KUMARAGURU COLLEGE OF TECHNOLOGY,

An Autonomous Institution affiliated to Anna University, Chennai

COIMBATORE – 641 049.

B.TECH., BIOTECHNOLOGY

REGULATIONS 2018

CURRICULUM AND SYLLABI

I to VIII Semesters

Department of Biotechnology

Signature of BOS chairman, BT

VISION

Strong teaching and research foundation in the area of biotechnology and allied fields through knowledge dissemination to students and the public and to scale new heights in the frontier areas of health and environment and ethics for welfare of humankind globally.

MISSION

- Develop dynamic curriculum and syllabus to promote innovative and creat practices.
- Encourage students for innovation and setting start-ups and equip leadership an entrepreneurial skills
- Train students on issues related to social welfare.

PEOs:

PEO 1: To become successful professional/ entrepreneur by inculcating knowledge in interdisplinary areas in Science, Technology, Engineering and Management

PEO 2: To provide strong foundation in core areas of biotechnology to provide biotechnological solutions to real life problems with economic, social and sustainable viability.

PEO 3: Sensitize on environmental, health and bioethical issues, IPR

POs :

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex

engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1: An ability to apply the knowledge of food/ medical / environmental and computational biology to perform image analysis and processing, data mining and Big data analytics.

PSO2: An ability to understand and design solutions using bioprocess principles, bioanalytical instrumentation and techniques and cell culture techniques.

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KUMARAGURU COLLEGE OF TECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY
B.TECH., BIOTECHNOLOGY
REGULATION 2018
CURRICULUM

Semester I

S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18ENI1201	Fundamental of English Communication-I	Embedded Theory & Lab	HS	2	0	2	0	3	Nil
2	U18MAI1202	Linear Algebra and Calculus	Embedded Theory & Lab	BS	3	0	2	0	4	Nil
3	U18MEI1201	Engineering Graphics	Embedded Theory & Lab	ES	2	0	2	0	3	Nil
4	U18PHI1202	Engineering Physics	Embedded Theory & Lab	BS	3	0	2	0	4	Nil
5	U18CSI1202	Problem Solving and Programming in C	Embedded Theory & Lab	ES	2	0	2	0	3	Nil
6	U18INI1600	Engineering Clinics I	Embedded Lab & Project	ES	0	0	4	2	3	Nil
									Total Credits:	20
									Total Contact Hours/ Week :	26

Semester II

S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18ENI2201	Fundamental of English Communication-II	Embedded Theory & Lab	HS	2	0	2	0	3	U18ENI1201
2	U18MAI2201	Advanced Calculus and Laplace transforms	Embedded Theory & Lab	BS	3	0	2	0	4	U18MAI1201
3	U18EEI1208	Basics Electrical and Electronics Engineering	Embedded Theory & Lab	ES	3	0	2	0	4	Nil
4	U18CHI2201	Engineering Chemistry	Embedded Theory & Lab	BS	3	0	2	0	4	Nil
5	U18CSI2201	Python Programming	Embedded Theory & Lab	ES	2	0	2	0	3	U18CSI1201
6	U18BTI2202	Introduction to Biotechnology	Embedded Theory & Lab	PC	2	0	2	0	3	Nil
7	U18INI2600	Engineering Clinics II	Embedded Lab & Project	ES	0	0	4	2	3	Nil
									Total Credits:	24
									Total Contact Hours/ Week :	26

Semester III

S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18MAT3103	Probability and Statistics	Theory	BS	3	1	0	0	4	Nil
2	UI18BTT3001	Bioorganic Chemistry	Theory	PC	3	0	0	0	3	Nil
3	U18BTT3102	Bioprocess Calculations	Theory	PC	3	1	0	0	4	Nil
4	U18BTI3203	Concepts in Biochemistry	Embedded Theory & Lab	PC	3	0	2	0	4	Nil
5	U18BTI3204	Microbiology	Embedded Theory & Lab	PC	3	0	2	0	4	Nil
6	U18INI3600	Engineering Clinics III	Embedded Lab & Project	ES	0	0	4	2	3	Nil
									Total Credits:	22
									Total Contact Hours/ Week :	25

Semester IV

S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18MAT4102	Numerical Methods	Theory	BS	3	1	0	0	4	Nil
2	UI18BTT4001	Fluid and Particle Mechanics in Bioprocess	Theory	PC	3	0	0	0	3	U18BTT3102
3	U18BTI4202	Protein and Enzyme Technology	Embedded Theory & Lab	PC	3	0	2	0	4	U18BTI3203
4	U18BTI4203	Instrumental Methods of Analysis	Embedded Theory & Lab	PC	3	0	2	0	4	Nil
5	U18BTI4204	Cell and Molecular Biology	Embedded Theory & Lab	PC	3	0	2	0	4	Nil
4	U18BTP4705	Industry Internship/ Innovation Project	Project	PC	0	0	0	0	1	Nil
7	U18INI4600	Engineering Clinics IV	Embedded Lab & Project	ES	0	0	4	2	3	Nil
									Total Credits:	23
									Total Contact Hours/ Week :	26

Semester V

S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18BTI5201	Genetic Engineering and Genomics	Embedded Theory & Lab	PC	3	0	2	0	4	U18BTI4203
2	U18BTI5202	Bioprocess Engineering	Embedded Theory & Lab	PC	3	0	2	0	4	U18BTT4001
3	U18BTI5203	Heat and Mass Transport in Bioprocess	Embedded Theory & Lab	PC	3	0	2	0	4	U18BTT4001
4	U18BTExxx	Professional Elective I	Theory	PE	3	0	0	0	3	Nil
5	U18INI5600	Engineering Clinics V	Embedded Lab & Project	ES	0	0	4	2	3	Nil
6	U18 —-	Open Elective I	Theory	OE	3	0	0	0	3	Nil
									Total Credits:	21
									Total Contact Hours/ Week :	25

Semester VI

S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18BTT6001	Biopharmaceutical Technology	Theory	PC	3	0	0	0	3	Nil
2	U18BTT6002	Cell Culture Techniques	Theory	PC	3	0	0	0	3	U18BTI4204
3	U18BTI6203	Immunology	Embedded Theory & Lab	PC	3	0	2	0	4	U18BTI4204
4	U18BTI6204	Biological Data Analysis	Embedded Theory & Lab	PC	2	0	2	0	3	U18CSI2201
5	U18BTP6505	Cell Culture Laboratory	Lab	PC	0	0	2	0	1	Nil
6	U18 —-	Open Elective II	Theory	OE	3	0	0	0	3	Nil
									Total Credits:	17
									Total Contact Hours/ Week :	20

Semester VII

S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18MBT7001	Engineering Economics and Financial Management	Theory	HS	3	0	0	0	3	Nil
2	U18BTT7002	Preclinical and Clinical Regulatory Affairs	Theory	PC	3	0	0	0	3	U18BTT6001
3	U18BTI7203	Bioinformatics	Embedded Theory & Lab	PC	3	0	2	0	4	U18BTI6204
4	U18BTI7204	Downstream Processing	Embedded Theory & Lab	PC	3	0	2	0	4	U18BTI5203
5	U18BTP7705	Project Phase I	Project	EEC	0	0	0	4	2	Nil
6	U18BTExxx	Professional Elective II	Theory	PE	3	0	0	0	3	Nil
7	U18BTExxx	Professional Elective III	Theory	PE	3	0	0	0	3	Nil
									Total Credits:	22
									Total Contact Hours/ Week :	26

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Semester VIII

S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18BTP8701	Project Phase II	Project	EEC	0	0	0	24	12	Nil
2	U18BTExxx	Professional Elective IV	Theory	PE	3	0	0	0	3	Nil
									Total Credits:	15
									Total Contact Hours/ Week :	27

Total Credits - 164

List of Mandatory Courses

S.No	Course Code	Course Title	Course Mode	CT	Sem
1	U18VEP1501	Personal Values	Lab	HS	1
2	U18VEP2502	Interpersonal Values	Lab	HS	2
3	U18VEP3503	Family Values	Lab	HS	3
4	U18CHT4000	Environmental Science & Engineering	Theory	MC	4
5	U18VEP4504	Professional Values	Lab	HS	4
6	U18INT4000	Indian Constitution	Theory	MC	4
7	U18VEP5505	Social Values	Lab	HS	5
8	U18VEP6506	National Values	Lab	HS	6
9	U18VEP7507	Global Values	Lab	HS	7

List of Professional Electives									
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**
Food and Bioprocess technology									
1.	U18BTE0001	Chemical Reaction Engineering	Theory	PE	3	0	0	0	3
2.	U18BTE0002	Food Process Engineering	Theory	PE	3	0	0	0	3
3.	U18BTE0003	Food Preservation Technology	Theory	PE	3	0	0	0	3
4.	U18BTE0015	Novel Food Packaging	Theory	PE	3	0	0	0	3
Biopharma and Medical Technology									
1.	U18BTE0004	Cancer Biology	Theory	PE	3	0	0	0	3
2.	U18BTE0005	Vaccine Technology	Theory	PE	3	0	0	0	3
3.	U18BTE0006	Molecular Diagnostics	Theory	PE	3	0	0	0	3
4.	U18BTE0013	Human Physiology & Allied Diseases	Theory	PE	3	0	0	0	3
5	U18BTE0014	Chemistry of Natural Products	Theory	PE	3	0	0	0	3
6	U18BTE0016	Molecular Pathogenesis	Theory	PE	3	0	0	0	3
7	U18BTE0017	Medical Textiles	Theory	PE	3	0	0	0	3
Research									
1.	U18BTE0007	Nanobiotechnology	Theory	PE	3	0	0	0	3
2.	U18BTE0008	Neurobiology and Cognitive Sciences	Theory	PE	3	0	0	0	3
3.	U18BTE0009	Membrane Technology	Theory	PE	3	0	0	0	3
General									
1.	U18BTE0010	Bioentrepreneurship	Theory	PE	3	0	0	0	3
2.	U18BTE0011	Industrial Biosafety and Bioethics	Theory	PE	3	0	0	0	3
3.	U18BTE0012	Bioprocess Design and Economics	Theory	PE	3	0	0	0	3

[1]

List of One Credit Courses		
S.No	**Course code**	**Course Title**
1.	U18BTI0101	Pharmacovigilance
2.	U18BTI0202	Mushroom Production
3.	U18BTI0203	Natural Products
4.	U18BTI0204	Protein Purification using FPLC
5.	U18BTI000-	

[1]Any new course to be included after obtaining approval

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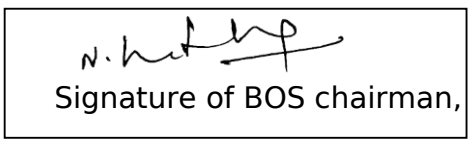
SEMESTER I



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U18ENI1201 – FUNDAMENTALS OF COMMUNICATION-I
(Common to all Branches of I Semester B.E/B/Tech Programmes)

L	T	P	J	C
2	0	2	0	3

Course Objectives:

1. To communicate effectively by using appropriate grammar and technical parlance in a range of academic scenarios.
2. To interpret and critically evaluate discourses related to functional English.
3. To disseminate professional information through appropriate means of communication.

Course Outcomes:

After the course the student will be able to:

CO1: Communicate in English with correct grammar
CO2: Communicate effectively (Oral and Written)
CO3: Use communication skills in the real world

CO/PO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation)S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes(POs)**												**PSO**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1										S		S		
CO2		M		W		W			M	S		S		
CO3		M		M		W			M	S		S		

Assessment Methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

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No	Topic	Hours
MODULE I - 12 Hrs		
1.1	Parts of Speech	2
1.2	Subject Verb Agreement	2
1.3	Speak up (Self Introduction, JAM)	4
1.4	Writing sentences using 'Be-forms'	3
1.5	Test	1
MODULE II - 12Hrs		
2.1	Articles, Gerunds, Infinitives	2
2.2	Speak up (Greetings & Polite English)	4
2.3	Dialogue Writing	3
2.4	Skimming & Scanning	2
2.5	Listening Skills - I	1
MODULE III - 12 Hrs		
3.1	Tenses & Voice	2
3.2	Sentences & its kinds	2
3.3	Speak up (Narration & Description)	4
3.4	Summarizing & Note-making	3
3.5	Listening Skills - II	1
MODULE IV - 12 Hrs		
4.1	Framing Questions – 4 types	2
4.2	Speak up (Role play)	4
4.3	Letter writing – Formal and Informal & Email Writing	3
4.4	Reading Comprehension & Cloze test	2
4.5	Listening Skills - III	1
MODULE V - 12 Hrs		
5.1	Degrees of Comparison	2
5.2	Clauses	2
5.3	Speak up (Power Point Presentation)	4
5.4	Writing (Picture perception)	3
5.5	Test	1
Total		**60**

Reference:

1. A Modern Approach to Non Verbal Reasoning (English, Paperback, Dr. R S Aggarwal)
2. The Power of Words(Bloomsbury, UK, 2012, Hyacinth Pink)
3. Word Power Made Easy: The Complete Handbook for Building a Superior Vocabulary (By Norman Lewis)
4. Effective Technical Communication Tata Mc Graw Hills Publications (Ashraf Rizvi)
5. English and Soft skills Orient Black Swan Publishers (S. P. Dhanavel)
6. Know Your Grammar: Trans.in Tamil & Malayalam –A Bilingual Approach (Bloomsbury, UK, 2012, Hyacinth Pink)

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U18MAI1201 **LINEAR ALGEBRA AND CALCULUS**

(Common to All branches)

L	T	P	J	C
3	0	2	0	4

COURSE OUTCOMES

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

CO1: Identify eigenvalues and eigenvectors and apply Cayley Hamilton theorem.
CO2: Apply orthogonal diagonalisation to convert quadratic form to canonical form.
CO3: Solve first order ordinary differential equations and apply them to certain physical situations.
CO4: Solve higher order ordinary differential equations.
CO5: Evaluate the total derivative of a function, expand the given function as series and locate the maximum and minimum for multivariate function.
CO6: Determine Rank, Inverse, Eigenvalues, Eigenvectors of the given matrix, Maxima-Minima of the function and Solving Differential equations using MATLAB

Pre-requisite: Basics of Matrices, Differentiation and Integration

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S			M				M	M		M	M	
CO2	S	S			M				M	M		M	S	
CO3	S	S			M				M	M		M	S	
CO4	S	S			M				M	M		M	S	
CO5	S	S			M				M	M		M	S	
CO6	S	S			M				M	M		M	M	

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

THEORY COMPONENT

MATRICES **6 Hours**

Rank of a matrix – Consistency of a system of linear equations - Rouche's theorem - Solution of a system of linear equations - Linearly dependent and independent vectors– Eigenvalues and

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Eigenvectors of a real matrix – Properties of eigenvalues and eigenvectors – Cayley Hamilton theorem (excluding proof)

DIAGONALISATION OF A REAL SYMMETRIC MATRIX 6 Hours

Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Reduction of quadratic form to canonical form by orthogonal transformation.

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS 11 Hours

Leibnitz's equation – Bernoulli's equation – Equations of first order and higher degree - Clairauts form – Applications: Orthogonal trajectories.

HIGHER ORDER LINEAR DIFFERENTIAL EQUATIONS 11 Hours

Linear equations of second and higher order with constant coefficients – Euler's and Legendre's linear equations – Method of variation of parameters – First order Simultaneous linear equations with constant coefficients – Applications.

FUNCTIONS OF SEVERAL VARIABLES 11 Hours

Total derivative – Taylor's series expansion – Maxima and minima of functions of two variables – Constrained maxima and minima: Lagrange's multiplier method with single constraints – Jacobians.

LAB COMPONENT **30 Hours**

List of MATLAB Programmes:

1. Introduction to MATLAB.
2. Matrix Operations - Addition, Multiplication, Transpose, Inverse
3. Rank of a matrix and solution of a system of linear equations
4. Characteristic equation of a Matrix and Cayley-Hamilton Theorem.
5. Eigenvalues and Eigenvectors of Higher Order Matrices
6. Curve tracing
7. Solving first order ordinary differential equations.
8. Solving second order ordinary differential equations.
9. Determining Maxima and Minima of a function of one variable.
10. Determining Maxima and Minima of a function of two variables.

Theory: 45 Tutorial: 0 Practical: 30 Project: 0 Total: 75 Hours

REFERENCES

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1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 41st Edition, 2011.
2. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.
3. Kreyzig E., “Advanced Engineering Mathematics”, Tenth Edition, John Wiley and sons, 2011.
4. Veerarajan T., Engineering Mathematics (for First Year), Tata McGraw Hill Pub. Co. Ltd., New Delhi, Revised Edition, 2007
5. Kandasamy P., Thilagavathy K., and Gunavathy K., “Engineering Mathematics”, S. Chand & Co., New Delhi, (Reprint) 2008
6. Venkataraman M.K., “Engineering Mathematics”, The National Pub. Co., Chennai,2003
7. Weir, MD, Hass J, Giordano FR: Thomas’ Calculus, Pearson education 12th Edition, 2015
8. P.Bali., Dr. Manish Goyal., Transforms and partial Differential equations, University Science Press, New Delhi, 2010
9. G.B.Thomas and R.L.Finney, Calculus and analytical geometry, 11th Edition, PearsonEducation, (2006)

U18MEI1201 ENGINEERING GRAPHICS

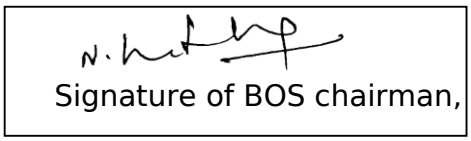
L	T	P	PJ	C
2	0	2	0	3

Course outcome

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

CO1: Construct various plane curves.
CO2: Construct projection of points and projection of lines.
CO3: Develop projection of surfaces and solids.
CO4: Solve problems in sections of solids and development of surfaces.
CO5: Apply free hand sketching and concepts of isometric in engineering practice.
CO6: Draw engineering drawing in AutoCAD with dimensions.

Pre-requisites: Nil



CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M										S		
CO2	S	S									W	S		
CO3	S	S									M	S		
CO4	S	S										S		M
CO5	S	S										S		M
CO6	S											S		M

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

PLANE CURVES, PROJECTION OF POINTS, LINES AND PLANES **10 Hours**

Importance of graphics in design process, visualization, communication, documentation and drafting tools, Construction of curves - ellipse, parabola, and hyperbola by eccentricity method only. Orthographic projection of points.

Projections of straight lines located in first quadrant - determination of true length and true inclinations.

Projections of plane surfaces - polygonal lamina and circular lamina, located in first quadrant and inclined to one reference plane.

PROJECTION AND SECTION OF SOLIDS **10 Hours**

Projection of simple solids - prism, pyramid, cylinder and cone. Drawing views when the axis of the solid is inclined to one reference plane.

Sectioning of simple solids - prisms, pyramids, cylinder and cone. Obtaining sectional views and true shape when the axis of the solid is vertical and cutting plane inclined to one reference plane.

DEVELOPMENT OF SURFACES, ISOMETRIC PROJECTIONS AND FREE-HAND SKETCHING **10 Hours**

Development of lateral surfaces of truncated prisms, pyramids, cylinders and cones.

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Isometric projection, Isometric scale, Isometric views of simple solids, truncated prisms, pyramids, cylinders and cones.

Free hand sketching techniques, sketching of orthographic views from given pictorial views of objects, including free-hand dimensioning.

INTRODUCTION TO AUTOCAD **15 Hours**

Introduction to Drafting Software (AutoCAD) & its Basic Commands. Introduction to coordinate systems, object selection methods, selection of units and precession. sketching – line, circle, arc, polygon, rectangle and ellipse. Working with object snaps, layers and object properties. Editing the objects – copy, move, trim, extend, working with arrays, mirror, scale, hatch, fillet and chamfer.

ISOMETRIC VIEWS WITH AUTOCAD **15 Hours**

Building drawings – Single and double bed room house (sectional Top view only). Introduction to Motion path animation. Isometric views of simple solid blocks.

Theory: 30	**Tutorial: 0**	**Practical:30**	**Project: 0**	**Total : 60 Hours**

REFERENCES

1. Basant Agrawal and CM Agrawal, Engineering Drawing, McGraw-Hill, New Delhi, First Edition, 2008.
2. Venugopal K. and Prabhu Raja V., Engineering Graphics, New Age International (P) Limited, New Delhi, 2008.
3. Nataraajan K.V., Engineering Drawing and Graphics, Dhanalakshmi Publisher, Chennai, 2005.
4. Warren J. Luzadder and Jon. M. Duff, Fundamentals of Engineering Drawing, Prentice Hall of India Pvt. Ltd., New Delhi, Eleventh Edition, 2005.
5. Gopalakirishna K.R., Engineering Drawing (Vol. I & II), Subhas Publications, 2001.
6. James Leach, AutoCAD 2017 Instructor, SDC Publications, 2016.

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U18 PHI1201	Engineering Physics	L	T	P	J	C
	(Common to All B.E., B .Tech.)	3	0	2	0	4

Course Outcomes

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

CO1: Understand the principles of motion and rotation of a rigid body in the plane.

CO2: Enhance the fundamental knowledge in properties of matter and its applications relevant to various streams of Engineering and Technology.

CO3: Recognise the nature and role of the thermodynamic parameters.

CO4: Compute electrostatic field and electric potential due to point and distributed charges.

CO5: Use electrostatic & magneto static boundary conditions to relate fields in adjacent media.

CO6: Introduce and provide a broad view of the smart materials and Nano science to undergraduates.

Pre-requisites : -

High School Education

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M										M		M
CO2	S	M			S							M	M	
CO3	S	M			S							M	M	
CO4	S	M			S							M		
CO5	S	M			S							M		
CO6	S	M					M					M	M	M

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Course Assessment methods

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Theory Component

KINEMATICS & RIGID BODY MOTION **9 Hours**

Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion; Euler's laws of motion, their independence from Newton's laws, and their necessity in describing rigid body motion; Examples.

PROPERTIES OF MATTER AND MATERIALS TESTING **9 Hours**

Properties of matter: Hooke's Law Stress - Strain Diagram - Elastic moduli - Relation between elastic constants - Poisson's Ratio - Expression for bending moment and depression - Cantilever - Expression for Young's modulus by Non uniform bending and its experimental determination.

Materials testing: Mechanism of plastic deformation, slip and twinning – types of fracture – Vickers Hardness test - fatigue and creep test.

HEAT **9 Hours**

Specific heat capacity, thermal capacity. Temperature rise. Coefficient of linear thermal expansion. Methods of measurement of thermal expansion. Thermal stresses in composite structures due to non-homogeneous thermal expansion. Applications -The bimetallic strip. Expansion gaps and rollers in engineering structures. Thermal conductivity: differential equation of heat flow. Lee's disc apparatus for determination of thermal conductivity. Thermal Insulation. Convection and radiation. Applications to refrigeration and power electronic devices.

ELECTROSTATICS & MAGNETOSTATICS **10 Hours**

ELECTROSTATICS : Maxwell's equation for electrostatics – E due to straight conductors, circular loop, infinite sheet of current - electric field intensity (D) - Electric potential - dielectrics - dielectric polarization - internal field – Clasious - Mosotti equation - dielectric strength - applications.

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MAGNETOSTATICS: Maxwell's equation for magnetostatics - B in straight conductors, circular loop, infinite sheet of current - Lorentz force, magnetic field intensity (H) – Biot–Savart's Law – Ampere's Circuit Law –Magnetic flux density (B) – magnetic materials – Magnetization – Applications.

8 Hours

NEW ENGINEERING MATERIALS AND NANO TECHNOLOGY

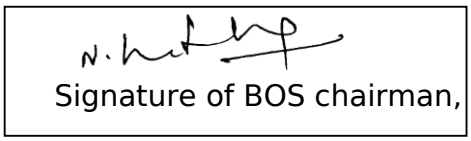
New Engineering Materials: Metallic glasses – preparation, properties and applications – Shape memory alloys (SMA) – characteristics, properties of NiTi alloy applications - advantages and disadvantages of SMA.

Nano Materials: synthesis - Ball milling - Sol-gel - Electro deposition — properties of nano particles and applications. – Carbon Nano Tubes – fabrication by Chemical Vapour Deposition - structure, properties & applications.

Theory: 45 Tutorial: 0 Practical: 0 Project: 0 Total: 45 Hours

REFERENCES

1. Elements of Properties of Matter, Mathur D.S., Shyamlal Charitable Trust, New Delhi, 1993.
2. Properties of matter, brijlal and Subharamaniam, S.Chand and Co, New Delhi, 2004.
3. Fundamentals of General Properties of Matter by Gulati H.R., R. Chand & Co., New Delhi, 1982.
4. Engineering Mechanics (2nd ed.), Harbola M. K., Cengage publications, New Delhi, 2009.
5. Introduction to Mechanics, Verma M. K. (CRC Press), University Press, 2000.
6. Thermodynamics: An Engineering Approach (SI Units), yunus a. cengel & michael a. boles 7th edition, mcgraw-hill companies 2014.
7. Engineering Electromagnetics, W. H. Hayt and John A. Buck, 6th Edition, Tata McGraw Hill, New Delhi, 2014.
8. Electromagnetic Field Theory, 5th Edition, Gangadhar K.A. and Ramanathan P.M., Khanna Publishers, New Delhi, 2013.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9. Problems and Solutions in Electromagnetics, 1st Edition, J.A. Buck and W. H. Hayt, Tata McGraw Hill, New Delhi, 2010.
10. Theory and Problems of Electromagnetic Schaum's Outline Series, 5th Edition, Joseph A. Edminister, Tata McGraw Hill Inc., New Delhi, 2010.
11. Engineering Physics, Rajendran V., Tata McGraw-Hill Education Pvt. Ltd., 2010
12. Nano – the Essentials, Pradeep T., McGraw-Hill Education, Pvt. Ltd., 2007.

Lab component:

LIST OF EXPERIMENTS

1. Determination of thermal conductivity of a bad conductor - Lee's disc
2. Determination of Acceleration due to Gravity – Compound Pendulum
3. Determination of wavelength of light, Numerical aperture and acceptance of optical fibre
4. Determination of band gap of a semiconductor
5. Determination of compressibility of a given liquid - Ultrasonic Interferometer
6. Determination of thickness of thin sheet – Air wedge
7. Determination of frequency of an electrically maintained turning fork – Melde's string
8. Determination of wavelength of mercury source using diffraction grating - Spectrometer
9. Determination of solar cell efficiency using Lux Meter
10. Determination of Young's Modulus – Non-uniform bending

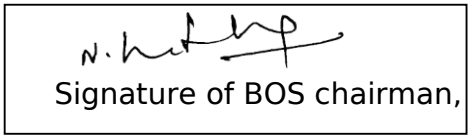
Experiments for Demonstration:

1. Hall effect
2. Hardness Test
3. Four probe experiment
4. Hysteresis curve

Theory: 0 Tutorial: 0 Practical: 30 Project: 0 Total: 30 Hours

REFERENCES

1. Laboratory Manual of Engineering Physics, Dr. Y. Aparna & Dr. K. Venkateswara Rao, V.G.S Publishers.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2. Practical Physics, G.L. Squires, Cambridge University Press, Cambridge, 1985.
3. Great Experiments in Physics, M.H. Shamos, Holt, Rinehart and Winston Inc., 1959.
4. Experiments in Modern Physics, A.C. Melissinos, Academic Press, N.Y., 1966.

U18CSI1202 **PROBLEM SOLVING AND PROGRAMMING USING C**

L	T	P	J	C
2	0	2	0	3

Course Outcomes

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

CO1: Acquire knowledge on different problem solving techniques.
CO2: Use appropriate data types and control structures for solving a given problem.
CO3: Execute different array and string operations.
CO4: Experiment with the usage of pointers and functions.
CO5: Organize data using structures and unions.

Pre-requisites : Nil

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M							L				S	
CO2	S	M							L	L			S	
CO3	S	L			L	L			L	L		L	S	
CO4	M	L	M	L	L	L			L	L		M	S	
CO5	M	L	M	L	L	L			L	L		M	S	

Course Assessment methods

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

THEORY COMPONENT CONTENTS

STRUCTURED PROGRAMMING **6 Hours**

Algorithms, building blocks of algorithms (instructions/statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration). Introduction to C Programming – Operators and Expressions – Data Input and Output – Control Statements.

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ARRAYS AND STRINGS **6 Hours**

Defining an array – Processing an array –Multidimensional Arrays Character Arithmetic – Defining a string – Initialization of Strings – Reading and Writing Strings – Processing Strings – Searching and Sorting of Strings

FUNCTIONS, STORAGE CLASSES **6 Hours**

Defining a function – Accessing a function – Function prototypes – Passing arguments to a function – Passing arrays to functions – Function with string - Recursion – Storage classes

POINTERS **7 Hours**

Pointer Fundamentals – Pointer Declaration – Passing Pointers to a Function – Pointers and one dimensional arrays – operations on pointers– Dynamic memory allocation.

STRUCTURES AND UNIONS **5 Hours**

Structures and Unions: Defining a Structure – Processing a Structure – User defined data types (Typedef) – Unions

Theory: 30 Hours	Tutorial: 0	Practical: 0	Project: 0	Total: 30 Hours

REFERENCES

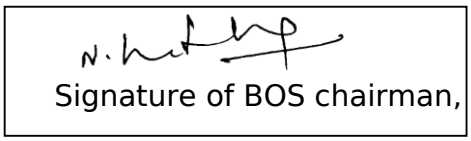
1. Byron S Gottfried and Jitendar Kumar Chhabra, "Programming with C", Tata McGraw Hill Publishing Company, Third Edition, New Delhi, 2011.
2. Pradip Dey and Manas Ghosh, "Programming in C", Second Edition, Oxford University Press, 2011.
3. Kernighan,B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2006
4. Ashok N. Kamthane, "Computer programming", Pearson Education, 2007.
5. Reema Thareja, "Programming in C", Second Edition, Oxford University Press, 2011.

