemann, USA, 2nd Edition, 2003.

BIT491	DOWNSTREAM PROCESSING LABORATORY	L	T	P	C
		0	0	6	2

Course Outcomes:

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

CO1: Carry out isoelectric precipitation of proteins from a protein mixture; perform ultrasonication of cells and monitor kinetics of protein release

CO2: Explain the principles of microfiltration and homogenization and perform these processes

CO3: Understand the principles of centrifugation and adsorption and carry out these processes

CO4: Understand and explain reaction equilibria; be familiar with the physical properties of filtration cakes

CO5: Explain the principles of the various types of planar and columnar chromatography

Course Outcomes Vs Program Outcomes Mapping:

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

List of Experiments:

1. Solid liquid separation , centrifugation, microfiltration
2. Cell disruptions techniques , ultrasonication, French pressure cell
3. Cell disruption techniques , dyno mill , batch and continuous

4. Precipitation , Ammonium sulphate Method
5. Ultra filtration separation
6. Aqueous two phase extraction of fermentation Broth
7. High resolution purification - Gel filtration chromatography
8. High resolution purification - Affinity chromatography
9. High resolution purification - Ion exchange chromatography
10. High resolution purification - Hydrophobic interaction chromatography.
11. Product Polishing - Spray drying, freeze drying

MAJOR ELECTIVES FOR III YEAR

BIT 307	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Describe ecosystem and soil microbiology

CO2: Describe xenobiotics and the strategies to eliminate them from the environment

CO3: Explain the microbial techniques employed for wastewater management and treatment

CO4: Describe the methods of effluent treatment in various industries

CO5:. Explain the role of microorganisms in the extraction of metals, coal and petroleum.

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION

Introduction to ecosystem - Microbial flora of soil - Interaction among Soil microorganisms , Bio geochemical cycle - Role of soil microorganisms

BIODEGRADATION AND BIOCONVERSION OF XENOBIOTIC COMPOUNDS

Xenobiotics - Persistence and biomagnification of xenobiotic molecules-Simple aromatics, chlorinated polyaromatic compounds, petroleum products, pesticides and surfactants - Mechanism of detoxification - oxidation, dehalogenation - Biotransformation of metals , Bioremediation concepts, strategies and applications.

MICROBIAL TECHNOLOGY FOR WASTE WATER TREATMENT

Waste water characteristics - Sewage and waste water treatments systems; Primary, secondary and tertiary treatments- Biological waste water treatment - Unit operations and unit processes - Design and modeling of activated sludge process - Anaerobic digestion- ; Bioreactors for waste water treatments

TREATMENT OF INDUSTRIAL WASTES

Physicochemical characteristics and treatment strategies for effluent generated by food and dairy industries; Paper and pulp industries; Dyes and dye intermediate producing industries and textile industries; Tanneries; pharmaceutical industries - Phytoremediation: Waste water treatment using aquatic plants; Solid waste management.

BIOTECHNOLOGY FOR MANAGEMENT OF RESOURCES

Role of environmental biotechnology in management of resources- Reclamation of wasteland- Biogas and biofuel production , Biofertilizers. Biological control of insect pests; Role of biopesticides/insecticides- Biotechnology and oil spills. Genetic manipulation for biodegradation

TEXT BOOKS

1. Rittman, B and McCarty, P.L, Environmental Biotechnology: Principles and Applications, McGraw- Hill, 2nd Edition, 2000.
2. Karnely, Chakrabarty, D, Omen, G.S., Biotechnology and Biodegradation, Advances in Applied Biotechnology Series, Volume1, Gulf Publications Company, London, 1st Edition, 1989.
3. Foster, C.F., John Ware, D.A., Environmental Biotechnology, Ellis Harwood Ltd., 1st Edition, 1987.

REFERENCES

1. Young, M.Y., Comprehensive Biotechnology, Vol 1-4, Pergamon Press, Oxford, 1st Edition, 1985.
2. Wanwright, M., An Introduction to Environmental Biotechnology, Springer Verlag, London, 1st Edition, 1999.

BIT 308	SPECTROSCOPIC METHODS FOR STRUCTURE DETERMINATION	L	T	P	C
		3	0	0	3

ELECTROMAGNETIC AND QUANTUM THEORY OF RADIATION

Wave - Particle Duality , Photons - Yukov•s Theory for Nature of Forces - Interaction of Light with Matter - Transition Dipole Moment - Group Theory - Jablonsky Diagram

SPECTROSCOPY OF BIOMOLECULES

UV-Visible Absorption Spectroscopy - Beer-Lambert's law - Applications of UV-Visible Difference Spectroscopy - Circular Dichroism in Protein Analysis - Fluorescence Spectroscopy - Quantum Yield - Static and Dynamic Quenching of Fluorescence - Energy Transfer , Polarization Anisotropy - Time-resolved Fluorescence

VIBRATIONAL SPECTROSCOPY

IR, FTIR and Raman Spectroscopy of Biomolecules - Nuclear Magnetic Resonance Spectroscopy - Chemical Shifts - Coupling Constants - Ring Currents - Paramagnetic Shifts, Spin-Spin and Spin-lattice Relaxation Times , NOE Chemical Exchange - Applications to Biomolecular Structure and Dynamics

ELECTRON SPIN RESONANCE SPECTROSCOPY

Hyperfine splitting , Zero-field splitting - Spin labels - Mass Spectrometry of Biomolecules

X-RAY DIFFRACTION

Crystal Systems and Space Groups - Miller Indices and Space Lattices - Diffraction of X-rays and Bragg•s Law - Structure Determination of Biomolecules - Refinement and Accuracy

of X-ray Crystallographic Structures - Scanning Tunneling Microscopy - Atomic Force Microscopy - Electron Microscopy of Biomolecules

TEXT BOOK

1. Cantor, C.R. and Schimmel, P.R., Biophysical Chemistry, Part-2, W.H.Freeman Company, New York, 1st Edition, 1980.

REFERENCES

1. Lakowicz, J.R., Principles of Fluorescence Spectroscopy, Plenum Press, Philadelphia, 3rd Edition, 2006.
2. Atkins, P.W. and Paula, J.De., Physical Chemistry, Oxford University Press, New York, 9th Edition, 2010.
3. Willard, H., Merritt, L., Dean J.A., and Settle, F.A., Instrumental methods of analysis, CBS publishers, New Delhi, 7th Edition, 1988.
4. Skoog, D.A., West, D.M., Holler, J.F and Crouch, S.R., Fundamentals of Analytical Chemistry, Cengage India, 9th Edition, 2013.

BIT 309	FOOD PROCESSING AND TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Outline the main ways in which primary production of food is of importance to food quality.

CO2: Describe the general features and importance of proteins, lipids and carbohydrates in foods

CO3 Describe the major chemical reactions that occur during food processing and storage

CO4: Apply the basic knowledge of food ingredients and processing operations to describe the production of cheese emulsions and milk powder

CO5: Identify the beneficial and detrimental roles played by microorganisms in the food industry.

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION TO FOOD PROCESSING

Biotechnology in relation to the food industry - Nutritive value of food - Recent trends in food biotechnology. Application of biotechnology in food

FOOD PRESERVATION

Principles involved in the use of sterilization, pasteurization and blanching - Thermal death curves of microorganisms , Canning - Frozen storage - Freezing characteristics of foods - Microbial activity at low temperatures - Factors affecting quality of foods in frozen storage - Irradiation preservation of foods

FOOD PROCESSING

Bioprocess of meat, fisheries, vegetables, Beverages, baking, diary product - Enzymes and chemicals used in food processing , Baking (fungal -amylase for bread making; maltogenic -amylases for anti-staling; xylanses and pentosanases as dough conditioners; lipases or dough conditioning; oxidases as replacers of chemical oxidants; synergistic effect of enzymes); HFCS (High Fructose Corn Syrup) - Biochemical engineering for flavor and food production,

FOOD MICROBIOLOGY

Importance and significance of microorganisms in food science.Types of microorganisms associated with food, its sources, Utilization of microorganisms in food industries - Genetic manipulations, Fermented Food Products, mycoproteins

FOOD SPOILAGE

Characteristic features, dynamics and significance of spoilage of different groups of foods. Food borne illness - Quality control - Case studies on biotechnology in the evolution of food quality.

TEXT BOOKS

1. Lopez, G.F.G. and Canovas, G.V.B., Food Science and Food Biotechnology, CRC Press, Florida, USA, 2003.
2. Roger, A., Gordan, B., and John, T., Food Biotechnology, Cambridge University Press, USA, 1st Edition, 1989
3. Pelezar, M.I and Reid, R.D., Microbiology, McGraw Hill Book Company, New York, 5th Edition, 1993.
4. James, M.J. Modern Food Microbiology, CBS Publisher, 2nd Edition, 2000.

REFERENCES

1. George, J. B., Basic Food Microbiology, Springer Verlag, London, 2nd Edition, 1995.
2. James, M. J., Modern Food Microbiology, Springer Verlag, London, 7th Edition, 2006.
3. Frazier, W.C., Westhoff, D.C., Food Microbiology, McGraw-Hill Book Co, New York, 4th Edition, 1988.

BIT 310	PHARMACEUTICAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Describe the concept of drug discovery and drug development

CO2: Differentiate the mechanisms of Synthesis and secretion of recombinant proteins

CO3: Categorize various blood clotting disorders and blood-clotting factors

CO4: Explain the cell and tissue based therapies

CO5: Perform assays involving in protein based contaminants detection

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION

History of the Pharmaceutical Industry , Current Status and Future Prospects of biopharmaceuticals , Drug Discovery , Drug Development , Pharmaceuticals of Animal, Plant and Microbial Origin , Sources of Biopharmaceuticals

THERAPEUTIC PROTEINS: GROWTH FACTORS, HORMONES AND CYTOKINES

Bioactivity of Expressed Proteins , Synthesis and Secretion of Recombinant Proteins , Xenotransplantation , Discovery, Biological Roles and Properties of Naturally produced Hormones: Insulin, Erythropoietin, Somatotropin and Interferons - Development of Recombinant Human Insulin, Erythropoietin, Growth Hormone and Interferons

RECOMBINANT BLOOD PRODUCTS, THERAPEUTIC ENZYMES, VACCINES AND ANTIBODIES

Introduction , Haemostasis: Coagulation Pathway, Clotting Disorders and Blood-clotting Factors , Anticoagulants: Hirudin and antithrombin , Thrombolytic agents: Tissue Plasminogen Activator, Streptokinase, Urokinase and Albumin , Therapeutic Enzymes: Asparaginase, Urate Oxidase and Superoxide Dismutase , Vaccines: Traditional Vaccine Preparations, Recombinant Vaccines and Peptide Vaccines , Adjuvant Technology , Polyclonal and Monoclonal antibodies

NUCLEIC ACID- AND CELL-BASED THERAPEUTICS

Introduction - Basic approach to gene therapy - Retroviral, Adenoviral and non-Viral Vectors , Gene Therapy and Genetic Disease , Gene Therapy and Cancer , Gene-based Vaccines , Antisense Technology , Cell- and Tissue-based Therapies: Stem Cells and Adult Stem Cells.

PRODUCT ANALYSIS

Introduction , Protein-based Contaminants , Product Potency and Determination of Protein Concentration , Detection of Protein-based Impurities , Immunological Approaches to Detection of Contaminants , Endotoxin and Other Pyrogenic Contaminants , Viral Assays , Miscellaneous Contaminants

TEXT-BOOK

1. Gary W., Pharmaceutical Biotechnology: Concepts and Applications, John Wiley & Sons Ltd., Sussex, England, 2007.

REFERENCES

1. S.S. Purohit, H.N. Kakrani and A.K. Saluja (2006) Pharmaceutical Biotechnology, Jodhpur, India, Student Edition, 2006.
2. Kayser, O. and Müller R. H., Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications Wiley-VCH, 2004.
3. Dutton, R. and Scharer, J., Advanced Technologies in Biopharmaceutical Processing, Blackwell Publishing, 2007.

BIT 311	HEALTHCARE BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Differentiate simple proteins and valuable therapeutic proteins

CO2: Explain the production of various recombinant growth hormones

CO3: Describe production and applications of monoclonal antibodies and vaccines

CO4: Understand the mechanism involving in gene therapy

CO5: Discuss the use of antisense oligonucleotides in neurological disorders

Course Outcomes Vs Program Outcomes Mapping:

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

SIMPLE PROTEINS AND THERAPEUTIC AGENTS

Proteins as therapeutic agents - Choice of expression systems and optimizing gene expression - Applications, delivery and targeting of therapeutic proteins , Regulatory aspects of therapeutic proteins

HORMONES, RECOMBINANT BLOOD PRODUCTS &ENZYMES AS THERAPEUTIC AGENTS

Insulin, Glucagon, Human growth hormones - Gonadotrophins - Haemostasis , Anticoagulants - Thrombolytic agents - Enzymes of therapeutic value - Asparaginase - Dnase , Glucocerebrosidase , Galactosidase - Urate oxidase , Laronidase - Superoxide dismutase - Debriding agents - Digestive aids

MONOCLONAL ANTIBODIES & VACCINES

Introduction to monoclonal antibodies - Development of monoclonal antibodies - Expression of antibody molecules - Purification of monoclonal antibodies - Clinical uses of monoclonal antibodies - Hybrid human - Mouse antibodies - Production of recombinant monoclonal antibodies, Bacterial polysaccharides, proteins and toxins as vaccines - Recombinant vaccines- subunit, attenuated and vector vaccines - Multivalent vaccine development against AIDS

CYTOKINES & GENE THERAPY

Interferons- Engineering human interferons -Tumour necrosis factor , interleukins - Haemopoietic growth factors - Gene therapy , in search of the perfect disease - Gene therapy , the real diseases - Delivery systems for gene therapy - Gene therapy in the clinic

PEPTIDES & ANTISENSE OLIGONUCLEOTIDES

The nervous system- Immune responses to peptides - Neurological diseases - The use of peptides in the treatment of neurological disease -The science of antisense - Requirements of a genetic drug- Mechanisms of action of antisense molecules - Animal models and oligonucleotides- Clinical trials- towards the next generation of antisense drugs

TEXT BOOKS

1. Ratledge, C., Kristiansen, B., Basic Biotechnology, Cambridge University Press, USA, 2nd Edition, 2001.
2. Walsh, G., Pharmaceutical Biotechnology: Concepts and Applications, John Wiley & Sons, England, 2007.
3. Brooks, G., Biotechnology in Healthcare: An introduction to biopharmaceuticals, Pharmaceutical Press, London, 1998.

REFERENCE

1. David, E., Technology and Future of health care, Preparing for the Next 30 years, Jhon Wiley, Singapore, 2nd Edition, 2000.

BIT 313	METABOLIC ENGINEERING	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: State the role of transport processes in metabolic pathways and material balance

CO2: Describe the regulation of enzymes involved in metabolic pathways

CO3: Employ various strategies to manipulate the production of industrially important metabolites

CO4: Build algorithms for biosynthesis pathways

CO5: Explain metabolic flux analysis and its role in manipulation of metabolite production.