LAB COMPONENT CONTENTS

LIST OF EXPERIMENTS

1. Writing algorithms, flowcharts and pseudo codes for simple problems.
2. Programs on expressions and conversions
3. Programs using if, if-else, switch and nested if statements
4. Programs using while, do-while, for loops
5. Programs on one dimensional arrays, passing arrays to functions and array operations
6. Programs using two dimensional arrays, passing 2D arrays to functions
7. Programs using String functions
8. Programs using function calls, recursion, call by value
9. Programs on pointer operators, call by reference, pointers with arrays
10. Programs using structures and unions.

Theory: 0	Tutorial: 0	Practical: 30 Hours	Project: 0	Total: 30 Hours



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REFERENCES

1. Byron S Gottfried and Jitendar Kumar Chhabra, "Programming with C", Tata McGraw Hill Publishing Company, Third Edition, New Delhi, 2011.
2. Pradip Dey and Manas Ghosh, "Programming in C", Second Edition, Oxford University Press, 2011.
3. Kernighan,B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2006
4. Ashok N. Kamthane, "Computer programming", Pearson Education, 2007.

U18VEP1501 PERSONAL VALUES

L	T	P	J	C
0	0	2	0	0

Course Outcomes

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

CO 1: Become an individual in knowing the self
CO 2 : Acquire and express Gratitude, Truthfulness, Punctuality, Cleanliness & fitness.
CO 3: Practice simple physical exercise and breathing techniques
CO 4: Practice Yoga asana which will enhance the quality of life.
CO 5: Practice Meditation and get benefited.
CO 6: Procure self healing techniques for propagating healthy society

Pre-requisites : NIL

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1												M		
CO2										S				
CO3						M								
CO4						S			M					
CO5										M				
CO6								W				S		

Course Assessment methods

Direct
1. Group Activity / Individual performance and assignment 2. Assessment on Value work sheet / Test

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Indirect
1. Mini project on values / Goodwill Recognition

Values through Practical activities:

1.Knowing the self : Introduction to value education - Need & importance of Value education – Knowing the self – realization of human life – animal instinct vs sixth sense.
2. Mental Health : Evolution of senses – functioning steps of human mind – Body and Mind coordination - Analysis of thoughts – moralization of desires– autosuggestions – power of positive affirmations. – Meditation and its benefits.
3.Physical Health: Physical body constitution– Types of food - effects of food on body and mind – healthy eating habits – food as medicine– self healing techniques.
4.Core value : Self love& Self care Gratitude - Happiness - Optimistic –Enthusiasm – Simplicity – Punctual - Self Control - Cleanliness & personal hygiene - Freedom from belief systems.
5.Fitness: Simplified physical exercises – Sun salutation - Lung strengthening practices: Naadi suddhi pranayama – Silent sitting and listening to nature – Meditation.

Workshop mode

REFERENCES

1. KNOW YOURSELF — SOCRATES – PDF format at www.au.af.mil/au/awc/awcgate/army/rotc_self-aware.pdf
2. STEPS TO KNOWLEDGE: The Book of Inner Knowing – PDF format at www.newmessage.org/wp-content/uploads/pdfs/books/STK_NKL_v1.5.pdf
3. PROMOTING MENTAL HEALTH - World Health Organization – PDF format at www.who.int/mental_health/evidence/MH_Promotion_Book.pdf
4. LEARNING TO BE: A HOLISTIC AND INTEGRATED APPROACH TO VALUES – UNESCO PDF format at www.unesdoc.unesco.org/images/0012/001279/127914e.pdf
5. PERSONALITY DEVELOPMENT By SWAMI VIVEKANANDA www.estudantedavedanta.net/Personality-Development.pdf

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U18INI1600 **ENGINEERING CLINIC - I**

L	T	P	J	C
0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

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

CO1: Identify a practical problems and find a solution
CO2: Understand the project management techniques
CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite:

NIL

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

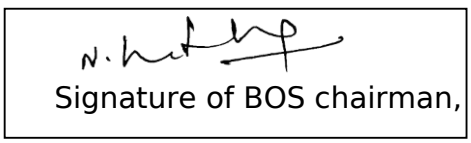
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S		M
CO2											S			
CO3										S				

Course Assessment methods:

Direct
1. Project reviews
2. Workbook report
3. Demonstration & Viva-voce

Content:

The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the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course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In this semester, students will focus primarily on IOT with C programming using Aurdino

Course	Semester	Focus
Engineering Clinic I	1	IOT with C programming using Aurdino
Engineering Clinic II	2	Raspberry pi based controllers with Python programming
Engineering Clinic III	3	Design project combining concepts learnt in Engineering clinics I and II
Engineering Clinic IV	4	Reverse engineering project to improve performance of a product
Engineering Clinic V	5	Design and developing a prototype

GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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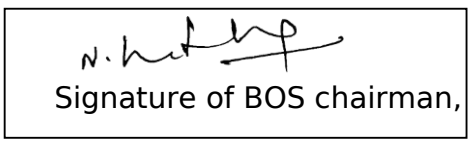
SEMESTER II



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U18ENI2201 – FUNDAMENTALS OF COMMUNICATION - II

(Common to all branches of II Semester B.E/B/Tech Programmes)

L	T	P	J	C
2	0	2	0	3

Course Objectives:

4. To adopt relevant job related oral and written communication skills to competently perform in campus recruitments.
5. To train students in presentation skills, persuasive skills and career skills.
6. To comprehend critical text leading to academic articulation.

Course Outcomes:

After the course the student will be able to:

CO1: Demonstrate comprehension

CO2: Write reports and projects

CO3: Communicate verbally in the business environment

Assessment Methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

CO/PO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation)S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)												PSO	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1		M		M						S		S		
CO2		W							W	S		S		
CO3			M			M			M	S		S		

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No	Topic	Hours
MODULE I - 12 Hrs		
1.1	Writing Instructions, Recommendations	2
1.2	Listening Skills - IV	1
1.3	Speak up (Debate)	5
1.4	Writing Memos, Circulars, Agenda and Minutes	3
1.5	Test	1
MODULE II - 12 Hrs		
2.1	Interview Skills I	4
2.2	Writing a Technical Report	3
2.3	Transcoding Graphics	3
2.4	Reading Short Stories – Home Assignment	1
2.5	Listening Skills -V	1
MODULE III - 12 Hrs		
3.1	Interview Skills II	5
3.2	Writing Reviews – Product Review/ Article Review	3
3.3	Book Review – Home Assignment	1
3.4	Reading Comprehension – Double Passage	2
3.5	Listening Skills - VI	1
MODULE IV - 12 Hrs		
4.1	Inferential Reading	2
4.2	Speak up (GD)	5
4.3	Creating an organizational flowchart	1
4.4	Drafting a project proposal	3
4.5	Listening Skills - VII	1
MODULE V - 12 Hrs		
5.1	Speak up (Formal Presentation)	4
5.2	Reading & Responding to texts	2
5.3	Writing a News story / Advertisement	2
5.4	Writing Essays	2
5.5	Test	2
Total		**60**

Reference:

1. Word Power Made Easy: The Complete Handbook for Building a Superior Vocabulary (By Norman Lewis)
2. Effective Technical Communication Tata McGraw Hills Publications (Ashraf Rizvi)
3. English and Soft skills Orient Black Swan Publishers (S. P. Dhanavel)
4. Verbal Ability (Bloomsbury, UK, June 2012) Hyacinth Pink

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U18MAI2101 ADVANCED CALCULUS AND LAPLACE TRANSFORMS
(Common to All branches)

L	T	P	J	C
3	0	2	0	4

COURSE OUTCOMES

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

CO1: Evaluate double and triple integrals in Cartesian coordinates and apply them to calculate area and volume.

CO2: Apply various integral theorems for solving engineering problems involving cubes and rectangular parallelepipeds.

CO3: Construct analytic functions of complex variables and transform functions from z-plane to w-plane and vice-versa, using conformal mappings.

CO4: Transform Functions in Time Domain to Frequency Domain using Laplace Transform

CO5: Use Laplace Transforms to Solve Ordinary Differential Equations and Integral Equations

CO6: Determine multiple integrals, vector differentiation, vector integrals and Laplace transforms using MATLAB.

Pre-requisites : U18MAI2201 – Advanced Calculus and Laplace Transform

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S			M				M	M		M	S	
CO2	S	S			M				M	M		M	S	
CO3	S	S			M				M	M		M	S	
CO4	S	S			M				M	M		M	S	
CO5	S	S			M				M	M		M	S	
CO6	S	S			M				M	M		M	S	

COURSE ASSESSMENT METHODS

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

THEORY COMPONENT

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MULTIPLE INTEGRALS **10 Hours**

Double integration – Cartesian coordinates – Change of order of integration - Application: Area as double integral - Triple integration in Cartesian coordinates — Volume as triple integral.

VECTOR DIFFERENTIATION **6 Hours**

Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields.

VECTOR INTEGRATION **6 Hours**

Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (excluding proofs) – Verification of theorem and simple applications

ANALYTIC FUNCTIONS **8 Hours**

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy- Riemann equations in Cartesian coordinates and sufficient conditions (excluding proofs) – Properties of analytic function – Construction of analytic function by Milne Thomson method – Conformal mapping : $w = z + c$, cz , $1 / z$.

LAPLACE TRANSFORMS **8 Hours**

Definition of the Laplace Transform; Properties of the Laplace Transform – Superposition, Shift in t or Time Delay, Shift in s, Time Derivatives, Time Integral-Initial Value Theorem - Final Value Theorem; Transform of periodic functions

INVERSE LAPLACE TRANSFORMS **7 Hours**

Inverse transforms - Convolution theorem – Applications to solution of linear ordinary differential equations of second order with constant coefficients - Solution of integral equations.

REFERENCES

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 41st Edition, 2011.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.
3. Veerarajan T., Engineering Mathematics (for First Year), Tata McGraw Hill Pub. Co. Ltd., New Delhi, Revised Edition, 2007.
4. Kandasamy P., Thilagavathy K., and Gunavathy K., "Engineering Mathematics", S. Chand & Co., New Delhi, (Reprint) 2008.
5. Kreyzig E., "Advanced Engineering Mathematics", Tenth Edition, John Wiley and sons, 2011.
6. Venkataraman M.K., "Engineering Mathematics", The National Pub. Co., Chennai, 2003.
7. Weir, MD, Hass J, Giordano FR: Thomas' Calculus Pearson education 12th ED, 2015.
8. N.P.Bali., Dr. Manish Goyal., — Transforms and Partial Differential equations, University science Press, New Delhi, 2010

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LAB COMPONENT **30 Hours**

List of MATLAB Programmes:

1. Evaluating double integral with constant and variable limits.
2. Area as double integral
3. Evaluating triple integral with constant and variable limits
4. Volume as triple integral
5. Evaluating gradient, divergence and curl
6. Evaluating line integrals and work done
7. Verifying Green's theorem in the plane
8. Evaluating Laplace transforms and inverse Laplace transforms of functions including impulse.
9. Heaviside functions and applying convolution.
10. Applying the technique of Laplace transform to solve differential equations.

Theory: 45 **Tutorial: 0** **Practical: 30** **Project: 0** **Total: 75 Hours**

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U18EEI2208 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

L	T	P	J	C
3	0	2	0	4

CO1 Solving basic DC and AC circuits .

CO2 Select suitable DC machine for given application

CO3 Select suitable AC machine for given application

CO4 Characterize logic gates, semiconductor devices according to their applications

CO5 Identify electronic components and use them to design simple circuits.

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M										W		
CO2	M	M										W		
CO3	M	M										W		
CO4	M	M										W		
CO5	M	M										W		

Course Assessment Method

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

DC circuits: **9hrs**

Basic circuit elements and sources, Ohms law, Kirchhoff's laws, series and parallel connection of circuit elements, Node voltage analysis, Mesh current analysis.

AC circuits:
Alternating voltages and currents - Single Phase Series RL, RC, RLC Circuits, Power in AC circuits –Power Factor. **9hrs**

Electrical Machines: **9hrs**

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Construction, Working Principle and applications of DC generators, DC Motors, single phase Transformers, three phase and single phase induction motors.

Semiconductor devices and Circuits: **9hrs**

PN junction diode – Zener Diode – Half wave and Full wave rectifier-voltage regulators – Bipolar Junction transistors, JFET, MOSFET – characteristics

9hrs

Digital Systems:

Binary Number System – Logic Gates – Boolean algebra – Half and Full Adders -sbutractor– Multiplexer – Demultiplexer-decoder-flip flops.

Laboratory experiments

1. Measurement of electrical quantities – voltage, current, power & power factor in RL, RC and RLC circuits.
2. Verification of Kirchoff's Voltage and Current Laws.
3. Verification of Mesh and Nodal analysis.
4. Load test on DC shunt motor.
5. Load test on single phase transformer.
6. Load test on single phase induction motor.
7. Verification of truth tables of OR, AND, NOT, NAND, NOR, EX-OR, EXNOR gates.
8. Full wave rectifier with and without filter.
9. Input and output Characteristics of BJT – CE configuration.
10. Characteristics of PN junction diode and Zener diode.

Theory: 45 Tutorial: 0 Practical: 30 H Project: 0 Total: 75 Hours

TEXT BOOKS:

1. Mittle N., "Basic Electrical Engineering", Tata McGraw Hill Edition, New Delhi, 1990.
2. Sedha R.S., "Applied Electronics", S. Chand & Co., 2006.

REFERENCES

1. Muthusubramanian R, Salivahanan S and Muraleedharan K A, "Basic Electrical, Electronics and Computer Engineering", Tata McGraw Hill, Second Edition, 2017.
2. Nagsarkar T K and Sukhija M S, "Basics of Electrical Engineering", Oxford press 2005.
3. Mehta V K, "Principles of Electronics", Third Edition, S.Chand & Company Ltd, 1994.
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
5. Premkumar N, "Basic Electrical Engineering", Anuradha Publishers, 2003.

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		L	T	P	J	C
U18CHI2201	**ENGINEERING CHEMISTRY**					
	(Common to All Branches)	**3**	**0**	**2**	**0**	**4**

Course Outcomes

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

CO1: Apply the basic principles of chemistry at the atomic and molecular level.

CO2: Analyze the impact of engineering solutions from the point of view of chemical principles

CO3: Apply the chemical properties to categorize the engineering materials and their uses

CO4: Integrate the chemical principles in the projects undertaken in field of engineering and technology

CO5: Develop analytical proficiency through lab skill sets to demonstrate in professional practice.

Pre-requisites : Nil

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M												
CO2	S	M		M									S	
CO3	S	M		S										
CO4	S	M		S										
CO5	S	M		S									S	
CO6	S	S												

Course Assessment methods

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Theory Component

CHEMICAL BONDING **7 Hours**

Bonding: Introduction – Ionic bonding - Van der Waal's forces (dipole - dipole, dipole - induced dipole, induced dipole - induced dipole interactions) - hydrophobic interaction.

Bonding in organic molecules: covalent and co-ordinate bonds (overview only) - hybridization (sp, sp2, sp3) - hydrogen bonding and its consequences.

THERMODYNAMICS **7 Hours**

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Introduction - Thermodynamic process – Internal energy – Enthalpy – limitations of First law of thermodynamics – Second law of thermodynamics - Entropy - Third law of thermodynamics – Free Energy and Work Function – Clausius-Clapeyron equation – Maxwell's relations – Kirchhoff's equation.

ELECTROCHEMISTRY AND CORROSION **7 Hours**

Electrodes - Electrode Potential – Nernst equation and problems - Galvanic cell - Electrochemical Series.

Corrosion: Classification and mechanism of chemical and electrochemical corrosion - Factors influencing corrosion

Corrosion control: Inhibitors – Cathodic protection (Sacrificial anodic protection, Impressed current cathodic protection) – Protective coating: Electroplating (Au) and Electroless plating (Ni).

WATER TECHNOLOGY **6 Hours**

Introduction - soft/hard water - Disadvantages of hard water in industries– scale, sludge, priming and foaming, caustic embrittlement.

Treatment of hard water: External treatment (Ion exchange method) - Internal treatment (colloidal, carbonate, phosphate and calgon conditioning) - Desalination (Reverse osmosis, Electrodialysis)

ENGINEERING MATERIALS **9 Hours**

Polymer: Introduction – Preparation, Properties and Applications of PMMA, PET, PVC.

Composites: Constituents of Composites – Polymer Composites - Metal Matrix Composites - Ceramic Matrix Composites – Applications

Lubricants: Classification - Functions - Properties (viscosity index, flash and fire point, oiliness, carbon residue, aniline point, cloud point and pour point) - Semi solid lubricant (greases with calcium based, sodium based, lithium based) - Solid lubricants (graphite, molybdenum disulphide)

SURFACE CHEMISTRY AND CATALYSIS **9 Hours**

Adsorption: Types of adsorption – Adsorption isotherms: Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – Applications of adsorption on pollution abatement.

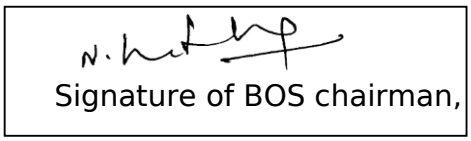
Catalysis: Catalyst – catalytic poisoning and catalytic promoters - autocatalysis –- acid base catalysis – enzyme catalysis – Michaelis-Menten equation – applications.

Chemical kinetics: Introduction – first order, pseudo first order, second order, zero order equations – parallel reactions – opposing reactions.

Theory: 45 Tutorial: 0 Practical: 0 Project: 0 Total: 45 Hours

REFERENCES

1. Jain P.C. and Jain. M., Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, Reprint 2017.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2. Puri B.R., Sharma L.R., Pathania, M.S. Principles of physical chemistry, Vishal Publishing Co., 2017
3. Atkins, P. and de Paula, J., Atkin's Physical Chemistry, 9th ed., Oxford Univ. Press, 2009.
4. Glasstone S., An introduction to Electrochemistry, 10th Edition, Affiliated to East West Press Private Limited, 2007.
5. Samir Sarkar., Fuels and Combustion, 3rd Edition, Orient Longman, India, 2009.
6. Dara S.S. and Umare S.S., A text book of Engineering Chemistry, S.Chand and Company Limited, New Delhi, 2014.
7. Engineering Chemistry, Wiley India Editorial Team, Wiley, 2018.

LABORATORY COMPONENT

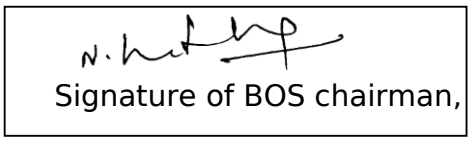
LIST OF EXPERIMENTS

1. Preparation of Standard solutions
2. Conductometric estimation of mixture of acids vs strong base
3. Estimation of extent of corrosion of Iron pieces by Potentiometry
4. Estimation of the extent of dissolution of Copper / Ferrous ions by spectrophotometry.
5. Estimation of acids by pH metry.
6. Determination of total, temporary and permanent hardness by EDTA method.
7. Estimation of DO by Winkler's method
8. Estimation of Alkalinity by Indicator method.
9. Estimation of Chloride by Argentometric method
10. Estimation of Sodium and Potassium in water by Flame photometry.
11. Determination of Flash and Fire point of lubricating oil
12. Determination of Cloud and Pour point of lubricating oil
13. Determination of relative and kinematic viscosities of lubricating oil at different temperatures
14. Determination of corrosion rate on mild steel by Weight loss method
15. Morphological studies of corrosion on mild steel by microscopic techniques

Theory: 0 Tutorial: 0 Practical: 30 Project: 0 Total: 30 Hours

REFERENCES

1. Jeffery G.H., Bassett J., Mendham J. and Denny R.C., Vogel's Text Book of Quantitative Chemical Analysis, Oxford, ELBS, London,2012.
2. Shoemaker D.P. and C.W. Garland., Experiments in Physical Chemistry, Tata McGraw-Hill Pub. Co., Ltd., London,2003.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U18CSI2201 **PYTHON PROGRAMMING**
(Common to All Branches)

L	T	P	J	C
2	0	2	0	3

COURSE OUTCOMES

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

CO1: Classify and make use of python programming elements to solve and debug simple logical problems.

CO2: Experiment with the various control statements in Python.

CO3: Develop Python programs using functions and strings.

CO4: Analyze a problem and use appropriate data structures to solve it.

CO5: Develop python programs to implement various file operations and exception handling.

Pre-requisites :Nil

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		S			M					M		M		
CO2			M							M		M		
CO3			M							M		M		M
CO4	S	S	M		M					M		M	M	M
CO5			M							M		M		
CO6														

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COURSE ASSESSMENT METHODS

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

THEORY COMPONENT CONTENTS

BASICS OF PYTHON PROGRAMMING 6 Hours

Introduction-Python Interpreter-Interactive and script mode -Values and types, operators, expressions, statements, precedence of operators, Multiple assignments, comments.

CONTROL STATEMENTS AND FUNCTIONS IN PYTHON 6 Hours

Conditional (if), alternative (if-else), chained conditional (if-elif-else)-Iteration-while, for, break, continue, pass – Functions - Introduction, inbuilt functions, user defined functions, passing parameters, return values, recursion, Lambda functions.

DATA STRUCTURES: STRINGS, LISTS and SETS 7 Hours

Strings-String slices, immutability, string methods and operations -Lists-creating lists, list operations, list methods, mutability, aliasing, cloning lists, list and strings, list and functions-list processing-list comprehension, searching and sorting, Sets-creating sets, set operations.

DATA STRUCTURES: TUPLES, DICTIONARIES 5 Hours

Tuples-Tuple assignment, Operations on Tuples, lists and tuples, Tuple as return value-Dictionaries-operations and methods, Nested Dictionaries.

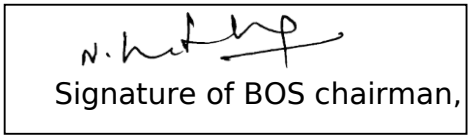
FILES, MODULES, PACKAGES 6 Hours

Files and Exception-Text files, reading and writing files, format Operator-Modules-Python Modules-Creating own Python Modules-packages, Introduction to exception handling.

Theory: 30	Tutorial: 0	Practical: 0	Project: 0	Total: 30 Hours

REFERENCES

1. Ashok Namdev Kamthane, Amit Ashok Kamthane, “Programming and Problem Solving with Python” , Mc-Graw Hill Education,2018.
2. Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, Second edition, Updated for Python 3, Shroff / O’Reilly Publishers, 2016.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python: An Inter-disciplinary Approach”, Pearson India Education Services Pvt. Ltd., 2016.
4. Timothy A. Budd,” Exploring Python”, Mc-Graw Hill Education (India) Private Ltd., 2015.
5. Kenneth A. Lambert, “Fundamentals of Python: First Programs”, CENGAGE Learning, 2012.
6. Charles Dierbach, “Introduction to Computer Science using Python: A Computational Problem Solving Focus”, Wiley India Edition, 2013.



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E BOOKS AND ONLINE LEARNING MATERIALS

1. www.mhhe.com/kamthane/python
2. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, Second edition, Updated for Python 3, Shroff / O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)

LAB COMPONENT CONTENTS 30 Hours

LIST OF EXPERIMENTS

1. Implement simple python programs using interactive and script mode.
2. Develop python programs using id() and type() functions
3. Implement range() function in python
4. Implement various control statements in python.
5. Develop python programs to perform various string operations like concatenation, slicing, Indexing.
6. Demonstrate string functions using python.
7. Implement user defined functions using python.
8. Develop python programs to perform operations on list
9. Implement dictionary and set in python
10. Develop programs to work with Tuples.
11. Create programs to solve problems using various data structures in python.
12. Implement python program to perform file operations.
13. Implement python programs using modules and packages.

Theory: 0	Tutorial: 0	Practical: 30	Project: 0	Total: 30 Hours

ONLINE COURSES AND VIDEO LECTURES:

1. http://nptel.ac.in
2. https://www.edx.org/course/introduction-to-python-fundamentals-1
3. https://www.edx.org/course/computing-in-python-ii-control-structures-0
4. https://www.edx.org/course?search_query=Computing+in+Python+III%3A+Data+Structures

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U18BTI2202	INTRODUCTION TO BIOTECHNOLOGY	L	T	P	J	C
		2	0	2	0	3

Course Objectives:

- Sensitize students on the safety measures in laboratory, including handling and care of instruments
- To introduce students to biological foundational concepts and their application in the field of biotechnology

Course Outcomes (COs):

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

CO1: To comprehend the historical development, current and future trends of the field of biotechnology

CO2 To understand Chemistry, Classification of life forms and Cellular components

CO3: To acquire knowledge in the basic functions of Large Biomolecules

CO4: To understand the fundamental calculations and preparations of solutions

CO5: To acquaint students with applications of General applications and Ethical issues in biotechnology

CO6: To Gain knowledge, scopes in field of process biotechnology such as food, biopharmaceutical industry, agriculture and environment sectors

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M				M			M	M		S	M	M
CO2	S	S		M					S	S		S	W	
CO3	S	S		W	M				S	S		S	W	W
CO4	S	S							S	S		S	M	M
CO5	S	M				S	M	M				W	S	S
CO6	S	S	W		W	S	W			M	M	M	M	M

Pre-requisite Course: Nil

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

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Course Content

SCOPE OF BIOTECHNOLOGY **5 hours**

Historical Use of microorganisms. Modern Biotechnology and its future, Classification of Biotechnology industries based on products; Skills and manpower requirement for biotechnology sector; Ideas, innovations and entrepreneurship in Biotechnology

ENGINEERED FORMS OF LIFE **5 hours**

Chemistry of life; Water and life; Carbon and Molecular diversity; Origin of life on earth; Theory of Evolution (key concepts only); Structure and function of cellular organelles; Cell division - mitosis and meiosis; Synthetic biology and its importance.

FUNCTION OF LARGE BIOMOLECULES AND FUNDAMENTAL CALCULATIONS **9 hours**

Carbohydrates, Lipids, Proteins – classification and function (overview only); Central dogma; Concept of genes (DNA and RNA structure in prokaryotes and eukaryotes); Introduction to primary, secondary, tertiary and quaternary protein structure; Role of active site and substrate binding sites in the action of chymotrypsin on proteins.

Concepts of pH, buffers, *Henderson–Hasselbalch* and Iso-electric point (pI), Titration curves. Calculations involving preparation of buffers, reagents stock solutions and dilutions

APPLICATION OF BIOTECHNOLOGY **6 hours**

Genetically engineered products (golden rice, BT cotton, and insulin), role of bacteria and fungi for pollution abatement; Genome sequencing method - Sanger's method; Medical and forensic applications of DNA fingerprinting, molecular diagnostics and biosensors. Introduction to Transgenic animals and Ethical issues in biotechnology.

PROCESS BIOTECHNOLOGY **5 hours**

Upstream and downstream processing steps in the industrial production of vinegar, penicillin, SCP, amino acid (aspartic acid), vaccine and alcohol production by fermentation; Biorefinery –. Concepts. Optional: Vaccine production/papain production/recombinant product production facility (field visit)

List of Experiments **30 Hours**

1. Lab safety and GLP concepts (CO1)
2. Calculations in biotechnology lab and solution preparation (CO4)
3. Handling of basic laboratory equipment (CO1)
4. Isolation of cells/disruption from tissue and subcellular fractionation of organelles (CO2)
5. Mitosis – onion root tip (CO2)
6. Estimation of Protein /DNA (C03)
7. Extraction of lycopene from tomato (CO6)
8. Effect of size reduction for polyphenols leaching from natural source (CO6)

Theory: 30 hours **Tutorial: 0 hours** **Practical: 30 hours** **Project: 0 hours** **Total Hours: 60**

References:

1. Casida, L. E. (2019). "Industrial microbiology". 2/ed. New Age International Private Limited, India

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2. David T Plummer (2017). “An Introduction to Practical Biochemistry” Indian Edition
3. Stanbury P. F., Hall, S., and Whitaker A, (2016). “Principles of Fermentation Technology”, 3/e. Butterworth-Heinesmann.
4. Venter, J. C. (2014). “Life at the speed of light: from the double helix to the dawn of digital life”. Penguin.
5. Pauline M. Doran, (2012). “Bioprocess Engineering Principles”, 2nd.”. Academic Press, New York.

U18INI2600 ENGINEERING CLINIC - II

L	T	P	J	C
0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

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

CO1: Identify a practical problems and find a solution
CO2: Understand the project management techniques
CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite:

U18INI1600 ENGINEERING CLINICS I

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S		
CO2											S			
CO3										S				

Course Assessment methods:

Direct
1. Project reviews
2. Workbook report
3. Demonstration & Viva-voce

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Content:
The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In this semester, students will focus primarily on Raspberry Pi based controller with python programming

Course	Semester	Focus
Engineering Clinic I	1	IOT with C programming using Audino
Engineering Clinic II	2	Raspberry pi based controllers with Python programming
Engineering Clinic III	3	Design project combining concepts learnt in Engineering clinics I and II
Engineering Clinic IV	4	Reverse engineering project to improve performance of a product
Engineering Clinic V	5	Design and developing a prototype

GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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U18VEP2502 **INTERPERSONAL VALUES**
(Mandatory)

L	T	P	J	C
0	0	2	0	0

Course Outcomes

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

CO 1: Develop a healthy relationship & harmony with others
CO 2: Practice respecting every human being
CO 3: Practice to eradicate negative temperaments
CO 4: Acquire Respect, Honesty, Empathy, Forgiveness and Equality
CO 5: Practice Exercises and Meditation to lead a healthy life
CO 6: Manage the cognitive abilities of an Individual

Pre-requisites :

1. U18VEP1501 / PERSONAL VALUES

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										S				
CO2									S					
CO3											M	S		
CO4						M								
CO5												M		
CO6										S				

Course Assessment methods

Direct
1.Group Activity / Individual performance and assignment 2.Assessment on Value work sheet / Test
Indirect
1. Mini project on values / Goodwill Recognition

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Values through Practical activities:

1. Introduction: Introduction to interpersonal values – Developing harmony with others – Healthy relationship – Need & importance of interpersonal values for dealing with others and team - Effective communication with others.
2. Maneuvering the temperaments: From Greed To Contentment - Anger To Tolerance - Miserliness To Charity – Ego To Equality - Vengeance To Forgiveness.
3. Core value : **Truthfulness -** Honesty –Helping–Friendship – Brotherhood – Tolerance – Caring & Sharing – Forgiveness – Charity –Sympathy — Generosity – Brotherhood - Adaptability.
4.Pathway to Blissful life :
Signs of anger – Root cause – Chain reaction – Evil effects on Body and Mind – Analyzing roots of worries – Techniques to eradicate worries.
5.Therapeutic measures: Spine strengthening exercises - Nero muscular breathing exercises - Laughing therapy - Mindfulness meditation.