Course Outcomes Vs Program Outcomes Mapping:

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

REVIEW OF CELLULAR METABOLISM AND MATERIAL BALANCE

Transport processes; Active and Passive transport, Facilitated diffusion - Fueling reactions; Glycolysis, TCA, fermentative pathways etc - Biosynthetic reactions; Biosynthesis of amino acids, nucleic acids, fatty acids and other building blocks - Polymerization - Growth energetic - Black Box model - Elemental balances and Heat balance

REGULATION OF METABOLIC PATHWAYS

Enzyme kinetics; Mechanisms and their dynamic representation - Regulation of enzyme activity versus regulation of enzyme concentration - Regulation of metabolic networks - Regulation of at the whole cell level - Regulation of metabolic networks - Example of important pathways - Case studies and analytical type problem

METABOLIC ENGINEERING IN PRACTICE

Examples of pathway manipulations - Enhancement of product yield and productivity - Extension of substrate range - Extension product spectrum and novel products - Improvement of cellular properties - Xenobiotic degradation

METABOLIC PATHWAY SYNTHESIS

Metabolic pathway synthesis algorithm - Overview of the algorithm - Case studies; Lysine biosynthesis etc. - Synthesis of alanine and serine synthesis

METABOLIC FLUX ANALYSIS

Metabolic flux analysis - Overdetermined systems - Underdetermined systems; Linear Programming - Sensitivity analysis - Applications of metabolic flux analysis; aminoacid production - Example: Glutamic acid production etc.

TEXT BOOK

1. Gregory N. Stephanopoulos, Aristos A. Aristidou., Metabolic engineering: Principles and Methodologies, Jens Nielsen Academic Press, 1st Edition, 1998.
2. Christina D. Smolke., The Metabolic Pathway Engineering Handbook: Fundamentals, CRC Press, New York, London, 1st Edition, 2010.
3. Cortassa S., Aon M.A., Iglesias A.A and Lioyd DAn Introduction to Metabolic and Cellular Engineering, World Scientific Publishing Co., Singapore, 1st Edition, 2002.
4. Sang Yup Lee and Eleftherios T. Papoutsakis., Metabolic Engineering, CRC Press, New York, 1st Edition, 1999.

REFERENCES

1. Wang.D.I.C Cooney C.L., Demain A.L., Dunnil.P. Humphrey A.E. Lilly M.D., Fermentation and Enzyme Technology, John Wiley and sons, 1980.
2. Stanbury P.F and Whitaker A., Principles of Fermentation Technology, Pergamon Press, 1984.
3. Zubay G., Biochemistry, Macmillan Publishers, 1989.
4. Gerhard Gottschalk., Bacterial Metabolism, Springer Verlag, 2nd Edition, 1986.

BIT 314	DRUG DESIGN AND DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Describe the stages in drug discovery and development

CO2: Depict the sources of drugs, screening of natural compounds and compound databases.

CO3: Explain about various drug targets and strategies for rational drug design.

CO4: Explain the use of computation in structure-based and Ligand-based drug design.

CO5: Describe the use of combinatorial chemistry to construct compound libraries and screening them using various computational tools.

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION TO DRUG DISCOVERY AND DEVELOPMENT

Organized drug discovery, Drug Development, Clinical Trials, and Sources of Drugs- Natural sources, Organic synthesis, Prokaryotic and Eukaryotic Cells as bio-factories, Pharmacology- Basics of Pharmacokinetics and Pharmacodynamics.

APPROACHES TO NEW DRUG DISCOVERY

Rational basis of Drug Design, New approaches for lead identification- Using Disease Models as Screens for New Drug leads, Developing bioassays for drug screening, Lead optimization approaches- Conformation restriction, Pharmacophore, Metabolic stabilization.

ENZYMES AND RECEPTORS AS TARGETS OF DRUG DESIGN

Enzyme catalytic principles- Lock and Key and Induced fit theory, Types of enzyme inhibition, Rational design of enzyme inhibitors, affinity labels, Suicide inhibitors, transition state mimicry, Illustrative examples - ACE, renin and HIV protease inhibitors, Receptor theory, Molecular Biology of receptors, Receptor Binding Assays, Lead Compound Discovery of Receptor agonists and antagonists, Illustrative examples- Adenosine receptor agonists and antagonists

COMPUTER AIDED DRUG DESIGN

Virtual Screening, CADD approaches, Structure based drug design: Molecular Docking , Force field Calculation, Energy minimization, Scoring methods in docking, Ligand based drug design: QSAR and Pharmacophore modeling. Overview of computer based tools for drug designing - auto dock, GRAMM, CAMD.

CURRENT STATUS AND FUTURE PROSPECTS

Combinatorial chemistry, Combinatrial synthesis and compound libraries, peptidomimetics, Peptide libraries- Peptide libraries through phage display; Applications in epitope and mapping, synthetic vaccine design.

TEXT BOOKS

1. Larsen, P.K, Liljefors, T and Madsen U., Text Book of Drug Design and Discovery, Taylor and Francis, London and Newyork, 3rd Edition, 2002.
2. Scolnick, E.M, Advances in Protein Chemistry, Vol 56, Drug Discovery and Design Academic Press, London, 2001.
3. Walsh, G., Biopharmaceuticals-Biochemistry and Biotechnology, Wiley, Singapore, 2nd Edition, 2003.

REFERENCES

1. Perun, T. J. and Propst, C. L., Computer Aided Drug Design, Dekker, 1st Edition, 1989.

BIT323	EXPLORING THE MICROBIAL WORLD	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Explain about the nutritional types of bacteria

CO2: Summarize the applications of microorganisms in petroleum augmentation and recovery

CO3: Describe about the microbial production of food

CO4: Explain about biofertilizers and biopesticides
CO5: Summarize the applications of microbes in waste water treatment

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION

Microorganisms: types, morphology, ultra, structure and reproduction of bacteria, nutritional requirements of microorganisms, nutritional types of bacteria, pure cultures and aseptic techniques

MICROORGANISMS AS A SOURCE OF RENEWABLE ENERGY

Scope and importance Renewable sources, energy from waste materials, production of non-conventional fuels , methane (biogas), hydrogen and ethanol. Use of microorganisms in petroleum augmentation and recovery; bio-diesel from microbial sources. Microbial fuel cells.

MICROORGANISMS AS FOOD

Microbial production of food (SCP), Essential prerequisites for organisms to be used as SCP & as food and feed supplements. Major groups of microorganisms used, relative advantages and disadvantages. Microbial production of flavours and food colorants. Probiotics and prebiotics.

BIOFERTILIZERS AND BIOPESTICIDES

Microbial Pesticides/Insecticides, Biocontrol of plant pathogens and mechanisms involved in biocontrol - amensalism, competition, predation and parasitism, antibiosis and siderophore production, Integrated pest management. Biofertilisers, biological nitrogen fixation and phosphate solubilisation, VAM fungi and crop productivity

MICROBIAL TECHNOLOGY FOR WASTEWATER TREATMENT

Wastewater characteristics - Biological wastewater treatment - Unit operations and processes; attached growth processes - trickling filters and rotating biological contactors, Suspended growth processes - aerated lagoons, oxidation ponds and the activated sludge process; anaerobic digestion.

TEXT BOOKS

1. Glazer, A.N. and Nikaido, Microbial Biotechnology, Freeman and company, 2nd Edition, 2007.

REFERENCES

1. Young, M.Y., Comprehensive Biotechnology, Vol 1-4, Pergamon Press, Oxford, 1st Edition, 1985.

2. Rittman, B and McCarty, P.L., Environmental Biotechnology: Principles and Applications, McGraw- Hill, 2nd Edition, 2000.

CHE 352	BIOPROCESS INSTRUMENTATION AND CONTROL	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Describe quantitatively the dynamic behavior of process systems

CO2: Describe different types of controllers and control strategies

CO3: Develop the ability to describe quantitatively the behavior of simple control systems

CO4: Develop the ability to design control systems

CO5: To tune a control loop and to apply this knowledge in measurements

Course Outcomes Vs Program Outcomes Mapping:

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

LINEAR OPEN LOOP SYSTEMS

- First order and linearized first order systems - Response to various disturbances - First order in series- Higher order systems - Response to various disturbances

FEEDBACK CONTROL SYSTEMS

Controls - Block diagram - Closed loop transfer function - Transient response - Simple alarm modes of control and controller characteristics- Servo and regulatory problems

STABILITY ANALYSIS

Stability - Routh analysis - Frequency response - Control system design - Controller tuning

ADVANCED CONTROL SYSTEMS

Cascade - Feed forward and ratio control - Dead time compensation - Internal Model Control - Control valves

APPLICATION TO BIOLOGICAL SYSTEMS

Process modelling and control in pharmaceutical operations - Process modelling and control for drug delivery , Gene regulatory control , Signal transduction networks

TEXT BOOKS

1. Seborg, D. E. and Mellichamp, D. A., Process Dynamics and Control, Wiley, New York, 3rd Edition, 2010.
2. Coughnowr, D. P., Process Systems Analysis and Control, McGraw Hill, New York, 2nd Edition, 1991.

REFERENCES

1. Harriot, P., Process Control, Tata McGraw Hill, New Delhi, 4th Edition, 2005.
2. Smith, C. A. and Corripio, A. B., Principles and Practice of Automatic Process Control, Wiley, New York, 2nd Edition, 1997.

CHE358	TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEMS	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Describe quantitatively the properties of fluids for momentum transport
CO2: Describe the dynamics of momentum transport
CO3: Develop the ability to describe quantitatively the behavior of energy transport
CO4: Develop the ability to describe quantitatively the behavior of mass transport
CO5: Develop the ability to describe quantitatively the behavior of oxygen transport in biochemical systems

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION TO TRANSPORT PROCESSES IN BIOLOGICAL SYSTEMS

Role of transport processes in biological systems , definition of transport processes , Relative importance of convection and diffusion , Transport within cells , Transcellular transport , Physiological transport systems , Application of transport processes in disease pathology, treatment and device development , Relative importance of transport and reaction processes

MOMENTUM TRANSPORT IN BIOLOGICAL SYSTEMS

Rheology and flow of blood , Conservation of mass in 3-D , Conservation of linear momentum and Navier-Stokes equation , Fluid motion with more than one independent variable , Dimensional analysis and Dimensionless groups

PHYSIOLOGICAL FLOW IN BIOLOGICAL SYSTEMS

Integral form of equation , Bernoulis equation applied to Stenotic heart valves , Boundary layer theory , Flow separation , Lubrication theory , peristaltic pumping

MASS TRANSPORT IN BIOLOGICAL SYSTEMS

Solute fluxes in mixtures , Conservation relations , Constitutive relations , Diffusion as random walk , Estimation of diffusion coefficients in solution , Steady state diffusion in one

dimension, unsteady state diffusion in one dimension , Diffusion limited reactions , Electrolyte transport , Diffusion and convection

POROUS MEDIA AND TRANSVASCULAR TRANSPORT

Porosity, tortuosity and volume fraction , Fluid flow in porous media , Solute transport in porous media , Fluid transport in poroelastic materials , Pathways for transendothelial transport , rates of transvascular transport , Phenomenological constants in the analysis of transvascular transport , A limitation of Starlings law

TEXT BOOKS

1. Truskey, G.A., Yuan, F., David, F.K., Transport Phenomena in Biological Systems, Prentice Hall, New Jersey, 2nd Edition, 2009.

REFERENCES

1. Bird, R.B., Stewart, W.E., Lightfoot, E.N., Transport Phenomena, Revised John Wiley and sons, Singapore, 2nd Edition, 2007.

MAJOR ELECTIVES FOR IV YEAR

BIT 405	NANOBIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Explain the characteristics of nanomaterials.

CO2: Identify the various nanodevices and nanostructures

CO3: Describe fabrication techniques.

CO4: Elucidate the applications of CNTs, fullerenes, quantum dots and gold nanoparticles

CO5: Suggest a suitable drug delivery nanodevice

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION - TECHNOLOGICAL IMPACT OF NANOSCALE SYSTEMS

Micro and nano systems and technologies - Overview of nanodevices and techniques

SYNTHESIS AND CHARACTERIZATIONS OF NANOSCALE MATERIALS

Strategies for nano architecture - Top down and bottom up approaches - Fabrication technologies and characterizations - Self assembly systems - some aspects of nanofluidics- Surfactants, polymers, emulsions and colloids.

INORGANIC NANOSCALE SYSTEMS FOR BIOSYSTEMS

Nano-structured materials , Properties, characteristics and applications, fullerenes, carbon nanotubes, quantum dots and wires, gold nanoparticles and nanopores

APPLICATIONS OF NANO-MOLECULES IN BIOSYSTEMS

Molecules of life - Proteins, lipids, RNA and DNA , Nanoscale elements for delivery of materials into cells, peptides coupled nanoparticles - DNA based artificial nanostructure proteins as components in nanodevices

APPLICATION OF NANO-BIOTECHNOLOGY IN DRUG DELIVERY

Nanoscale devices for drug discovery Micelles for drug delivery protein targeting - Small molecule - Protein interactions, microarray and genome chips

TEXT BOOKS

1. Wilson, M., Kannangra, K. and Smith, G., Nanotechnology, Oversees Press India Private Ltd, NewDelhi, 2nd Edition, 2005.

2. Jain, K.K., Nanobiomolecular Diagnostics: Current Techniques and Application, Taylor and Fransis Publishers, New York, 1st E dition, 2006.

REFERENCES

1. Nill, K., Glossary of Biotech and Nanobioterms, CRC Publisher, California, 4th Edition, 2005.

BIT 406	IPR IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Explain the establishment of Intellectual property Rights (IPR), including Patents, Trademark and Copyright and other

CO2: Describe patent claim writing and analysis

CO3: Elaborate planning and documenting IPR development in organized research, using modern ICT tools like MS project, MS Vision and Data Base Systems for IPR maintenance

CO4: Explain development of Patent Search Strings and their use in Business Intelligence work in reading and analyzing Law texts

CO5: Read and interpret state of the art scientific literature, and generate new ideas to tackle technical problems in the area of biotechnology.

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION TO IPR

Invention and Creativity - Intellectual Property (IP), Importance - Protection of IPR - Basic Types of Property (Movable, Immovable and Intellectual Property)

PATENTS IN IPR

Patents - Copyrights and related rights - Trade Marks and Rights Arising from Trademark Registration - Definitions - Industrial Designs and Integrated Circuits - Protection of Geographical Indications at National and International Levels - Application procedures, PBR. IPR for Bioprocesses and Bioproducts

INTERNATIONAL CONVENTION RELATING TO INTELLECTUAL PROPERTY

Establishment of WIPO - Mission and activities - History - General agreement on Trade and tariff (GATT). WIPO Copyright Treaty (WCT)

INDIAN POSITION VS WTO AND STRATEGIES & CASE STUDIES

Indian IPR Legislations - Commitments to WTO - Patent Ordinance and the Bill - draft of a National Intellectual Property Policy - Case studies on - Patents (Basmati rice, Turmeric, Neem, etc.) - Copyright and Related Rights - Trade Marks - Industrial Design and Integrated Circuits - Geographic Indications - Protection against Unfair Competition

IPR TRANSACTIONS AND TECHNOLOGY TRANSFER CONTRACT

Various Types of Contracts - Assignment, Lease and License, Conditionality, Drafting of Technology Transfer Contract and Global Sharing of Technology - Confidentiality and Proper Use - Further Innovation and Invention - Ever-greening Chain

TEXT BOOKS

1. Carlos. C., Trade Related aspects of IPR, a Commentary on TRIPS agreement, Oxford University Press, USA, 1st Edition, 2007.
2. Cornish, W.R., Intellectual Property- Patent, Copyright Trademarks and Allied rights, Sweet and Maxwell, USA, 5th Revised Edition, 2003.

REFERENCES

1. Intellectual Property Today [www.iptoday.com].
2. Eli Whitney., United States Patent Number: 72X, Cotton Gin, March 14, 1794.
3. David, C., The Role of Intellectual Property Rights in Biotechnology Innovation, Edward Elgar Publishing Limited, Cheltenham, UK, 2009.
4. Storz, U., Intellectual Property Issues , Therapeutics, Vaccines and Molecular Diagnostics, Springer, Heidelberg, Germany, 2012.