Workshop mode

REFERENCES

1. INTERPERSONAL SKILLS Tutorial (PDF Version) - TutorialsPoint www.tutorialspoint.com/interpersonal_skills/interpersonal_skills_tutorial.pdf
2. INTERPERSONAL RELATIONSHIPS AT WORK - KI Open Archive - Karolinska www. publications.ki.se/xmlui/bitstream/handle/10616/39545/thesis.pdf?sequence=1
3. VALUES EDUCATION FOR PEACE, HUMAN RIGHTS, DEMOCRACY – UNESCO www.unesdoc.unesco.org/images/0011/001143/114357eo.pdf
4. MANEUVERING OF SIX TEMPERAMENTS - Vethathiri Maharishi www.ijhssi.org/papers/v5(5)/F0505034036.pdf
5. THE BLISS OF INNER FIRE: HEART PRACTICE OF THE SIX ... - Wisdom Publications - www.wisdompubs.org/sites/.../Bliss%20of%20Inner%20Fire%20Book%20Preview.pd... .

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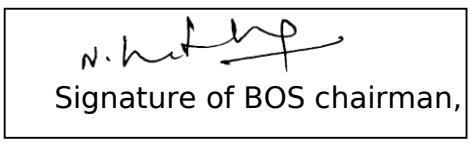
SEMESTER III



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U18MAT3103 **PROBABILITY AND STATISTICS** **(Common to TXT/BT)**

L	T	P	J	C
3	1	0	0	4

Course Outcomes

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

CO1: Compute measures of central tendencies, dispersions and correlate the variables.

CO2: Understand the concept of probability and its role in engineering.

CO3 : Construct probabilistic models for observed phenomena through distributions, which play an important role in many engineering applications.

CO4 : Carry out hypothesis testing and interpret the results

CO5: Understand the principles of design of experiments and perform analysis of variance.

CO6: Sketch control charts and outlines the process control.

Pre-requisites : Nil

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S							M	M		M	S	
CO2	S	S							M	M		M	S	
CO3	S	S							M	M		M	S	
CO4	S	S							M	M		M	S	
CO5	S	S							M	M		M	S	
CO6	S	S							M	M		M	S	

Course Assessment methods

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

STATISTICAL MEASURES **9 +3 Hours**

Measures of central tendency: Arithmetic Mean, Median and Mode **–** Measures of variation: Range, Mean deviation, Standard deviation and Coefficient of variation – Correlation (Discrete Data) – Karl Pearson's Correlation coefficient – Spearman's Rank Correlation – Regression lines (Discrete Data).

PROBABILITY AND RANDOM VARIABLES **9+3 Hours**

Axioms of probability - Conditional probability – Total probability – Bayes' theorem - Random variable – Distribution function – properties – Probability mass function – Probability density function – moments - Moment Generating functions.

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STANDARD DISTRIBUTIONS **9+3 Hours**

Binomial, Poisson and Normal distributions – Moments, Moment Generating functions and properties for the above distributions - Fitting of Binomial and Poisson distributions

9+3 Hours

TESTING OF HYPOTHESIS

Testing of hypothesis for large samples (single mean, difference of means, single proportion, difference of proportions) – Small samples tests based on t and F distributions (single mean, difference of means, paired *t*- test and variance ratio test) – Chi-square test for independence of attributes and goodness of fit

DESIGN OF EXPERIMENTS **5 +2 Hours**

Analysis of Variance (ANOVA) – Completely Randomized Design (CRD) – Randomized Block Design (RBD) – Latin Square Design (LSD).

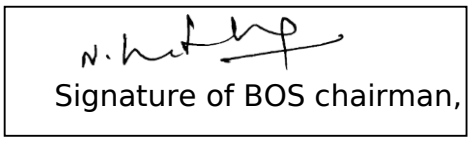
STATISTICAL QUALITY CONTROL **4 +1 Hours**

Concept of process control - Control charts for variables – Mean and Rangecharts – Control charts for attributes – p, np, c – charts.

Theory: 45 Tutorial: 15 Practical: 0 Project: 0 Total: 60 Hours

REFERENCES

1. Veerarajan T., Probability, Statistics and Random Processes, Tata McGraw Hill, 3rd edition, 2008.
2. Gupta S. P, Statistical Methods, Sultan Chand & Sons Publishers, 2014.
3. Johnson R. A., Miller & Freund's "Probability and Statistics for Engineers", Sixth Edition, Pearson Education, Delhi, 2000.
4. Gupta.S.C and Kapoor V.K, Fundamentals of Mathematical Statistics, 11th extensively revised edition, Sultan Chand & Sons, 2007.
5. Walpole R. E., Myers S.L. & Keying Ye, "Probability and Statistics for Engineers and Scientists", Pearson Education Inc, 9th edition, 2012.
6. Gupta S.C, and Kapur V.K, Fundamentals of Applied Statistics, Sultan Chand, New Delhi, 4th Edition, 2014.
7. Charles Henry Brase and Corrinne Pellillo Brase "Understandable Statistics", D.C. Heath and Company, Toronto, 9th edition, 2007.



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U18BTT3001	BIOORGANIC CHEMISTRY	L	T	P	J	C
		3	0	0	0	3

Course Objectives:

- To gain knowledge on chemical principles governing biochemical reactions
- To learn synthetic strategies and stereochemistry of biomolecules
- To understand the extraction and separation methods for natural products

Course Outcomes (COs):

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

CO1: Recognize role of organic chemistry in biological reactions
CO2: Explain the chemical reactions of coenzymes and metal ions in biocatalysis
CO3 Evaluate the role of metal ions proteins and enzymes
CO4: Describe the chemistry of nucleic acids
CO5: Analyze the synthesis and properties of natural products
CO6: Demonstrate the techniques used to separate natural products

Prerequisites:

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S			M									M	
CO2	S			S									M	
CO3	S	M	M		M									
CO4	S	S												
CO5	S				M									
CO6	S	M			M								M	

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Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

GENERAL REACTIONS IN BIOORGANIC CHEMISTRY **9 Hours**

Reactions of Fatty acids – Saponification and transesterification, acid number and iodine number of oils; General reactions of amino acid - side chain, carboxyl and amino group, Chemical reactions of amino acids with Ninhydrin, and Sanger's reagent; Merrifield Peptide Synthesis; Natural β-amino acids and β-peptides; Conformation analysis of ethane, butane and cyclohexane; Fischer and Haworth projections of glucose in hemiacetal formation.

Case study: Chemical modification of cellulose with acyl chlorides

BIOORGANIC CHEMISTRY OF COENZYMES **9 Hours**

Coenzymes in catalysis, Mechanism and role of: pyridoxal phosphate (aminotransferases), NAD/NADP (dehydrogenases); Thiamine pyrophosphate (carboxylases); Enzymes in organic transformations - hydrolysis of amide bond, esters; reduction of aldehydes and ketones using enzymes and whole cells; Cyclodextrins and their applications

Case study: Structure and mechanism of α-chymotrypsin

METAL-LIGAND COMPLEXES IN PROTEINS **9 hours**

Octet rule; Hund's rule, Aufbau principle, and the Pauli exclusion principle; Transition metal ions and oxidation states; Coordinate bonds in proteins and ligands; Types of ligands; Role of iron in haemoglobin and cytochromes; Copper in hemocyanin; Magnesium in chlorophyll; Cobalt in vitamin B-12 and molybdenum in nitrogenase; Role of important metaloenzymes; Geometrical and optical isomerism in coordination complexes

BIOORGANIC CHEMISTRY OF NUCLEIC ACIDS **9 Hours**

Conformation of sugar-phosphate backbone; Stability of double helix; A, B, and Z double helices; DNA intercalators; Chemical synthesis of DNA and RNA; Catalytic RNA, siRNA; micro RNA; Bioconjugation: Fluorescently-labelled nucleosides and oligonucleotide probes.

Case Study: Aptamers

CHEMISTRY OF NATURAL PRODUCTS **9 Hours**

Extraction of natural products – maceration, reflux extraction, Soxhlet extraction and supercritical fluid extraction; Separation of natural products – silica gel, alumina and molecular imprinted technology; Types, properties and applications of alkaloids - [(drugs - cocaine and quinine) and toxins (nicotine)]; Types, properties and applications of terpenes - volatile oils, and steroids. Isoprene rule; Structure and synthesis of menthol.

Case study: Curcumin – Extraction, structure, properties and applications

Signature of BOS chairman, BT

Theory: 45 Hours **Tutorial: 0 Hours** **Practical: 0 Hours** **Total : 45 Hours**

REFERENCES

1. McMurry, J. E. (2014). Organic Chemistry with Biological Applications. Cengage Learning.
2. Kalsi, P. S., & Jagtap, S. (2013). Pharmaceutical, medicinal and natural product chemistry. Alpha Science.
3. Davis, J.S. (2006). Amino acids, peptides and proteins. Davies, Royal Society of Chemistry, UK, Vol. 35.
4. Dugas, H. (2003). Bioorganic Chemistry - A chemical approach to enzyme action. 3rd Edition, Springer.
5. Berg, J. M., Tymoczko, J. L., Stryer, L., Berg, J. M., Tymoczko, J. L., & Stryer, L. (2002). Biochemistry: International version (hardcover).
6. Silverman R B, (2000). The organic chemistry of enzyme-catalyzed reactions. Academic Press, San Diego.
7. Fruton, J.S. (1999). Proteins, Enzymes, Genes: the Interplay of Chemistry and Biology. Yale University Press.

Web references

1 https://nptel.ac.in/downloads/104103018/

2 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5905184/

		L	T	P	J	C
U18BTT3102	**BIOPROCESS CALCULATIONS**	**3**	**1**	**0**	**0**	**4**

Course Objectives:

- To understand and learn about stoichiometry.
- To learn in detail the role of product and yield in bioprocess.
- To recall the thermodynamic preliminaries.

Course Outcomes (COs):

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

CO1: Apply the unit conversion and basic calculations.

CO2 Solve the material balance without and with involving chemical reactions.

CO3: Analyze the energy balance involving chemical reactions.

CO4: Conceptualize energy balance without involving chemical reactions.

CO5: Elucidate the concept of thermodynamic preliminaries.

CO6: Elaborate the stoichiometry for growth and product formation

Pre-requisite Course: -

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CO/PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M					M			S		S			S
CO2	S	S		M	S					M		M		M
CO3	S	M	S							S				
CO4				S	S	M			M		M			M
CO5	S	M		M										S
CO6	M					M			S		S		M	M

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

CONVERSION AND BASIC CALCULATIONS **9 hours**

Dimensions and System of units - Fundamental and derived quantities, Unit conversions, Representation of units, Dimensional consistency. Composition calculations: Solid, liquid and gaseous mixtures. Gas Laws: Ideal gas law, Boyle's Law, Charles' Law, Dalton's law, Amagat's law, Raoult's law, Henry's law.

MATERIAL BALANCE WITHOUT AND WITH INVOLVING CHEMICAL REACTION **9 hours**

Material balances without chemical reactions: Material balances involved in distillation, extraction, drying, evaporation, and crystallization - recycle, bypass and purge streams Material balances with chemical reactions: Selectivity, conversion and yield, Limiting and excess reactant.

ENERGY BALANCE WITHOUT AND WITH INVOLVING CHEMICAL REACTION **9 hours**

Thermophysics: Energy balance equation formulation, Components of energy balance, Heat capacity of solids, liquids and gases, Sensible and latent heat. Thermochemistry: Hess's law, Standard heat of reaction: formation and combustion, Enthalpy determination.

THERMODYNAMIC PRELIMINARIES **9 hours**

System: Homogeneous, Heterogeneous, Closed and Open. Processes: Reversible and Irreversible. Properties: Intensive, Extensive, Reference, Energy and Derived. Process involving ideal gases: Constant Volume, Pressure, Temperature, Adiabatic and Polytropic Process. Energy: Entropy, Internal energy, Enthalpy, Heat capacity, Helmholtz free energy and Gibbs free energy. Exact Differential Equations, Fundamental Property Relations, Maxwell's Equations

STOICHIOMETRY OF GROWTH AND PRODUCT FORMATION **9 hours**

Signature of BOS chairman, BT

Growth stoichiometry and elemental balances, Respiratory quotient, Degree of reduction, Electron balances, Biomass yield, Product Stoichiometry, Theoretical Oxygen Demand, Unsteady and steady state operation, Material and Energy Balances with Recycle, By-Pass and Purge Streams.

Theory: 45 hours Tutorial: 15 hours Practical: 0 hours Project: 0 hours Total Hours: 60

References:

1. Narayanan, K.V., Lakshmikutty, B., (2017) "Stoichiometry and process calculations",nd2Edition., PHI learning private limited.
2. Doran, P. M. (2013), "Bioprocess engineering principles". 2nd Edition Elsevier.
3. Narayanan, K.V. (2004) , "A Textbook of Chemical Engineering Thermodynamics", Prentice Hall India,.
4. Bhatt, B.L., Vora, S.M., (2004) "Stoichiometry ", 4th Edition, Tata McGraw-Hill
5. Smith, J.M., Van Ness, H.C and Abbot M.M (2003) "Introduction to Chemical Engineering Thermodynamics ",6th Edition., McGraw Hill Publishers.

Web references

1. https://nptel.ac.in/courses/113104060/4
2. https://nptel.ac.in/courses/103101004/

U18BTI3203	CONCEPTS IN BIOCHEMISTRY	L	T	P	J	C
		3	0	1	0	4

Course Objectives:

- To learn the principles in the metabolism of macromolecules and biological oxidation.

Course Outcomes (COs):

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

CO1: Comprehend and evaluate the nutritional aspects and metabolism of carbohydrates.

CO2 Analyze and evaluate the dietary importance and metabolism of lipids.

CO3: Critically evaluate and analyze the structure and metabolic pathways of amino acids.

CO4: Interpret the metabolic disorders of amino acid metabolism and evaluate the functions of proteins

CO5: Imbibe the conformation and metabolism of nucleic acids and analyze the metabolic disorders of nucleic acids

CO6: Conceptualize the biological oxido-reduction reactions and respiratory chain

Signature of BOS chairman, BT

Pre-requisite Course: -

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	S	M		S						S	M	
CO2	S	M	S	M		S						S	M	
CO3	S	M	S	M		S						S	M	
CO4	S	M	S	M	S	S						S	M	
CO5	S				S							S		
CO6	S	M		M								S	M	

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

CARBOHYDRATES **9 hours**

Nutritional importance and dietary requirements of carbohydrates

An outline of monosaccharides – Glucose & Fructose, disaccharides – lactose, sucrose and polysaccharides – starch & cellulose - structure and functions, Introduction to metabolism – Glycolysis, Gluconeogenesis, TCA cycle, Glycogenesis and Glycogenolysis. Blood glucose and its regulation.

Case Study: Importance of zinc implementation in diabetes mellitus.

LIPIDS **9 hours**

Nutritional importance and dietary requirements of lipids.

An outline of lipids – structure, classifications and functions – Triglycerides and phospholipids. Biosynthesis of fatty acids, Oxidation of fatty acids – β – oxidation, Biosynthesis of phospholipids and triglycerides. Biosynthesis of Cholesterol.

Metabolic disorders of lipid metabolism : familial hypercholesterolemia

AMINO ACIDS AND PROTEINS **9 hours**

Nutritional importance and dietary requirements of proteins.

Amino acids – Structure, classification, properties and functions. Reactions - transamination and oxidative deamination. Biosynthesis of aliphatic and aromatic amino acids (any one each). Formation of Urea. Proteins – Classifications and functions. Metabolic disorders of amino acid metabolism: phenyketonuria, Albinism.

Case study – Role of proteins in Alzheimer's disease

NUCLEIC ACIDS **9 hours**

Three dimensional structures of DNA and RNA. Biosynthesis of purines and pyrimidines; Biodegradation of Purines and Pyrimidines. Metabolic disorders of nucleic acid metabolism : Gout

BIOENERGITICS AND OXIDATIVE PHOSPHORYLATION **9 hours**

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Biological oxidation-reduction reactions; redox potentials; High energy phosphate compounds; Mitochondrial respiratory complexes and free radical complex; oxidative phosphorylation.

List of Experiments: 30 hours

1. Estimation of free reducing sugars by 3,5-dinitrosalicylic acid.
2. Estimation of starch by Anthrone method.
3. Estimation of protein by Lowry method.
4. UV spectrophotometric analysis of proteins.
5. Estimation of glycine by Ninhydrin method.
6. Determination of cholesterol by Zak's method.
7. Estimation of DNA by diphenylamine method
8. UV spectrophotometry analysis of DNA.
9. Estimation of RNA by orcinol method
10. Antioxidant assay – calculation of ED_{50} and LD_{50}

Theory: 45 hours Tutorial: 0 hours Practical: 30 hours Project: 0 hours Total Hours: 75

References:

1. Murray, R. K. (2018). *Harper's illustrated biochemistry.* 31st edition, Prentice Hall International.
2. Voet, D., Voet, J. G., & Pratt, C. W. (2016). *Fundamentals of Biochemistry*: life at the molecular level 5th edition, John Wiley and Sons.
3. Puri, D. (2014). *Textbook of Medical Biochemistry*. Elsevier Health Sciences.
4. Cox, M. M., & Nelson, D. L (2013). *Lehninger Principles of Biochemistry*. 6th edition. WH Freeman & Co., New York.
5. Sathyanarayana. U and Chakrapani U (2013). *Biochemistry*, 3rd edition, Elsevier
6. Devlin, T. M. (2011). *Textbook of Biochemistry*. 6th edition. John Wiley &Sons.
7. Sadasivam,S and Manickam A (2005). *Biochemical Methods.* 3 rd Edition, New Age International (P) Limited Publishers

Web References:

1. http://nptel.ac.in/courses/102105034
2. http://web.expasy.org/pathways/
3. http://nptel.ac.in/courses/122103039/12

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U18BTI3204 **MICROBIOLOGY**

L	T	P	J	C
3	0	2	0	4

Course objectives

- The course helps the student to understand the microbial world and their nutritional requirements for growth and metabolism
- Understand the controlling of microbes using physical and chemical methods
- Understand and evaluate the working principles, procedures of microbiology lab experiments

Course Outcomes (COs)

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

CO1 : Comprehend knowledge about the taxonomical classifications and fundamentals of Microscopy

CO2 : Recognize the fundamental concepts in the structure and functioning of a microbial cell

CO3 : Understand concepts of nutritional requirements for microbial growth and pure culture isolation

CO4 : Demonstrate the microbial nutritional requirements for growth and metabolism

CO5: Understand the controlling of microbes using physical and chemical methods

CO6: Apply and evaluate the antibiotics and antifungal agents to control the microbial species

CO/PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S		S		M	S	S	S	S		M	S	S
CO2	S				M		S		S	S		S	S	S
CO3	S	S	S	S		M	W		S	S		S	S	S
CO4	S	M	S	S		M	W		S	S		S	S	S
CO5	S	M	M	S		M	M		M	M		M	M	M
CO6	M			M		M	M		M	S		M	M	M

Course Assessment methods

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

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FUNDAMENTALS OF MICROBIOLOGY AND MICROSCOPY **12 Hours**

Classification and Nomenclature of microorganisms; Bright field light Microscopy: Compound, Phase Contrast, Fluorescence; Electron microscopy: Transmission and Scanning Electron Microscopy, an outline of specimen preparations for electron microscopy; Microbiological growth media: different types of growth media; Principles of staining methods to differentiate microbes.

MICROBIAL STRUCTURE AND MULTIPLICATION **9 Hours**

Microbial morphology: Microbial shapes and Classifications, Structure and Functional anatomy of Prokaryotic and Eukaryotic Cells; Microbial multiplications: Bacteria, viruses and Bacteriophage; algae, protozoa and fungi; Actinomycetes and yeast; Mycoplasma.

MICROBIAL NUTRITION, GROWTH AND METABOLISM **12 Hours**

Nutritional requirements; chemical elements as nutrients; different types of microbial medium for culture; Microbial strain improvement and maintenance. Definition of microbial growth; binary fission and cell division; Growth curve in batch culture or closed system; Different methods to quantify microbial growth; Mathematics of microbial growth: Generation time and growth rate constant, factors affecting growth; Microbial metabolism: Entner–Doudoroff pathway, Aerobic and anaerobic respiration.

CONTROL OF MICROORGANISMS AND ANTIMICROBIALS **12 Hours**

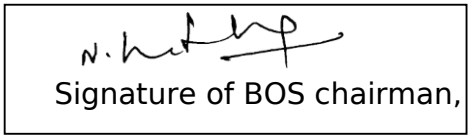
Physical and chemical control of microorganisms; Sterilization: Heat sterilization (moist heat, autoclave, and dry heat), radiation and filtration; Disinfection: phenol, alcohol, detergents and gases; Antimicrobial Chemotherapy: antibacterial, anti-fungal, anti-viral, Anti parasitic agents; common Mechanism of actions to control microbes; Nosocomial infections, Bacterial resistance to antibiotics.

Case Study- Antibiotic sensitivity assay (*Staphylococcus aureus*)

LIST OF EXPERIMENTS **30 Hours**

1. Handling of Microbiology laboratory equipment (SOP/ Biological Safety/ Microbial Air Monitoring Systems)
2. Preparation of microbial growth media
3. Culture Inoculation: Bacterial & fungal culture
4. Staining methods: Simple, Gram's, Negative, endospore; Lacto phenol cotton blue staining
5. Pure culture techniques: Serial dilutions, Pour plate, Spread plate and Streak plate.
6. Turbidimetry and Nephelometry (McFarland standards)
7. Enumeration of yeast cells: Direct and Indirect methods (Haemocytometer & Total viable counts).
8. Determination of growth Curve and Kinetics
9. Anaerobic Cultivation: Anaerobic jar methods & fluid thioglycollate medium)
10. Antibiotic sensitivity assay : Diffusion assay and (MIC & MBC)

Theory: 45 Tutorial : 0 Practical: 30 Project : 30 Total: 75 Hours



REFERENCES

1. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2010). Microbiology: an application based approach. *Tata McGraw Hill Education Private Limited. New Delhi*, *1*, 01-260.
2. Talaro, K. P., & Chess, B. (2018). *Foundations in microbiology*. McGraw-Hill.
3. Ray, B., & Bhunia, A. (2013). *Fundamental food microbiology*. CRC press.
4. Lim D, "Microbiology", Second Edition, WCB-McGraw Hill, 2001.
5. Talaron K, Talaron A, Casita, Pelczar and Reid, Foundations in Microbiology, W. C. Brown Publishers, 2005.
6. Remaut, H., & Waksman, G. (2004). Structural biology of bacterial pathogenesis. *Current opinion in structural biology*, *14*(2), 161-170.

Web References:

1. http://faculty.washington.edu/korshin/Class-486/MicrobiolTechniques.pdf
2. http://www.microbiologybook.org
3. http://www.textbookofbacteriology.net/

U18INI3600 ENGINEERING CLINIC - III

L	T	P	J	C
0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

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

CO1: Identify a practical problems and find a solution
CO2: Understand the project management techniques
CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite: -

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U18INI2600 ENGINEERING CLINICS II

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S		
CO2											S			
CO3										S				

Course Assessment methods:

Direct
1. Project reviews
2. Workbook report
3. Demonstration & Viva-voce

Content:

The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In this semester, students will focus primarily on Design project combining concepts learnt in engineering clinics I and II

Course	Semester	Focus
Engineering Clinic I	1	IOT with C programming using Audino
Engineering Clinic II	2	Raspberry pi based controllers with Python programming
Engineering Clinic III	3	Design project combining concepts learnt in Engineering clinics I and II
Engineering Clinic IV	4	Reverse engineering project to improve performance of a product
Engineering Clinic V	5	Design and developing a prototype

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GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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U18VEP3503 **FAMILY VALUES**

L	T	P	J	C
0	0	2	0	0

Course Outcomes

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

CO 1: Develop skills in maintaining the harmony in the family.
CO 2: Create impulsive activities for healthy family
CO 3: Be receptive to troubled Individuals
CO 4: Gain healthy life by practicing Kundalini Yoga & Kayakalpa
CO 5: Possess Empathy among family members.
CO 6: Reason the life and its significance

Pre-requisites :

1. U18VEP1501 / PERSONAL VALUES
2. U18VEP2502 / INTERPERSONAL VALUES

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									S					
CO2							M							
CO3										M				
CO4												S		
CO5						S								
CO6								M						

Course Assessment methods

Direct
1.Group Activity / Individual performance and assignment 2.Assessment on Value work sheet / Test

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Values through Practical activities:

1. Family system: Introduction to Family Values – elements of family values - Adjustment, Tolerance, Sacrifice - Family structure in different society – work life balance.
2. Peace in Family : Family members and their responsibility - Roles of parents, children, grant parents -. Respectable women hood
3. Core value: Empathy: Unconditional love - Respect - Compassion - sacrifice–Care &share - helping – emotional support- hospitality – cleanliness
4. Blessing: Blessing - methods - Vibration effect - Benefits - Reason for misunderstanding in the Family and resolution through blessings.
5. Healthy Family: Good relationship with neighbors - Counseling - Simplified Kundalini Yoga - Kaya Kalpa Yoga

Workshop mode

REFERENCES

1. FAMILY - www.download.nos.org/331courseE/L-13%20FAMILY.pdf

2. FRAMEWORK FOR ACTION ON VALUES EDUCATION IN EARLY CHILDHOOD – UNESCO – PDF –www.unesdoc.unesco.org/images/0012/001287/128712e.pdf

3. TRUE FAMILY VALUES Third Edition - Tparents Home www.tparents.org/Library/Unification/Books/TFV3/_TFV3.pdf

4. FAMILY VALUES IN A HISTORICAL PERSPECTIVE - The Tanner Lectures on www.tannerlectures.utah.edu/_documents/a-to-z/s/Stone95.pdf

5. PROBLEMS OF INDIA'S CHANGING FAMILY AND STATE ... - the United Nations - www.un.org/esa/socdev/family/docs/egm09/Singh.pdf

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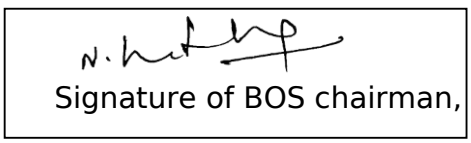
SEMESTER IV



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U18MAT4102 **NUMERICAL METHODS**
(Common to FT/BT/TXT)

L	T	P	J	C
3	1	0	0	4

Course outcomes

After successful completion of the course, the student would be able to:

CO1: Solve a set of algebraic equations representing steady state models formed in engineering problems

CO2: Fit smooth curves for the discrete data connected to each other or to use interpolation methods over these data tables

CO3: Find the trend information from discrete data set through numerical differentiation.

CO4: Estimate integrals from discrete data through numerical methods.

CO5: Predict the system dynamic behaviour through solution of ODEs modeling the system

CO6: Solve PDE models representing spatial and temporal variations in physical systems through numerical methods.

Pre-requisite:

Basic knowledge in differentiation, integration and numerical operations.

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S			M				M	M			S	
CO2	S		S	S									M	
CO3	S	S	M		M				M	M			S	
CO4	S	S		S	M								S	
CO5	S	S	M	M					M	M			M	
CO6	S													

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

NUMERICAL SOLUTION OF ALGEBRAIC EQUATIONS **9+3 Hrs**

Solution of nonlinear equations - False position method – Fixed point iteration – Newton Raphson method for a single equation and a set of non- linear equations. Solution of linear system of equations by Gaussian elimination, Gauss Jordan method - Gauss Seidel method. Matrix Inversion by Gauss Jordan method - Eigenvalues of a matrix by Power method.

CURVE FITTING AND INTERPOLATION **9+3Hrs**

Curve fitting – Method of least squares - Newton's forward and backward difference formulas – Divided differences – Newton's divided difference formula - Lagrange's interpolation – Inverse interpolation.

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NUMERICAL DIFFERENTIATION AND INTEGRATION **9+3Hrs**

Numerical differentiation by using Newton's forward, backward and divided differences – Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules – Numerical double integration.

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS **9+3Hrs**

Initial value problems - Single step methods: Taylor's series method – Truncation error – Euler and Improved Euler methods – Fourth order Runge – Kutta method – Multistep method: Milne's predictor - corrector method.

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS **9+3Hrs**

Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain–Solution of one dimensional heat equation using Bender Schmidt and Crank Nicholson difference schemes –Solution of one dimensional wave equation by explicit scheme.

Theory: 45 hour **Tutorial: 15 hour** **Practical: 0 hour** **Project: 0 hour** **Total Hour: 60**

REFERENCES:

1. Kandasamy P., Thilagavathy K. and Gunavathy K., "Numerical Methods", S.Chand Co. Ltd., New Delhi, 2007.
2. Steven C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers with Programming and Software Applications", McGraw-Hill, 2004.
3. John H. Mathews and Kurtis D. Fink, "Numerical Methods using Matlab", Prentice Hall of India, 2004.
4. Gerald C. F. and Wheatley P.O, "Applied Numerical Analysis",Pearson Education Asia, New Delhi, 2002.
5. Sastry S.S, "Introductory Methods of Numerical Analysis", PrenticeHall of India Pvt Ltd, New Delhi, 2003.

Signature of BOS chairman, BT

U18BTT4001	FLUID AND PARTICLE MECHANICS IN BIOPROCESS	L	T	P	J	C
		3	0	0	0	3

Course Objectives:

- To familiarize the principles and concepts of fluid flow and particle properties for application in bioprocess.

Course Outcomes (COs):

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

CO1: Conceptualize fluids properties and its behaviour under static conditions.
CO2 Identify and analyse the significance of pressure drops and boundary layers concepts.
CO3: Elucidate the flow measurements and transportation of fluids.
CO4: Apply the principles of size reduction and equipments.
CO5: Solve importance of mixing and agitation and scale up
CO6: Elaborate the principles of filtration, centrifugal and sedimentation.

Pre-requisite Course:

1. U18BTT3003 Bioprocess Calculations

CO/PO /PSO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M					M			S		S			S
CO2	S	S		M	S					M		M		M
CO3	S	M	S							S				
CO4				S	S	M			M		M			M
CO5	S	M		M										S
CO6	M					M			S		S		M	M

Course Assessment methods:

Direct
4. Continuous Assessment Test
5. Assignment
6. End Semester Examination

Course Content

PROPERTIES OF FLUIDS **9 hours**

Newtonian and non-Newtonian fluids: Nature of fluids, Newton's law, Shear dependent, Time dependent fluids. Classification of fluid flow: Laminar, Transient, Turbulent. Fluid statics: Pressure variation in a static fluid. Manometry: Types of manometers, Pressure drop calculation. Dimensional analysis: Rayleigh method and the Pi-theorem.

FLUID DYNAMICS **9 hours**

Flow through pipes: Straight pipe, Annular, Conduits. Pressure drop under laminar and turbulent flow conditions: Continuity equation, Euler's equation, Bernoulli equation, Hagen-Poiseuille

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equation, Darcy-Weisbach equation. Flow past body: Boundary layer concepts, Flow over a sphere. Flow through fixed and Fluidized beds - Ergun equation.

9 hours

FLOWMETERY AND TRANSPORTATION

Constant and variable head meters: Venturi, Orifice, Rotameter. Mass Flow meter: Coriolis meter. Anemometer. Valves: Types, characteristics and sizing of valves. Pumps: Centrifugal pump, Piston pump, Gear pump, Screw pump, performance characteristics and sizing of pumps. Compressors and fans

COMMUTATION AND EQUIPMENTS **9 hours**

Concepts of shape factor, surface area and particle size. Particle fracture mechanisms, Laws of comminution. Screening: Mechanism, Screen analysis, Screen effectiveness, Ideal and actual screening, Screening equipments. Size enlargement: Granulation. Laws of size reduction, Size reduction equipment - crushers, grinders, disintegrators.

PARTICLE DYNAMICS **9 hours**

Agitation: Purpose, Flow patterns, Standard design, Dimensional analysis for power correlation, Flow number, Agitator scale-up, Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed, Agitation equipments. Filtration: Introduction, Filter media and filter aids, Basic theory of filtration, Filtration equipments. Sedimentation (Thickening and Clarification): Sedimentation test, Sedimentation theory, Thickeners and clarifiers.

Theory: 45 hours Tutorial: 0 hours Practical: 0 hours Project: 0 hours Total Hours: 45

References:

1 Gavhane, K.A., (2016). "Unit Operations-I [Fluid Flow and Mechanical Operations]", 9th Edition, Nirali Prakashan.

2 Frank M. White (2015). "Fluid mechanics", McGraw-Hill Education

3 R.K.Bansal (2009), "A Textbook of Fluid Mechanics and Hydraulic Machines", Laxmi publications (P) Ltd., New Delhi.

4 Warren Lee McCabe, (2005). "Unit Operations of Chemical Engineering", New York: McGraw-Hill.

5 Badger W.L. and Banchero J.T. (1997) "Introduction to Chemical Engineering", Tata McGraw Hill.

Web references

1. https://nptel.ac.in/courses/103104043/
2. https://nptel.ac.in/courses/103107127/

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U18BTI4202	PROTEIN AND ENZYME TECHNOLOGY	L	T	P	J	C
		3	0	2	0	4

Course Objectives:

- To learn the various topologies of proteins structures
- To understand the relationship between protein structure and function
- To apply the knowledge on enzymes for their applications

Course Outcomes (COs):

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

CO1: Analyze and demonstrate the secondary, super-secondary, tertiary and quaternary structures of proteins and structure-function relationship

CO2: Apply the knowledge on protein structures in protein engineering and protein prediction

CO3 Compare the enzyme properties and kinetics

CO4: Evaluate the immobilization of enzymes and its effectiveness

CO5: Apply the knowledge on design of enzyme based biosensors and their applications

CO6: Conduct experiments and interpret results on protein structure / enzyme isolation immobilization and their applications

Prerequisites:

U18BTI 3203 Concepts in Biochemistry

CO/PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO1 0	PO1 1	PO 12	PSO 1	PS O2
CO1	S			S	S					M		S	S	
CO2	S	M	M	S	W					M		S	S	
CO3	M	S	W	S	W					M		M	S	
CO4	M		S	S	S				S	M		M	S	
CO5	S	S		M	M					M		S	S	S
CO6	S		S	S					S				S	S

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

SUPER SECONDARY, TERTIARY AND QUATERNARY STRUCTURES 9 hours

Primary structure: Insulin; Secondary structures: Alpha (keratin), beta (silk fibroin), loop structures, structure of collagen; Super secondary structures: Helix-turn-helix, hairpin β motif; Ramachandran plot. α-Domain: Four helix bundle; β-domain: Greek key; α / β domains: TIM barrel, Horseshoe fold; Protein folding by chaperones. Quaternary structure: Modular nature, formation of complexes.

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PROTEIN STRUCTURE-FUNCTION RELATIONSHIP AND PROTEIN ENGINEERING **9 hours**

DNA-binding proteins: helix-turn-helix motif of TRP- repressor & CRO protein in DNA binding; Eukaryotic transcription factors: TATA box-binding proteins, TFIIA and TFIIB and Zn-fingers; Membrane Proteins: Photosynthetic reaction center and Bacteriorhodopsin. de novo protein design

Case study: Site directed mutagenesis to increase the thermal stability of T4-lysozyme

ENZYMES AND KINETICS **9 hours**

Nomenclature and Classification of enzymes; concept of active site, substrate binding site, allosteric site, and allosteric regulation of enzymes; specificity of enzyme; Kinetics of single substrate reactions: Michaelis & Menten equation, LB Equation; Bisubstrate reactions: single displacement Types of enzyme inhibition – Competitive, non-competitive and un-competitive.

ENZYME PURIFICATION AND IMMOBILIZATION **9 hours**

Extraction and purification of enzyme from plant, animal and microbial sources; Methods of characterization of enzymes; Development of enzymatic assays; Physical and chemical techniques for enzyme immobilization: adsorption, matrix entrapment, encapsulation, cross-linking and covalent binding. Kinetics of immobilized enzymes.

Case study - Extraction and purification of bromelain enzyme

ENZYME APPLICATIONS **9 hours**

Design of enzyme electrodes and their applications as biosensors in industries and health care. Application of enzymes in industries: Food, detergent, leather, wool, brewery, and environment;

Case study - Development of enzyme-based biosensors for environmental applications.

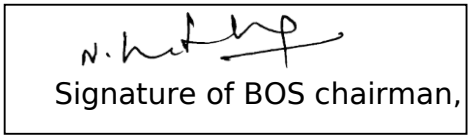
List of Experiments **30 hours**

1. Exploring the Protein Data bases for protein structures
2. Conducting DNA mobility shift assay to understand DNA-protein interaction
3. Perform and interpret the results of an enzyme assay: α-Galactosidase / Amylase / Cellulase / laccase
4. Analyzing Enzyme kinetics: Michaelis-Menten parameters
5. Conduct enzyme inhibition studies and interpret the results: Sugars, metal ions and reagents
6. Prepare immobilized enzymes and evaluating their effectiveness : Agar-agar / sodium alginate / chitin
7. Extraction of papain enzyme from papaya leaf and fruit
8. Removal of blood stain from the cloth by papain / removal of starch stain by amylase
9. Partial purification of enzymes: Ultrafiltration / solvent & salt precipitation

Theory: 45 hours Tutorial: 0 hours Practical: 30 hours Project: 0 hours Total Hours: 75

REFERENCES

1. Shanmugham.S and Sathishkumar.T, (2012); Enzyme Technology, 2nd edition, I.K. International Publishing House Pvt. Ltd., New Delhi, India.
2. Voet D and Voet G. (2010), Biochemistry,4th edition, John Wiley & Sons
3. Nicholas Price and Lewis Stevens, (2009); Fundamentals of Enzymology, 3rd Edition, Oxford University Press, India.
4. Trevor Palmer, Enzymes (2007); Biochemistry, Biotechnology and Clinical Chemistry, 2nd Edition, Horwood Publishing Limited, United Kingdom
5. Branden C and Tooze J. (1999), Introduction to protein structure. 2nd Edition, Garland Science.



6. Fersht, Alan. (1999), Structure and mechanism in protein science: A Guide to Enzyme Catalysis and Protein Folding.3rd revised edition, W.H.Freeman & Co Ltd.
7. Moody, Peter CE, Anthony J. Wilkinson, and Tony Wilkinson. (1990), Protein engineering. 2nd Edition, Oxford University Press, USA.

Web references

1 http://www.novozymes.com(/en/about-us/our-business/what-are enzymes/Pages/default.aspx
2 https://nptel.ac.in/courses/104105076/7

U18BTI4203	INSTRUMENTAL METHODS OF ANALYSIS	L	T	P	J	C
		3	0	2	0	4

Course Objectives:

- To discuss the basic concepts and applications of fundamental statistical, and extraction methods
- To apply and interpret the data originated from spectroscopy, chromatography and electrophoretic methods
- To know the concept of centrifugal technique, and apply mass spectrometry, x-ray diffraction and NMR techniques

Course Outcomes (COs):

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

CO1: Understand and apply the statistical principles to solve biological issues, and apply appropriate extraction methodologies to process biological samples

CO2 Compare, apply and interpret the data of biological solutions acquired from different spectroscopy techniques

CO3: Describe, apply and evaluate the data originated by chromatographic techniques to solve biological problems

CO4: Explain, apply and evaluate the data obtained from different electrophoretic techniques

CO5: Describe and apply mass spectrometry, x-ray diffraction and NMR techniques in the broad field of biotechnology

CO6: Discuss the fundamentals of centrifugation techniques

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	M	W	S	M			S	S		S	S	S
CO2	S	S	S	S	S				S	S		S	S	S
CO3	S	S	S	S	M				S	S		S	S	S
CO4	S	S	S	W	M							S	S	S
CO5	S	S	M	S						M		M	S	S
CO6	S	M		W									M	M

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Pre-requisite Course: U18CHI2201 Engineering Chemistry

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

BASICS OF MEASUREMENT AND EXTRACTION METHODS **9 Hours**

Classification of instrumental methods; Fundamentals of accuracy, precision and limits of detection (LOD) and limits of quantification (LOQ); Quality control/ assurance – definition, standard operating procedure, calibration, validation; Introduction and significance of signal to noise ratio (S/N); Solvent extraction – introduction and principle; Factors affecting extraction process; Principle and applications – Temperature assisted and supercritical fluids based extraction.

SPECTROSCOPY **9 Hours**

Principle, instrumentation and applications - UV-Vis, IR and atomic absorption spectroscopy; Principle, instrumentation and applications - Fluorometry, nephelometry and circular dichroism (CD); Principle and applications of laser light scattering (LLS) technique

CHROMATOGRAPHY AND ELECTROANALYTICAL METHODS **9 Hours**

Factors affecting the resolution of chromatography; Rate and plate theory; Significance of VanDeemter equation; Principle, technique and applications - Thin layer chromatography, Supercritical fluid chromatography, Gel permeation chromatography, ion exchange chromatography, High Performance Chromatography (HPLC), High Performance thin layer Chromatography (HPTLC), Ultraperformance liquid chromatography (UPLC) and Gas chromatography (GC); pH electrodes – principle, instrumentation and applications.

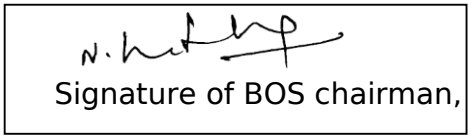
ELECTROPHORESIS **9Hours**

Electrophoresis – introduction & trouble shooting parameters; Paper, agarose gel, polyacrylamide gel (PAGE), SDS-PAGE, denaturing gradient gel electrophoresis (DGGE) or temperature gradient gel electrophoresis (TGGE), capillary electrophoresis, isoelectric focusing – principle, instrumentation and applications.

Case study – PAGE and SDS PAGE

CENTRIFUGATION AND STRUCTURAL ELUCIDATION METHODS **9 Hours**

Basic principle of sedimentation; Preparative centrifugation – principle and classification; Analytical centrifugation – instrumentation; Mass spectrometry – principle, instrumentation (electron spray ionization [ESI] & chemical ionization [CI]) and applications; x-ray diffraction and nuclear magnetic resonance (NMR) – principle, instrumentation and applications.



Theory: 45 hours	Tutorial: 0 hours	Practical: 30 hours	Project: 0 hours	Total Hours: 75

LIST OF EXPERIMENTS

1. Temperature assisted extraction of analytes from a sample and estimation of a targeted analyte (spectroscopy method) by construction of calibration curve (standard operating procedure (SOP), simple regression method, Karl Pearson correlation and coefficient of variation (CV))
2. Calculation of ED_{50} or IC_{50} of a bioanalyte (Spectroscopy method)
3. Prediction of functional group of a standard bioanalyte using IR spectroscopy and interpretation with unknown sample
4. Analysis of an analyte using flourimetry method (simple regression method, Karl Pearson correlation and coefficient of variation (CV))
5. Preparation of buffers and determination of pH of an unknown solution
6. Interpretation of R_f value using TLC analysis
7. Interpretation of HPLC and GC peaks (DEMO: model Chromatogram peaks), and structural analysis of bioanalyte fingerprints using MS spectral analysis (DEMO using graphs)

References:

1. Skoog, D., Holler, F., & Crouch, S. (2014). Principles of Instrumental analysis (6th ed.). USA: Brooks Cole Publishing Company.
2. Sharma, B. (2014). Instrumental methods of chemical analysis (analytical chemistry)(24th ed.). India: GOEL Publishing House.
3. Gurdeep R. Chatwal and Sham K. Anand, G. (2012). Instrumental Methods of Chemical Analysis (5th ed.). India: Himalaya Publishing House.
4. Patil, V.P., Tathe, R. D., Devdhe, S. J., Angadi, S.S and Kale, S. H. (2011). Ultraperfromance liquid chromatography: A review, International Research Journal of Pharmacy, 2 (6): 39-44
5. Avis, K., Wagner, CM., (2009). Biotechnology Quality Assurance and Validation: Drug Manufacturing Technology (Vol:4). CRC press.
6. Wilson, K., & Walker, J. (2006). Principles and techniques of biochemistry and molecular biology (7th ed.). Cambridge: Cambridge University Press.

Other references:

1. http://nptel.ac.in/courses.php
2. http://nptel.ac.in/downloads/102103044/
3. http://nptel.ac.in/courses.php?disciplineId=102

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U18BTI4204	CELL AND MOLECULAR BIOLOGY	L	T	P	J	C
		3	0	2	0	4

Course Objectives:

To gain conceptual understanding on central dogma of biology.

To acquire in-depth knowledge on prokaryotic and eukaryotic genome organization and evaluate the feasibility of gene expression and molecular biology tools.

Course Outcomes (COs):

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

CO1: Critically evaluate and comprehend the fundamental concepts of cell and cell membrane structure and functions.

CO2 Imbibe the concept of membrane transport and signal transduction in cells.

CO3: Critique the concepts of genome organization and replication of prokaryotes and eukaryotes.

CO4: Comprehend the process involved in transcription and translation and interpret the consequences of mutation.

CO5: Apply the concept of gene activity regulation and DNA repair mechanisms in prokaryotes.

CO6: Gain hands-on experience in cell and molecular biology experiments.

Pre-requisite Course:

1. U18BTI3203 Concepts in Biochemistry

CO/PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S									S		S		
CO2	S											S		
CO3	S				S	M			S	S		S		
CO4	S	M	S	S		S			S	S		S	S	
CO5	S	M	S									S	S	
CO6	S			M	S				S	S		S	M	

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

CELL STRUCTURE AND FUNCTIONS **8 hours**

Introduction to prokaryotic and eukaryotic cells ; Intracellular organelles of eukaryotic cells – Structure and functions (Nucleus, Mitochondria and Golgi apparatus); Plasma membrane – structure. Composition of Biomolecules, properties (fluidity and asymmetry) and functions. Cell cycle and Cell Division. Regulation of cell cycle.

Case study - Cancer cell cycle.

MEMBRANE TRANSPORT AND CELL SIGNALING **7 hours**

Membrane transport – passive and active transport, roles of channel proteins, carrier proteins and pumps in membrane transport, bulk transport. Cell signaling - autocrine, endocrine and paracrine models of cell

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signaling; signal transduction cascade – role of signaling molecules, receptors, second messengers and protein kinases.

Case study: Quorum sensing and cell-cell communication in bacteria.

NUCLEIC ACIDS AND DNA REPLICATION **8 hours**

Griffith; Hershey and Chase; Avery McLeod & McCarty experiments. ;Cot value; C-value paradox; satellite DNA; Complexity of genes - Pseudogenes, jumping genes, split genes. Prokaryotic replication: Unidirectional and bidirectional replication; Replication in eukaryotic chromosomes; Replication of telomeres in eukaryotes. Inhibitors of replication.

TRANSCRIPTION **8 hours**

Features of promoters and enhancers; Transcription factors; Classes of RNA molecules; Transcription in prokaryotes – initiation, elongation, termination. Transcription in eukaryotes. Post-transcriptional processing – RNA splicing – trans-splicing of mRNA, processing of tRNA and rRNA, capping, polyadenylation. An outline of snRNA

TRANSLATION AND MUTATION **9 hours**

Elucidation of genetic code, Wobble hypothesis, Redundancy, Codon-Anticodon interaction; Polycistronic mRNA. Protein synthesis in prokaryotes and eukaryotes (Initiation, elongation, termination).Inhibitors of translation, Post translational modifications. Introduction to Mutations – Physical, Chemical and Biological mutagens; Reversion.

REGULATION OF GENE ACTIVITY AND REPAIR MECHANISMS **9 hours**

Principles of Regulation. Constitutively expressed genes and Inducible genes. Transcriptional Regulation (*Lac* Operon, Tryptophan Operon) Attenuation; Autoregulation; Constitutively Expressed Genes.DNA Repair Mechanisms: Photo reactivation; Direct Reversal; Excision Repair; The SOS Response. **Case study:** DNA integrity scanning proteins in bacteria.

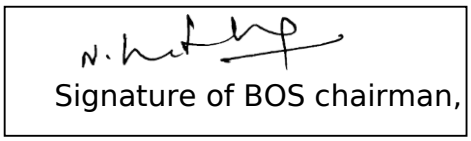
List of Experiments 30 hours

1. Dose dependant mutation studies using UV irradiation.
2. Chemical carcinogenicity test: Ethidium Bromide intercalation.
3. Analysis of the size of DNA fragments using agarose gel electrophoresis.
4. Isolation of genomic DNA from plant and analyse using agarose gel electrophoresis.
5. Isolation of total RNA from bacteria and analyse of the size of RNA using agarose gel electrophoresis.
6. Chromosome staining and Karyotyping.
7. Analysis of Single and Double stranded DNA using hydroxyapatite column.
8. Visualization of sub-cellular organelles (mitochondria or cell membrane) using fluorescent dyes.
9. Subcellular fractionation by differential centrifugation and assessment of purity.

Theory: 45 hours Tutorial: 0 hours Practical: 30 hours Project: 0 hours Total Hours: 75

References:

1. Harvey Lodish, Arnold Berk, S.L Zipursky, Paul Matsudaira, David Baltimore and James Danell (2016). *Molecular Cell Biology*, 4thEdition, New York: W.H Freeman and company.
2. Malacinski, G.M (2015*). Freifelder's Essentials of Molecular Biology*, 4th edition, Nasora Publishing House, New delhi.



3 Waston, B.B. & Gann, L.L (2014) "*Watson Molecular Biology of the Gene*", 7th Edition, Pearson Education.
4 Benjamin L. (2013). *Genes IX*, 9th Edition, Jones & Bartlett Publishers Inc.
5 Weaver, R.F. (2011), "*Molecular Biology*", 3rd Edition, McGraw Hill.
6 Rastogi, S.C. (2010) *Cell and Molecular Biology*,nd2 Edition, New Delhi: New Age International Publishers.
7. Bruce A., Dennis B., Karen H., Alexander J., Julian L., Martin R., Keith R., Peter W. (2006). *Essential Cell Biology*, 2nd edition, Garland Science (Taylor and Francis Group).

Other References:

1. http://leadingstrand.cshl.edu/Course/Keynote/2013/A-MEMBRANE/93
2. http://leadingstrand.cshl.edu/Course/Keynote/2012/A-SYSTEM/83

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U18INI4600 **ENGINEERING CLINIC - IV**

L	T	P	J	C
0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

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

CO1: Identify a practical problems and find a solution
CO2: Understand the project management techniques
CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite:

U18INI3600 ENGINEERING CLINICS III

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S		
CO2											S			
CO3										S				

Course Assessment methods:

Direct
1. Project reviews
2. Workbook report
3. Demonstration & Viva-voce

Content:

The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the

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course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In this semester, students will focus primarily on Design project combining concepts learnt in engineering clinics I and II

Course	Semester	Focus
Engineering Clinic I	1	IOT with C programming using Audino
Engineering Clinic II	2	Raspberry pi based controllers with Python programming
Engineering Clinic III	3	Design project combining concepts learnt in Engineering clinics I and II
Engineering Clinic IV	4	Reverse engineering project to improve performance of a product
Engineering Clinic V	5	Design and developing a prototype

GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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U18VEP4504 **PROFESSIONAL VALUES**
(Mandatory)

L	T	P	J	C
0	0	2	0	0

Course Outcomes

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

Pre-requisites :

1. U18VEP1501 / PERSONAL VALUES
2. U18VEP2502 / INTERPERSONAL VALUES
3. U18VEP3503 / FAMILY VALUES

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M										S		
CO2	S	S									W	S		
CO3	S	S									M	S		
CO4	S	S										S		
CO5	S	S										S		
CO6	S											S		

Course Assessment methods

Direct
1.Group Activity / Individual performance and assignment 2.Assessment on Value work sheet / Test

Values through Practical activities:

1.Professional skills With Values: Positive Attitude, Adaptability, Responsibility, Honesty and Integrity, Self Esteem, & Self Confidence

2.Building Innovative work cultures: Creative thinking, Critical thinking, Conflict Resolution, Problem Solving, & Decision making

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3.Professional Work Ethics: Types of Ethics, Etiquette, personality Grooming, Emotional quotient, Human Dignity, Safety & Role of Professional in Social Responsibility

4.Engineering Ethics: Engineering Council of India - Objectives - Code of Ethics - Social responsibility -Professional Quality - Ethical issues - Effects - Strategy – Corruption, Consequences, Cures

5.Case studies in engineering ethics: Discussion of case studies relating to Public safety, health, welfare, Quality of product, Improper conduct by management, Product responsibility, Intellectual property

Workshop mode

REFERENCES

1. LEARNING TO DO SOURCEBOOK 3 - UNESCO-UNEVOC -PDF
   www.unevoc.unesco.org/fileadmin/user_upload/pubs/LearningToDo.pdf
2. DECLARATION OF PROFESSIONAL VALUES AND ETHICAL STANDARDS
   www.garda.ie/Documents/User/declarationvalues.pdf
3. KARMA YOGA - SWAMI VIVEKANANDA
   www.vivekananda.net/PDFBooks/KarmaYoga.pdf
4. PROFESSIONAL ETHICS IN ENGINEERING - Sasurie College of Engineering
   www.sasurieengg.com/.../GE2025%20Professional%20Ethics%20in%20Engineering.
5. ENGINEERING ETHICS CASE STUDY; Challenger
   www.ucc.ie/en/processeng/staff/academic/ebyrne/.../PE1006PptNotesLect7.pdf

U18CHT4000 **Environmental Science and Engineering (Common to All branches)**

L	T	P	C
3	0	0	0

Course Outcomes

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

CO 1: Analyze the impact of engineering solutions in a global and societal context.

CO 2: Discuss contemporary issues that results in environmental degradation and would attempt to provide solutions to overcome those problems.

CO 3: Highlight the importance of ecosystem and biodiversity.

CO 4: Consider issues of environment and sustainable development in his/her personal and professional undertakings.

CO 5: Paraphrase the importance of conservation of resources.

CO 6: Play an important role in transferring a healthy environment for future generations.

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CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M					S		M				S	
CO2						M				M			S	
CO3							M						M	
CO4						M	S						S	
CO5							S						S	
CO6			W				S						M	M
Course Assessment methods														
Direct														
1. Continuous Assessment Test														
2. Assignment														

INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES **14 Hours**

Definition, scope and importance – Need for public awareness – Forest resources: Use and over-exploitation, deforestation, case studies – Timber extraction, mining, dams and their effects on forests and tribal people.

Water resources: Use and overutilization of surface and ground water, conflicts over water, dams – benefits and problems – Water conservation, rain water harvesting, watershed management.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, case studies.

Energy resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources, case studies.

Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification, Wasteland reclamation – Role of an individual in conservation of natural resources.

ECOSYSTEMS AND BIODIVERSITY **9 Hours**

ECOSYSTEM: Concept of an ecosystem – Structure and function of an ecosystem: Producers, consumers and decomposers, Food chain, Food web, Energy flow in the ecosystem and Ecological pyramids – Ecological succession – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

BIODIVERSITY: Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity – Bio geographical classification of India – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic values – India as a mega-diversity nation – Hot-spots of

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biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

ENVIRONMENTAL POLLUTION **8 Hours**

Definition – Causes, effects and control measures of: (a) Air pollution – Organic and inorganic pollution – cyclone separator, electrostatic precipitator (b) Water pollution (c) Heavy metal pollution (d) Noise pollution (e) Thermal pollution (f) Nuclear hazards – Role of an individual in prevention of pollution – Pollution case studies – Solid waste and hazardous Management: Causes, effects and control measures from factories, small scale and large scale industries – Waste minimization – Disaster management: floods, earthquake, cyclone and landslides.

SOCIAL ISSUES AND THE ENVIRONMENT **7 Hours**

From Unsustainable to Sustainable development – Urban problems related to energy – Resettlement and rehabilitation of people; its problems and concerns, case studies – Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Human Rights.

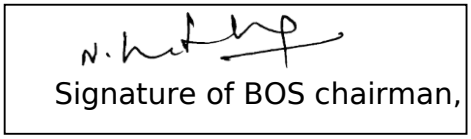
HUMAN POPULATION AND THE ENVIRONMENT **7 Hours**

Population growth and explosion – Welfare Program – Environment and human health – Communicable disease – Role of Information Technology in Environment and human health – Case studies.

Theory: 45 Hours **Total: 45 Hours**

REFERENCES

1. G. Tyler Miller and Scott Spoolman, 'Environmental Science', Fourteenth Edition, Brooks Cole, 2012.
2. Gilbert M. Masters and Wendell P. Ela, 'Introduction to Environmental Engineering and Science', Third Edition, Pearson Education, 2013.
3. Bharucha Erach, 'The Biodiversity of India', Mapin Publishing Pvt. Ltd., Ahmedabad, 2002.
4. Trivedi R.K and P.K.Goel, 'Introduction to Air Pollution', Techno-Science Publications, 2003.
5. Trivedi R.K., 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media, 1996.
6. Cunningham, W.P.Cooper and T.H.Gorhani, 'Environmental Encyclopedia', Jaico Publication House, Mumbai, 2001.
7. Wager K.D., 'Environmental Management', W.B. Saunders Co., Philadelphia, USA, 1998.
8. Colin R. Townsend, Michael Begon and John L. Harper, 'Essentials of Ecology', Third Edition, Blackwell Publishing, 2008.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U18INT4000

CONSTITUTION OF INDIA
(Mandatory course)

L	T	P	J	C
2	0	0	0	0

Course Outcomes:

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

CO 1: Gain Knowledge about the Constitutional Law of India
CO 2: Understand the Fundamental Rights and Duties of a citizen
CO 3: Apply the concept of Federal structure of Indian Government
CO 4: Analyze the Amendments and Emergency provisions in the Constitution
CO 5: Develop a holistic approach in their life as a Citizen of India

Pre-requisites : NIL

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						M			W			S		
CO2						S		S				M		
CO3									M	S		W		
CO4								W	M			M		
CO5						M		M				S		
CO6														

Course Assessment methods

Direct
1. Continuous Assessment Test
2. Assignment

THEORY COMPONENT:

Module.1: Introduction to Indian Constitution **4 hours**

Meaning of the constitution law and constitutionalism - Historical perspective of the Constitution - Salient features and characteristics of the Constitution of India

Module.2: Fundamental Rights **8 hours**

Scheme of the fundamental rights - Right to Equality - Fundamental Right under Article 19 - Scope of the Right to Life and Liberty - Fundamental Duties and its legal status - Directive Principles of State Policy – Its importance and implementation

Module.3: Federal Structure **8 hours**

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Federal structure and distribution of legislative and financial powers between the Union and the States - Parliamentary Form of Government in India - The constitutional powers and status of the President of India

Module.4: Amendment to Constitution **6 hours**

Amendment of the Constitutional Powers and Procedure - The historical perspectives of the constitutional amendments in India

Module.5: Emergency Provisions **4 hours**

National Emergency, President Rule, Financial Emergency
Local Self Government – Constitutional Scheme in India

Total **30 hours**

Theory: 30	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 30 hours**

REFERENCES

1. Constitution of India - Ministry of Law & Justice – PDF format **awmin.nic.in/coi/coiason29july08.pdf**
2. Basu, D. D. (1982). Introduction to the Constitution of India. Prentice Hall of India.
3. The Constitution of India – Google free material - www.constitution.org/cons/india/const.html
4. Parliament of India – PDF format
   a. *download.nos.org/srsec317newE/317EL11.pdf*
5. The Role of the President of India – By Prof.Balkrishna
6. Local Government in India – E Book - Pradeep Sachdeva https://books.google.com/books/.../Local_Government_in_In...