BIT 407	BIOREACTOR DESIGN AND ANALYSIS	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Describe the kinetics of reactions

CO2: Design equations to determine the performance of ideal reactors

CO3: Create various models for describing non- ideal behavior of reactors

CO4: Analyze Interaction of heat and mass transfer in the microbial processes

CO5: Describe the Scale up criteria of bioreactors

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION

General design information; Material and energy balance calculations; Process Flow sheeting.

IDEAL REACTORS

Fed-Batch reactors, Enzyme catalyzed reactions in CSTRs, CSTR reactors with Recycle and Wall growth, Ideal Plug- Flow Tubular reactor.

DESIGN OF BIOREACTOR

Vessel, agitation system materials, welds, finish, valves, piping and valves for biotechnology, special requirements of utilities and cleaning of production plants. Physical and chemical sensors for the medium and gases, online sensors for cell properties, off-line analytical methods; Biosensors. Calculation for designing a bioreactor.

SELECTION OF BIOPROCESS EQUIPMENT (UPSTREAM AND DOWNSTREAM)

Specifications of bioprocess equipment; Mechanical design of reactors, heat transfer and mass transfer equipment; Design considerations for maintaining sterility of process streams and process equipment; Piping and instrumentation; Materials of construction for bioprocess plants.

BIOREACTOR SCALE-UP

Scale up and scale down issues: Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculums development, nutrient availability and supply; Bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer coefficients. Scale up of downstream processes: Adsorption (LUB method); Chromatography (constant resolution etc.); Filtration (constant resistance etc.); Centrifugation (equivalent times etc.); Extractors (geometry based rules). Scale-down related aspects.

TEXT BOOK

1. Robert H. Perry and Don W. Green., Perry's Chemical Engineers' Handbook, McGraw Hill Book Co., 8th Edition, 2008.

REFERENCES

1. Michael Shuler and Fikret Kargi, Bioprocess Engineering, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2nd Edition, 2002.
2. Roger Harrison et al., Bioseparations Science and Engineering, Oxford University Press,. 3rd Edition, 2010.
3. J. M. Coulson and J. F. Richardson, R.K.Sinnott., An introduction to Chemical Engineering Design, Butterworth-Heinemann Ltd., UK, 5th Edition.

B1T 409	CANCER BIOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Understand the regulation and modulation of cell cycle in cancer by various signal switches

CO2: Explain and compare various types of carcinogenesis and its metabolism

CO3: Describe the role of activation of kinases, identification of oncogenes, and how telomerase induced cancer

CO4: Explain metastasis and its significant clinical markers for invasion and metastasis

CO5: Describe molecular tool for early diagnosis of cancer, different forms of cancer chemotherapy and radiation therapy

Course Outcomes Vs Program Outcomes Mapping:

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

FUNDAMENTALS OF CANCER BIOLOGY

Regulation of cell cycle, mutations that cause changes in signal molecules - Effects on receptor, signal switches, tumour suppressor genes - Modulation of cell cycle in cancer, different forms of cancers, diet and cancer

PRINCIPLES OF CARCINOGENESIS

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

PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER

Signal targets and cancer, activation of kinases - Oncogenes, identification of oncogenes, retroviruses and oncogenes - Detection of oncogenes, oncogenes and proto oncogene activity - Growth factors related to transformation - Telomerases

PRINCIPLES OF CANCER METASTASIS

Clinical significances of invasion, heterogeneity of metastatic phenotype - Metastatic cascade, basement membrane disruption - Three step theory of invasion, proteinases and tumour cell invasion

NEW MOLECULES FOR CANCER THERAPY

Cancer screening and early detection, detection using biochemical assays, tumor markers - Molecular tools for early diagnosis of cancer-Different forms of therapy - Chemotherapy,

radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection, use of signal targets towards therapy of cancer - Gene therapy

TEXT BOOKS

1. Weinberg, R.A., The Biology of Cancer, Garland Science Taylor and Francis Group, New York, 1st Edition, 2007.
2. Kleinsmith. L.J., Principles of Cancer Biology, Pearson Education Inc., San Francisco, CA, 1st Edition, 2006.

REFERENCE

1. DeVita Jr, V.T., Lawrence, T.S., Rosenberg, S.A., DePinho, R.A. and Weinberg, R.A., DeVita, Hellman, and Rosenberg's Cancer: Principles and Practice of Oncology, Lippincott Williams & Wilkins Philadelphia, PA, 9th Edition, 2011.

BIT 410	BIOMEDICAL ENGINEERING	L	T	P	C
		3	0	0	3

INTRODUCTION TO BIOMEDICAL ENGINEERING, HUMAN ANATOMY AND PHYSIOLOGY

Evolution of the Modern Health Care System , The Modern Health Care System , What is Biomedical Engineering? , Roles of the Biomedical Engineer , Recent Advances in Biomedical Engineering , Professional Status of Biomedical Engineering , Professional Societies , Introduction to Anatomy and Physiology - Cellular Organization , Tissues , Major Organ Systems , Homeostasis.

BIOMECHANICS, BIOMATERIALS AND TISSUE ENGINEERING

Introduction to Biomechanics , Basic Mechanics , Mechanics of Materials , Viscoelastic Properties , Cartilage, Ligament, Tendon and Muscle , Cardiovascular Dynamics , Biomaterials: Types, Properties and Their Applications , Tissue-Biomaterial Interactions , Biomaterials Processing Techniques for Guiding Tissue Repair and Regeneration , Application-specific Strategies for Design and Selection of Biomaterials , Introduction to Tissue Engineering , Physical and Biological Considerations , Scaling Up , Implementation of Tissue Engineered Products.

BIOINSTRUMENTATION, BIOMEDICAL SENSORS AND BIOSIGNAL PROCESSING

Introduction , Basic Bioinstrumentation System , Fundamental Electrical Quantities , Linear Network Analysis , Linearity and Superposition , Thevenin•s Theorem - General Approach to Solving Circuits Involving Resistors, Capacitors and Inductors , Operational Amplifiers , Time-Varying Signals , Active Analog Filters , Bioinstrumentation Design , Introduction to Biomedical Sensors , Biopotential Measurements , Physical Measurements , Blood gas, Bioanalytical and Optical sensors , Physiological Origins of Biosignals , Characteristics of Biosignals , Signal Acquisition , Frequency Domain Representation of Biological Signals , Linear Systems , Signal Averaging.

BIOELECTRIC PHENOMENA AND BIOMEDICAL TRANSPORT PROCESSES

Introduction and History , Neurons , Basic Biophysics Tools and Relationships , Equivalent Circuit Model for Cell Membrane , Model of Whole Neuron , Chemical Synapses , Biomedical Mass Transport , Biofluid Mechanics and Momentum Transport , Biomedical Heat Transport.

IMAGING, BIOMEDICAL OPTICS AND LASERS

Introduction to Radiation Imaging , Emission Imaging Systems , Instrumentation and Imaging Devices , Radiographic Imaging Systems , Introduction to Medical Imaging , Diagnostic Ultrasound Imaging , Magnetic Resonance Imaging , Magnetoencephalography , Contrast Agents - Comparison of Imaging Modes , Image Fusion , Introduction to Essential Optical Principles , Basics of Light Propagation in Biological Tissue , Physical Interaction of Light and Physical Sensing , Biochemical Measurement Techniques Using Light , Photothermal Therapeutic Effects of Light Sources , Fibre Optics and Waveguides in Medicine , Biomedical Optical Imaging.

TEXT BOOK

1. Enderle, J. and Bronzino, J., Introduction to Biomedical Engineering, Academic Press, MA, USA, 3rd Edition, 2012.

REFERENCE

1. Bankman, N.I. et al., Biomedical Engineering Desk Reference, Academic Press, MA, USA, 1st Edition, 2009.

BIT 411	BIORESOURCE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Identify various renewable energy sources

CO2: Describe large- scale fuel technologies and bioconversions

CO3: Demonstrate how biogas is produced from various bio-resources

CO4: Distinguish between the processes involved in bioethanol and butanol production

CO5: Evaluate the mechanisms involved in biodiesel production

Course Outcomes Vs Program Outcomes Mapping:

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

RENEWABLE ENERGY SOURCE

Hydropower, geothermal power, solar power, wind power , Biofuel -Biomass - Feed stocks (agricultural crops, bioenergy crops, agricultural waste residues, wood residues, waste stream)

FUEL TECHNOLOGY AND BIOCONVERSION

History - Definition of biofuel, applications of biofuel (transport, direct electricity generation, home use and energy content of biofuel) - Bioconversion of lignocellulosics, cellulose saccharification, pretreatment technologies (air separation process, mechanical size reduction, autohydrolysis) - Pulping and bleaching , Enzymatic deinking.

BIOGAS

Biogas plant, feed stock materials, biogas production, factors affecting methane formation - Role of methanogens , Biohydrogen production - Oxygen sensitivity problems in hydrogenenases

BIO ETHANOL AND BUTANOL

Advantages of ethanol over fossil fuels, production of ethanol from cellulosic materials, ethanol recovery - Biobutanol production, energy content and effects on fuel economy - Octane rating, air fuel ratio, specific energy, viscosity, heat of vaporization -Butanol fuel mixtures

BIODIESEL

Production of biodiesel, oil extraction from algae by chemical solvents, enzymatic, expeller press - Osmotic shock and ultrasonic assisted extraction - Applications of biodiesel, environmental benefits and concerns

TEXT BOOKS

1. Alain A.V., Biomass to biofuels strategies for global Industries, John Wiley & sons ltd, 1st Edition, 2010.
2. Twidell., J & Weir., T., Renewable energy resources, Taylor & Francis 2nd Edition, 2006.

REFERENCE

1. Luque, R., Camp, J., Hand book of biofuel production processes and technologies, Woodhead publishing ltd., 1st Edition, 2011.

BIT 412	RNAi TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO 1: Rationlize the discovery of gene silencing phenomenon

CO 2: Analyze the award of Nobel prize for the discovery of RNA interference

CO 3: Design vectors to initiate gene silencing

CO4: Report a method to avoid off-target gene silencing and its importance

CO5: Identify ways of applying RNA interference in Agriculture and Healthcare

Course Outcomes Vs Program Outcomes Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	H	H		M		M		M		M	M	
CO 2	M			M	H	M				M	M	
CO 3	H	M		M	H	M		M		M	M	
CO4	H			M	H	M		M		M	M	
CO5	H	H		M	M	M		M		M	M	M

INTRODUCTION TO RNAi TECHNOLOGY

Introduction to Gene silencing , Different names of gene silencing, Antisense RNA technology -Discovery of gene silencing in petunia plants , Sense co-suppression in plants and animals- Discovery in nematodes (*C. elegans*) and award of Nobel Prize - Biochemistry of RNAi.

METHYLATION, TRANSCRIPTIONAL AND SYSTEMIC SILENCING

Methylation of DNA and proteins, Viroid infection in plants and methylation of DNA, Epigenetics, RNA directed DNA methylation (RdDM) - Proposed model of RdDM , Transcriptional gene silencing and methylation, Induction of transcriptional gene silencing, systemic silencing in plants and animals.

TECHNIQUES IN RNAi TECHNOLOGY

Particle bombardment method - Stable transformation of plants and animals by RNAi vectors, agroinfiltration, VIGS methodology in plants and animals, selection of siRNA sequence, delivery of siRNA using nanoparticles, transfection of siRNA Duplexes -Protein knock down detection by western blotting and immunofluorescence.

Micro RNA

Biosynthesis of micro RNA, Differences between siRNA and miRNA, - Mechanism of micro-RNA mediated interference, Artificial micro-RNA, Micro RNA in plants and animals.

APPLICATIONS OF RNAi TECHNOLOGY

RNAi for crop improvement , Functional genomics in plants by gene silencing , RNAi to control plant viruses , Viral encoded silencing suppressors and its applications , RNAi to control cancer , miRNA directed control of cancer

TEXT BOOKS

1. Gaur R.K., Gafni Y, Sharma P, Gupta V.K., RNAi Technology. CRC Press, New York, 2011.
2. Gregory, J., Hannon., RNAi- A Guide to Gene Silencing, Cold spring harbor laboratory Press New York, 2003.
3. Latterich M., RNAi Advanced Methods, Taylor and Francis, New York, 2007.

BIT 413	VACCINOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Explain the history and background of most important vaccines

CO2: Distinguish various types of vaccines and guidelines for current vaccine practices

CO3: Identify the challenges in the development, testing and approval of new vaccines

CO4: Defend the ethics surrounding the use of vaccines

CO5: Assess the advantages and disadvantages of current vaccines critically

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION TO IMMUNITY

Innate Immunity; Activation of the Innate Immunity through TLR mediated signaling; Adaptive Immunity; T and B cells in adaptive immunity; Immune response in infection; Protective immune response in bacterial; Viral and parasitic infections; Correlates of protection

IMMUNE RESPONSE

Vaccination and immune response; Appropriate and inappropriate immune response during infection: CD4+ and CD8+ memory T cells; Memory B cells; Generation and Maintenance of memory T and B cells; Dendritic cells in immune response

VACCINATION

Adjuvants in Vaccination; Induction of Th1 and Th2 responses by using appropriate adjuvants; Microbial, Liposomal and Microparticles as adjuvant; Chemokines and cytokines; Role of soluble mediators in vaccination; Oral immunization and mucosal Immunity

VACCINES

Conventional vaccines; Bacterial vaccines; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine

NEW VACCINE TECHNOLOGIES

Rationally designed Vaccines; DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for specific targets; Tuberculosis Vaccine; Malaria Vaccine; HIV
vaccine

TEXT BOOKS

1. Edited by Stefan H.E. Kaufmann, Novel Vaccination Strategies, Wiley-VCH Verlag GmbH & Co. KgaA, 2004.

REFERENCES

1. Topley & Wilson•s, Microbiology and Microbial Infections Immunology Edited by Stefan H.E. Kaufmann and Michael W Steward Holder Arnold, ASM Press, 2005.
2. Charles A Janeway. Jr, Paul Travers, Mark Walport and Mark J Shlomchik, Immuno Biology, The Immune system in health and Disease, Garland Science, New York, 6th Edition , 2005.

BIT417	BIOSENSORS	L	T	P	C
		3	0	0	3

Course Outcomes:

At the end of the course, students would be able to
CO1:Understand the basic concepts of biosensors
CO2:Compare various types of biosensors
CO3:Apply immobilization techniques
CO4:Analyze multi analytes
CO5:Illustrate various applications of biosensors

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION TO BIOSENSORS

Definitions, , types of sensors, target analytes, various recognition, signals, and device types, history of field - course overview, class survey, definitions, motivation, biological inspiration.

RECOGNITION / TRANSDUCTION

Enzyme sensors- affinity sensors: antibodies, oligo-nucleotides measuring binding in affinity sensors, SPR, quartz crystal microbalance, FRET- membrane protein sensors: ion channels, receptor - whole cell sensors , bacteria, yeast, mammalian cells

IMMOBILIZATION

Immobilization: adsorption, encapsulation - (hydro-gel, sol-gel glass, etc.), covalent attachment, diffusion issues - optical fiber sensors, planar wave-guides

DEVICE INTEGRATION

Micro-scale and nanoscale: BioMEMS, nanowires, quantum dots, magnetic beads, PEBBLE sensors measuring complex samples, multi-analyte detection, continuous measurements, reagentless biosensors

APPLICATIONS

Agricultural, food safety, food processing : state of the field, market potential, unique design criteria and needs, current sensors in use biomedical applications, bio-security, environmental : state of the field, market potential, unique design criteria and needs, current sensors in use

TEXT BOOKS

1. Bilitewski, U. and Turner, A.P.F., Biosensors for Environmental Monitoring. Harwood Academic Publishers, The Netherlands. ISBN: 90-5702-449-7, 2000.
2. Ligler, F.S. and Rowe Taitt, C.A., Optical Biosensors: Present & Future. Elsevier, The Netherlands. ISBN: 0-444-50974-7, 2002.

REFERENCE

1. Yang, V.C. and T.T. Ngo., Biosensors and Their Applications. Kluwer Academic/Plenum Publishers, New York, NY. ISBN: 0-306-46087-4, 2000.

BIT418	MOLECULAR PATHOGENESIS	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Understand the genetics and molecular biology of microbial pathogenesis.

CO2: Describe the clinical importance of host defense mechanisms and explain the mechanisms of humoral and cellular defense.

CO3: Explain the role of microbial virulence factors in host- pathogen interactions.

CO4: Describe the methods used for studying host pathogen interactions.

CO5: Illustrate the classical and new therapeutic strategies for diagnosing and controlling microbial pathogens.

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION:

Historical perspective - Pasteur•s contributions, Koch•s postulates, early discoveries of

microbial toxins and antibiotics - Introduction to pathogenesis, components of microbial pathogenicity - Population genetics of microbial pathogenesis , epidemiology - various types of pathogens and modes of entry , attributes and components of pathogenicity

HOST-DEFENSE MECHANISMS

Host defense against pathogens, clinical importance of understanding host defense, components of the host surface defences systems like skin, mucosa, eye, mouth, respiratory tract, physical movements, limitation of free iron, antimicrobial compounds - mechanism of killing by humoral and cellular defense mechanisms, complements, inflammation process, general disease symptoms, Pathogenic adaptations to overcome the above defenses.

HOST-PATHOGEN INTERACTION:

Virulence and virulence factors, colonising virulence factors, virulence factors damaging the host tissues, virulence genes and regulation of the virulence genes

Case studies: Diphtheria disease by colonisation; Disease without colonization: Clostridium botulinum and Staphylococcus aureus; Intestinal infections: Shigella and E. coli infections; Vibrio cholera Salmonella infections; fungal infections

EXPERIMENTAL METHODS TO STUDY HOST PATHOGEN INTERACTIONS:

Experimental methods to study host-pathogen interaction, selecting the pathogen model, measurement of virulence - virulence assays: adherence, invasion, cytopathic, cytotoxic effects identification of potential virulence factors; molecular characterization of virulence factors, attenuated mutants, signal transduction & host response

.

DIAGNOSIS AND CONTROL OF PATHOGENS:

Classical approaches based on serotyping; modern diagnosis , highly conserved virulence factors, immuno & DNA-based techniques - New therapeutic strategies , novel drugs for new targets, vaccines - DNA, subunit and cocktail vaccines.

TEXTBOOKS

1. Groisman, E.A., Principles of Bacterial Pathogenesis, Academic Press, 2001.
2. Janeway C.A. Jr, and Travers P. T., Immunobiology, Blackwell J Scientific Publishers, 1994.

REFERENCES

1. Iglewski B.H. and Clark V.L., Molecular basis of Bacterial pathogenesis, Academic press, 1990.
2. Williams, P., Ketley, J. and Salmond, G., Methods in Microbiology: Bacterial Pathogenesis, Vol. 27, Academic Press, 1998.
3. Salyers, A.A. and Whitt, D.D., Bacterial Pathogenesis , A molecular Approach, ASM Press, Washington, 2nd Edition , 2002
4. Nester, Anderson, Roberts, Pearsall, Nester., Microbiology: A Human Perspective, McGraw-Hill, 3rd Edition, 2001.
5. Recent reviews in Infect. Immun. Mol. Microbiol, Biochem. J., EMBO etc.

BIT419	MOLECULAR DIAGNOSTICS AND THERAPEUTICS	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Explain the molecular techniques for the analysis of Genetic and Neurological disorders.

CO2: Discuss current methods of diagnosis for specific diseases, like tuberculosis

CO3: Recognize the importance of monoclonal and polyclonal antibodies in diagnosis

CO4: Apply genetic engineering tools in disease diagnosis.

CO5: Discuss current methods used for production of recombinant protein.

Course Outcomes Vs Program Outcomes Mapping:

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

MOLECULAR DIAGNOSIS OF DISORDERS

Biochemical disorders; Immune, Genetic and Neurological disorders; Molecular techniques for analysis of these disorders; Assays for the Diagnosis of inherited diseases; Bioinformatic tools for molecular diagnosis

PROTEINS IN DIAGNOSTIC TECHNIQUES

Isolation of proteins and other molecules associated with disease; Process and their profiling for diagnosis; 2D analysis of such proteins by sequencing individual spots by Mass Spectrometry; Protein Micro array; Present methods for diagnosis of Specific diseases like Tuberculosis, Malaria and AIDS; Ethics in Molecular Diagnosis

ANTIBODY BASED DIAGNOSIS

Monoclonal antibodies as diagnostic reagents; Production of monoclonal antibodies with potential for diagnosis; Diagnosis of bacterial, viral and parasitic diseases by using; ELISA and Western blot.

THERAPEUTIC AGENTS

Proteins as therapeutic agents - Choice of expression systems and optimizing gene expression - Applications, delivery and targeting of therapeutic proteins - Engineering human interferons and human growth hormones - Regulatory aspects of therapeutic proteins - Enzymes as therapeutic agents - Use of genetically engineered DNase I and alginate lyase for treatment of Cystic Fibrosis

VACCINES

Bacterial polysaccharides, proteins and toxins as vaccines - Recombinant vaccines- subunit, attenuated and vector vaccines - Multivalent vaccine development against AIDS - Commercial and regulatory aspects of vaccine production and its distribution-Production of Recombinant Proteins having therapeutic and diagnostic applications, recombinant vaccine

TEXT BOOKS

1. Campbell, M.A and Heyer L.J., Discovering Genomics, Proteomics and Bioinformatics, CSHL Press, Pearson/Benzamin Cummings San Francisco, USA, 2nd Edition, 2007.

REFERENCES

1. Andrew Read and Dian Donnai, New Clinical Genetics, Scion Publishing Ltd, Oxfordshire, UK, 2007.
2. James W Goding., Monoclonal antibodies: Principles and Practice, Academic Press, 3rd Edition , 1996.

BIT420	SIGNAL TRANSDUCTION	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: List the key regulatory mechanism of messengers and G protein coupled receptors role in transport and cell cycle regulation

CO2: Demonstrate structure, function and modulation of different receptors and its cross talk with in the cell communication

CO3: Explain and illustrate how the alteration of cellular signaling through either induction or inhibition of transcription factors, phosphorylation and mrystoilation

CO4: Discuss molecular mechanism of signals in microbes and plants through regulation of defense and elicitors and root nodule in rhizobium

CO5: Explain importance and various classifications of Ras proteins and its significance of housekeeping function in cells

Course Outcomes Vs Program Outcomes Mapping:

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

MOLECULAR MECHANISMS OF SIGNAL TRANSDUCTION

Introduction - basic elements of Cell Signaling Systems - sensors, primary and secondary messengers, calcium signaling, signaling Molecules and Cell-Surface Receptors Intracellular Signal Transduction, G Protein, Coupled Receptors, G Protein, Coupled Receptors That Regulate Ion Channels, Phospholipase C, Activation of Gene Transcription by G Protein,

Coupled Receptors, Regulation of the Cell Cycle by Protein Kinases, Oncogenes, Tumor Suppressor Genes, and Programmed Cell Death,

STRUCTURE AND FUNCTION OF SIGNALING PATHWAY

TGF Receptors and the Direct Activation of Smads, Cytokine Receptors and the JAK-STAT Pathway, Receptor Tyrosine Kinases and Activation of Ras, MAP Kinase Pathways, Phosphoinositides as Signal Transducers, Pathways That Involve Signal-Induced Protein Cleavage, Down-Modulation of Receptor Signaling, Cross-Talk Among Different Signaling, Pathways, the Role of NO as an Intercellular Messenger

SIGNALS AND GENE CONTROL

Experimental approaches for building a comprehensive view of signal- induced responses, responses of cells to environmental Influences, control of cell fates by graded Amounts of regulators, boundary creation by different combinations of transcription factors, extracellular signals, reciprocal induction and lateral Inhibition, integrating and Controlling Signals, signaling in regulation of protein phosphorylation, mrystioylation

SIGNALING IN MICROORGANISMS AND PLANTS

Molecular mechanism of ethylene signaling, light signal transduction in higher plant, LRR-containing receptors regulating plant development, signaling in plant defense response like PR protein family, salicylic acid, methyl jasmonate, super oxide anion, auxin action signaling, signaling in transport and the control of plant growth and development, the roll of signaling in formation of root nodule in rhizobium,

SIGNAL TRANSMISSION VIA RAS PROTEINS

General Importance and Classification of Ras Proteins, Membrane Localization of Ras Protein, GTPase-activating Protein (GAP) in Ras Signal Transduction, Structure of Ras-GAP Protein, Function of Ras-GAP Protein, Guanine Nucleotide Exchange Factors (GEFs) in Signal Transduction via Ras Proteins, Raf Kinase as an Effector of Signal Transduction by Ras Proteins, Structure of Raf Kinase, Interaction of Raf Kinase with Ras Protein, Mechanism of Activation and Regulation of Raf Kinase, Reception and Transmission of Multiple Signals by Ras Protein

TEXT BOOKS

1. B. D. Gomperts, Peter E. R. Tatham, Ijsbrand M. Kramer, Signal transduction, Academic Press, 2nd Edition, 2009.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter., Molecular Biology of the Cell, Garland Science;. New York, 5th Edition, 2007.
3. Harvey Lodish, Arnold Berk, Chris A. Kaiser and Monty Krieger, Molecular Cell Biology, W. H. Freeman and company, New York, 5th Edition, 2007.

BIT421	FUNCTIONAL GENOMICS	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Summarize genome organization, sequencing, annotation and prediction of gene structure in both prokaryotes and eukaryotes

CO2: Explain structure and function of genome based on sequence comparison, structural analysis, functional and comparative genomics

CO3: Evaluation of pharmacogenomics and toxicogenomics through personalized medicine, alteration of gene expression by drug, SNP marker for drug response, metabolism of xenobiotics and predictive toxicogenomics

CO4: Describe personalized nutrition and disease prevention and its therapeutic applications and epigenome analysis

CO5: Analyze effect of chemicals on gene changes such as mutation, DNA intercalation, and chemogene in drug discovery

Course Outcomes Vs Program Outcomes Mapping:

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

ORGANIZATION AND SEQUENCING OF GENOME

Genome organization (prokaryotes and Eukaryotes) - Whole genome sequencing - Large scale genome sequencing strategies - Genome sequence annotation - Genome assembly and annotation - Prediction of Genes - ORF and functional prediction; Promoters, splice sites - Regulatory regions , Analysis of gene expression- Basic principles of DNA microarrays and SAGE

STRUCTURAL AND FUCNTIONAL GENOMICS

Basic principles, approaches for target selection - application of sequence based and structure-based approaches to assignment of gene functions, e.g. sequence comparison, structure analysis (especially active sites, binding sites) and comparison, pattern identification, etc. - Use of various derived databases in function assignment - Functional genomics and Comparative genomics, Metagenomics.

PHARMACOGENOMICS AND TOXICOGENOMICS

Pharmacogenetic difference between populations, concept of personalized medicine ,Gene-drug interactions, Drugs affecting gene expression, Biomarkers of drug response, SNPs as markers of drug response, Pharmacogenomics of human p-Glycoprotein. Introduction to

toxicology, Absorption, distribution and excretion of toxicants, Metabolism of xenobiotics, Gene Expression profiling in toxicology, Predictive toxicogenomics.

NUTRIGENOMICS

Induvidual differences and nutrition, personalized nutrition and disease prevention, Personalized nutrition and therapeutic applications, Nutrigenomics of protein intake and carbohydrate intake, Genetic association studies of coffee intake, Nutritional effect on epigenome

CHEMOGENOMICS

Definition, Effect of chemicals on genes, delayed mutations, Interaction of molecules (small & Big) with DNA intercalation, Cofactor Chemogenomics, Chemogenomics in drug discovery.

TEXT BOOKS

1. Primrose, S. B., Twyman, R. M., Principles of Genome Analysis, Blackwell Publishing, Singapore, 3rd Edition, 2002.

REFERENCES

1. Linco, J and Wong, M.L. (Eds)., Pharmacogenomics: The search for individualized therapies, WILEY-VCH verlag Gmbh, Weinheim , Germany, 2002.
2. Innocenti, F., Pharmacogenomics: Methods and Protocols, Humana Press, New Jersey, 1st Edition, 2005.
3. Hamadeh, H.K. and Afshari, C.A. (Eds.)., Toxicogenomics; Principles and applications, John Wiley and sons, Canada, 2004.
4. Burczynski, M. E. (Ed.)., An Introduction to Toxicogenomics, CRC press, Florida, 2003
5. Bouchard, C. and Ordovas, J.M., Recent Advances in Nutrigenetics and Nutrigenomics, Academic Press, USA, 2012.
6. Edgar, J. (Ed.)., Chemogenomics: Methods and Applications, Humana Press, New Jersey, 2009.

BIT422	RADIATION BIOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Describe the concept involving in radiation biology

CO2: Differentiate the molecular and cellular effects of radiation

CO3: Understand the mechanisms of radiation protection

CO4: Explain the basic concepts in radiation oncology

CO5: Know the application of radiotherapy

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION TO RADIATION BIOLOGY

Physics and chemistry of radiation interactions with matter , source and Types of ionizing radiation - Particulate radiations - Linear Energy Transfer and Relative Biologic Effectiveness- Radiation dose and units - Principles of radiation dosimetry - Direct and indirect effects.

MOLECULAR AND CELLULAR RADIOBIOLOGY

Radiation lesions in DNA - DNA Strand Breaks and Chromosomal Aberrations - Cell Survival Curves , Radio-sensitivity and Cell Age in the Mitotic Cycle - Consequences of unrepaired DNA damage: chromosome damage - Repair of Radiation Damage and the Dose Rate Effect - Relative biological effectiveness (RBE) - Cellular repair exemplified in survival curves - Cellular hyper-radiosensitivity (HRS) and induced repair (IRR) - Other molecular targets: bystander (epigenetic) effects , Molecular techniques.

RADIOBIOLOGICAL BASIS OF RADIATION PROTECTION

Radiation accidents and environmental radiation exposure - Long term radiation risks from low radiation doses - Diagnosis and medical management of radiation syndromes - Radiation carcinogenesis - Heritable radiation effects - Effects on the developing embryo - system for radiation protection

RADIATION ONCOLOGY

Cell signaling - oncogenes and tumor suppressor genes - The cell cycle - Tumor growth and cell kinetics - Cell death mechanisms - In vitro and in vivo assays for cell survival - Repair of radiation damage - Tumor biology and host/tumor interactions - Radiobiology of normal tissue damage - Time-dose-fractionation - Predictive assays

RADIOTHERAPY

Doses and Risks in Diagnostic Radiology, Interventional Radiology and Cardiology and Nuclear Medicine - Clinical Response of Normal Tissues - Model Tumor System - Cell, Tissue, and Tumor Kinetics - Time, dose, and fractionation in Radiotherapy- Combined radiation and drug treatments - Clinical radiobiology of common cancers - Second cancers in radiotherapy patients.