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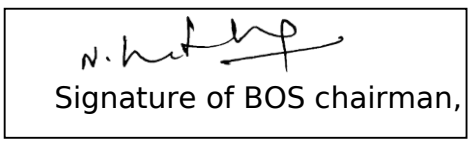
SEMESTER V



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GENETIC ENGINEERING AND GENOMICS

L	T	P	J	C
3	0	2	0	4

U18BTI5201

Course Objectives:

- To apply types of host-vector systems and steps in creating a recombinant DNA molecule
- To gain knowledge on various recombinant DNA techniques and their applications

Course Outcomes (COs):

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

CO1: Comprehend and choose cloning steps for recombinant DNA construction

CO2 Analyse the features of various types of gene cloning vectors and design a suitable vector for recombinant protein expression

CO3: Interpret various types of gene isolation and screening methods

CO4: Apply suitable modern molecular techniques to solve real life problems

CO5: Evaluate regulatory issues of GMOs and their environmental and societal impact

CO6: Analyse and interpret various genome analysis methods

CO/PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S								S				M	S
CO2	S		S						S				M	S
CO3	S			S					S				S	S
CO4	S				S	S			S			S	S	S
CO5	S	M							S			S	M	S
CO6	S		S	S					S				M	S

Pre-requisite Course:

U18BTI4204 Cell and Molecular Biology

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

BASICS OF RECOMBINANT DNA TECHNOLOGY **15 hours**

DNA manipulating enzymes, construction of recombinant DNA molecules, transformation of r-DNA molecules into target host organisms: Calcium chloride mediated, electroporation, microinjection, gene gun, selection methods for recombinants: antibiotic resistance, reporter assays: blue and white selection, GFP and Luciferase, Cloning vector; properties of a cloning vector: origin of replication, polylinker region, selectable marker genes; Plasmid Vectors: Lambda phage vectors, phagemid, cosmid, yeast vectors , Baculoviral based vector, mammalian expression vectors, plant transformation vector; binary vector,

Case study: TOPO vector- Vector Map

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GENE CLONING AND APPLICATIONS **15 hours**

Construction and screening of genomic and cDNA libraries, over-expression and purification of recombinant His tag fusion proteins using Ni+ column. Blotting techniques, Polymerase Chain Reaction (PCR); DNA fingerprinting, gene silencing: RNAi and gene knock-out; site directed mutagenesis, genome editing: CRISPR-Cas9 technology, TALEN tool, Modern molecular diagnostic tools; Q –PCR, Spectral karyotype Imaging, MPLA, Application of genetically modified organisms: medicine, agriculture, Biosafety guidelines and release procedure for GMOs in India

Case study: BT cotton -Safety issues

GENOME MAPPING AND SEQUENCING **15 hours**

History and mile stones of human genome project, Genome organization: prokaryote, eukaryote; complexity of genomes; genome mapping: FISH, STS content mapping, Advanced DNA sequencing methods: pyrosequencing, nanopore sequencing, genome sequencing methods: top down approach, bottom- up approach; genome sequence assembly; comparative study on the genome sequencing methods, Differential gene expression analysis; DDRT- PCR, subtractive hybridization, representational display analysis, Serial Analysis of Gene Expression, Microarray: fabrication of cDNA based array, DNA chip; application microarray in gene expression analysis.

Case study: Analysis and interpretation of microarray data

List of Experiments **30 Hours**

1. PCR amplification of DNA fragment using gene specific primers
2. Elution of DNA from agarose gel using silica column and calculation of Insert-vector ratio and Ligation of a PCR product in plasmid vector
3. Preparation and Transformation of competent cells (*E.coli* by heat-Shock/electroporation method)
4. Selection of recombinant clones using blue & white selection.
5. Confirmation of presence of insert in the recombinant clones by colony PCR.
6. Optimization of inducer concentration for recombinant protein expression.
7. Confirmation of recombinant protein using Western blotting.
8. DNA fingerprinting by RAPD analysis.
9. Molecular diagnosis of pathogens in water sample.
10. Metagenomic analysis of soil microbes.

Theory:45 **Tutorial: 0 hours** **Practical: 30 Hours** **Project: 0 hours** **Total Hours: 75**

References:

1. Brown T.A., (2017), Genomes 4, Bios Scientific Publishers Ltd, Oxford, 3rd edition.
2. Primrose S.B., Twyman RM., (2006), Principles of Gene Manipulation and Genomics , 7th Edition, Blackwell Science.
3. Glick B.R.,and Pasternick J.J., (2017), Molecular Biotechnology: Principles and Applications of Recombinant DNA, 5th Edition, ASM press, Eashington.
4. Sathyanarayana U (2008) Biotechnology, Books & Allied (p) ltd.-Kolkata
5. Sambrook (Joseph) and Russell(David W), (2001), Molecular Cloning :A manual, Cold Spring Harbour Laboratory Press.

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- **Web References**

1. http://nptel.ac.in/courses/102103013/
2. http://www.lsic.ucla.edu/ls3/tutorials/gene_cloning.html
3. https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinant-dna/

		L	T	P	J	C
U18BTI5202	**BIOPROCESS ENGINEERING**	**3**	**0**	**2**	**0**	**4**

Course Objectives:

- To apply the various chemical engineering principles in production of bioproducts using bioreactor

Course Outcomes (COs):

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

CO1: Apply the knowledge of various optimization methods to design the media for fermentation broth

CO2 Evaluate the sterilization kinetics of media and able to design the holding time for batch sterilization

CO3: Develop a suitable mathematical models for batch, fed-batch and continuous fermentation and able to simulate and evaluate the constants for microbial growth

CO4: Understand and analyse the application of various bioreactors and importance of mass transfer effect in bioprocess engineering

CO5: Apply the various scale-up criteria to design the bioreactors

CO6: Identify and provide the solution for non- ideal performance of bioreactor

Pre-requisite Course:

1. U18BTI3204 Microbiology

CO/PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S		S	S					M				S
CO2	S	S		S	M					M				S
CO3	S	S		S	M					M				S
CO4	S	S		S	S		M			M				S
CO5	S	S		S	S					M				S
CO6	S	S		S	S					M				S

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

MEDIA AND ITS OPTIMIZATION METHODS **9 Hours**

Criteria for good medium; Various carbon, nitrogen, minerals, vitamins and other complex nutrients for fermentation industry; Simple and complex media for microbial, plant and animal cells; oxygen requirements;

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medium formulation for optimal growth and product formation; Stoichiometric analysis of media . Medium optimization methods: Plackett-Burman design, simplex design and response-surface methodology.
Case study: Enzyme production using Plackett-Burman design.

STERILIZATION KINETICS **9 Hours**

Thermal death kinetics of microorganisms; batch and continuous heat sterilization of liquid media; filter sterilization of liquid media; sterilization of air; design of sterilization equipment for batch and continuous process.

FERMENTATION KINETICS **9 Hours**

Modes of operation – batch, fed-batch and continuous cultivation, Simple unstructured kinetic models for microbial growth - Monod model; Growth of filamentous organisms and yeast. Product formation kinetics; Leudeking-Piret models, substrate and product inhibition on cell growth and product formation.

TRANSPORT PHENOMENA IN BIOREACTOR AND TYPES OF BIOREACTOR **9 Hours**

Aeration and agitation in gas-liquid mass transfer, Oxygen transfer rate (OTR), determination of K_La, Factor affecting in OTR in bioreactor, Mass transfer correlation in Oxygen transfer. Types and industrial applications of bioreactors; Stirred-tank reactor and its ancillaries; Bubble-column reactor; Packed-bed reactor; Fluidized-bed; Air-lift reactor; and Photobioreactor.
Case study: alagal cultivation

SCALE-UP OF BIOREACTORS AND NON-IDEAL REACTOR **9 Hours**

Scale-up criteria for bioreactors; Major factors involved in scale-up; Scaling-up of mixing systems: Scale-up of aeration/agitation regimes in stirred tank reactors. Introduction to non- ideal reactors: Residence time distribution (RTD), Reasons for non-ideality in reactors, RTD function and measurement, RTD in plug flow and mixed flow reactor.

List of Experiments **30 Hours**

1. Medium optimization by Plackett-Burman design/response surface methodology (RSM) using design expert software
2. Batch sterilization design
3. Determination of specific growth rate for production of bacterial cells
4. Estimation of K_La – power correlation / sulfite oxidation / dynamic gassing method
5. Production of microbial metabolites (enzymes / antibiotics) in bioreactor
6. Production of biofertilizers / biopesticides / mushroom
7. Residence Time Distribution (RTD) studies to find non-ideality of a fermenter
8. Introduction to SuperPro Designer – Material and Energy balance
9. Unit Operations, Component Library and registration, Pure and stock mixtures in Super pro
10. Production of monoclonal antibodies in Super pro

Theory: 45 hours Tutorial: 0 hours Practical: 30 hours Project: 0 hours Total Hours: 75

References:

1. Stanbury P. F., Hall, S., and Whitaker A, (2016).“Principles of Fermentation Technology3/e.’’ Butterworth-Heinesmann.
2. Pauline M. Doran, (2012).“Bioprocess Engineering Principles, 2nd.”. Academic Press, New York.

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3. Bailey and Ollis, (2010). “Biochemical Engineering Fundamentals, 2nd.”. McGraw-Hill, New Delhi.
4. Rajiv Dutta(2008). “Fundamentals of Biochemical Engineering”. Ane Books India, New Delhi.
5. Lee, J. M (2010). “Biochemical Engineering’ ’NJ: Prentice Hall.
6. Blanch H. W. And Clark D. S. (2007). “Biochemical Engineering, 2nd.” CRC Press, London.
7. Shuler, M. L., and F. Kargi. (2002). “Bioprocess Engineering: Basic Concepts, 3rd . ” New Delhi, Prentice-Hall of India.

Web References:

1. http://www.nptel.ac.in/syllabus/syllabus.php?subjectId=102107029
2. http://users.ox.ac.uk/~dplb0149/publication/NPRBiocatalysisRev.pdf 4

U1BTI5203	HEAT AND MASS TRANSPORT IN BIOPROCESS	L	T	P	J	C
		3	0	2	0	4

Course Objectives:

- To comprehend and apply the principles and operations of heat transfer
- To understand the fundamentals and applications of mass transfer in bioprocess engineering.

Course Outcomes (COs):

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

CO1: Outline the modes of heat of transfer
CO2 Design the heat transfer equipment in bioprocess industries
CO3: Illustrate the principles of diffusion and apply the concepts of interphase mass transfer in bioreactor
CO4: Apply the concept of distillation and drying in bioprocess
CO5: Comprehend the extraction separation in bioprocess
CO6: Interpret the membrane separation in bioprocess

Prerequisite

1. U18BTT3002 Bioprocess Calculations

CO/PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M								M	M				S
CO2	S	S	M	M	S				S	S				S
CO3	S	M							S	S				S
CO4				M	S				S	S				S
CO5	S	M		M	S				S	S				S
CO6	S	S	M	S	S				S	S				S

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

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Course Content

FUNDAMENTALS OF HEAT TRANSFER **9 hours**

Modes of heat transfer; Conduction: Fourier's law, Thermal conductivity of biological materials, Conduction through plane wall, hollow cylinder and hollow sphere; Convection: Individual and overall heat transfer coefficients, Dimensional analysis for free and forced convection.

HEAT TRANSFER EQUIPMENTS **9 hours**

Heat Exchangers: Basic calculations, Heat exchanger types, Design heat exchanger for Food and Bioprocess; LMTD and NTU concepts: Industrial evaporators - types, Methods of operation, Single effect evaporator and its enthalpy calculations.

DIFFUSION AND INTERPHASE MASS TRANSFER **9 hours**

Modes of mass transfer; Diffusion: Fick's first law, Molecular diffusion in gases, liquids and solids; Interphase mass transfer: Individual and overall mass transfer coefficients, Theories of mass transfer; Mass transfer in bioreactors: Factors affecting oxygen transfer rate.

DISTILLATION AND DRYING **9 hours**

Distillation: Overview of vapour-liquid equilibria, Flash, differential, continuous, steam, azeotropic and extractive distillation, Determination of number of stages by McCabe-Thiele method; Drying– theory; classification of dryers; batch drying – Mechanism and time of cross through circulation drying.

EXTRACTION AND MEMBRANE SEPARATION **9 hours**

Extraction and leaching: Ternary liquid-liquid equilibria, choice of solvents, Single and multistage extraction, Co-current and cross - current extraction. Extraction and leaching equipments, Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

LIST OF EXPERIMENTS **30 hours**

1. Heat transfer calculation in double pipe exchanger
2. Heat transfer calculation in shell and tube heat exchanger
3. Studies on simple distillation
4. Studies on steam distillation
5. Convective drying of food/biological materials
6. Mass transfer studies on rotating disc contactor
7. Liquid membrane separation of bioactive compounds

Theory: 45 hours **Tutorial: 0 hours** **Practical: 30 hours** **Project: 0 hours** **Total Hours: 75 hours**

REFERENCES

1. Treybal, R.E., (2017) *Mass-transfer operations*. McGraw-Hill.
2. Doran, P. M. (2012). *Bioprocess engineering principles*. Elsevier.
3. Rajput, R.K. (2008) Heat and Mass Transfer, S. Chand and Co.
4. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. 2nd edition. *Upper Saddle*.

WEB REFERENCES

1. http://nptel.ac.in/courses/103103032
2. http://nptel.ac.in/courses/103103035

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U18INI5600 **ENGINEERING CLINIC -**

VL	T	P	J	C
0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

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

CO1: Identify a practical problems and find a solution
CO2: Understand the project management techniques
CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite:

U18INI4600 ENGINEERING CLINICS II

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S		
CO2											S			
CO3										S				

Course Assessment methods:

Direct
1. Project reviews
2. Workbook report
3. Demonstration & Viva-voce

Content:

The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

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In the semester, students will focus primarily on Design project combining concepts learnt in Engineering clinics I and II

Course	Semester	Focus
Engineering Clinic I	1	IOT with C programming using Audino
Engineering Clinic II	2	Raspberry pi based controllers with Python programming
Engineering Clinic III	3	Design project combining concepts learnt in Engineering clinics I and II
Engineering Clinic IV	4	Reverse engineering project to improve performance of a product
Engineering Clinic V	5	Design and developing a prototype

GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a spec
4. ific tasks, or projects related to real world problems.
5. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
6. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
7. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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U18VEP5505 **SOCIAL VALUES**
(Mandatory)

L	T	P	J	C
0	0	2	0	0

Course Outcomes

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

CO 1: Understand the transformation from self to society
CO 2: Acquire knowledge about disparity among Human Beings
CO 3: Realize the new ethics in creating a more sustainable Society
CO 4: Develop skills to manage challenges in social issues
CO 5: Acquire the skills for Management of Social work & Holistic Society
CO 6: Validate the social liabilities at dissimilar situations

Pre-requisites :

1. U18VEP1501 / PERSONAL VALUES
2. U18VEP2502 / INTERPERSONAL VALUES
3. U18VEP3503 / FAMILY VALUES
4. U18VEP4504 / PROFESSIONAL VALUES

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						S								
CO2							S							
CO3								M						
CO4											S			
CO5												S		
CO6									M					

Course Assessment methods

Direct
1.Group Activity / Individual performance and assignment 2.Assessment on Value work sheet / Test
Indirect
1. Mini project on values / Goodwill Recognition

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Values through Practical activities:

1. Self and Society: Relation between self and society – Different forms of society - Elements of Social structures – Realization of Duties and Responsibilities of Individual in the Society
2. Social Values: Tolerance – Responsibility – Sacrifice – Sympathy - Service – peace-nonviolence - right conduct- Unity – forgive – dedication – Honest
3. Social issues : Disparity among Human beings- Poverty-Sanitation -corruption- un employment-superstition – religious intolerance & castes – terrorism.
4. Emerging Ethics for Sustainable Society: Unison of Men in Society - Positive Social Ethics - Cause and Effect - Ensuring an Equitable Society- Effect of Social Media in society - development of Education and Science in the Society
5. Social Welfare: Social welfare Organization - Programme by Government and NGO's - Benefits of Social Service - Balancing the Family and Social Life – Development of Holistic Society

Workshop mode

REFERENCES

1. SOCIAL PROBLEMS IN INDIA - ForumIAS.com – PDF
   discuss.forumias.com/uploads/File upload/.../711b18f321d406be9c79980b179932.pd...

2. INVESTING IN CULTURAL DIVERSITY AND INTERCULTURAL DIALOGUE: UNESCO ...
   www.un.org/en/events/culturaldiversityday/pdf/Investing_in_cultural_diversity.pdf

3. INDIAN SOCIETY AND SOCIAL CHANGE - University of Calicut
   www.universityofcalicut.info/SDE/BA_sociology_indian_society.pdf

4. CULTURE, SOCIETY AND THE MEDIA - E- class
   www.eclass.uoa.gr/.../MEDIA164/.../%5BTony_Bennett,_James_Curran,_Michael_G

5. SOCIAL WELFARE ADMINISTRATION - IGNOU
   www.ignou.ac.in/upload/Bswe-003%20Block-2-UNIT-6-small%20size.pdf

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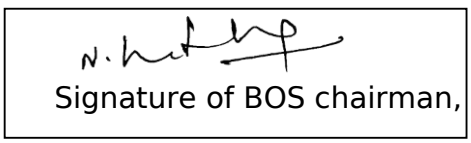
SEMESTER VI



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U18BTT6001	BIOPHARMACEUTICAL TECHNOLOGY	L	T	P	J	C
		3	0	0	0	3

Course Objective

- To understand the importance of regulatory affairs in drug control, standards and drug manufacture process.

Course Outcomes

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

CO1 : Outline National, International drug Standards, Control and pharmacopoeia commission

CO2 : Describe the principles of drug action and mechanism of action

CO3:Discuss and obtain knowledge on the drug development, manufacture process and Regulatory practices

CO4 : Understand the importance of biopharmaceutical final products production using upstream downstream process and ensure the quality of the product analysis

CO5 : Explain the principles and materials involved during the drug manufacture in pharmaceutical industries

CO6 : Discuss the clinical uses of biopharmaceutical therapeutics

Pre-requisites : Nil

CO/PO Mapping
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		M		M						M			
CO2	M		M								M	S	S	
CO3	M		S		M							S	S	S
CO4			M								M	M	S	S
CO5	M			S									S	S
CO6	M	S		S										S

Course Assessment methods

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

DRUG CONTROL AND STANDARDS **8 Hours**

Drug standards, regulation and control organizations: National agencies (Central Drug Standards and Control Organization (CDSCO); Indian Pharmacopoeia commission (IPC); Drugs Controller General of India (DCGI) and Indian Council for Medical Research (ICMR). International agencies (WHO guidelines on medicines policy; Food and Drug Administration (FDA); New Drug Application (NDA); Medicines and Healthcare products Regulatory Agency (MHRA).

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PHARMACOKINETICS AND PRINCIPLES OF DRUG ACTION **7Hours**

Route of drug administration: Enteral and parenteral; Pharmacokinetics: Drug Absorption, Distribution, Metabolism and Elimination (ADME); factors influencing ADME process; Pharmacodynamics: basic principles of drug action, Mechanism of drug action through enzymes, drug receptor interactions; radiopharmaceutical

DRUG DEVELOPMENT AND MANUFACTURE PROCESS **7Hours**

New Drug development: Drug discovery, patenting, preclinical and clinical trials, and regulatory authorities; Manufacturing process: special manufacturing facilities, sources of biopharmaceuticals, production of final product and analysis of the final products

REGULATORY PRACTICES **7Hours**

Good manufacturing practices (GMP); Good clinical practices (GCP); Good laboratory practices (GLP); The Drugs & Cosmetics Act, 1940; Schedule M & Y; Applications monitoring quality control; types of validation

PRINCIPLES OF DRUG MANUFACTURE IN PHARMACEUTICALS **9Hours**

Dosage form design: Need for dosage forms, General considerations in Dosage form design; Solid dosage forms: powders, granules, capsules and tablets; Semisolid dosage forms: ointments, creams and gels; transdermal drug delivery system; Pharmaceutical inserts: suppositories and inserts; Liquid dosage forms: solutions; Sterile dosage forms: parenteral (injections), Biologics (vaccine).

BIOPHARMACEUTICAL THERAPEUTICS AND CLINICAL USES **7Hours**

Various categories of therapeutics production and uses: Cytokines: interferons, interlukins, tumour necrosis factor. Haemotopoietic growth factors; Colony stimulating factor (granulocyte, macrophage), erythropoietin; Hormones: insulin, glucagons.

REFERENCES

1. Ansel H.C., et al. (2007) Pharmaceutical dosage forms and drug delivery systems- 8th edition, Lippincott Williams & Wilkins.
2. Gary Walsh. (2005) Biopharmaceutical technology-biochemistry and biotechnology, 1st Edition, John Wiley and Sons, Ltd.
3. Remington (2000) Pharmaceutical sciences, 20th edition, Mack publishing and Co., PA
4. Brahmankar, D.M. and Jaiswal, S.B. (2009) Biopharmaceutics and Pharmacokinetics. 2nd Edition, VallabhPrakashanPublication.

OTHER REFERENCES:

1. http://onlinelibrary.wiley.com/book/10.1002/9780470259818
2. https://ocw.mit.edu/courses/health-sciences-and-technology/hst-151-principles-of-pharmacology-spring-2005/lecture-notes/

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U18BTI6202	CELL CULTURE TECHNIQUES	L	T	P	J	C
		3	0	0	0	3

Course Objectives:

- To elucidate the general requirements and fundamentals of plant and mammalian cell culture.
- To understand the different cell culture techniques in both plant and animal cell culture and its applications

Course Outcomes (COs):

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

CO1: Outline and design model laboratory layout for setting up a plant tissue culture and animal cell culture lab.

CO2 Compare and illustrate plant and mammalian cell culture techniques and media for culturing of plant and mammalian cells

CO3: Elaborate and compare various plant tissue culture techniques.

CO4: Significant applications of tissue culture techniques in generating transgenic plants.

CO5: Explain and illustrate techniques for development of primary and established cell culture and measurement of cell viability.

CO6: Illustrate the plant and mammalian cell techniques for economic importance

Prerequisite

U18BTI3204 Microbiology

U18BTI5201 Genetic engineering and genomics

CO/PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		S		S								S	
CO2	S		S		S	S							S	
CO3	S		M			M		S					S	
CO4	S					S		S			S		S	
CO5	S							S					S	
CO6											M			

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

GENERAL REQUIREMENTS FOR CELL CULTURE **9 hours**

Basic operations and general equipment's and facility for mammalian and plant tissue culture lab; Maintenance of Aseptic Laboratory; Precautions to maintain aseptic conditions; Biosafety cabinet, inverted microscope, biosafety level in plant and animal cell culture lab.

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BASICS OF PLANT AND MAMMALIAN CELL CULTURE **9 hours**

Media requirement and stock solution preparation; Callus induction and differentiation; primary and secondary hardening; Importance and progress in animal cell culture; Importance of serum and serum free media; mycoplasma detection and control; Passage procedures; Doubling and generation time; cryopreservation of mammalian cell line and characterization.

PLANT TISSUE CULTURE TECHNIQUES **9 hours**

Types of culture techniques: callus, root tip, shoot tip, anther culture, pollen culture; endosperm culture etc.., Callus induction and differentiation; primary and secondary hardening; Protoplast culture and protoplast fusion and cell viability test

Case study - Commercialization of banana tissue culture /Micro propagation of tissue culture plants

MAMMALIAN CELL CULTURE TECHNIQUES **9 hours**

Primary culture and established cell lines; cell strain, continuous cell line- finite and infinite cell line, commonly used cell lines; Maintenance of cell culture; Measurement of viability and cytotoxicity; Monolayer culture, Anchorage dependent and independent cultures; suspension cell cultures; Cell culture reactors: scaling up

Case study – Development of monoclonal antibodies

APPLICATION OF PLANT AND MAMMALIAN CELL CULTURE **9 hours**

Gene transfer methods in plants; Transgenic plants with beneficial traits: herbicide, drought, virus resistance; Transgenic plants as bioreactors- Concept of Molecular farming and pharming.

Gene transfer methods in mammalian cells; Transgenic animal for production of recombinant proteins - vaccines, diagnostic antigens and other pharmaceutical agents (insulin, growth factors); Transfection Technology.

-

Theory: 45 hours **Tutorial: 0 hours** **Practical:0 hours** **Project: 0 hours** **Total Hours: 60**

REFERENCES

1. Ian R Freshney (2011) Animal cell culture: A manual of basic technique and specialized applications, Wiley and sons.
2. Ranga,M.M (2007), Animal Biotechnology, fourth Edition, Agrobios India limited, Jodhpur.
3. Rama Dass,P.and Meera Rani S (2007) Text Book of Animal Biotechnology, Akshara Printers, New Delhi
4. Masters, J.R.W (2007) Animal Cell culture. Practical Approach, Oxford University Press, UK
5. Sant Saran Bhojwani and M. K. Razdan (1996) Plant Tissue Culture: theory and practice; Elsevier Science.

WEB REFERENCES

1. http://nptel.ac.in/courses/102103012/34
2. http://nptel.ac.in/courses/102103016/4

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		L	T	P	J	C
U18BTI6203	**IMMUNOLOGY**	**3**	**0**	**2**	**0**	**4**

Course Objectives:

- To gain an in-sight into the cells and effectors of immune system and mechanisms of immunity.
- To learn the concept of antigen-antibody interactions and demonstrate the techniques for their evaluation.

Course Outcomes (COs):

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

CO1: Comprehend the general concepts of immune system and elaborate the cells and organs of the immune system.

CO2 Analyze and evaluate the properties of antigens and antibodies with special emphasis on haptens.

CO3: Demonstrate and evaluate various antigen-antibody interactions and techniques.

CO4: Apply the concept of cell mediated immunity and complement system.

CO5: Illustrate the mechanisms behind hypersensitivity and autoimmunity mechanisms.

CO6: Imbibe the concept of transplantation and cancer immunology

Pre-requisite Course:

1. U18BTI3203 Concepts in Biochemistry

CO/PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		M						S	S		S	S	
CO2	S			W	S				S	S			S	
CO3	S	M			S				S	S			S	
CO4	S												S	
CO5	S		S			S							S	
CO6	S		S	M		S							S	

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

CELLS AND ORGANS OF IMMUNE SYSTEM **6 hours**

General concepts of the immune system. Innate and adaptive immunity. Hematopoeisis.Structure, properties and functions of the immune cells and organs: T and B-lymphocytes, NK cells; Monocytes and macrophages; Neutrophils, eosinophils, and basophils Mast cells and dendritic cells. Thymus and bone marrow; Lymph nodes, spleen, MALT, GALT and CALT.

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ANTIGENS AND ANTIBODIES **6 hours**

Antigens and haptens; Properties; B and T cell epitopes. T-dependent and T- independent antigens. Adjuvants. Antibodies: Classification, Structure, function and properties of the antibodies; Antibody as B cell receptor, antigenic determinants on antibodies (isotype, allotype and idiotype).

TECHNIQUES ON ANTIGEN-ANTIBODY INTERACTIONS **9 hours**

Immunological principles of various reactions and techniques: Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, ELISA –types and applications, Western Blotting. Hybridoma technology-Monoclonal antibodies production and applications.

Case study: AIDS diagnosis by monoclonal antibodies.

CELL MEDIATED IMMUNITY & COMPLEMENT **12 hours**

Major histocompatibility gene complex: Organization of MHC- Types and Functions, Structure and cellular distribution of HLA antigens. Cell mediated immunity: Cell types (CTLs, NK cells, macrophages and TDTH cells), effector mechanisms and molecules of cell mediated reactions. Cytokines – interleukins and interferons (outline only).Complement system: Components of the complement activation - classical, alternative and lectin pathways. Biological consequence of complement activation and complement deficiencies.

HYPERSENSITIVITY,AUTOIMMUNITY&TRANSPLANTATION IMMUNOLOGY 12 hours

Hypersensitivity: Types and mechanism of hypersensitive reactionsAutoimmunity: Mechanisms of induction of organ specific and systemic, autoimmune diseases (rare genetic disorders). Therapeutic approach. Transplantation immunology: Types of grafts, immunologic basis of graft rejection, properties and types of rejection, tissue typing, immunosuppressive therapy. Cancer Immunology: types of tumors, tumor antigens (TSTA and TATA), immune response to tumors.

Case study: Immunotherapy of breast cancer.

LIST OF EXPERIEMENTS **30 hours**

1. Blood smear preparation and identification of leucocytes by Giemsa stain
2. Separation of Peripheral Blood Mononuclear cells(PBMC) and analysis of cell viability by Tryphan blue staining
3. Separation of leucocytes by dextran method
4. IgE estimation by myeloperoxidase assay
5. Cytokine assay by ELISA

Assays for Antigen/antibody interactions

6. Determination of antigen/antibody concentration by Single radial immunodiffusion test.
7. Assay for antigen / antibody specificity- Ouchterlony Double Immuno Diffusion.
8. Assay for analysis of heterogeneity of antibody by Immuno-electrophoresis.
9. Determination of antigen concentration by rocket electrophoresis.
10. Determination of antigen/antibody concentration by ELISA

Theory: 45 hours Tutorial: 0 hours Practical: 30 hours Project: 0 hours Total Hours: 75

References:

1. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). *Essential immunology*. 13 th edition. John Wiley & Sons.
2. Abbas. A., Lichman, A.H., Pillai, S. (2017).Cellular and Molecular Immunology, 9th edition, Elsevier Health Services
3. Owen, J. A., Punt, J., & Stranford, S. A. (2016). *Kuby immunology*. 7th edition, WH Freeman, New York

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4. Pillai, A.(2008). *A Textbook of Immunology and Immunotechnology*. 1st edition, S.Chand & Co. New Delhi.
5. Tizard, R.I. (2007). *Immunology: An Introduction*, 4th Edition, Brooks/Cole publisher

Web References:

1. http://www.raymondcheong.com/Year1/immuno.html

U18BTI6204	BIOLOGICAL DATA ANALYSIS	L	T	P	J	C
		2	0	2	0	3

Course Objectives:

- To introduce the concept of massive data mining from biological experiments.
- To identify basic experimental design principles in solving biological questions.
- To develop and test hypothesis statistically using data using R – programming.