TEXT BOOKS

1. Radiation biology: A handbook for teachers and students, Training course series no. 42, International Atomic Energy Agency (IAEA), Vienna, 2010.
2. Eric J. Hall and Amato J. Giaccia., Radiobiology for the Radiologist, Lippincott, Williams and Wilkins, 6th Edition, 2006.

REFERENCE

1. A.H.W. Nias, An Introduction to Radiobiology, Second Edition, John Wiley and Sons, 1998.

BIT423	RECOMBINANT PROTEIN PRODUCTION	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Understand structure of proteins, motifs, protein folding and posttranslational modification of proteins

CO2: Explain and illustrate cloning of a gene in expression vectors of both bacterial and mammalian expression vectors

CO3: Illustrate the overexpression and purification of proteins form both bacterial and mammalian system by using His-tag, T7 and GST fusion tag

CO4: Explain the identification of differentially expressed proteins from infected tissues through proteomics approaches such as 2D gel followed by LC-MS/MS analysis

CO5: Describe the commercial applications of recombinant proteins in pharmaceutical, Immunological, and biosensor

Course Outcomes Vs Program Outcomes Mapping:

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

STRUCTURE OF PROTEINS AND POSTTRANSLATIONAL MODIFICATIONS

Introduction to primary, secondary, tertiary, quaternary and loop structure of proteins, motifs, protein folding and denaturation. Post-translational modifications: acetylation, phosphorylation, glycosylation, palmitoylation, mristoylation, sumolation and methylation. Transcription factors.

TYPES OF EXPRESSION VECTORS AND CLONING

Major elements in the expression vectors: promoter, terminator, enhancer, fluorescent and non fluorescent tags. Prokaryotic and eukaryotic expression vectors: pET, Gateway, pcDNA expression system. Cloning of a gene: designing gene specific primers - PCR cloning.

OVER EXPRESSION AND PURIFICATION OF PROTEINS

Over expression of proteins in bacterial system, induction of †lac• promoter by IPTG, over expression of proteins using mammalian expression vectors with fusion proteins: Priniciple of Purification of protein using affinity chromatography (His-Taq, T7-tag and GST , fusing tag), ion exchange, gel filtration and FPLC.

PROTEOMIC APPROACHES

Introduction to proteomics, differential expression of proteins in healthy and infected tissues, protein isolation from tissues, two dimensional gel electrophoresis, mass spectrophotometer analysis, protein array and its applications.

APPLICATIONS OF RECOMBINANT PROTEINS

Raising of antibodies against recombinant proteins, antibody purification and immuno-localization in tissues - generation of recombinant vaccines and purifications - different applications of recombinant enzymes: industrial, environmental, therapeutic and biosensor

TEXT BOOK

1. Primrose, B., Twyman, R. M., Genomics: Applications in Human Biology, Blackwell Publishing, Singapore, 4th Edition, 2004.

REFERENCE

1. Westermeier, R., Naven, T., Proteomics in Practice (A Laboratory Manual of Proteome Analysis), Wiley-VCH, London, 3rd Edition, 2002.

BIT424	CLINICAL TRIALS AND MANAGEMENT	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Understand the concept of new drug development process

CO2: Explain about good clinical practice and regulations

CO3: Know about feasibility and activity studies

CO4: Describe about clinical trial data

CO5: Know about international clinical trials

Course Outcomes Vs Program Outcomes Mapping:

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

DEVELOPING NEW DRUGS, BIOLOGICS, AND DEVICES

The Drug Development Process - Pre-Clinical Studies - Clinical Trial Phases - Application to Market New Drugs and Biologics - FDA Review Groups - Developing New Devices - Post

marketing Surveillance of Drugs, Biologics, and Devices - Direct Reporting Based on Observations

GOOD CLINICAL PRACTICE AND THE REGULATIONS

Guidelines - Local Laws - Principal Investigator Responsibilities - Sponsor Responsibilities - Sponsor-Investigators - FDA Guidance Documents - Online Resources - Informed Consent and the Regulations - Institutional Review Boards - Monitoring, Audits, and Inspections

PROTOCOL, FEASIBILITY AND ACTIVITY STUDIES, AND DOCUMENTATION

Common Components of a Protocol - Study Organization - Objectives/Endpoints - Study Design - Study Population and treatment plan - Safety Assessment, Management, and Reporting - Statistical Aspects - Subject Data and Record Retention , Monitoring - Reviewing a Specific Protocol - Study Start-up Phase - Study Maintenance Phase - Study Completion and Close-Out Phase - Documents at Study Start-Up - Documents While the Study is in Progress - Documents at Study Close-out - Maintaining Site Study File-Management of Study Drugs, Biologics, and Devices

MANAGING CLINICAL TRIAL DATA

HIPAA, the Privacy Rule, and Clinical Trial Data - Guidelines and Regulations Regarding Clinical Trial Data - Study Site Responsibilities Regarding Clinical Trial Data - Source Document Verification of Clinical Trial Data - Release of Protected Medical Information - Confidentiality of Clinical Trial Data - Endpoint Adjudication

GLOBAL HEALTH AND INTERNATIONAL TRIALS

International Clinical Trials - Ethnic and Racial Differences - Ethical Issues and Cultural Sensitivities - Importance of International Trials - HIV/AIDS , Malaria , Tuberculosis , Polio - International Regulations - Future Efforts

TEXT BOOK

1. Liu, M.B. and Davis, K., Clinical trials manual from the Duke Clinical Research Institute: lessons from a horse named Jim., John Wiley & Sons, Ltd., 2nd Edition, 2010.

REFERENCE

1. Gallin, J.I. and Ognibene, F.P. Principles and Practice of Clinical Research, Academic Press.

MINOR ELECTIVES

CHE 354	MASS TRANSFER	L	T	P	C
		3	0	0	3

Course Outcomes:

At the end of the course, students would be able to
CO1: Solve diffusion and diffusion related problems
CO2: Estimate mass transfer coefficients for gas , liquid contacting systems
CO3: Estimate the number of stages for distillation and absorption column
CO4: Solve problems related to extraction, leaching, adsorption and drying
CO5: Explain about membrane separation operations

Course Outcomes Vs Program Outcomes Mapping:

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

DIFFUSION

Diffusion, Equation of continuity - Unimolecular diffusion and equimolar counter diffusion applied to both gases and liquids - Diffusion in solids, Knudsen diffusion, measurement of diffusivity of liquids and gases - Empirical relations for measurement of diffusivity of gases and liquids

INTERPHASE MASS TRANSFER

Mass transfer coefficients (k type and f-type), overall and local mass transfer coefficients, Lewis Whitman two phase theory, estimation of mass transfer coefficients, analogy between transport processes - Theories of mass transfer - Gas liquid contacting devices - Convective mass transfer

VAPOR € LIQUID & GAS € LIQUID OPERATIONS

Vapor liquid equilibria, T-x-y and P-x-y diagrams, steam distillation, flashing, differential distillation, design of continuous counter current distillation process - McCabe Thiele method, (binary components only) - Packed column distillation, HTU, NTU and HETP concepts - Principles of gas absorption, single and multi component absorption, absorption

with chemical reaction, design principles of absorbers, HTU & NTU concepts, industrial absorbers

LIQUID € LIQUID & SOLID - LIQUID OPERATIONS

Liquid - liquid equilibria, staged and continuous extraction - Solid-liquid Equilibria - Leaching principles - Adsorption equilibria - Batch and fixed bed adsorption - Ion exchange drying , Mechanism, drying curves, time of drying, batch and continuous dryers

MEMBRANE SEPARATION PROCESSES

Membrane separation processes -Types liquid and gas - Membrane processes - Complete mixing - Cross flow and counter current flow models - Concentration polarization and membrane fouling, ultra filtration and micro filtration

TEXT BOOKS

1. Treybal, R.E., Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 3rd Edition, 1981
2. Geankoplis, C.J., Transport Processes and Unit Operations, Prentice Hall of India, New Delhi, 3rd Edition, 2002.

REFERENCES

1. Coulson, J.M., Richardson, J.F., Backhurst, J.R. and Harker, J.M., Coulson and Richardson•s Chemical Engineering, Volume II, Butter worth Heinemann, Oxford, 5th Edition, 2002.

CHE 355	BIOPROCESS PLANT DESIGN AND ECONOMICS	L	T	P	C
		3	0	0	3

Course Outcomes:

At the end of the course, students would be able to
CO1: Describe about Business organizations processes
CO2: Describe Project design and development
CO3: Summarize Economics of plant Design
CO4: Discuss Process optimization for economic production
CO5: Choose Quality control requirements for production

Course Outcomes Vs Program Outcomes Mapping:

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

PROCESS ECONOMICS AND BUSINESS ORGANIZATIONS

Definition of bioprocess - Bioprocess economics - Importance of various M-inputs - Globalization concept - Competition by dumping and it•s effect on plant size - Status of India with adjoining ASIAN countries (Singapore, Malaysia, Indonesia etc) - Project profile concept ,details - Structure and types of organizations - Simple management principles

PROJECT DESIGN AND DEVELOPMENT

Choosing a project - Market survey, importance of techno-economic - Viability studies - Sourcing of processes - Process alternatives - Fixing most economic processes technology , Scanning - Plant location principles - Plant lay out - Process flow sheets, preparation of budgetary investment and production costs

COST ESTIMATION, PROFITABILITY AND ACCOUNTING

Capital investment - Concept of time -Value of money - Source sink concept of profitability, capital costs, depreciation, estimation of capital costs, manufacturing costs, working capital, profitability standards, project profitability evaluation - Alternative investments and replacements - Annual reports - Balance sheets - Performance analysis

PROCESS OPTIMIZATION TECHNIQUES

Optimum design - Design strategy, economic - Balance, different unit operations with single and multiple variables

QUALITY AND QUALITY CONTROL

Current good manufacturing practices, concepts of quality control in 20^{th} century, elements of quality control envisaged by ISI since 1947 - Emergence of statistical process control (SPC) - Simple SPC concept details - Fundamental concepts of ISO 9000 Quality System and the various requirements for ISO certification

TEXT BOOK

1. Peters, and Timmerhaus., Plant design and Economics for Chemical Engineers, McGraw Hill, New Delhi, 4^{th} Edition, 1989.

REFERENCE

1. Rudd, D.F., Watson., Strategy of Process Engineering, John Wiley, Singapore, 3^{rd} Edition, 1987

CHE 356	CHEMICAL AND BIO- THERMODYNAMICS	L	T	P	C
		3	0	0	3

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

CO1: Apply the laws of thermodynamics to chemical and bio processes

CO2: Calculate differences in thermodynamic properties using equations of state, charts and tables

CO3: Solve problems dealing with multiphase physical and reactive systems

CO4: Explain the molecular basis of thermodynamics

CO5: Interpret thermodynamic data for applications in chemical engineering processes and biological sciences

Course Outcomes Vs Program Outcomes Mapping:

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

FIRST LAW OF THERMODYNAMICS

Joules Experiment, Internal Energy, Formulation of first law of Thermodynamics - Thermodynamic state and state functions, enthalpy, reversible processes , Steady-state-flow process - Heat effects accompanying phase change, standard heat of reaction, formation and combustion - Effect of temperature on standard heat of reaction - Heat effects of industrial reactions

SECOND LAW OF THERMODYNAMICS

Statement of Second law , The heat engine , Thermodynamic temperature scales , Carnot cycle for an ideal gas - Entropy, Entropy changes of an ideal gas , Principle of the increase of Entropy; Mathematical statement of the second law , Entropy from the macroscopic view point

THERMODYNAMIC PROPERTIES OF MIXTURES AND SOLUTION

Partial molar properties and relation with total mixture property - Gibbs'-Duhem equation, chemical potential, mixing rules, departure functions for real gas mixtures, fugacity and fugacity coefficients of real gas mixtures. Ideal and non-ideal solutions - Dilute solutions, thermodynamic properties of solutions, Lewis-Randall rule, Raoult's Law and Henry's Law

PHASE EQUILIBRIA

Phase transitions and phase equilibria - Gibbs' phase rule, binary vapor-liquid equilibria (VLE),VLE at low and high pressures, modified Raoult's law, VLE for miscible, partially miscible and immiscible systems, VLE using equations of state, liquid-liquid equilibria (LLE), adsorption equilibria - Common adsorption isotherms

CHEMICAL REACTION EQUILIBRIA

Extent of reaction, equilibrium constant, effect of operating conditions on equilibrium conversion, determination of equilibrium compositions for homogeneous gas-phase reactions - Single and multiple reactions, liquid-phase reaction equilibria - Electrochemical equilibria and applications

TEXT BOOKS

1. Smith, J.M., Van Ness H.C., Abbot M.M., Chemical Engineering Thermodynamics, McGraw-Hill, New Delhi, 6th Edition, 2001.
2. Narayanan, K.V., A Text Book of Chemical Engineering Thermodynamics, Prentice Hall India, New Delhi, 2nd Edition, 2001.

REFERENCE

1. Nag,P.E., Engineering Thermodynamics, McGraw Hill, New Delhi, 2nd Edition, 1995.

CHE314	COLLOIDS & SURFACE SCIENCE	L	T	P	C
		3	0	0	3

INTRODUCTION

Hamaker's analysis for interparticle attractive forces, experiments verifying Van der Waals interactions between surfaces, Lifshitz macroscopic theory for the Hamaker constant, Parsegian, Ninham's approximation to Lifshitz theory, Casimir and Polder's correction for relaxation effects - Example calculations of Hamaker constants for several specific metal, polymer, and ceramic systems - Influence of other types of interparticle forces

HIERARCHY OF SURFACE CHEMICAL MODELS

Hierarchy of surface chemical models for surface charging - Monoprotic surface charging systems lattices and organic acids, metallic and non,oxide systems - Role of surface oxygen in dictating surface charge for metal and non-oxide ceramic systems

ELECTRIC DOUBLE LAYER

Isolated electric double layer - Overlap of the double layer for interacting particles - Free NRGs of isolated and interacting double layers, repulsive NRG due to overlapping double layers - Derjaguin approximation for the interaction of spherical particles - Concept of the critical coagulation concentration, - Influence of salt concentration, ionic strength, and ionic size- Influence of surface charge for monoprotic surface charge systems - Role of surface charging in the dispersion of solids in non, aqueous systems

STABILIZATION OF PARTICLES WITH NON- IONIC POLYMERS

Criteria for stabilization of particles with non-ionic polymers - Role of polymer solubility in stabilization - Role of co, and ter, polymers in providing stabilization reconciling surface attachment with polymer extension from the surface - Impenetrable barrier model for polymeric stabilization - Compression model by Bagchi for polymeric dispersion - Interpenetration and compression model for polymeric dispersion - Other assumptions with respect to the relative contribution of the Hamaker constant toward stabilization with polymers - Selection criteria for polymeric dispersants for specific types of material systems - Polymeric dispersion of nanometer size particles

FEATURES OF POLYELECTROLYTE

Features of polyelectrolyte that contribute to their dispersing power - pKa, molecular size and distribution, type of polymer - Criteria for polyelectrolyte adsorption to charged surfaces - Role of pKa - Monitoring adsorption via solution depletion, EM scattering, and zeta potential measurements, polyelectrolyte conformation at charged surfaces - Combined electrostatic and impenetrable barrier model for dispersion of particles with polyelectrolytes - Some other concepts regarding nonionic dispersants in aqueous systems, interaction of polyelectrolyte with ionic species in solution

TEXT BOOKS

1. Hiemenz, P.C, Raj Rajagopalan., Principles of Colloids and Surface Chemistry, Marcel Dekker, New York, 3rd Edition, 1997.
2. De Keizer., Johannes Lyklema., Hans Lyklema., Fundamentals of Interface and Colloid Science, Elsevier, New Delhi, 2nd Edition, 2000.