Course Outcomes (COs):

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

CO1: Understand and apply the biological annotation for macromolecules; apply and interpret the structural analysis of macromolecules using high throughput experiment.

CO2 Apply and interpret the biological data through fundamental statistical analysis.

CO3: Apply and interpret biological data related with hypothesis testing

CO4: Explore and infer biological data using visualization.

CO5: Understand and apply R-programming for biological data analysis

CO6: Provide optimal solution and statistics to biological problems

Pre-requisite

1. U18BTI3203 Concepts of Biochemistry
2. U18MAT3103 Probability & Biostatistics

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S			S	S					M	S		S	S
CO2	S			S	S									
CO3	S			S	S									
CO4	S			S	S									
CO5	S			S	S									
CO6	S			S	S					S		M	S	S

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

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Course Content

BIOINFORMATICS: MINING THE MASSIVE DATA FROM HIGH THROUGHPUT GENOMICS EXPERIMENTS **6 hours**

Introduction – Sequence alignment, Genome sequencing - Nanopore and illumina sequencing, gene annotation, RNA folding - RNAhybrid, protein structure prediction - Secondary structure information; Microarray analysis, proteomics, Protein-Protein Interaction

INTRODUCTION TO BIOSTATISTICAL ANALYSIS **6 hours**

Statistical methods in the context of biological research – Data exploration and Analysis - Arithmetic mean, standard deviation, coefficient of variation, standard error of mean, correlation analysis; regression analysis [Problems alone should be solved]

HYPOTHESIS TESTING **6 hours**

Introduction to general concepts; characteristics - Type I and II error; Student's t-test, chi-square test, One Way ANOVA (Kruskal–Wallis H test), Mann–Whitney U test; Wilcoxon signed-rank test

DATA EXPLORATION **6 hours**

Data visualization and summary statistics – variable types, Exploring categorical variable – Relative frequency and percentage, Bar graph, Pie chart; Exploring numerical variables – Histogram, Mean and median, Variance and Standard deviation, quantiles, Box plots; Data Preprocessing – Outliers, data transformation

BIOLOGICAL DATA ANALYSIS USING R PROGRAMMING **6 hours**

Overview – Variable, Data types, Operators, Useful Function, Data frames, Working with images and strings, Library functions.

List of Experiments **15 hours**

1. Introduction to R installation, package management and basic operators
2. Bioconductor tools – Introduction & usage
3. Biological sequences and sequence analysis
4. Basic plot and customized plot using ggplot2
5. R for large biological datasets
6. Descriptive statistics and One-way ANOVA
7. Image analysis using EBImage
8. Case Study : Microarray data analysis using Bioconductor package [Demo only]

Theory: 30 hour **Tutorial: 0 hour** **Practical: 30 hour** **Project: 0 hour** **Total: 60 hours**

REFERENCES

1. Sanghamitra, B., Ujjwal, M., & TL, W. J. (Eds.). (2007). *Analysis of biological data: a soft computing approach* (Vol. 3). World Scientific.
2. O'Brien, C. M. (2013). Biostatistics with R: An Introduction to Statistics Through Biological Data by Babak Shahbaba. *International Statistical Review*, *81*(3), 472-473.
3. McDonald, J. H. (2009). *Handbook of biological statistics* (Vol. 2, pp. 173-181). Baltimore, MD: sparky house publishing.

Web References:

1. http://bioconductor.org/
2. https://onlinecourses.science.psu.edu/statprogram/r
3. http://www.r-tutor.com/r-introduction

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U18BTP6505	CELL CULTURE LABORATORY	L	T	P	J	C
		0	0	2	0	1

Course Objectives:

- To gain hands-on training on the methods of sterilization and media preparation for cell culture learn about the techniques in the establishment of primary culture.
- To develop skills in working with cell lines and cell viability and DNA fragmentation assay

Course Outcomes

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

CO1: Prepare stock solutions and media for plant tissue

CO2: Preparation of explants from the various plant parts

CO3: Induction of callus and regeneration of plants

CO4: Develop skills for sterilization and preparation of culture media for mammalian cell culture

CO5: Perform the establishment of primary culture from chick embryo and demonstrate the cell counting and determine cell viability

CO6: Attain skills in working with cell lines and maintain monolayer cultures and learn to freeze the viable cells by cryopreservation.

Course Assessment methods

Pre-requisites: -

CO/PO MAPPING
(S/M/W indicates strength of correlation)
S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO1	S		W		S	M			S					
CO2					S									
CO3		M			S									
CO4	S		M		S									
CO5	S				S				S					M
CO6					S				S					M

Course Assessment Method

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

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LIST OF EXPERIEMENTS

1. Media and Stock solution preparation and sterilization
2. Selection of explants and Induction of callus
3. Suspension culture and production of secondary metabolites
4. Micro propagation of commercial plant for economic importance (Potato / Banana / Bamboo / Jatropha etc.)
5. Establishment of primary culture from leaves and stem explants
6. Establishment of organogenesis from leaves and stem explants
7. Sterilization techniques, media and stock solution and sera preparation
8. Establishment of primary culture using chick embryo
9. Establishment of cell lines by using primary and / or secondary cell culture
10. Staining, Cell counting and viability (Tryphan Blue assay)
11. Preservation of cell line- Cryopreservation
12. DNA fragmentation assay – (Demo only)
13. Field visit : - Animal handling and care

Theory: 0 Tutorial: 0 Practical: 30 Project: 0 Total: 30 Hours

REFERENCES

1. Ian R Freshney (2011) Animal cell culture: A manual of basic technique and specialized applications, Wiley and sons.
2 Sant Saran Bhojwani and M. K. Razdan (1996) Plant Tissue Culture: theory and practice; Elsevier Science.

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SEMESTER - VII

U18MBT7001	ENGINEERING ECONOMICS & FINANCIAL MANAGEMENT	L	T	P	PJ	C
		3	0	0	0	3

Course Outcomes (COs):

After successful completion of the course, the students should be able to

CO1: Evaluate the economic theories, cost concepts and pricing policies
CO2: Analyze the market structures and integration concepts
CO3: Apply the concepts of national income and understand the functions of banks and concepts of globalization
CO4: Apply the concepts of financial management for project appraisal and working capital management
CO5: Understand accounting systems
CO6: Analyze financial statements using ratio analysis

CO/ PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
	PROGRAMME OUTCOMES (Pos)												PSOs	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M			M						M		M	
CO2				M	M						M		M	
CO3					M						M			
CO4				M							M			M
CO5											M			
CO6		M		M							M			M

Course Assessment Methods			
Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments		
3	End semester examination		

Course Content **45 hours**

1. **ECONOMICS, COST & PRICING CONCEPTS** **9 hours**

Economic theories – Demand analysis – Determinants of demand – Demand forecasting – Supply – Actual Cost and opportunity Cost – Incremental Cost and sunk Cost – Fixed and variable Cost – Marginal Costing – Total Cost – Elements of Cost – Cost curves – Breakeven point and breakeven chart – Limitations of break even chart – Interpretation of break even chart – Contribution – P/V-ratio, profit-volume ratio or relationship – Price fixation – Pricing Policies – Pricing methods.

2. **CONCEPTS ON FIRMS & MANUFACTURING PRACTICES** **9 hours**

Firm – Industry – Market – Market structure – Diversification – Vertical integration – Merger – Horizontal integration.

3. **NATIONAL INCOME, MONEY & BANKING, ECONOMIC ENVIRONMENT**

9 hours

National income concepts – GNP – NNP – Methods of measuring national income – Inflation – Deflation – Kinds of money – Value of money – Functions of bank – Types of bank – Economic liberalization – Privatization – Globalization

4. **CONCEPTS OF FINANCIAL MANAGEMENT** **9 hours**

Financial management – Scope – Objectives – Time value of money – Methods of appraising project profitability – Sources of finance – Working capital and management of working capital

5. **ACCOUNTING SYSTEM, STATEMENT & FINANCIAL ANALYSIS 9 hours**

Accounting system – Systems of book-keeping – Journal – Ledger – Trail balance – Financial statements – Ratio analysis – Types of ratios – Significance – Limitations

Theory: 45 hours Tutorial: 0 hours Practical: 0 hours Project: 0 hours Total hours: 45

Textbooks:

1. Chandra, P. (2009). Projects 7/E. Tata McGraw-Hill Education.
2. Besley, S., & Brigham, E. F. (2008). Essentials of managerial finance. Thomson South-Western.

References:

1. Pandey, I. M. (1988). Financial management research in India.
2. Fenner, W. G. (1978). Fundamentals of financial management: James C. Van Horne, Prentice-Hall, 1977, Price:[UK pound] 11.95. Engineering and Process Economics, 3(3), 221-222.
3. Bhaskar S. (2003). Engineering Economics and Financial Accounting, Anuradha Agencies, Chennai, 2003.
4. Van Horne James, C. (2002). Financial Management & Policy, 12/E. Pearson Education India..
5. Khan, M. Y., & Jain, P. K. (2006). Management accounting and financial analysis.
6. Saravanavel, P. (2018). Management Accounting Principles & Practice.
7. Ramachandra Aryasri.A., & Ramana Murthy V.V. (2006). Engineering Economics & Financial Accounting, Tata McGraw Hill, New Delhi.
8. Varshney, R. L., & Maheshwari, K. L. (2001). managerial Economics. Chand.
9. Samuelson, P. A., & Nordhaus, W. D. (2009). Economics. 19th International Edition.

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U18BTT7002	PRECLINICAL AND CLINICAL & REGULATORY AFFAIRS	L	T	P	PJ	C
		3	0	0	0	3

Course Objectives:

- Understand key areas of drug development: preclinical and clinical research regulations
- Understand the basic concepts of trial management, clinical data analysis and reporting

Course Outcomes (COs):

After successful completion of the course, the students should be able to

CO1: Understand the regulatory aspects and ethical considerations involving human subjects.
CO2: Understand the timelines and resources required to discover and develop new drugs in a preclinical setting.
CO3: Demonstrate an understanding of the critical features of each stage of the preclinical drug development process.
CO4: Classify different types of trial designs.
CO5: Apply and demonstrate critical analysis of clinical data using statistical analysis tools
CO6: Identify quality parameters of clinical research report.

Pre-requisite:

1. U18BTI6204 Biological Data Analysis
2. U18BTT6001 Biopharmaceutical Technology

CO/ PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
	PROGRAMME OUTCOMES (Pos)												PSOs	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		M										S	S
CO2	S			W									S	
CO3	S	M			S								S	
CO4	S											M	S	
CO5			S									M	S	
CO6										S			S	

Course Assessment Methods			
Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments		
3	End semester examination		

Course Content **45 hours**

1. **REGULATORY BODIES AND ETHICAL GUIDELINES** **9 hours**

Regulatory bodies: National and International perspective, Drug and in vitro diagnostic device regulatory submissions, approvals and registrations, Ethical guidelines in Clinical Research: Nuremberg code, Declaration of Helsinki, Belmont report; International Conference on Harmonization, Drug and cosmetic act; Schedule Y, ICMR Guidelines: National Ethical Guidelines for Biomedical and Health Research Involving Human Participants

2. **DRUG DISCOVERY AND PRECLINICAL RESEARCH** **9 hours**

Drug development phases, Preclinical drug development, Types of Pre-clinical trials, safety studies, dose response information to support drug registration, Guidelines for animal studies, carcinogenicity studies, chronic toxicity testing in animals, Importance of CYP Metabolism studies, Pharmacodynamics (PD): Toxicity LD_{50} and ED_{50}.

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3. **CLINICAL RESEARCH** **9 hours**

Scope of Clinical Research, Good Clinical Practices (GCP), History of clinical research, Belmonte report, Thalidomide disaster, Types of clinical trials, Special Clinical Trials, Medical Devices Trials, Investigator Brochure, Informed Consent Form, Sponsor Monitor and Investigator responsibility, SOP in Clinical Trials, Clinical Trial Monitoring, Role of CRA, QA and QC in Clinical Trials, CRF Design, Study management: Monitoring process, Coordinating protocol implementation

4. **CLINICAL RESEARCH STUDY DESIGNS** **9 hours**

Overview of study design, Types of studies: Experimental, uncontrolled, RCTs, other designs – equivalence, non-inferiority, observational, retrospective, sample size, bias and confounding, Experimental Design – Randomized Clinical Trials: parallel-group design, stratified parallel group design, parallel group randomized block design, complete cross-over design, simultaneous treatments design, factorial design. Types of randomization: simple, blocked, stratified and Adaptive, Blindness:– unblinded, Single Blind, Double-blind and Triple blind trials. Case Study: Clinical Trial Study Design

5. **CLINICAL DATA ANALYSIS AND REPORT** **9 hours**

Types of data and normal distribution, significance tests and confidence intervals, comparison of means, comparison of proportions, analysis of survival data, subgroup analysis, regression analysis, Good Clinical Data Management Practices, Data Management Plan, CRF designing. Serious adverse event data reconciliation, Database closure, Design and analysis of surveys, CDISC standards, Dataset preparation for analysis, Overview of reporting, Internal and external reporting.

Theory: 45 hours Tutorial: 0 hours Practical: 0 hours Project: 0 hours Total hours: 45

Textbooks:

1. Tom Brody, (2016) Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines, Academic Press.

2. Stephen B Hulley, Steven R Cummings, Warren S Browner, Deborah G Grady, Thomas B Newman,(2008) Designing clinical research, Second edition Lippincott Williams & Wilkins Publishers.

3. T.A. Durham and J Rick Turner. (2008) Introduction to statistics in pharmaceutical clinical trials. Pharmaceutical Press.

4. Antonella Bacchieri, Giovanni Della Cioppa (2007). Fundamentals of Clinical Research , First edition, Springer publishers

Web-References:

1. `http://www.ich.org/products/guidelines/safety/safety-single/article/preclinical-safety-evaluation-of-biotechnology-derived-pharmaceuticals.html`

2. `http://clinicalcenter.nih.gov/training/training.html`

3. `https://onlinecourses.science.psu.edu/stat509/node/6/`

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U18BTI7203 BIOINFORMATICS

L	T	P	PJ	C
3	0	2	0	4

Course Objectives:

- Introduce the student to biological data resources, algorithms and alignment tools
- Apply various algorithms and computational tools for protein structure and stability analysis.

Course Outcomes (COs):

After successful completion of the course, the students should be able to

CO1: To introduce the concept of biological sequence alignment and various genome sequence protocols.
CO2: To familiarize with various biological database searches, parameters and algorithm.
CO3: To apply, interpret and analyze multiple sequence alignments.
CO4: To construct, interpret and access molecular phylogenetic tree prediction .
CO5: To apply, interpret and analyze protein structures prediction algorithms
CO6: To introduce the concept of computer-aided drug designing (CADD).

Pre-requisite:

1. U18BTI3203 Concepts in Biochemistry
2. U18BTI4202 Protein and Enzyme Technology
3. U18BTI4204 Cell and Molecular Biology

CO/ PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
	PROGRAMME OUTCOMES (Pos)												PSOs	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		S	M										
CO2	S	S		M	S							M	M	M
CO3	S	S		M	S							S	S	S
CO4	S	M		M	S								S	S
CO5	S	S	M	M	M							M	S	S
CO6	S	S	M	M	M							M	M	M

Course Assessment Methods			
Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments		
3	End semester examination		

Course Content **60 hours**

1. **INTRODUCTION TO BIOINFORMATICS** **9 hours**

Introduction to Bioinformatics; Biological Sequences – Formats; Databases – types, architecture of Biological Databases; Sequence Identify and Similarity, Edit distance – Levenstein and Hamming Distance. Dot plot analysis.

2. **SEQUENCE ALIGNMENT** **12 hours**

Sequence alignment – Pairwise alignment; Gaps – Constant, Linear, Affine, Convex and Profile-based gaps; Dynamic Programming algorithm – Needleman and Wunch Algorithm, Smith-Waterman Algorithm; Scoring Matrices – PAM and BLOSSUM; BLAST. Limits of detection & significance. Advanced BLAST: PSI-BLAST & PHI-BLAST. Introduction to Next Generation Sequencing techniques and applications.

Case Study: NGS-based sequencing for infectious diseases.

3. **MULTIPLE SEQUENCE ALIGNMENT** **7 hours**

Multiple Alignment Methods – Block-based methods for multiple-sequence alignment, Algorithm of multiple sequence alignments: Sums of pairs method (SP), CLUSTAL W, PILEUP; Overview of iterative MSA methods; Construction of Position-Specific Scoring Matrices (PSSM).

4. **PHYLOGENETICS** **7 hours**

Molecular Phylogenetics – Newick Format, Methods for tree construction – Unweighted pair group method of arithmetic mean (UPGMA), Fitch-Margoliasch algorithm (FM), Neighbor-Joining method (NJ); Character based methods: Maximum parsimony, maximum likelihood, Tree Reconstruction and evaluation - Bootstrapping technique.

Case Study: Computational exploration of coevolution.

5. **APPLICATIONS IN BIOINFORMATICS** **12 hours**

Prediction of secondary structure – Globular and Transmembrane protein, Prediction of Tertiary structure – Homology Modeling and Threading. Methods for predicting conserved patterns in protein sequence and structure; Comparison of protein tertiary structures.

Introduction to Drug Discovery Process, Target Identification and Validation, Virtual Screening of lead compounds, Docking – Principles, Rigid and Flexible docking.

Case study: Drug discovery approaches targeting a metabolic pathway.

List of Experiments:

1. Basics of Unix Commands & Scripting
2. Biological Sequence Retrieval
3. Molecular Visualization using Pymol
4. Sequence Homology using BLAST
5. Multiple Sequence Alignment
6. Phylogenetic Analysis
7. NGS Data Analysis of SNP Identification
8. Molecular Modelling of Protein structure and Loop refinement
9. Molecular Docking

Theory: 45 hours Tutorial: 0 hours Practical: 30 hours Project: 0 hours Total hours: 60

Textbooks:

1. Pevzner, P., & Shamir, R. (Eds.). (2011). Bioinformatics for biologists. Cambridge University Press.
2. Higgins, D., & Taylor, W. (2000). Bioinformatics: sequence, structure and databanks. New York: Oxford University Press.
3. Rastogi, S. C., Rastogi, P., & Mendiratta, N. (2008). Bioinformatics Methods And Applications: Genomics Proteomics And Drug Discovery 3Rd Ed. PHI Learning Pvt. Ltd..
4. Baxevanis, A. D., Bader, G. D., & Wishart, D. S. (Eds.). (2020). Bioinformatics. John Wiley & Sons.
5. Gu, J., & Bourne, P. E. (Eds.). (2009). Structural bioinformatics (Vol. 44). John Wiley & Sons.
6. Stawinski, P., Sachidanandam, R., Chojnicka, I., & Płoski, R. (2016). Basic Bioinformatic Analyses of NGS Data. In Clinical Applications for Next-Generation Sequencing (pp. 19-37). Academic Press.

7. Gromiha, M. M. (2010). Protein bioinformatics: from sequence to function. Academic Press.

8. Yu, W., & MacKerell, A. D. (2017). Computer-aided drug design methods. In Antibiotics (pp. 85-106). Humana Press, New York, NY.

Web-References:

1. `https://nptel.ac.in/courses/102106065/`

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U18BTI7204 DOWNSTREAM PROCESSING

L	T	P	PJ	C
3	0	2	0	4

Course Objectives:

- To provide an insight about the chemical engineering concepts for bio-product recovery from biological sources.

Course Outcomes (COs):

After successful completion of the course, the students should be able to

CO1: Apply the various unit operation principles and engineering fundamentals to design the separation processes specific to biologically derived products.
CO2: Analyze and design the various solid-liquid unit operations and different cell-disruption techniques used in downstream processing.
CO3: Apply and analyse the various principles underlying the different unit operations used for the isolation and extraction of bio-products.
CO4: Select and design the various methods of chromatography used in protein purification.
CO5: Apply the different unit operations for polishing and packing the final bioproducts .
CO6: Evaluate the techno-economical analysis for purification of bioproducts.

Pre-requisite:

1. U18BTI5202 Bioprocess Engineering

CO/ PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
	PROGRAMME OUTCOMES (Pos)												PSOs	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S		S	S					M				S
CO2	S	S		S	S					M				S
CO3	S	S		S	S					M				S
CO4	S	S		S	S					M				S
CO5	S	S		S	S					M				S
CO6	S	S		S	S					M	S			S

Course Content **60 hours**

1. **INTRODUCTION TO DOWNSTREAM PROCESSING AND PRIMARY SEPARATION** **9 hours**

Downstream processing principles, classification and characteristics of biomolecules; cell disruption methods for intracellular products release: mechanical methods, chemical, physical and enzymatic methods; unit operations for solid-liquid separation-filtration, types of equipment, batch-continuous, pretreatment methods and centrifugation, scale-up of centrifugation, centrifugal filtration.

2. **ISOLATION OF PRODUCTS** **9 hours**

Adsorption, Extractive separation: Solvent extraction, Aqueous Two Phase Extractions, Reverse Micelle Extraction, Super Critical Extraction. Precipitation methods: Salts; Organic solvents and Polymers. Membrane Based Separation: Ultrafiltration; Microfiltration; Nanofiltration; Reverse Osmosis; Dialysis and Electrodialysis.

3. **PURIFICATION OF PRODUCTS** **9 hours**

Size exclusion Chromatography, Ion exchange chromatography, Reverse-phase chromatography, hydrophobic interaction chromatography (HIC), Affinity chromatography, HPLC, FPLC and GC – Operations & application.

4. **POLISHING OF PRODUCTS** **9 hours**

   Crystallization: Methods of super saturation, types of nucleation and crystal growth, Material and energy balance, yield of crystal, Types of crystallization and equipment's. Drying: types of moistures, batch drying process, mechanism of drying, drying time calculation, drying equipment's; Freeze-drying and Spray drying.

5. **TECHNO-ECONOMICAL ANALYSIS FOR BIOPRODUCT PRODUCTION 9 hours**

   Techno-economical analysis of bioproducts, Illustrative Example of Citric Acid Production, Human Insulin Production. Case studies: Therapeutic Monoclonal Antibody Production.

List of Experiments:

1. Disruption of cell walls and estimation of intracellular proteins using cell disruption techniques
2. Concentration of yeast cells using Micro filtration
3. Isolation of proteins using precipitation techniques
4. Recovery of proteins using aqueous two phase extraction
5. Chromatography column packing
6. Purification of enzyme using ion exchange chromatography
7. Purification of enzyme using size exclusion chromatography
8. Purification of enzyme using affinity chromatography
9. Purification of high value product using Fast Protein Liquid Chromatography (FPLC)
10. Freeze-Drying
11. Simulation of production and purification of bioproducts using Superpro software (demo)

Theory: 45 hours Tutorial: 0 hours Practical: 30 hours Project: 0 hours Total hours: 60

Textbooks:

1. Li, Y. (2016). Bioenergy: principles and applications. John Wiley & Sons.
2. Roger G.Harrison, Paul Todd, Scott R.Ruger and Demetri P. Petrides. (2009). Bioseparation Science and Engineering. Oxford University Press, 2nd ed. NewYork.
3. Sivashankar, B (2005). Bioseparation : Principles and Techniques, Prentice Hall of India, New Delhi.
4. Scopes, R.K. (2005). Protein Purification – Principles and Practice, 2nd ed. Narosa Publications.
5. Ladisch, M. R. (2001). Bioseparations Engineering: Principles. Practice and Economics, Wiley.
6. Belter P.A, Cussler,E.L and Wei-Houhu . (1998). Bioseparations- Downstream Processing for Biotechnology, Wiley Interscience Publications, USA.
7. BIOTOL series-(1995). Product recovery in Bioprocess Technology VCH publications,

Web-References:

1. `http://nptel.ac.in/courses/102106022/`
2. `http://www.intelligen.com/superpro_features.html`

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U18BTP7705 PROJECT PHASE-I

L	T	P	PJ	C
0	0	0	4	2

Course Objectives:

- To develop skills to identify and find solutions to various problems using biotechnology.

Course Outcomes (COs):

After successful completion of the course, the students should be able to

CO1: Ability to survey literature relevant to the topic under consideration.
CO2: Design a research problem using sound scientific principles.
CO3: Conduct experiments with suitable controls and safety considerations.
CO4: Perform statistical operations and analyze results.
CO5: Interpret results and derive new information.
CO6: Present and communicate results to a scientific audience.

Pre-requisite:

1. All core theory and lab courses

CO/ PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
	PROGRAMME OUTCOMES (Pos)												PSOs	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		S												
CO2			S											
CO3			S		S				S					
CO4														
CO5								M						
CO6					S					S				

Course Content **30 hours**

Student in discussion with the guide chooses to design and carry out a novel research problem

Theory: 0 hours Tutorial: 0 hours Practical: 0 hours Project: 60 hours Total hours: 30

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U18VEP7507	GLOBAL VALUE	L	T	P	PJ	C
		3	0	0	0	3

Course Outcomes (COs):

After successful completion of the course, the students should be able to

CO1: Aware of the concept of Universal Brotherhood and support the organizations which areworking for it.
CO2: Follow the path of Ahimsa in every aspect of their life
CO3: Uphold the Universal declaration of Human Rights
CO4: Understand the unequal distribution of wealth in the World and bestow their effort towards inclusive growth
CO5: Sensitize the environmental degradation and work for the sustainable development
CO6: Amalgamate harmony through Non-violence and edify the nation headed for upholding development.

Pre-requisite:

1. U18VEP1501 Personal Values
2. U18VEP2502 Interpersonal Values
3. U18VEP3503 Family Values
4. U18VEP4504 Professional Values
5. U18VEP5505 Social Values
6. U18VEP6506 National Values

CO/ PO Mapping														
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
	PROGRAMME OUTCOMES (Pos)												PSOs	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1							M							
CO2								S						
CO3									M					
CO4						S								
CO5											M			
CO6												S		

Course Assessment Methods			
Direct		Indirect	
1	Group Activity/ Individual Performance	1	Mini project on values
2	Assignment	2	Goodwill Recognition
3	Assessment on values work sheet/ test		

Course Content

1. **Universal Brotherhood**

Meaning of Universal Brotherhood- Functioning of Various organization for Universal human beings -Red Cross, UN Office for Humanitarian Affairs – Case study on humanitarian problems and intervention - Active role of Students/Individual on Universal Brotherhood.

2. **Global Peace, Harmony and Unity**

Functions of UNO - Principal Organizations - Special organization – Case study relating to disturbance of world peace and role of UNO – Participatory role of Students/Individual in attaining the Global peace and Unity.

3. **Non-Violence**

   Philosophy of nonviolence- Nonviolence practiced by Mahatma Gandhi – Global recognition for nonviolence - Forms of nonviolence - Case study on the success story of nonviolence– Practicing nonviolence in everyday life.

4. **Humanity and Justice**

   Universal declaration of Human Rights - Broad classification - Relevant Constitutional Provisions– Judicial activism on human rights violation - Case study on Human rights violation– Adherence to human rights by Students/Individuals.

5. **Inclusive growth and sustainable development**

   Goals to transform our World: No Poverty - Good Health - Education – Equality - Economic Growth - Reduced Inequality –Protection of environment – Case study on inequality and environmental degradation and remedial measures.

WORKSHOP MODE

Web-References:

1. Teaching Asia-Pacific Core Values Of Peace And Harmony – Unicef
2. Three-Dimensional Action For World Prosperity And Peace- Iim Indore -
3. My Non-Violence - Mahatma Gandhi
4. Human Rights And The Constitution Of India 8th ... - India Juris
5. The Ethics Of Sustainability – Research Gate

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SEMESTER - VIII

U18BTP8701 PROJECT PHASE-II

L	T	P	PJ	C
0	0	0	24	12

Course Objectives:

- To develop skills to identify and find solutions to various problems using biotechnology.

Course Outcomes (COs):

After successful completion of the course, the students should be able to

CO1: Ability to survey literature relevant to the topic under consideration.
CO2: Design a research problem using sound scientific principles.
CO3: Conduct experiments with suitable controls and safety considerations.
CO4: Perform statistical operations and analyze results.
CO5: Interpret results and derive new information.
CO6: Present and communicate results to a scientific audience.

Pre-requisite:

1. All core theory and lab courses

CO/ PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
	PROGRAMME OUTCOMES (Pos)												PSOs	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		S												
CO2			S											
CO3			S		S				S					
CO4														
CO5								M						
CO6					S					S				

Course Content **30 hours**

Student in discussion with the guide chooses to design and carry out a novel research problem

Theory: 0 hours Tutorial: 0 hours Practical: 0 hours Project: 180 hours Total hours: 180

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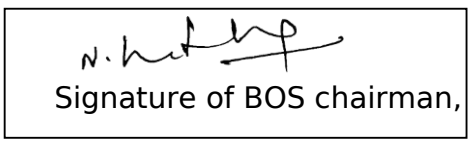
ELECTIVES



Signature of BOS chairman, BT

U18BTE0001	CHEMICAL REACTION ENGINEERING	L	T	P	J	C
		3	0	0	0	3

Course Objectives:

- To familiarize the principles and concepts of kinetics and application of reactors.

Course Outcomes (COs):

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

CO1: Elucidate the basic laws on chemical kinetics and its application on different types of reactions
CO2 Apply the various ideal reactors and their design equations
CO3: Elaborate the non-ideal behaviour of reactors
CO4: Conceptualize the basic of heterogeneous reacting systems
CO5: Identify and analyse the various multiphase reactors
CO6: Solve the importance of multiphase rectors

Pre-requisite Course:

1. U18BTT4001: Fluid and Particle mechanics in Bioprocess

CO/PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M					M			S		S			S
CO2	S	S		M	S					M		M		M
CO3	S	M	S							S				
CO4				S	S	M			M		M			M
CO5	S	M		M										S
CO6	M					M			S		S		M	M

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

CHEMICAL REACTION KINETICS **9 hour**

Classification of chemical reactions, order and molecularity, rate equation, rate constant; Activation energy, Concentration and temperature dependence; Search for reaction mechanism, Methods of analyzing batch reactor data - Integral and differential, Analysis of total pressure data obtained in constant volume system

IDEAL REACTORS **9 hour**

Performance equations - batch, plug flow and mixed flow reactors; Space time and Space velocity; Size comparison of single reactors, multiple reactor systems, Recycle reactor and autocatalytic reactions.

NON-IDEAL REACTORS **9 hour**

Reasons for non-ideality in reactors; RTD function and measurement; RTD in plug flow and mixed flow reactor ; conversion in non ideal flow, relation among E,F and C curve, non - ideal flow models- tank in series and dispersion models.

HETEROGENEOUS REACTING SYSTEM **9 hour**

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Introduction to heterogeneous reacting systems, Ideal contacting patterns, Solid catalysed reactions - Surface kinetics and pore resistance, Kinetics of non catalytic fluid particle systems - Progressive conversion model and shrinking core model, Determination of rate controlling step

INDUSTRIAL REACTORS **9 hour**

Reactors to carry out G/L reactions on solid catalysts - Trickle bed, slurry, three phase fluidized bed, fluid-fluid and fluid-particle reactors.

Theory: 45 hour Tutorial: 0 hour Practical: 0 hour Project: 0 hour Total Hour: 45

References:

1. Coulson & Richardson's, (2009) "Chemical Engineering, Volume.3: Chemical & Biochemical Reactors & Process control", 3rd Edition, Butterworth – Heinemann, United Kingdom.
2. Levenspiel, Octave, (2008), "Chemical Reaction Engineering", John Wiley & Sons.
3. Walker, D. (2007). Chemical Reactions. Evans Brothers.
4. Fogler, H.S.(1999), Elements of Chemical Reaction Engineering, 2nd Edition, New Delhi: Prentice Hall of India.
5. Carberry, J. J., & Varma, A. (1987). Chemical reaction and reactor engineering.

Web reference

1. https://nptel.ac.in/courses/103108097/

U18BTE0002	FOOD PROCESS ENGINEERING	L	T	P	J	C
		3	0	0	0	3

Course Objectives:

- To illustrate various pre-processing techniques in food processing
- To discuss the methods in processing foods

Course Outcomes (COs):

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

CO1: Apply and analyse the pre-cleaning techniques in food processing
CO2 Apply different types of high temperature processing operations
CO3: Illustrate different drying and dehydration techniques
CO4: Categorize several low temperature processing and preservation techniques
CO5: Classify various post -processing operations
CO6: Apply and analyse various packaging operations

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	M	S	S	S							S	
CO2	S	M											S	
CO3		M	M			S							S	
CO4		M											S	
CO5	S												S	
CO6		M											S	

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Pre-requisite Course: U18BTI3205 Microbiology

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

INTRODUCTION TO PRE-PROCESSING **12 Hour**

Raw material preparation: cleaning, air screen cleaners, disk, indent cylinder, spiral, and specific gravity, stone, inclined belt, pneumatic , aspirator; separators: magnetic, cyclone, colour separator, grading; sorting; washing; peeling: flash peeling, steam peeling , knife peeling , abrasion peeling ,lye peeling , flame peeling.

HIGH TEMPERATURE PROCESSING **9 Hour**

Concepts and equipment used in blanching: Blanching theory, equipment, steam blanchers, hot water blanchers; pasteurization and heat sterilization techniques; extrusion; Case Study :evaporation.

PROCESSING USING HOT AIR AND OIL **9 Hour**

Drying: advantages of drying, moisture content, definition, direct and indirect methods of determination; drying methods: heated air and heated surface drying: hot air dryer, contact dryer, rehydration; drying methods and equipment; osmotic dehydration; baking and roasting: theory and equipment; frying: theory and equipment, Osmotic dehydration

PRESERVATION BY LOW TEMPERATURE **9 Hour**

Chilling: theory and equipment, freezing equipment, freeze drying equipment, freeze drying, freeze concentration, thawing, Modified atmospheric storage(MAS),controlled atmospheric storage (CAS).

POST PROCESSING OPERATIONS **6 Hour**

Coating, enrobing, packaging-, Modified atmospheric packaging(MAP), controlled atmospheric packaging(CAP),filling, sealing.

Theory: 45 hour Tutorial: 0 hour Practical: 0 hour Project: 0 hour Total Hour: 45

REFERENCES:

1 Barbosa-Canovas, G. V., & Ibarz, A. (2014). Introduction to food process engineering. CRC Press.

2 Sahu, J. K. (Ed.). (2014). Introduction to advanced food process engineering. CRC Press.

3 Earle, R. L. (2013). Unit operations in food processing. Elsevier(e-book).

4 Fellows, P. J. (2009). Food processing technology: principles and practice. Elsevier.

5 Sahay, K. M., & Singh, K. K. (1996). Unit operations of agricultural processing. Vikas Publishing House Pvt. Ltd.

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WEB REFERENCES

1. www.fao.org/wairdocs/x5434e/x5434e00.htm

U18BTE0003	FOOD PRESERVATION TECHNOLOGY	L	T	P	J	C
		3	0	0	0	3

Course Objectives:

- To explain the principles of food preservation and their impact on the shelf life, quality, and other physical and sensory characteristics of foods.
- To describe with the recent methods of minimal processing of foods
- To discuss the materials and types of packaging for foods

Course Outcomes (COs):

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

CO1: Identify the causes of spoilage
CO2 Categorize high temperature processing techniques
CO3: Apply drying techniques for different foods
CO4: Compare various low temperature processing techniques
CO5: Examine various non-thermal methods of preservation
CO6: Analyze various packaging techniques

CO/PO /PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M				M							S	
CO2	S	M	M										S	
CO3		M	M			S							S	
CO4	M				M								S	
CO5	S												S	
CO6		M											S	

Pre-requisite Course:

1. U18BTE002 Food Process Engineering

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

FOOD AND ITS PRESERVATION **6 Hour**

General principles of preservation, classification of methods used for preservation, need and importance of preservation at domestic and large scale, Causes of food spoilage; Nature of harvested crop, plant and animal – moisture, pH and water activity of foods.

CANNING, RETORT PROCESSING, CONCENTRATION AND DRYING **12 Hour**

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Types and classification of foods used for canning; spoilage of canned and bottled foods, storage of canned foods; Influence of canning on the quality of food; retort pouch processing. Drying –influence of drying on pigments and enzymes; Dehydration of fruits, vegetables, milk, animal products ; Case Study :Osmotic methods. Principles of preservation by use of acid, sugar and salt; High solid - high acid foods; jelly making, food concentrates. Pickling and curing and microbial fermentation.

PRESERVATION BY LOW TEMPERATURE **9 Hour**

Principles of storage using low temperature; Product storage; Effect of cold storage on quality, storage of grains; Principles of refrigerated gas storage of foods, Gas packed refrigerated dough, Sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers. Principles of food freezing: Freezing of raw and processed foods, freeze concentration, freeze drying, IQF.

NON-THERMAL METHODS **9 Hour**

Chemical preservatives, preservation by ionizing radiations, ultrasonication, high pressure, fermentation, curing, pickling, smoking, membrane technology; Hurdle technology, application of infra-red microwaves; Ohmic heating; control of water activity.

FOOD PACKAGING **9 Hour**

Basic packaging materials, types of packaging materials used for different kinds of foods, HACCP Introduction and Principles, Introduction to Food Labelling.

Theory: 45 hour Tutorial: 0 hour Practical: 0 hour Project: 0 hour Total Hour: 45

References:

1 Hui, Y. H., & Evranuz, E. Ö. (Eds.). (2015). Handbook of vegetable preservation and processing. CRC press.

2. Gould, G. W. (2012). New methods of food preservation. Springer Science & Business Media.

3. Rahman, M. S. (2007). Food Preservation. In Handbook of Food Preservation, Second Edition (pp. 14-29). CRC press.

4. Subbulakshmi, G., and Shobha A. Udipi.(2006) .Food Processing and Preservation. New Age Publications.

5. Gould, G. W. (1996). Methods for preservation and extension of shelf life. International journal of food microbiology, 33(1), 51-64.

		L	T	P	J	C
U18BTE0004	**CANCER BIOLOGY**	**3**	**0**	**0**	**0**	**3**

Course Objectives:

- To learn about the fundamentals of carcinogenesis and role of oncogenes
- To understand the regulation of cell cycle in cancer and mechanism of cancer metastasis
- To know about the strategies for cancer diagnosis and therapy

Course Outcomes (COs):

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

CO1: Comprehend role and function of genes in cell cycle regulation

CO2 Apply and evaluate mechanism of oncogenes and proto-oncogenes in cell cycle regulation in cancer

CO3: Attain the knowledge in the fundamentals of carcinogenesis and its role in cancer

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CO4: Illustrate the mechanism of cancer metastasis and progression of cancer stage
CO5: Comprehend the basis of molecular diagnosis of cancer and cancer therapy
CO6: Apply techniques in the field of cancer diagnosis and forms of therapy

Prerequisite

U18BTI4203 Cell & Molecular Biology
U18BTI5201 Genetic engineering and genomics

CO/PO/PSO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		S										S	
CO2	S												S	
CO3	S		S			S							S	
CO4	S		M	S		S							S	
CO5	S		S			S							S	
CO6	S		S	S		S							S	

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

CELL CYCLE REGULATION **9 hour**

Regulation of cell cycle - *S. pombe*, *S. cerevesiae* and mammalian system; Types of mutations that cause changes in signal molecules; Effects on receptor; Tumor suppressor genes -p53 and Rb proteins; Modulation of cell cycle in cancer; Mechanism of action of telomerase. Interaction of cancer cells with normal cells. Role of antioxidants in preventing cancer

ONCOGENES AND PROTO ONCOGENES **9 hour**

Mechanism of oncogene and proto oncogene – epidermal growth factor (EGF), platelet derived growth factor (PDGF), transforming growth factor (TGF), src and myc; RAS cycle; Oncogenes – Identification and detection; Apoptosis – intrinsic and extrinsic pathways. Genetic rearrangements in progenitor cells

MECHANISM OF CARCINOGENESIS **9 hour**

Carcinogenesis – introduction and types; Chemical carcinogenesis – Direct acting and indirect acting carcinogens; Metabolism of carcinogens - CYP450 reductase mechanism; Mechanism of radiation carcinogenesis – ionizing and non-ionizing radiation; Retroviruses - RSV life cycle and its role in cancer; Identification of carcinogens- Long (rat or mice model) and short term bioassays (Bacteria and yeast culture).

CANCER METASTASIS **9 hour**

Metastasis – Introduction and cascade; Clinical significances and three step theory of invasion; Significance of proteases in basement membrane disruption; Properties of cancer cell; brain, oral, lung, uterus, breast & blood – etiology, diagnosis and treatment.

Case study – oral, breast and blood cancers

MOLECULAR DIAGNOSIS AND THERAPY **9 hour**

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Cancer diagnosis– biochemical assays; Tumor markers; Molecular tools for early diagnosis of cancer; Prediction of aggressiveness of cancer; Different forms of therapy – stem cell therapy, Chemotherapy, Radiation therapy and Immunotherapy.

Theory: 45 hour Tutorial: 0 hour Practical: 0 hour Project: 0 hour Total Hour: 45

REFERENCES

1. Weinberg, R. (2013). The biology of cancer. Garland science.
2. Pelengaris, S., & Khan, M. (Eds.). (2013). The molecular biology of cancer: A bridge from bench to bedside. John Wiley & Sons.
3. Fauci, A. S. (Ed.). (2008). Harrison's principles of internal medicine (Vol. 2, pp. 1888-1889). New York: Mcgraw-hill.
4. Thomas, G. (2011). Medicinal chemistry: an introduction. John Wiley & Sons..
5. Tannock, I. F. (2005). The basic science of oncology. McGraw-Hill.
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Web References:

1. http://www.cyclacel.com/research_science_cell-cycle.shtml
2. http://www.cancer.org/treatment/treatmentsandsideeffects/treatmenttypes/
3. http://www.cancer.gov/about-cancer/treatment/types

U18BTE0005	VACCINE TECHNOLOGY	L	T	P	J	C
		3	0	0	0	3

Course Objectives:

- To describe the differences between conventional vaccines and purified antigen vaccines.
- To understand advancement of therapeutic vaccines preparation methods and technological applications
- To acquire fundamental knowledge related to regulatory issues, guidelines and environmental concerns with the use of recombinant vaccines

Course Outcomes (COs):

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

CO1: Comprehend knowledge about the historical vaccine development and conventional vaccines in disease prevention

CO2: Classify and understand about different bacterial vaccine preparation methods

CO3: Acquire fundamental research knowledge to implement the production viral vaccines

CO4: Understand advancement of therapeutic vaccines and technological applications

CO5: Recognize the fundamental knowledge vaccine production through modern recombinant DNA and vaccine delivery methods

CO6: Understand the regulatory issues, guidelines and environmental concerns with the use of recombinant vaccines

Prerequisite

U18BTT6001 Biopharmaceutical Technology; U18BTT6204 Immunology

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CO/PO/PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	S	M	S	S	S						S	M
CO2	S		S		M	S	S							
CO3	S		S		M		S							
CO4	S		S		M		S							
CO5	S		S		S	M	M							
CO6	M		S				S						M	S

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

INTRODUCTION TO VACCINATION **9 hour**

History of vaccine development, Conventional Vaccines, Purified antigen Vaccines. Role of WHO and UIP in disease prevention, Conventional strategies for vaccine development. Live, attenuated, subunit and killed vaccines

BACTERIAL VACCINES **9 hour**

Brief history of Fermentation culture; Technology related to monitoring, temperature, sterilization, environment, quality assurance and related areas. Production techniques - growing the microorganisms in maximum toxicity level, preservation techniques, production and testing of BCG, DPT,TT,

Case Study : A cellular pertussis vaccine and Meningococcal vaccine

VIRAL VACCINES **9 hour**

Primary culture, secondary culture, continuous cell lines, suspension cultures; application of animal cell culture for virus isolation, application of cell culture technology in production of human and animal viral vaccines, Bioreactor technology, freeze drying.

Case study

VACCINE BIOTECHNOLOGY AND DELIVERY METHODS **9 hour**

Vaccine production through recombinant DNA - Various approaches for Novel Vaccine production. Recombinant polypeptide Vaccines, DNA vaccines, Edible Vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines, plant-based vaccines, Strategies and Development (Vaccinia virus recombinants), Role and properties of adjuvants, types of adjuvant, Immunomodulators Innovative methods of delivery of immunogen through liposome's, microspheres, ISCOMS, Nasal immunization.

Case study**:** Nanoemulsion

GUIDELINES FOR THE MANAGEMENT **9 hour**

Regulatory issues Environmental concerns with the use of recombinant vaccines - Disease security and biosecurity principles and OIE guidelines such as seed management Method of manufacture – in-process control, batch control, test on final products.

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Theory: 45 hour Tutorial: 0 hour Practical: 0 hour Project: 0 hour Total Hour: 45

REFERENCES

1. Plotkin, S., Orenstein, W., Offit, P., & Edwards, K. M. (2018). Plotkin's vaccines. *Ljugman P. Cap*, *69*, 1381.
2. Fox, C. B. (2017). *Vaccine Adjuvants*. Humana Press,.
3. Ellis, R. W. (2001). *New vaccine technologies* (Vol. 26). Landes Bioscience.
4. Davies, G. (2010). *Vaccine Adjuvants*. Nova York: Humana Press.
5. Singh, M. (Ed.). (2007). *Vaccine adjuvants and delivery systems*. John Wiley & Sons.
6. Owen, J. A., Punt, J., & Stranford, S. A. (2013). *Kuby immunology* (p. 692). New York: WH Freeman.

		L	T	P	J	C
U18BTE0006	**MOLECULAR DIAGNOSTICS**	**3**	**0**	**0**	**0**	**3**

Course Objectives:

- To learn about the diagnostic techniques related to pathogenic diseases and pre-natal testing.
- To understand the biomarkers for disease diagnosis and biochemical diagnostics.
- To explore the diagnostics tools available for cancer and genetic disorders.

Course Outcomes (COs):

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

CO1: Define the significance of molecular diagnostics and enlist the type of diseases and infections.
CO2 Evaluate the diagnostic tools available for identifying the infections caused by micro-organisms
CO3: Relate the biomarkers as diagnostic tools and infer the biochemical diagnostics for metabolic disorders.
CO4: Comprehend the techniques for the pre-natal testing of inherited genetic disorders.
CO5: Apply the methods available for the diagnosis of cancer.
CO6: Outline the genetic disorders and the tools employed for the detection of neo-natal diseases.

Pre-requisite Courses:

1. U18BTI5201 – Genetic Engineering and Genomics

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CO/PO/PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		S			S							S	
CO2	S	M	S		S	S							S	
CO3	S	M	S		S	S							S	
CO4	S	M	S		S	S							S	
CO5	S	M	S		S	S							S	
CO6	S		S		S	S							S	

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

INTRODUCTION TO MOLECULAR DIAGNOSTICS **9 hour**

History of diagnostics, Age of molecular diagnostics, Significance, Scope, Rise of diagnostic industry in Indian and global scenario.

Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases- bacterial, viral, fungal, protozoans and other parasites.

PATHOGEN DIAGNOSTIC TECHNIQUES **6 hour**

Diagnosis of DNA and RNA viruses. Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis. Study of helminthic diseases: *Fasciola hepatica* and *Ascaris lumbricoides*. Filariasis and Schistosomiasis

Case study: Diagnosis of Dengue virus

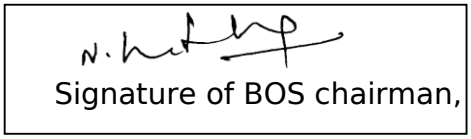
BIOMARKERS IN DISEASE DIAGNOSTICS AND BIOCHEMICAL DIAGNOSTICS 9 hour

FDA definition of disease markers, Role of markers in Disease diagnosis. Approaches and methods in the identification of disease markers, predictive value, diagnostic value, emerging blood markers for sepsis, tumour & cancer markers, markers in inflammation and diagnosis of cytoskeletal disorders.

Biochemical diagnostics: inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses, lipidoses, and glycogen storage disorders

PRENATAL DIAGNOSIS **9 hour**

Invasive techniques - Amniocentesis, Fetoscopy, Chorionic Villi Sampling (CVS), Non-invasive techniques -Ultrasonography, X-ray, TIFA, maternal serum and fetal cells in maternal blood. Diagnosis using protein and enzyme markers, monoclonal antibodies. DNA/RNA based diagnosis Hepatitis, CML-bcr/abl, HIV - CD 4 receptor. Microarray technology- genomic and cDNA arrays, application to diseases.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CANCER AND GENETIC DISORDERS DIAGNOSTICS **12 hour**

Methods available for the diagnosis of genetic diseases and metabolic disorders.

Cancer - Cancer cytogenetics. Spectral karyotyping. Genes in pedigree. Genetic Counselling.

Genetic disorders - Sickle cell anaemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis and Sex –linked inherited disorders.

Neonatal and Prenatal disease diagnostics. Gender identification using amelogenin gene locus. Amplification of Y chromosome specific Short Tandem Repeats (Y-STR). Analysis of mitochondrial DNA for maternal inheritance. karyotype analysis. G-banding, in situ hybridization (FISH and on-FISH), and comparative genomic hybridization (CGH).

Case study: Immuno diagnosis of cancer

Theory: 45 hour Tutorial: 0 hour Practical: 0 hour Project: 0 hour Total Hour: 45

References:

1. Nader, R.(2018). *Teitz Textbook of Clinical Chemistry and Molecular Diagnostics.* 6th edition, Saunders.
2. George, P., Wilhelm, A., Philip, B.D. (2016). *Molecular Diagnostics*. 3rd edition. Academic Press.
3. Wayne W. G, Robert M. N, Frederick L. K. and Charles S. (2010) *In: Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory*, 2nd edition, Elsevier Science.
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5. David E. B, Edward R. A. and Carl A. B. (2007). *Fundamentals of Molecular Diagnostics.* 1st edition, Saunders Group.

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6. https://www.sciencedirect.com/topics/medicine-and-dentistry/molecular-diagnostics
7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1214554/
8. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4375750/

U18BTE0007	NANOBIOTECHNOLOGY	L	T	P	J	C
		3	0	0	0	3

Course Objectives:

- To develop the knowledge on nanomaterials synthesis and characterization and their appli

Course Outcomes (COs):

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

CO1: Understand the synthesis processing of various nanomaterials

CO2: Apply and interpret the various characterization techniques for nanomaterials

CO3: Apply and evaluate the various nanomaterials applications in different field

CO4: Understand and apply the natural bionanomlecules for various biological applications

CO5: Understand and apply the nanobiochips, nanobiosensor and micro array for biological applications

CO6: Evaluate the nanomaterials in cancer diagnosis and treatment

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Prerequisite: U18BBT3002 – Biomolecules and Genetics

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S				M								
CO2	S	S	M			S						M		
CO3	S		S									S	M	S
CO4	S		S	M								M		S
CO5	S	S										S		S
CO6	S													S

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

INTRODUCTION TO NANOBIOTECHNOLOGY **9 hour**

Introduction to Nanotechnology and nanobiotechnology: Properties at nanoscale; overview of nanodevices and techniques; General synthesis methods of nanoscale materials; top down and bottom up approaches; Biological approach to self assembly.

CHARACTERIZATION TECHNIQUES **9 hour**

X-ray diffraction technique; Scanning Electron Microscopy with EDX; Transmission Electron Microscopy, Zeta Potential, Particle size analyzer; Surface Analysis techniques;: AFM, SPM, STM, SNOM, ESCA, SIMS; Nanoindentation.

NANOMATERIALS AND APPLICATIONS **9 hour**

Inorganic nanoscale systems for biosystems: nanostructure materials of fullerenes, carbon nanotubes, quantum dots and wires, preparation, properties and applications; Nanopores: applications.

NANOMOLECULES IN BIOSYSTEMS **9 hour**

Nanomolecules in biosystems: Proteins, RNA and DNA nanoscale elements for delivery of materials into cells; DNA based artificial nanostructures; proteins as components in nanodevices; Tissue regeneration using anti-inflammatory nanofibres; Polymer nanofibers and applications; polymer nanocontainer; magnetosomes; bacteriorhodopsin: applications; S-layer proteins.

APPLICATION OF NANOBIOTECHNOLOGY **9 hour**

Nanoscale devices for drug delivery: micelles for drug delivery; targeting; bioimaging; microarray and genome chips; nanobiosensors and nanobiochips; Nanotechnology for cancer diagnosis and treatment; Case study: Nanomaterials on drug delivery.

Theory: 45 hour **Tutorial: 0 hour** **Practical: 0 hour** **Project: 0 hour** **Total Hour: 45**

REFERENCES

1. Niemeyer, C. M., and CA Mirkin, C. A., (2010); NanoBiotechnology II – More concepts,

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and applications. First edition, Wiley –VCH publications
2. Rosenthal, S.J. and Wright, D.W., (2010); Nanobiotechnology Protocols, First Edition, Humana Press
3. Oded shoseyov & Ilan Levy (2008); Nanobiotechnology – Bioinspired and materials of the future. Humana press, New Jersey
4. Mirkin, C. A., & Niemeyer, C. M. (Eds.). (2007). Nanobiotechnology II: more concepts and applications. John Wiley & Sons.
5. Jain, K. K. (2006); NanoBiotechnology in molecular diagnostics –current technique and applications, First edition, Taylor and Francis

Web References

1. http://www.understandingnano.com

		L	T	P	J	C
U18BTE0008	**NEUROBIOLOGY AND COGNITIVE SCIENCES**	**3**	**0**	**0**	**0**	**3**

Course Objectives:

- To learn about the neuroanatomy and neurophysiology
- To understand the concept of synaptic transmission and mechanism of action of neurotransmitters
- To gain insight into the mechanism of sensations and disorders related to nervous system.

Course Outcomes (COs):

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

CO1: Comprehend the central and peripheral nervous system, and describe the structure and functions of neurons and supporting cells

CO2 Analyze the mechanism of action potential conduction and working of voltage dependent channels.

CO3: Illustrate the concept of synaptic transmission and mechanism of action of neurotransmitters.

CO4: Evaluate mechanism of sensations and skeletal muscle contraction.

CO5: Enumerate the mechanisms associated with motivation behaviors.

CO6: Summarize the various disorders of nervous system.

Pre-requisite Course:

1. U18BTI3204 Concepts in Biochemistry

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CO/PO/PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		S			M								
CO2	S													
CO3	S					M							W	
CO4	S		M		S	S						S	W	
CO5	S		S			S							M	
CO6	S	S	S			S						S	S	

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

NEUROANATOMY **9 hour**

Classification of central and peripheral nervous system, Neurons: structure, types and functions – Neuronal membrane, cytoskeleton, axon, dendrites; Glial cells: types; Synapses: types and functions; Myelination; Blood Brain barrier; Neural Development; Cerebrospinal fluid: origin and composition; Spinal cord - functions.

NEUROPHYSIOLOGY **9 hour**

Resting and action potential: introduction; Properties and mechanism of action potential conduction; Voltage dependent channels: sodium and potassium channels; Principle of metabotropic receptors; Electrical transmission

NEUROPHARMACOLOGY **9 hour**

Synapse formation; Synaptic transmission: Principles of Chemical synaptic transmission.
Principles of synaptic integration; neurotransmitters and their mechanism of action: acetyl choline, serotonin, dopamine and ɣ-amino butyric acid (GABA); Peptide transmitters: mechanism of action; Nicotinic and muscarinic acetyl choline receptors; hypothalamic control of neuronal function

APPLIED NEUROBIOLOGY & MODERN DIAGNOSTIC TOOLS **9 hour**

Basic mechanisms of sensations: touch, pain, smell, taste; neurological mechanisms of vision and audition; skeletal muscle contraction (neuromuscular junction).
Imaging techniques to study Brain functions – EEG, MRI
Case study – Brain-Machine Interface

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BEHAVIOURAL SCIENCE **9 hour**

Basic mechanisms associated with motivation; Hypothalmus, homeostasis and motivated behavior; regulation of feeding, sleep, emotions. Molecular mechanisms of memory and leaning; Disorders associated with nervous system: Parkinson's disease, Alzheimer's disease, Schizoprenia, Epilepsy; Anxiety and mood disorders - Depression, Agrophobia.

Case study – Degenerative diseases of the nervous system

Theory: 45 hour Tutorial: 0 hour Practical: 0 hour Project: 0 hour Total Hour: 45

References:

1. Striedter, G. F. (2015). Neurobiology: a functional approach. Oxford University Press.
2. Squire, L., Berg, D., Bloom, F.E., du Lac, S., Ghosh, A., Spitzer, N.C (2012). Fundamental Neuroscience, 4th edition, UK: Academic Press.
3. Abel, L. & Sylvester, E.V (2008). Handbook of Neurochemistry and Molecular Neurobiology: Neurotransmitter systems, 3rd edition, Springer.
4. Bear, M., Connors, B., &Paradiso, M. (2006). *Neuroscience – Exploring the Brain*, 3rd edition, USA: Lippincott Williams & Wilkins
5. Mathews G G. (2000). *Neurobiology*: Molecules, cells and systems, 2nd edition, UK: Blackwell Science.

Web References:

1. https://ocw.mit.edu/courses/brain-and-cognitive-sciences/9-01-introduction-to-neuroscience-fall-2007/lecture-notes/
2. https://ocw.mit.edu/courses/brain-and-cognitive-sciences/9-01-neuroscience-and-behavior-fall-2003/study-materials/

		L	T	P	J	C
U18BTE0009	**MEMBRANE TECHNOLOGY**	**3**	**0**	**0**	**0**	**3**

Course Objectives:

- To learn and apply the principles of membranes in the water treatment, bioprocess and food process industries

Course Outcomes (COs):

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

CO1: Learn various transport models for the calculation of membrane fluxes and the extent of separation for various membrane systems

CO2 Identify the types of experimental data needed for the calculation of membrane parameters

CO3: Understand the pretreatment techniques for the membranes

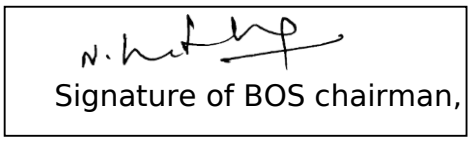
CO4: Select a membrane process and design components to carry out a specific separation

CO5: Comprehend advancements in membrane techniques to solve environmental problems

CO6: Design the membrane separation for bio and food processes

Prerequisite

1. U18BTT3003 Bio-process Calculations



2. U18BTI5205 Heat and mass transport in Bioprocess

CO/PO/PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	S			S							M		S
CO2	M	S			S							M		S
CO3	M	S			S							M		S
CO4	M	S			S							M		S
CO5	M	S			S		M					M		S
CO6	M	S			S		M		M			M		S

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

INTRODUCTION **9 hour**

Solid Liquid separation systems - Filtration -Theory of Membrane separation - Mass transport Characteristics - Cross Flow filtration - Types and choice of membranes, Plate and Frame, spiral wound and hollow fibre membranes - Liquid Membranes: Emulsion and supportive liquid membrane

THEORY AND PRINCIPLE **9 hour**

Microfiltration-Ultrafiltration-Nano Filtration -Reverse Osmosis -Electro dialysis-Pervaporation - Membrane Module/Element designs-Membrane System components-Design of Membrane systems

PRETREATMENT **9 hour**

Membrane Fouling -Pretreatment methods and strategies -monitoring of Pretreatment-Langlier Index, Silt Density Index, Chemical cleaning, Biofoulant control

HETEROGENEOUS REACTING SYSTEM MEMBRANES IN WATER TREATMENT **9 hour**

Introduction and Historical Perspective of Membrane Bioreactors (MBR), Biotreatment Fundamentals, Biomass Separation MBR Principles, Fouling and Fouling Control, MBR Design Principles, Design Assignment, Alternative MBR Configurations

MEMBRANE IN BIO AND FOOD PROCESSES **9 hour**

Bioprocess: Hemodialysis-electrodialysis-Virus removal by ultrafiltration. Food process: membrane distillation, Pervaporation, membranes in dairy industry

Theory: 45 hour Tutorial: 0 hour Practical: 0 hour Project: 0 hour Total Hour: 45

References:

1. Ho, W., & Sirkar, K. (2012). *Membrane handbook*. Springer Science & Business Media.
2. Bungay, J. K. (2012). *Synthetic Membranes:: Science, Engineering and Applications* (Vol. 181). Springer Science & Business Media.
3. Mulder, J. (2012). *Basic principles of membrane technology*. Springer Science & Business Media.