REFERENCE

1. Milling,A.J., Surface Characterization Methods Principles, Techniques and Applications, (Surfactant Science Series- V, 87), CRC, New York, 1st Edition, 1999.

CIV369	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	C
		3	0	0	3

INTRODUCTION

Impact of development projects under Civil Engineering on environment - Environmental Impact Assessment (EIA) - Environmental Impact Statement (EIS) , EIA capability and limitations , Legal provisions on EIA.

METHODOLOGIES

Methods of EIA , Check lists , Matrices , Networks , Cost-benefit analysis , Analysis of alternatives , Case studies.

PREDICTION AND ASSESSMENT

Assessment of Impact on land, water and air, noise, social, cultural flora and fauna, Mathematical models, public participation , Rapid EIA.

ENVIRONMENTAL MANAGEMENT PLAN

Plan for mitigation of adverse impact on environment - options for mitigation of impact on water, air and land, flora and fauna, addressing the issues related to the Project Affected People , ISO 14000

CASE STUDIES

EIA for infrastructure projects - Bridges - Stadium - Highways - Dams - Multi-storey Buildings - Water Supply and Drainage Projects.

TEXT BOOKS

1. Canter,L., Environmental Impact Assessment, McGraw-Hill Inc., New Delhi, 1996.
2. Shukla, S.K. and Srivastava, P.R., Concepts in Environmental Impact Analysis, Common Wealth Publishers, New Delhi, 1992.

REFERENCES

1. John G. Rau and David C Hooten (Ed)., Environmental Impact Analysis Handbook, McGraw-Hill Book Company, New York, 1990.
2. Environmental Assessment Source book, Vol. I, II and III. The World Bank, Washington, D.C., 1991.
3. Judith Petts, Handbook of Environmental Impact Assessment Vol. I and II, Blackwell Science, 1999.

CIV463	SOLID WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

SOURCES AND TYPES OF MUNICIPAL SOLID WASTES

Sources and types of solid wastes - Quantity - Factors affecting generation of solid wastes; characteristics - methods of sampling and characterization; Effects of improper disposal of solid wastes - public health effects - Principle of solid waste management , social and economic aspects; Public awareness; Role of NGOs; Legislation

ON-SITE STORAGE AND PROCESSING

On-site storage methods - Materials used for containers - on-site segregation of solid wastes - public health and economic aspects of storage - options under Indian conditions - Critical Evaluation of Options

COLLECTION AND TRANSFER

Methods of Collection - types of vehicles - Manpower requirement - collection routes; transfer stations - selection of location, operation and maintenance; options under Indian conditions

OFF-SITE PROCESSING

Processing techniques and Equipment; Resource recovery from solid wastes - composting, incineration, Pyrolysis - options under Indian conditions

DISPOSAL

Dumping of solid waste; sanitary land fills - site selection, design and operation of sanitary landfills - Leachate collection and treatment

TEXT BOOKS

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil Integrated Solid Waste Management, McGraw-Hill Publishers, 1993.
2. B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, *f*Waste Management,,, Springer.

REFERENCES

1. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000

2. R.E.Landreth and P.A.Rebers., Municipal Solid Wastes - problems and Solutions, Lewis Publishers, 1997.
3. Bhide A.D. and Sundaresan B.B., Solid Waste Management in Developing Countries, INSDOC, 1993.

CIV416	INDUSTRIAL WASTEWATER MANAGEMENT	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Describe the nature and composition of industrial pollutants, their origin and their impact on the environment

CO2: Explain the principles of various processes available for wastewater treatment

CO3: Choose methods for waste minimization and water conservation

CO4: List the problems associated with the operation of industrial wastewater treatment facilities and provide an explanation of the causes and possible solutions

CO5: Determine the toxicity levels of industrial effluents

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION

Industrial scenario in India- Industrial activity and Environment - Uses of Water by industry - Sources and types of industrial wastewater - Industrial wastewater and environmental impacts - Regulatory requirements for treatment of industrial wastewater - Industrial waste survey - Industrial wastewater generation rates, characterization and variables - Population equivalent - Toxicity of industrial effluents and Bioassay tests

INDUSTRIAL POLLUTION PREVENTION

Prevention Vs Control of Industrial Pollution - Benefits and Barriers - Source reduction techniques - Waste Audit - Evaluation of Pollution prevention options - Environmental statement as a tool for pollution prevention - Waste minimization Circles

INDUSTRIAL WASTEWATER TREATMENT

Equalisation - Neutralisation - Oil separation - Flotation - Precipitation - Heavy metal Removal - Refractory organics separation by adsorption - Aerobic and anaerobic biological treatment - Sequencing batch reactors - High Rate reactors , Chemical oxidation - Ozonation - Photocatalysis - Wet Air Oxidation - Evaporation - Ion Exchange - Membrane Technologies - Nutrient removal

WASTEWATER REUSE AND RESIDUAL MANAGEMENT

Individual and Common Effluent Treatment Plants - Joint treatment of industrial wastewater - Zero effluent discharge systems , Quality requirements for Wastewater reuse - Industrial reuse - Disposal on water and land - Residuals of industrial wastewater treatment - Quantification and characteristics of Sludge - Thickening, digestion, conditioning, dewatering and disposal of sludge - Management of RO rejects

CASE STUDIES

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles - Tanneries - Pulp and paper - metal finishing- Petroleum Refining - Pharmaceuticals - Sugar and Distilleries - Food Processing - fertilizers - Thermal Power Plants and Industrial Estates

REFERENCES

1. Eckenfelder, W.W., Industrial Water Pollution Control, McGraw-Hill, 1999
2. Arceivala, S.J., Wastewater Treatment for Pollution Control, Tata McGraw-Hill, 1998
3. Frank Woodard, Industrial waste treatment Handbook, Butterworth Heinemann, New Delhi, 2001
4. World Bank Group Pollution Prevention and Abatement Handbook - Towards Cleaner Production, World Bank and UNEP, Washington D.C.1998
5. Paul L. Bishop Pollution Prevention: - Fundamentals and Practice, McGraw-Hill International, 2000

CSE103	DATA STRUCTURES	L	T	P	C
		3	0	0	3

INTRODUCTION

The Role of Algorithms in Computing - Algorithms, Algorithms as a technology - Structures in C , Implementation of structures - Unions in C - Implementation of unions - Structure parameters - Recursive definition and processes: Factorial function - Fibonacci sequence - Recursion in C - Efficiency of recursion.

STACKS, QUEUES AND HASHING

Abstract Data Types- Stacks-Stack applications- Balancing symbols, Infix to postfix expression conversion, Postfix Expression evaluation, Function calls- Queues- Linked lists- Hash Tables - Direct-address tables, Hash tables, Hash functions - Open addressing.

TREES

Tree Terminologies - Binary tree - Binary tree traversal - Expression tree construction- Binary Search Trees- Querying a binary search tree, Insertion and deletion, AVL trees- rotations, insertion. B-Trees-Definition of-trees- Basic operations on B-trees- insertion and deletion.

SORTING AND SEARCHING

Priority Queues (Heaps) , Model , Simple implementations , Binary Heap-Properties. Sorting-Bubble sort, insertion sort, selection sort, shell sort, Heap sort, quick sort, Radix sort, Merge sort. Searching - Linear search, Binary search.

GRAPHS

Graph Terminologies - Representations of Graphs, Breadth-first search, Depth-first search, Topological sort, strongly connected components. Minimum Spanning Trees- Growing a minimum spanning tree - The algorithms of Kruskal and Prim-Shortest paths in directed acyclic graphs, Dijkstra's algorithm, All Pairs Shortest Paths - The Floyd - Warshall algorithm.

TEXT BOOK

1. Weiss M. A., Data Structure and Algorithm Analysis in C, Addison Wesley,.
2. Cormen T. H., Leiserson C. E., Rivest R. L. and Stein C., Introduction to Algorithms, Prentice Hall India, 2nd Edition, 2002.

REFERENCES

1. Aaron Tenenbaum M, Yeedidyah Langsam, Moshe Augenstein J., (2004) Data structures using C, Pearson Education.
2. Horowitz E., Shan S, Fundamentals of Data Structures, Pittman, 1977.

EIE409	BIOMEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

ANATOMY, PHYSIOLOGY AND TRANSDUCERS

Brief review of human physiology - anatomy , cell structures , electrical activities - mechanical activities - chemical activities , action potential - resting potential , different types of electrodes , sensors used in biomedicine , selection criteria for transducers - electrodes , necessity for low noise pre-amplifiers , difference amplifiers , difference amplifiers , chopper amplifiers , electrical safety , grounding , isolation

MEASUREMENT OF BIOPOTENTIAL AND PHYSIOLOGICAL PARAMETERS

ECG , Phonocardiography , Neurophysiology , Central nervous system , EEG , Respiratory system , Muscular system - EMG, - Eye , ERG, Physiological Transducers - Measurement of Blood pressure , Blood flow - Cardiac output measurement , heart rate , respiration rate , measurement of lung volume , Oximeters , Audiometer

THERAPEUTIC AND SURGICAL EQUIPMENTS

Electro Surgical unit , short wave - microwave diathermy , Laser surgical unit , Anesthesia machine , Pacemakers , Total artificial heart (TAH) , Dialyser , Heart lung machine , Defibrillators , Ventilators , Nerve stimulators , centralized and Bedside patient monitoring system , Nerve stimulators

BIOMEDICAL EQUIPMENTS AND ELECTRICAL SAFETY

-Flame photometer , spectrophotometer , chromatography , pH, pCO_2, analysis , sterilizers , Electrical safety hazards in hospitals

IMAGING SYSTEMS AND TELEMETRY

Computerized Tomography (CT) , MRI instrumentation , Ultrasound scanner , X-ray machine , Fluroscopic techniques , angiography , Cardiac catherisation lab , Echo cardiograph , vector cardiograph , Biotelemetry

TEXT BOOKS

1. Kandpur, R.S., Handbook of Biomedical Instrumentation, TMH
2. Richard Aston, Principles of Biomedical Instrumentation and Measurement, Merrill publishing company, 1990.

REFERENCES

1. Arumugam, M., Biomedical Instrumentation, Anuradha Agencies, Publishers, Kumbakonam, 1992.
2. Geddes, L.A. and Baker, L.E., Principles of Applied Biomedical Instrumentation, John wiley and Sons, 1989.

EIE416	OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

INTRODUCTION TO OPTIMIZATION

Engineering applications - classical optimization techniques , linear programming , simplex method , duality - karmankar•s method

MULTIVARIABLE OPTIMIZATION

With equalities - without equalities - weighted sum method , E constraint method - goal programming

NON LINEAR PROGRAMMING

One dimensional minimization - geometric programming , dynamic programming - queuing theory - game theory

EVOLUTIONARY COMPUTATION TECHNIQUES

Genetic algorithm , EP , PSO , ANT , NSGA-II

APPLICATION

Conventional - Evolutionary optimization methods for control problems

TEXT BOOKS

1. Kalyanmoy deb, Multi objective evolutionary Algorithms, John wiley & sons, 1st Edition, 2002.
2. Rao, S.S., Optimization: theory and applications, 4th edition, New age international publishers, 4th Edition, 2002.

REFERENCES

1. Kanti Swarup, et al, Operation Research, Sultan Chand, 11th Edition, 2003.

INT 303	DATABASE MANAGEMENT SYSTEMS	L	T	P	C
		3	0	0	3

INTRODUCTION AND CONCEPTUAL MODELING

Introduction to File and Database systems- Database system structure , Data Models , Introduction to Network and Hierarchical Models , ER model , Relational Model , Relational Algebra and Calculus.

RELATIONAL MODEL

SQL , Data definition- Queries in SQL- Updates- Views , Integrity and Security , Relational Database design , Functional dependences and Normalization for Relational Databases (up to BCNF).

DATA STORAGE AND QUERY PROCESSING

Record storage and Primary file organization- Secondary storage Devices- Operations on Files- Heap File- Sorted Files- Hashing Techniques , Index Structure for files , Different types of Indexes- B-Tree - B+Tree , Query Processing.

TRANSACTION MANAGEMENT

Transaction Processing , Introduction- Need for Concurrency control- Desirable properties of Transaction- Schedule and Recoverability- Serializability and Schedules , Concurrency Control , Types of Locks- Two Phases locking- Deadlock- Time stamp based concurrency control , Recovery Techniques , Concepts- Immediate Update- Deferred Update - Shadow Paging.

CURRENT TRENDS

Object Oriented Databases , Need for Complex Data types , OO data Model- Nested relations - Complex Types- Inheritance Reference Types - Distributed databases- Homogenous and Heterogenous- Distributed data Storage , XML , Structure of XMLData- XML Document- Schema- Querying and Transformation. , Data Mining and Data Warehousing.

TEXT BOOKS

1. Abraham Silberschatz, Henry F., Korth and Sudarshan, S., Database System Concepts, McGraw-Hill, 4th Edition, 2002.

REFERENCES

1. Ramez Elmasri and Shamkant B. Navathe, Fundamental Database Systems, Pearson Education, 3rd Edition, 2003.
2. Raghu Ramakrishnan, Database Management System, Tata McGraw-Hill Publishing Company, 2003.
3. Hector Garcia, Molina., Jeffrey D.Ullman and Jennifer Widom., Database System Implementation- Pearson Education, 2000.

4. Peter Rob and Corlos Coronel., Database System, Design, Implementation and Management, Thompson Learning Course Technology, 5th Edition, 2003.

HUMANITIES ELECTIVES

HSS001	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1:Explain the role and nature of quality in evolving international economic conditions

CO2:Describe the quality encounter process, including supporting facilities and customer requirements/characteristics

CO3:Classify quality measurement methods and continuous improvement process

CO4:Discuss Quality Management strategy methods, including identification, development, implementation and feedback processes

CO5:Select quality recovery processes and their role in the marketing process

Course Outcomes Vs Program Outcomes Mapping:

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

INTRODUCTION TO QUALITY MANAGEMENT

Definitions , TOM framework, benefits, awareness and obstacles. Quality , vision, mission and policy statements. Customer Focus , customer perception of quality, Translating needs into requirements, customer retention. Dimensions of product and service quality. Cost of quality.

PRINCIPLES AND PHILOSOPHIES OF QUALITY MANAGEMENT

Overview of the contributions of Deming, Juran Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi, Shingeo and Walter Shewhart. Concepts of Quality circle, Japanese 5S principles and 8D methodology.

STATISTICAL PROCESS CONTROL AND PROCESS CAPABILITY

Meaning and significance of statistical process control (SPC) , construction of control charts for variables and attributed. Process capability , meaning, significance and measurement , Six sigma concepts of process capability. Reliability concepts , definitions, reliability in series and parallel, product life characteristics curve. Business process re-engineering (BPR) , principles, applications, reengineering process, benefits and limitations.

TOOLS AND TECHNIQUES FOR QUALITY MANAGEMENT

Quality functions development (QFD) , Benefits, Voice of customer, information organization, House of quality (HOQ), building a HOQ, QFD process. Failure mode effect analysis (FMEA) , requirements of reliability, failure rate, FMEA stages, design, process and documentation.

TAGUCHI TECHNIQUES

Taguchi techniques , introduction, loss function, parameter and tolerance design, signal to noise ratio. Seven old (statistical) tools. Seven new management tools. Bench marking and POKA YOKE.

REFERENCES:

1. Dale H.Besterfield et al, Total Quality Management, Thrid edition, Pearson Education (First Indian Reprints 2004).
2. Shridhara Bhat K, Total Quality Management , Text and Cases, Himalaya Publishing House, First Edition 2002.
3. William J.Kolarii, Creating quality, Mcgraw Hill, 1995
4. Poornima M.Charantimath., Total quality management, Pearson Education, First Indian Reprint 2003.

HSS002	ENGINEERING MANAGEMENT	L	T	P	C
		3	0	0	3

Introduction - Demand and Revenue Analysis - Demand Forecasting - Production Analysis - Cost and Supply Analysis, Price and output Determination - Investment Analysis - Plant Location - Economic Optimization.

Types of Business Organisation, Forms, Planning - Organizing - Designing effective organisations - Coordination.

Human Resource Development - Motivating individuals and workgroups - Leadership for Managerial Effectiveness - Team working and Creativity - Managerial Communication - Personal Management , Time Management - Stores Management - Career Planning.

Financial Management - Product development - Management techniques in product development - Nature of controlling - Operations Management - Just-in-Time.

Managing World Economic Change - The global environment - Multinational Strategies - Economic Cycles and Director Investment - Change and Organisation Development - Managerial Ethics and Social responsibilities.

REFERENCES:

1. Harold Koontz& Heinz Weihrich - Essentials of Management Tata McGraw Hill publishing company Ltd.
2. Koontz, Weihrich& Aryasri , Priniciples of Management Tata McGraw Hill publishing company Ltd.
3. Tripathi& Reddy - Priniciples of Management Tata McGraw Hill publishing company Ltd.

4. Hampton , Management Tata McGraw Hill publishing company Ltd.
5. L.M.Prasad - Principles of Management

HSS004	INDUSTRIAL PSYCHOLOGY	L	T	P	C
		3	0	0	3

The role of the psychologist in industry, the field of occupational Psychology: Study of behaviour in work situation and applications of Psychological principles to problems of selection, Placement, Counseling and training

Design of work environments: Human engineering and physical environment techniques of job analysis, Social environment - Group dynamics in Industry Personal psychology: Selection, training, placement, promotion, counseling, job motivations, job satisfaction.

Special Study of problem of fatigue, boredom and accidents, Consumer behavior; study of consumer preference, effects of advertising, Industrial morale The nature and scope of engineering psychology, its application to industry.

Efficiency at work: the concept of efficiency, the work curve, its characteristics. The work methods; hours of work, nature of work, fatigue and boredom, rest pauses. The personal factors; age abilities, interest, job satisfaction the working environment: noise, illumination, atmospheric conditions. Increasing efficiency at work; improving the work methods; Time and motion study, its contribution and failure resistance to time and motion studies, need for allowances in time and motion study.

Work and equipment design: Criteria in evaluation of job-related factor, job design, human factors, Engineering information, input processes, mediation processes, action processes, methods design, work space and its arrangement, human factors in job design. Accident and Safety: The human and economic costs of accidents, accident record and statistics, the causes of accidents situational and individual factors related to accident reduction

REFERENCES:

1. Tiffin,J and McCormic E.J.: Industrial Psychology, (Prentice Hall), 6th Edition, 1975
2. McCormic E.J.: Human Factors engineering and design (McGraw Hill), Mair, N.R.F.: Principles of Human relations 4th Edition, 1976
3. Gilmer: Industrial Psychology
4. Ghiselli & Brown: Personnel and Industrial Psychology
5. Myer: Industrial Psychology
6. Dunnete, M.D.: Handbook of Industrial and Organizational Psychology
7. Blum & Taylor: Industrial Psychology

HSS005	CONSUMER PSYCHOLOGY	L	T	P	C
		3	0	0	3

Consumer behaviour , introduction , Consumer behaviour , concepts , dimensions of consumer behaviours , application of consumer behaviour knowledge in marketing decisions , approaches to the study of consumer behaviour.

Motivation, ability and opportunity; exposure, attention and perception Categorizing and comprehending information Attitude formation and change , memory and retrieval Process of decision making , psychographics Consumer behaviour outcomes , consumer welfare

Group dynamics and consumer reference groups , Family , Social class cultural and sub-cultural aspects , cross cultural consumer behaviour.

Personal influence and opinion leadership , diffusion of innovations , consumer decision , making process , models of consumer decision process , Nicosia- Howard Sheth and Engel-Kollat model- post purchase behaviour

Consumerism , consumer protection , difficulties and challenges in predicting consumer behaviour , online consumer behaviour , organizational and industrial buyer behaviour , consumer behaviour in Indian context , emerging issues.

REFERENCES:

1. David L.Loudon, Albert J Della Bitta, ƒConsumer Behaviour,„ McGraw Hill, New Delhi 2002.
2. Jay D. Lindquist and M.Joseph sirgy, ƒShopper, buyer & consumer Behaviour, Theory and Marketing application,„ Biztantra Publication, New Delhi 2005.
3. Sheth Mittal, ƒConsumer Behaviour A Managerial Perspective,„ Thomson Asia (P) Ltd., Singapore, 2003.
4. K.K.Srivastava, ƒConsumer Behaviour in Indian Context,„ Goal Gotia Publishing Co, New Delhi 2002.
5. S.L. Gupta & Sumitra Pal, ƒConsumer Behaviour an Indian Perspective,„ Sultan Chand, New Delhi 2001.
6. Ms.Raju, Dominique Xavedel, ƒConsumer behaviour, Concepts Applications and Cases,„ Vikas publishing house (P) Ltd., New Delhi , 2004.

HSS006	PROFESSIONAL ETHICS	L	T	P	C
		3	0	0	3

Course Outcomes:

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

CO1: Understand the importance of balancing professional and personal commitments

CO2: Recognize the importance of avoiding conflicts of interest at the workplace

CO3: Explain how ethical theories help in resolving moral dilemmas confronting professionals

CO4: Know the dividing line between loyalty to employers and commitments to public welfare

CO5: Appreciate the need to avoid gender bias and related discrimination at the workplace

Course Outcomes Vs Program Outcomes Mapping:

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

Functions of Being a Manager , Stock holder and stakeholder management. Ethical treatment of employees - ethical treatment of customers- supply chain management and other issues

Senses of 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 , Theories about right action , Self-interest , Customs and religion , Use of Ethical Theories

Corporate social responsibility. Collegiality and loyalty , Respect for Authority , Collective Bargaining , Confidentiality , Conflicts of Interest , Occupational Crime , Professional Rights , Employee Rights , Discrimination

Moral imagination, stake holder theory and systems thinking. One approach to management Decision , making Leadership

Multinational Corporations , Environmental Ethics , Computer Ethics , Weapons Development , Engineers as Managers , Consulting Engineers , Engineers as Expert Witnesses and Advisors , Moral Leadership , Sample code of conduct.

REFERENCES:

1. Mike Martin and Roland Schinzinger, Ethics in Engineering, McGraw Hill, New York, 1996
2. Charles D Fledderman, Engineering Ethics, Prentice Hall, New Mexico, 1999.
3. Laura Schlesinger, How Could You Do That: The Abdication of Character, Courage, and Conscience, Harper Collins, New York, 1996.
4. Stephen Carter, Integrity, Basic Books, New York 1996.
5. Tom Rusk, The Power of Ethical Persuasion: From Conflict to Partnership at Work and in Private Life, Viking, New York, 1993

HSS007	OPERATIONS MANAGEMENT	L	T	P	C
		3	0	0	3

INTRODUCTION TO PRODUCTION AND OPERATION MANAGEMEN

Production and Operations Management (POM) , Need, History, System, Types, functions and communication in POM.

MATERIAL AND INVENTORY MANAGEMENT:

Material Management (MM) , Handling Technology (Robots, Automated storage and retrieval systems (ASRS) and methods (JIT, / Kanban, ABC Systems).
Independent Demand Inventory Models , Fixed order system, Basic EOQ, EBQ Models, Quantity discount models.
Dependent Demand Inventory models , MRP and MRP II systems Introduction to ERP, e-business and e-operations strategies.

PLANNING AND FORECASTING:

Introduction to Strategic, Tactical, Operational, Aggregate and Capacity Planning. Planning Product design and development , Applications of CAD, CAM, Computer Integrated Manufacturing

FORECASTING AND SCHEDULING:

Forecasting , Types, Methods (Qualitative and Quantitative), Types of variation in data, Minimizing forecasting errors and selection of forecasting methods. Johnson•s Algorithm for job sequencing (n job thro• 2 machines, n jobs thro• 3 machines, n jobs thro• m machines and 2 jobs thro• m machines) Use of Gantt charts, Queuing analysis and Critical Ratios as methods for job scheduling.

FACILITY, LAYOUT LOCATION AND WORK MEASUREMENT

Facility Location Decisions (FLcD) , . Facility Layout Decision (FlyD) , Types (Fixed Position, and Production, Process, Flexible), Methodologies (Distance Minimising, Computer software systems (CRAFT, CORELAP, ALDEP), Line Balancing and performance ratios, work measurement methods (WM) - Time study, methods-time measurement,

REFERENCES:

1. R.Paneer Selvam, Production and Operations Management, Prentice Hall of India, 2002.
2. Sang M Lee and Marc J Schniederjans, Operation Management, All India Publishers and Distributors, First Indian edition 1997.
3. Robert H. Lowson, Strategic operations Management (The new competitive advantage), Vikas Publishing House, First Indian reprint 2003.

HSS008	INTRODUCTION TO ECONOMICS	L	T	P	C
		3	0	0	3

DEFINITION AND SCOPE OF ECONOMICS: Definitions by A. Smith, A. Marshal and L. Robbins, P.Samuelson and their critical examination. Nature and scope of Economics. Micro-economics in relation to other branches of Economics.

Law of Demand, Elasticity of demand - price, income and cross, concepts and measurement. Marshallian theory of consumers• behaviour and its critical examination. Indifference curve analysis. Price, income and substitution effects. Giffen goods. Engel curve.

MARKET STRUCTURE: Definition of market. Concepts of product and factor markets. Different types of market: perfect competition, monopoly, imperfect competition, monopolistic,competition and oligopoly. Demand and Supply schedules. Price determination under perfect competition in long and short run. Price determination under monopoly. Discriminating monopoly.

MACRO-ECONOMICS: Meaning, Macro-economic Policy and Its Objectives and Instruments. National Income and Social Accounting: Concepts, components, and measurement. Basic circular flow of income model, Unemployment, trade cycle, Inflation**:** causes, types, effects and control.

Commercial and Central Banks, Credit creation, monetary policy and tools. Balance of payments: Items in the balance of payments account, equilibrium in the balance of payments.

REFERENCES:

1. Ackley, G., Macroeconomics: Theory and Policy, Macmillan Publishing Company, New York, 1978.
2. Gupta, S.B., Monetary Economics, S. Chand & Co., New Delhi, 1994.
3. Ruddar Datt and K.P.M.Sundharam, Indian Economy, S.Chand & Company Ltd., New Delhi, 2003.
4. Kindleberger, C.P., International Economics, R.D. Irwin, Home Wood, 1973
5. Lewis, M.K. and P.D. Mizan., Monetary Economics, Oxford University Press, New Delhi, 2000.
6. Ahuja H.L., Economic Environment of Business, Macroeconomic analysis, S.Chand & Company Ltd., New Delhi, 2005.
7. Gupta, G.S. Macroeconomics, Theory and Applications, Tata McGraw-Hill publishing company Ltd., New Delhi, 2001.

8. D.N.Dewedi, Macro economic , Theory and policy, Tata McGraw-Hill publishing company Ltd., New Delhi, 2001.
9. K.P.M.Sundaram, Money Banking and international Trade, Himalaya Publishing House.

HSS010	INTERNATIONAL TRADE AND FINANCE	L	T	P	C
		3	0	0	3

INTERNATIONAL TRADE

International Trade , Meaning and Benefits , Basis of International Trade , Foreign Trade and Economic Growth , Balance of Trade , Balance of Payment , Current Trends in India , Barriers to International Trade , WTO , Indian EXIM Policy.

EXPORT AND IMPORT FINANCE

Special need for Finance in International Trade , INCO Terms (FOB, CIF, etc.,) , Payment Terms , Letters of Credit , Pre Shipment and Post Shipment Finance , Forfaiting , Deferred Payment Terms , EXIM Bank , ECGC and its schemes , Import Licensing , Financing methods for import of Capital goods.

FOREX MANAGEMENT

Foreign Exchange Markets , Spot Prices and Forward Prices , Factors influencing Exchange rates , The effects of Exchange rates in Foreign Trade , Tools for hedging against Exchange rate variations , Forward, Futures and Currency options , FEMA , Determination of Foreign Exchange rate and Forecasting.

DOCUMENTATION IN INTERNATIONAL TRADE

Export Trade Documents: Financial Documents , Bill of Exchange- Type- Commercial Documents - Performa, Commercial, Consular, Customs, Legalized Invoice, Certification of Origin Certificate Value, Packing List, Weight Certificate, Certificate of Analysis and Quality, Certificate of Inspection, Health certificate. Transport Documents - Bill of Landing, Airway Bill, Postal Receipt, Multimodal Transport Document. Risk Covering Document: Insurance Policy, Insurance Cover Note. Official Document: Export Declaration Forms, GR Form, PP From, COD Form, Softer Forms, Export Certification, Certification of Origin, GSPS , UPCDC Norms

EXPORT PROMOTION SCHEMES

Government Organizations Promoting Exports , Export Incentives : Duty Exemption , IT Concession , Marketing Assistance , EPCG, DEPB , Advance License , Other efforts I Export Promotion , EPZ , EQU , SEZ and Export House.

REFERENCES

1. Apte P.G., †International Financial Management•, Tata McGraw Hill
2. Larceny & Bhattacharya, †International Marketing•- Sultan Chand & Sons.
3. B.M.Wali and AB Kalkumdrikas, †Export Management• - Sterling Publishers Pvt., Ltd.

4. Websites of WTO, World Bank, IMF, Ministry of Commerce, ECGC and EXIM Bank.

HSS011	INFORMATION SYSTEMS FOR MANAGERIAL DECISION MAKING	L	T	P	C
		3	0	0	3

INTRODUCTION
Information system , establishing the framework , business model , information system architecture , evolution of information systems.

INFORMATION SYSTEM
Functional areas, Finance, marketing, production, personnel , levels, Concepts of DSS, EIS, ES , comparison, concepts and knowledge representation , managing international information system.

SYSTEM DEVELOPMENT
Modern information system , system development life cycle , structured methodologies , designing computer based method, procedures control, designing structured programs.

IMPLEMENTATION AND CONTROL
Testing security , coding techniques , detection of error , validation , cost benefits analysis , assessing the value and risk information systems.

SOFTWARE ENGINEERING
Software engineering qualities , design, production, service, software specification, software metrics, and software quality assurance , software life cycle models , verification and validation.

REFERENCES:
1. Kenneth C. Laudon and Jane Price Laudon, Management Information systems Managing the digital firm, Pearson Education Asia.
2. Gordon B.Davis, Management Information system: Conceptual Foundations, Structure and Development, McGraw Hill, 1974.
3. Joyce J. Elam, Case series for Management Information System Silmon and Schuster, Custom Publishing 1996.
4. Steven Alter, Information system , A Management Perspective , Addison , Wesley, 1999.
5. James AN O• Brein, Management Information Systems, Tata McGraw Hill, New Delhi, 1999.
6. Turban Mc Lean, Wetherbe, Information Technology Management making connection for strategic advantage , John Wiley, 1999.
7. Ralph M.Stair and George W.Reynolds Principles of Information Systems , A Managerial Approach Learning, 2001.

HSS013	COST ANALYSIS AND CONTROL	L	T	P	C
		3	0	0	3

INTRODUCTION TO COSTING
Costing, Elements of costing, Types of cost, Preparation of cost sheet

COST ANALYSIS
Marginal costing, Cost - volume , Profit analysis, Break-Even-Analysis, Break - Even-Chart, Applications.

CONTROL TECHNIQUES
Budgeting and Budgetary control, Types of Budgets , Preparation of purchase Budget, Flexible budgets ,Cash Budget, Sales Budget, Materials Budget, Master Budget, Zero based Budgeting.

STANDARD COSTING
Types of Standards, Setting up of standards, Advantages and Criticism of Standard Costing , Control through variances.

ACTIVITY BASED COSTING
Transfer Pricing, Target costing, Life Style Costing, Activity Based Costing (only theory).

REFERENCES:
1. Advanced Cost Accounting and Cost Systems by V.K.Saxena & C.D. Vashist ; Sultan Chand & Sons Publishers.
2. Advances Cost Accounting by S.P. Jain & K. L. Narang; Kalyani Publishers
3. Cost Management by The Institute of Charted Accountants of India.

HSS014	INTRODUCTION TO MARKETING MANAGEMENT	L	T	P	C
		3	0	0	3

MARKETING: Meaning - concept - functions - marketing Planning & implementation marketing Programmes - Marketing environment , Market Segmentation and consumer behaviour , Influencing factors, Decision process , Marketing mix , Marketing department.

PRODUCT: Meaning - Product planning - policies - positioning - New product development Product life cycle , BCG Matrix-branding. Packing, labeling.

PRICING: Pricing objectives , Setting and modifying the price , Different pricing method Product line pricing and new product pricing

DISTRIBUTION: Nature of Marketing channels - Types of Channel flows - Channel functions - Channel co-operation, conflict and competition - Direct Marketing Telemarketing, Internet shopping.

PROMOTION:
Promotion Mix - Advertisement - Message - copy writing , Advertisement budgeting - Measuring advertisement effectiveness - Media strategy - sales promotion - Personal selling, publicity and direct marketing

REFERENCES:

1. Philip Kotler., Marketing Management- Analysis Planning and Control, Prentice Hall of India, New Delhi
2. Cundiff, Still & Govoni., Fundamentals of Modern Marketing, Prentice Hall of India, New Delhi
3. Ramaswamy. V S & Namakumari. S., Marketing Management-Planning Implementation and Control, Macmillan Business Books, 2002
4. Jobber., Principles and Practice of Marketing, Mcgraw-Hill.

HSS016	ORGANIZATIONAL PSYCHOLOGY	L	T	P	C
		3	0	0	3

FOCUS AND PURPOSE
Definition, need and importance of organizational Behaviour , nature and scope , frame work.

INDIVIDUAL BEHAVIOUR
Personality , types , factors influencing personality , theories , learning , types of learners , learning theories , organizational Behaviour modification. Attitudes , characteristics , components , formation , measurement. Perceptions , importance , factors influencing perception , interpersonal perception.

GROUP BEHAVIOUR
Organization structure , formation , groups in organizations , influence , group dynamics , emergence of informal leaders and working norms , group decision making techniques , interpersonal relations , communication , control.

POWER
Leadership styles , theories , leaders Vs managers , sources of power , power centers , power and politics.

DYNAMICS OF ORGANIZATIONAL BEHAVIOURS
Organizational climate , factors affecting organizational climate , importance. Job satisfaction , determinants , measurements , influence on behavior. Organizational change , importance , stability Vs change , proactive Vs reaction change , the change process , resistance to change , managing change. Organizational development , characteristics , objectives , team building. Organizational effectiveness , perspective , effectiveness Vs efficiency , approaches , the time dimension , achieving organizational effectiveness.

REFERENCES:

1. Stephen P.Robins, Organisational Behavior, Prentice Hall of India, 9th edition, 2001.
2. Hellriegel, Slocum and Woodman, Organisational Behavior, South-Western, Thomson Learning, 9th edition, 2001.
3. Schermerhorn, hunt and Osborn, Organisational behavior, John Wiley, 7th edition, 2001.
4. Jit S.Chand, Organisational Behavior, Vikas publishing House Pvt. Ltd. 2nd edition, 2001.
5. Fred Luthans, Organisational Behavior, McGraw Hill Book Co., 1998.
6. New Strom & Davis, Organisational behaviour, McGraw Hill, 2001.
7. Jaffa Harris and Sandra Hartman, Organisational Behaviour, Jaico, 2002.

HSS017	INTERNATIONAL ECONOMICS	L	T	P	C
		3	0	0	3

Introduction: The Traditional Theory of International Trade, The Basic Trade Model, Heckscher-Ohlin-Samuelson Model, Effects of Tariffs & Quotas, Theory of Factor Movements. New Theories of International Trade and Industrial Policies

The Balance of Payments and National Accounts, Determinants of Exchange Rates The Exchange-Rate Regime Choice and a Common Currency Area, International Debt and Currency Crises.

Political Economy of Trade Disputes, the FTA and the WTO. The role of the IMF and other International Financial Organizations.

Reasons for Protection World Trade, International Movements of Capital. The Balance of Trade and Other Measures of International Transactions. Export and import policies.

International Macroeconomics European Monetary Unification and the Euro Preferential Trading Arrangements and the NAFTA International Policies for Economic Development, Trade Outsourcing and Offshoring

REFERENCES

1. N. Bhagwati, A. Panagariya and T. N. Srinivasan, Lectures on International Trade, MIT Press, 2nd edition, 1998.
2. M. Obstfeld and K. Rogoff, Foundation of International Macroeconomics, McGraw-Hill, 1996.
3. Romer, D., Advanced Macroeconomics, McGraw Hill, 1996.

HSS018	COMMUNICATION SKILLS	L	T	P	C
		3	0	0	3

COMMUNICATION IN BUSINESS

Systems approach, forms of business communication, management and communication, factors facilitating communication.

COMMUNICATION PROCESS

Interpersonal perception, selective attention, feedback, variables, listening barriers to listening, persuasion, attending and conducting interviews, participating in discussions, debates and conferences, presentation skills, paralinguistic features, oral fluency development.

BUSINESS CORRESPONDENCE

Business letter. Memos, minutes, agendas, enquiries, orders, sales letters notice, tenders, letters of application, letter of complaints.

TECHNICAL REPORTS

Format, Choice of vocabulary, coherence and cohesion, paragraph writing, organization.

PROJECT REPORTS

Project proposal, project reports, and appraisal reports.

REFERENCES:

1. Sharan J.Genrson and Steven M.Gerson., Technical Writing , Process and Product, Pearson Education , 2000.
2. Raymond V.Lesikar, John D. Pettit and Mary E.Flatley , Lesikass Basic Communication Tata McGraw Will 8th Edition , 1999.
3. Stevel. E. Pauley, Daniel G.Riordan , Technical Report Writing Today , AITBS Publishing & Distributors, India 5th edition , 2000.
4. Robert L.Shurter, Effective letters in business Third Ed. 1983.
5. McGraith , Basic Managerial Skills for all Prentice Hall of India , 6th Edition 2002.
6. Halliday, M.A.Ky R.Hasan, Cohesion in English, Longman, London 1976.

HSS022	BANKING THEORY AND PRACTICE	L	T	P	C
		3	0	0	3

EVOLUTION OF BANKING SYSTEM
Central Banking functions, Reserve Bank control over banks

BANKER - CUSTOMER RELATIONSHIP
Bank as borrowers, customer accounts, duties of paying and collecting bankers

LENDING BY BANKS
RBI control over loans and advances, Securities for loans

AGENCY SERVICES BY BANKS
Banker as bailee, safe deposit vaults, credit cards

CONSUMERS OF BANKING SERVICES
Protection against deficiency in banking services.

REFERENCES:

1. M.L.Tannan, "Tannan's Banking Law and Practice in India", India Law House, New Delhi, 1997.
2. S.N.Gupta, "The Banking Law in theory and Practice", Vol. I & II, Universal Law Publishing Co., 1999.
3. M.S.Parthasarathy, "Banking Law-Leading Indian Cases", N.M.Tripathi, 1985.
4. L.C.Goyle, "Law of Banking and Bankers", Eastern Law House, 1995.

HSS023	ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
		3	0	0	3

ENTREPRENEURIAL COMPETENCE
Entrepreneurship concept , Entrepreneurship as a Career , Entrepreneur , Personality Characteristics of Successful. Entrepreneur , Knowledge and Skills Required for an Entrepreneur.

ENTREPRENEURIAL ENVIRONMENT
Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organisational Services - Central and State Government Industrial Policies and Regulations - International Business.

BUSINESS PLAN PREPARATION
Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

LAUNCHING OF SMALL BUSINESS

Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching.

MANAGEMENT OF SMALL BUSINESS

Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units. Effective Management of small Business.

REFERENCES:

1. Hisrich, †Entrepreneurship•, Tata McGraw Hill, New Delhi, 2001.
2. P. Saravanavel, †Entrepreneurial Development•, Ess Pee kay Publishing House, Chennai -1997.
3. S.S.Khanka, †Entrepreneurial Development•, S.Chand and Company Limited, New Delhi, 2001.
4. Prasama Chandra, Projects , †Planning, Analysis, Selection, Implementation and Reviews•, Tata McGraw-Hill Publishing Company Limited, 1996.
5. P.C.Jain (ed.), †Handbook for New Entrepreneurs•, EDII, Oxford University Press, New Delhi, 1999.
6. Staff College for Technical Education, Manila and Centre for Research and Industrial Staff Performance, Bhopal, †Entrepreneurship Development•, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1998.

HSS025	SCIENCE FICTION: AN APPRECIATION	L	T	P	C
		3	0	0	3

This advanced optional course aims at a close analytical study of the impact of science and technology on Man and his several institutions in society as expressed in science fiction. It introduces the students to some samples of science fiction, and through a critical discussion and analysis helps them appreciate the creative link between scientific discoveries and technological inventions and human civilization. Finally, it will further improve the student•s ability to analyse scientific concepts in extended discussions and compositions. Special emphasis will be laid on increasing ability and style.

HSS026	GERMAN € I	L	T	P	C
		3	0	0	3

German for science and technology, based on the book †German for science and Technology• by stecker/Davids, for beginners grammar, noun group; verb, prepositions, pronouns, modal verbs, compound verbs, reading and translating practice. Simple colloquial German.

HSS028	FRENCH € I	L	T	P	C
		3	0	0	3

Definite and indefinite articles , Adjectives , agreement with their nouns , Conjucation of verbs; to have, to be affirmative, negative and interrogative forms , Possessive adjectives. Contraction of †of the• †to the• (Singular and Plural), demonstrative adjectives , The three groups of verbs , present perfect tense with †to have• and †to be•, The partitive article , Future tense , immediate future recent past , Reflexive verbs , Present perfect of reflexive verbs.

HSS030	SCIENCE, TECHNOLOGY & MEDICINE IN INDIA: A HISTORICAL PERSPECTIVE	L	T	P	C
		3	0	0	3

This course is designed to provide a broad historical overview of the growth of science, technology and medicine in India. It aims to explicate to the students the rich scientific and technological heritage of India and the positive response to the abvent of modern science through the colonial agency, resulting in the emergence of a viable modern scientific community in India.

COURSE CONTENTS:

1. Early Indian approaches to the universe, understandings of the physical world, theories of matter and the quest to transcend existential limitations.
2. Development of science and medicine till the colonial era. Astronomy of the Vedas and Aryabahata, Varmaihira and Bhaskar I, Brahmagupta, the Arab connection, Sawai Jai Singh, Mathematics & Geometry: Shulabha Sutra, the Indian numerals, the decimal notations, calendars and algebra. Medicine and Surgery: Charaka ans Sushruta Samhitas, Physiology, Anatomy, Meteria Medica, Unani & Ayurveda. Physical and Botanical Sciences, Antiquity of Indian Chemistry and Alchemy.
3. Advancements in Technology till pre-colonial times: Metallurgy, Artillary, Gun Powder technology, Persian Wheel, textile technology, the charka, bleaching, dyeing, Architecture: Monuments, Bridges, and Naval Architecture, Shipbuilding and Agricultural technologies.
4. Advent of colonial science: Early colonial settlement and scientific exploarations. The East India company , Surveyors, Botanists and Doctors under the company•s Service, The Indian Medical Service, Encounters with Indian medicine, Introduction of stream technologies, Railways, Textiles, Mining, Telegraphs, Canals and Dams.
5. Indian response to modern science, the colonial restrictions and limitation, Science and nationalism and the emergence of the Indian scientific community.

SUGGESTED READING:

BOOKS:

1. Arnold, David, Science, Technology and Medicine in colonial India Cambridge, 1999.
2. Bose, D.M.S.N. Sen, and B.V. Subarayappa, A Coincise History of science in India, New Delhi. 1971.
3. Chattopadhayaya, Debiprasad, Science and Society in Ancient India, Calcutta, 1979.
4. Headrick, D.R., The Tools of Empire: Technology and European Imperialism in the Nineteenth Century, New York, 1981.
5. Jaggi, O.P History of Science, Technology and Medicine in India, 15 volumes, Delhi, 1969-84.
6. Kumar, Deepak, Science and the Raj, Delhi, 1995.
7. Lourdusamy, J.B., (forthcoming) Science and National Consciousness in Bengal, c 1870-1930, Hyderabad, (Jan 2004).
8. Macleod, Roy and Deepak Kumar, eds., Technology and Culture, Delhi, 1982.
9. Qaisar, AJ The Indian Response to European Technology and culture, Delhi, 1982.
10. Sen, S.N. Cultural Heritage of India, Vol vi. Calcutta, 1972.

JOURNALS:

1. Studies in History of Medicine and Science.
2. Bulletin of Indian Institute of History of Medicine.
3. Indian journal of History of Science.
4. Science and culture.
5. Journal of the Asiatic Society of Bengal.

HSS033	MODERN SCIENCE IN INDIA	L	T	P	C
		3	0	0	3

The course is deal with the advent and growth of modern science in India under the aegis of colonialism and the Indian response to it. It would delineate the many ways in which the entire process was implicated not only in the political axis of colonialism and nationalism but also in the various socio-cultural developments of the period.

COURSE STRUCTURE:

a) What is modern Science? , The Scientific Revolution and the rise of modern science in the [1500 , 1700].
b) The advent of modern science in India: Early travelers, missionaries, colonial settlements and scientific explorations, The east India Company , surveyors, botanists and doctors under the company•s service, The Asiatic Society [1500-1757].
c) Institutionalized Colonial Science: The various scientific departments, the Indian medical service, Introduction of new technologies , Railways, Textiles, Mining, Telegraphs, Canals and Dams. [1757-1900].
d) Science education in colonial India: Origins of English and western education, founding of the Universities, the content of science in the curricula, setting up of technical institutes, the restrictions and limitations of colonialism. [1980-1930].
e) The Indian response: Response to English Education, its implications for indigenous society and culture, and the role of social and religious reformers, the taste for modern science, setting up of indigenous society for the learning and cultivation of modern science. [1830-1930].
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Science and Technology in the Primitive society , Development of Science and Technology in early civilized societies , Science in classical Greece , The rise and Development of early Indian Science and Technology , European Science and the Renaissance movement , Science and the Revolutionary era (Industrial, American and French Revolution) Growth of Specific Sciences in Eighteenth and 19^{th} centuries , Heat and Energy Chemistry and Biology , Twentieth Century Science , Physical Sciences , Organization of Indian Science , Recent advances in Indian Science.