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4. Baker, R. W., & Updated by Staff. (2000). Membrane technology. *KirkOthmer Encyclopedia of Chemical Technology*.
5. Cheryan, M. (1998). *Ultrafiltration and microfiltration handbook*. CRC press.

Web References

1. 1. http://nptel.ac.in/courses/103103032
2. 2. http://nptel.ac.in/courses/103103035

		L	T	P	J	C
U18BTE0010	**BIOENTREPRENEURSHIP**	**3**	**0**	**0**	**0**	**3**

Course Objectives:

- To learn about the factors, attributes and indicators of bio-entrepreneurship.
- To learn the business strategies and technology transfer in biotech companies.
- To study the various concepts on creativity, innovation, product development and technology transfer

Course Outcomes (COs):

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

CO1: Learn about the factors, attributes and indicators of bio-entrepreneurship.
CO2 Learn business strategies and technology transfer in biotech companies.
CO3: Illustrate the components of biotechnology companies
CO4: Impart the knowledge on Creativity, Innovation and New product development.
CO5: Inculcate novel strategies on identifying market demands, establishing market niche.
CO6: Understand the market and product development strategies

Pre-requisite Course:

1. -

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M					M			S		S			
CO2	S	S		M	S					M		M		
CO3	S	M	S							S				
CO4				S	S	M			M		M			
CO5	S	M		M										
CO6	S												S	

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

FUNDAMENTALS OF ENTREPRENEURSHIP **9 hour**

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Entrepreneurship, Definition; Factors necessary for Entrepreneurship, Attributes in an Entrepreneur, Bio-entrepreneurship, Indicators of Bio-entrepreneurship Case study: Building of a Bio-entrepreneur.

FUNDING OPTIONS, FINANCIAL PLANNING AND INVESTMENT STRATEGIES 9 hour

Writing a business proposal, funding and establishing a biotech start-up, basics of trading, stocks and shares, risk management and diversification of risks.

COMPONENTS OF BIOTECH COMPANY AND BUSSINESS MODELS 9 hour

Paths for starting new biotech ventures, history of pioneering biotech companies, Key for success, Mission and Strategy, product selection for new biotech venture, evaluation of company's annual report (a case study).

INNOVATION AND TECHNOLOGY TRANSFER 9 hour

Intellectual property in biotech - Licensing, Accessing University technology, Licensing of Biotechnological invention, Funding agencies in India.

MARKET RESEARCH AND PRODUCT DEVELOPMENT 9 hour

Strategies to identify market demands, establishing market niche, competing in a crowded market place, adaptation to market needs and case study on Indian and global entrepreneurs.

Theory: 45 hour Tutorial: 0 hour Practical: 0 hour Project: 0 hour Total Hour: 45

REFERENCES:

1. Navi R, 2015, Frugal Innovation: How to do more with less, The Economist.
2. Joel G and Andrew T, 2015, The Little Book That Still Beats the Market, Wiley Books.
3. Venter J.C, 2014, Life at the Speed of Light: From the Double Helix to the Dawn of Digital Life, Little Brown Book Group.
4. Branson R, 2009, Business Stripped Bare: Adventures of a Global Entrepreneur, Virgin Books.
5. Jogdand, S.N. 2007. Entrepreneurship and Business of Biotechnology, Himalaya Publishing Home,

		L	T	P	J	C
U18BTE0011	**INDUSTRIAL BIOSAFETY AND BIOETHICS**	**3**	**0**	**0**	**0**	**3**

Course Objectives:

- To create awareness, practice of Industrial biosafety regulation and bioethics

Course Outcomes (COs):

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

CO1: Describe various risk assessments and associated biosafety practices at industrial level.
CO2 Demonstrate and Classify Biosafety levels
CO3: Elucidate various biosafety guidelines, norms and regulations.
CO4: Assess GMO's and its regulation in terms of environmental release
CO5: Acquire knowledge on ethical issues, guideline and regulations.
CO6: Discuss environmental release of GMOs and their impact

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CO/PO/PSO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S												S	
CO2	S	S			M		M	M					S	S
CO3		M			S		S	S						M
CO4		M			S		S	M						M
CO5		S			M							M		S
CO6	S	S											S	S

Pre-requisite Course: -

Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

Course Content

INDUSTRIAL BIOSAFETY **9 hour**

Introduction to Biosafety; Causes- classification, identification of hazards; issues handling; awareness of accidents at industrial level; types of accidents; first aid, precautionary measure;Clean room procedures- Classification specification; Personal protective equipment working with biohazards; Proper gowning and hygiene for clean room work; Behavioral requirements in a controlled environment; Basic methods for safe handling, transport, and storage of biological and chemical materials; Equipment related hazards; safe laboratory techniques; Contingency plan and emergency procedures.

LEVELS OF BIOSAFETY **12 hour**

Introduction to Biological safety cabinets; Horizontal & Vertical Laminar Air Flow Cabin; Fume hood; Primary and secondary containments; Biosafety levels of specific Microorganisms (food and water borne pathogens), Infectious Agents (Chemicals and carcinogens); MSDS- Material Safety Data Sheet- Understanding, and infected animals (test animals).

FDA AND FPO BIOSAFETY GUIDELINES **6 hour**

FDA guideline and approval; FPO specification and guidelines for food products; GOI - Biosafety procedure, time frames and specification for Production and manufacturing industries- Case study

INTRODUCTION TO BIOETHICS **6 hour**

Definition of bioethics; Environmental release of GMOs- Risk analysis, Risk assessment, Risk management and Communication; Precaution before and after environmental release of GMO's – case study.

REGULATORY AFFAIRS **12 hour**

Overview of national regulation and international agreement on GMO; Cartagena protocol- articles; Ethical committee- administration channel; Role of NIH, IACUC,IBSC

Theory: 45 hour Tutorial: 0 hour Practical: 0 hour Project: 0 hour Total Hour: 45

References:

1. Deepa Goel and Ms.Shomini Parashar , (2013) IPR, Biosafety and Bioethics, Pearson Education publisher

Signature of BOS chairman, BT

2. Kumar S (2012) Biosafety issues in laboratory research. Biosafety 1:e116.
3. Sateesh, M. K. (2010) Bioethics and biosafety. IK International Pvt Ltd.
4. Singh. K, (2010), Intellectual Property Rights in Biotechnology, BCLI, New Delhi
5. Shaleesha A. Stanley (2007) Bioethics, Wisdom educational service, Chennai.
6. Fleming, D.A., Hunt, D.L., (2000). Biological safety Principles and practices (3rd Ed). ASMPress, Washington.

Web References

1. http://blink.ucsd.edu/safety/research-lab/biosafety/
2. http://ces.iisc.ernet.in/hpg/cesmg/iprdoc.html
3. https://www.fic.nih.gov/RESEARCHTOPICS/BIOETHICS/Pages/teachers-students.aspx
4. 4https://www.omicsonline.org/open-access/biosafety-issues-of-genetically-modified-organisms-2167-0331.1000e150.php?aid=27764&view=mobile
5. http://www.who.int/csr/resources/publications/biosafety/Biosafety

U18BTE0012	BIOPROCESS DESIGN AND ECONOMICS	L	T	P	PJ	C
		3	0	0	0	3

Course Objectives:

To introduce about the various application of chemical engineering principles for development of new processes to produce these new chemicals, and development of marketable technology

Course Outcomes (COs):

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

CO1: Able to apply and develop the flow sheets used in bioprocess industry

CO2 Apply and evaluate the capital cost for construction of a new plant or modifications to an existing chemical manufacturing plant

CO3: Apply and evaluate the manufacturing cost (operating cost)for production of bioproducts

CO4: Apply and evaluate the economic evaluation of the bioproducts

CO5: Understand the basics of techno-economical assessments for bioenergy systems

CO6: Understand the basics of life cycle assessments for the analysis of bioenergy system

Prerequisite: U18BTI5203 Heat and Mass Transport in Bioprocess

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		M			S								S
CO2	S		M			S								S
CO3	S		M			S								S
CO4	S		M			S								S
CO5	S		M			S								S
CO6	S		M			S								S

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Course Assessment methods:

Direct
1. Continuous Assessment Test
2. Assignment
3. End Semester Examination

DIAGRAMS FOR UNDERSTANDING CHEMICAL PROCESSES **9 hours**

Block Flow Diagrams (BFDs), Block Flow Process Diagram, Block Flow Plant Diagram, Process Flow Diagram (PFD), Process Topology, Stream Information, Equipment Information, Combining Topology, Stream Data, and Control Strategy to Give a PFD, Piping and Instrumentation Diagram (P&ID).

ESTIMATION OF CAPITAL COSTS **9 hours**

Classifications of Capital Cost Estimates, Estimation of Purchased Equipment Costs, Estimating the Total Capital Cost of a Plant- problem solving.

ESTIMATION OF MANUFACTURING COSTS **9 hours**

Factors Affecting the Cost of Manufacturing a Chemical, Product, Cost of Operating Labor, Utility Costs, Background Information on Utilities, Calculation of Utility Cost, Raw Material Costs ,Yearly Costs and Stream Factors, Estimating Utility Costs from the PFD, Cost of Treating Liquid and Solid Waste Streams. Case study: Evaluation of Cost of Manufacture for the Production of bioethanol.

ENGINEERING ECONOMIC ANALYSIS **9 hours**

Investments and the Time Value of Money. Different Types of Interest. Time Basis for Compound Interest Calculations. Cash Flow Diagrams. Inflation. Depreciation of Capital Investment. Taxation, Cash flow and profit.
Case studies: A Typical Cash Flow Diagram for a New Project. Profitability Criteria for Project Evaluation

TECHNO-ECONOMIC ASSESSMENT **5 hours**

Introduction to Techno-Economic analysis (TEA). Basic steps in TEA; Tools, Software & Data source for performing TEA – Tools available for performing TEA, Procedure for TEA using commercial software, Data source for performing TEA, Process optimization using TEA.

LIFE CYCLE ANALYSIS **4 hours**

Introduction to Life cycle analysis (LCA). Procedure for LCA: Goal and defining and scoping , life cycle Inventory, Life cycle Impact Assessment, Life cycle Interpretation. Tools available to perform LCA. Case studies: Life cycle assessment of bio-based products from agro wastes

Theory : 45 hours **Tutorial: 0 hours** **Practical: 0 hours** **Total: 45 Hours**

References

1. Bhattacharya B.C. (2018), i*ntroduction to chemical equipment design: mechanical aspects*. Chemical Engineering Education Development Centre, Indian Institute of Technology, 1976.
2. Max, S. P., Klaus, D. T., & Ronald, E. W. (2017). Plant design and economics for chemical engineers. *International edition*.
3. Li, Y. (2016). Bioenergy: Principles and Applications. John Wiley & Sons

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4. Turton, R., Bailie, R. C., Whiting, W. B., & Shaeiwitz, J. A. (2008) 4/e, *Analysis, synthesis and design of chemical processes*. Pearson Education.

5. Peters, Max S., K.D. Timmerhaus and R.E. West, Plant Design and Economics for Chemical Engineers (2003) 5/e, McGraw-Hill International Editions (Chemical Engineering Series), New York, USA (2003).

Web References

1. https://nptel.ac.in/syllabus/103103039/

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U18BTE0013 HUMAN PHYSIOLOGY AND ALLIED DISEASES

L	T	P	PJ	C
3	0	0	0	3

Course Objectives:

- To learn the fundamental concepts of different physiological processes of human beings
- To understand and describe the pathophysiology of selected diseases contracted by mankind
- To analyze and interpret the clinical results of few selected diseases

Course Outcomes (COs):

After successful completion of the course, the students should be able to

CO1: Describe the digestion and absorption physiology, and to evaluate the pathophysiological conditions
CO2: Understand , elaborate and interpret the functioning of cardiac cycle, mechanism of regulation of blood pressure, and allied pathophysiology
CO3: Demonstrate the physiological and pathophysiological processes of renal and respiratory systems
CO4: Discuss the phenomenon of conduction of nerve impulses and interpret the mechanism of Parkinson's disease
CO5: Understand and illustrate the physiological phases of spermatogenesis and menstrual cycle, and explain the etiology of menopause
CO6: Analyze and interpret the clinical oriented diagnostic results of selected diseases

Pre-requisite:

1. Nil

CO/ PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
	PROGRAMME OUTCOMES (Pos)												PSOs	
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	M	M		M						M	W	
CO2	S	S	M	M		M						M	W	
CO3	S	S	M	M		M						M	W	
CO4	S	S	M	M		M						M	W	
CO5	S	S	M	M		M						M	W	
CO6	S	S	S	S		S						M	W	

Course Assessment Methods			
Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments		
3	End semester examination		

Course Content **45 hours**

1. **GASTROINTESTINAL PHYSIOLOGY AND PATHOPHYSIOLOGY** **9 hours**

Introduction to digestive system; Overview of GI tract layers; Overview of digestion and absorption processes; Composition and functions – salivary, gastric, pancreatic and bile juices; Functions of small and large intestines. Functions of liver; Pathophyisology – peptic ulcer and diabetes mellitus

2. **CARDIOVASCULAR PHYSIOLOGY AND PATHOPHYSIOLOGY** **9 hours**

Blood – composition, properties and functions; Overview of layers of heart wall and heart valves; Physiology of blood circulation process; Overview of cardiac cycle (briefing the stages is sufficient); Overview of blood pressure and mechanism of renin-angiotensin and baroreceptor system to control blood pressure; Pathophysiology – Myocardial infarction & valvular diseases.

3. **RENAL AND RESPIRATORY PHYSIOLOGY, AND PATHOPHYSIOLOGY**

9 hours

Functions of renal system (kidney); Overview of structure of nephron; Mechanism of urine formation; Overview of structure of respiratory tract; Mechanism of gaseous exchange in lungs; Bohr's effect and chloride shift

Etiology of acute and chronic failures; Pathophysiology of pulmonary tuberculosis & SARS CoV infection

4. **NEURO AND REPRODUCTIVE PHYSIOLOGY AND PATHOPHYISOLOGY**

9 hours

Introduction and classification of nervous system, Structure and functions of neuron, Conduction of nerve impulse – resting and action potentials; Physiological phases of spermatogenesis & menstrual cycle; Functions of sex hormones. Etiology, symptoms and therapy of menopause; Pathophysiology of Parkinson's disease.

5. **CLINICAL DIAGNOSIS** **9 hours**

Diabetes type I & II – Plasma glucose levels (fasting & postprandial), oral glucose tolerance test (OGTT), immunoassay predictions & serum glycated hemoglobin (HbA1c) levels; Impact of cholesterol levels in several diseases (hypo- & hypercholesterolemia); Impact of International Normalized Ratio (INR) in critical cardiac diseases; Liver function tests (LFTs) – serum aminotransferases, bilirubin, prothrombin time (PT) & albumin; Renal function tests (RFTs) – physical, microscopic & biochemical analysis of urine, and serum biochemical analysis.

(Protocols NOT needed; Interpretation of diseases based upon normal values is sufficient)

Theory: 45 hours Tutorial: 0 hours Practical: 0 hours Project: 0 hours Total hours: 45

Textbooks:

1. Sembulingam, K & Prema Sembulingam. (2019) Essentials of Medical Physiology (8th Ed.). Jaypee Brothers Medical Publishers (P) Ltd. New Delhi.
2. Nitin Ashok John. (2019). CC Chatterjee's Human Physiology Volume 1 (13th Ed.) CBS Publishers & Distributors, New Delhi. item Nitin Ashok John. (2019). CC Chatterjee's Human Physiology Volume 2 (13th Ed.) CBS Publishers & Distributors, New Delhi.
3. John E. Hall. (2016). Guyton and Hall Textbook of Medical Physiology (13th Ed.). Elsevier Inc.
4. Stuart H. Ralston, Ian D Penman, Mark W J Strachan, Richard Hobson. (2018). Davidson's Principles and Practice of Medicine. Elsevier Inc.
5. Nessar Ahmed. (2017). Clinical Biochemistry, Oxford University Press, UK.
6. Carl A. Burtis, David E. Bruns. (2015). Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics (7th Ed.). Elsevier Inc.
7. Mohanty & Basu. (2006). Fundamentals of Practical Clinical Biochemistry. B. I. Publications (P) Ltd. New Delhi.
8. Ranjna Chawla. (2014).Practical Clinical Biochemistry: Methods and Interpretations (4th Ed.). Jaypee Brothers Medical Publishers (P) Ltd. New Delhi.
9. Gillian Pocock, Christopher D. Richards, David A. Richards. (2013). Human Physiology (4th Ed.). Oxford University Press, UK.

Web-References:

1. SARS-CoV
2. SARS CoV Mechanism

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U18BTE0014 CHEMISTRY OF NATURAL PRODUCTS OF PLANTS

L	T	P	PJ	C
3	0	0	0	3

Course Objectives:

- To understand the impact of various traditional medicinal systems against ailments
- To learn the occurrence, extraction methods and biological applications of different phytochemicals or natural products from plant sources
- To comprehend the significance of herbal medicine and nutraceuticals

Course Outcomes (COs):

After successful completion of the course, the students should be able to

CO1: Compare and contrast the significance of different types of traditional medicine
CO2: Understand and explain the classification and biological applications of alkaloids
CO3: Learn and demonstrate the types and functional benefits of flavonoids
CO4: Describe the classification and health benefits of essential oils
CO5: Illustrate the classification and biological applications of phytosterols
CO6: Explain the overview of biological impact of herbal medicines and nutraceuticals

Pre-requisite:

1. Nil

CO/ PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
	PROGRAMME OUTCOMES (Pos)												PSOs	
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	W			W								
CO2	S	S	M	M		M								
CO3	S	S	M	M		M								
CO4	S	S	M	M		M								
CO5	S	S	M	M		M								
CO6	S	S	M			S						M	W	

Course Assessment Methods			
Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments		
3	End semester examination		

Course Content **45 hours**

1. **INTRODUCTION TO TRADITIONAL MEDICINE** **9 hours**

Traditional medicine – Introduction, types and history; Ayurveda, siddha and traditional Chinese medicine (TCM) - basic principles, diagnosis and therapy; Overview of African, Middle East, Australian and European traditional medicine; Natural products – definition, historical background and classification.

2. **ALKALOIDS** **9 hours**

Alkaloids – definition, occurrence, classification, biosynthesis (Structures NOT needed, any one type of alkaloid is sufficient), physical properties, extraction and purification methods, and biological applications.

Case Study: Piperdine, pyridine and opium alkaloids – occurrence, isolation, characteristic features and biological applications.

3. **FLAVONOIDS** **9 hours**

Polyphenols – Introduction and classification; Flavonoid – Classification, biosynthesis (Structures NOT needed, any one type of flavonoid is sufficient), physical properties, extraction and purification methods, and biological applications.

Case Study: Occurrence and biological applications (any ONE flavonoid with mechanism)

4. **ESSENTIAL OILS AND PHYTOSTEROLS** **9 hours**

Essential oils - definition, classification, occurrence, physical properties, extraction methods, and biological applications; Phytosterols - definition, classification, occurrence, and biological applications.

5. **HERBAL INDUSTRY AND NUTRACEUTICALS** **9 hours**

Herbal industry – overview of standardization of plant materials, regulatory requirements for herbal medicines; WHO guidelines on traditional / herbal medicine; Nutraceuticals – definition, classification, and biological applications.

Theory: 45 hours Tutorial: 0 hours Practical: 0 hours Project: 0 hours Total hours: 45

Textbooks:

1. Simone Badal Mccreath & Rupika Delgoda. (2017). Pharmacognosy: Fundamentals, Applications and Strategies. Elsevier Inc.
2. Dr.M.Pitchiah kumar, Dr.G.Senthilvel & Dr.J.Jeyavenkatesh. (2018). Fundamentals of Siddha Internal Medicine. Shanlax Publications, Madurai, Tamil Nadu, India.
3. Kofi Busia. (2016). Fundamentals of Herbal Medicine: History, Phytopharmacology and Phytotherapeutics, (Vol. 1). Xlibris Publishing, UK.
4. Shukla, Y.M., Jitendra J. Dhruve., Patel, N.J., Ramesh Bhatnagar., Talati, J.G., & Kathiria, K.B (2009). Plant secondary metabolites. New India Publishing Agency, New Delhi.
5. Alan Crozier, Michael N. Clifford & Hiroshi Ashihara. (Eds). (2006). Plant Secondary Metabolites: Occurrence, Structure and Role in the Human Diet. John Wiley & Sons
6. Rensheng Xu, Yang Ye, Weimin Zhao. (Eds). (2012) Introduction to Natural Products Chemistry. CRC press (Taylor & Francis group, LLC).
7. Ashutosh Kar. (2003). Pharmacognosy And Pharmacobiotechnology. New Age International (P) Ltd. Publishers, New Delhi
8. Shanti Bhushan Mishra (2018). Essentials of Herbal Drug Technology: A Guide of Standardization Quality Control. Educreation Publishing, New Delhi, India.
9. Alexandru Grumezescu. (2016).Nutraceuticals (Nanotechnology in the Agri-Food Industry; Vol. 4). Elsevier Inc.

Web-References:

1. Flavonoid
2. Quercetin Review
3. Phytosterol
4. Nutraceuticals

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U18BTE0015 NOVEL FOOD PACKAGING

L	T	P	PJ	C
3	0	0	0	3

Course Objectives:

- The purpose of this course is to explain the various recent techniques of food packaging, applications, principles and requirements of these techniques.
- Identify the purpose, principle and advance knowledge related to the various packaging technology systems.
- Awareness of students about the recycling of packaging materials, biodegradable packaging materials and safety and legislative aspects.

Course Outcomes (COs):

After successful completion of the course, the students should be able to

CO1: Comprehend advance knowledge on the properties of various packaging materials and effect of various indicators used in supply chain management to indicate the food quality
CO2: Learn about different types of packaging machineries.
CO3: Understand about active packaging systems requirements
CO4: Learn about consumer response about new packaging systems and safety and legislative requirements
CO5: Acquaint about food-package interaction between package-flavour, gas storage systems for food storage
CO6: Recycling and use of green plastics for reducing the pollution and their effect on food quality

Pre-requisite:

1. Nil

CO/ PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
	PROGRAMME OUTCOMES (Pos)												PSOs	
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M				M							S	
CO2	S	M	M										S	
CO3		M	M			S							S	
CO4	M				M								S	
CO5	S												S	
CO6		M											S	

Course Assessment Methods			
Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments		
3	End semester examination		

Course Content **45 hours**

1. **TYPES OF PACKAGING** **9 hours**

Important functions of package, packaging materials and various package forms, pouches, Properties, advantages and limitations of the following packaging materials: Glass, aluminum, its foil, metal tin containers; Paper and paperboards, laminates and multilayer composition, retortable pouches plastic films- LDPE, and LLDPE, HDPE, PVC, PS, PP, BOPP,PVD, EVA Polyester, cellulose acetate, PET, blister packaging; packaging regulations of FSSAI.

2. **PACKAGING MACHINERY, LABEL AND PACK DESIGN, TESTING AND IDENTIFICATION** **9 hours**

Form fill and Seal machine, gravitational and volumetric filling, filler for pasty products, filler for dry products, piston type filling machine Label, types of label, importance of Nutritional Labeling Package design consideration, cushioning materials and their properties Testing and Identification of packaging materials.

3. **ACTIVE PACKAGING TECHNIQUES** **9 hours**

Active and intelligent packaging techniques, oxygen, ethylene and other scavengers: Oxygen scavenging technology, selection of right type of oxygen scavengers, ethylene scavenging technology, carbon dioxide and other scavengers, antimicrobial food packaging, antimicrobial packaging system, effectiveness of antimicrobial packaging.

Case Study: Perspectives of Human Wisdom on Eco-Friendly Food.

4. **MODIFIED AND CONTROLLED ATMOSPHERIC PACKAGING** **9 hours**

Modified atmosphere packaging (MAP): Novel MAP applications for fresh-prepared produce, novel MAP gases, testing novel MAP applications, Applying high O2 MAP. Combining MAP with other preservation techniques, role of differing packaging materials. Controlled atmospheric packaging: CAP gases, methods.

5. **MODERN PACKAGING SYSTEMS** **9 hours**

Green plastics for food packaging, problem of plastic packaging waste, range of biopolymers, developing novel biodegradable materials, storage and distribution: alarm systems and time temperature indicators, traceability: radio frequency identification, outline on recycling packaging materials, aseptic packaging, biodegradeable polymers.

Theory: 45 hours Tutorial: 0 hours Practical: 0 hours Project: 0 hours Total hours: 45

Textbooks:

1. Han, J. H. (Ed.). (2014). Innovations in food packaging. Academic Press
2. Ahvenainen, R. (Ed.). (2003). Novel food packaging techniques. Elsevier
3. Rober. Robertson, G. L. (2005). Food packaging: principles and practice. CRC press
4. Robertson, G. L. (Ed.). (2009). Food packaging and shelf life: a practical guide. CRC Press

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U18BTE0016 MICROBIAL PATHOGENESIS

L	T	P	PJ	C
3	0	0	0	3

Course Objectives:

- To gain knowledge about host-pathogen interaction and defense mechanisms
- To understand the microbial pathogenesis of specific pathogens
- To explore the experimental and diagnostics tools available to control pathogens

Course Outcomes (COs):

After successful completion of the course, the students should be able to

CO1: Outline the principles of microbial pathogenesis, clinical importance of specific pathogens.
CO2: Acquire importance of Host defense mechanisms and pathogen adaptation against host defense.
CO3: Compare the molecular mechanisms involved in pathogenesis of diseases caused by *E.coli*, Vibrio, Shigella, Salmonella, malarial parasite and Influenza virus.
CO4: Evaluate the different host-pathogen interaction with respoect to the pathological damage of pathogens
CO5: Acquire knowledge about virulence and virulence factors in genomic approach
CO6: Recognize the different diagnostic techniques like ELISA, RIA *etc.,*

Pre-requisite:

1. U18BTI3204 Microbiology

CO/ PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
	PROGRAMME OUTCOMES (Pos)												PSOs	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		S		S	S							S	
CO2	S	M	S		S	S							S	
CO3	S	M	S		S	S							S	
CO4	S	M	S		S	S							S	
CO5	S	M	S		S	S							S	
CO6	S		S		S	S							S	

Course Assessment Methods			
Direct		Indirect	
1	Internal Tests	1	Course end survey
2	Assignments		
3	End semester examination		

Course Content **45 hours**

1. **MICROBIAL PATHOGENESIS** **9 hours**

Introduction to the infectious diseases: Molecular Koch postulates; Clinical importance of pathogenic bacteria, fungi, virus and parasite with Examples; Principles of microbial pathogenesis: Microbial modes of entry mechanism and colonization; Components of microbial pathogenesis; Inflammation process.

2. **HOST-DEFENSE AGAINST PATHOGENS AND PATHOGENIC STRATEGIES**

9 hours

Virulence, virulence factors, virulence-associated factors and virulence lifestyle factors; Introduction to host defense: First line and second line defense mechanisms; Antimicrobial compounds; Mechanism of killing by humoral and cellular defense mechanisms; Pathogenic adaptations to overcome the above defenses; Complement system: types of complement system.

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3. **MOLECULAR MICROBIAL PATHOGENESIS**

9 hours

Clinical features and molecular mechanism of pathogenesis: Enteric pathogens- E.coli pathogens(Enteropathogenic (EPEC), Enterotoxicgenic (ETEC), Enteroinvasive E.coli (EIEC)); Shigella ; Salmonella; Vibrio - PAI; Superficial mycoses: Dermatophytes, Candidiasis; Malaria: Plasmodium life cycle; Influenza virus: Intracellular stage, H1N1; HIV.

4. **EXPERIMENTAL STUDIES ON HOST-PATHOGEN INTERACTIONS**

9 hours

Virulence assay: Adherence, cytopathic, cytotoxic; Criteria and tests in identifying virulence factors- Classical, biochemical, genetic and genome approaches; Molecular characterization of virulence factors.

5. **MODERN DIAGNOSIS TO CONTROL PATHOGENS** **9 hours**

Modern diagnosis based on highly conserved virulence factors: Immuno and DNA-based techniques (Precipitation, agglutination, ELISA, RIA, PCR, Blotting techniques- Southern and Western blotting); Vaccines: types, applications and their advantages and disadvantages.

Theory: 45 hours Tutorial: 0 hours Practical: 0 hours Project: 0 hours Total hours: 45

Textbooks:

1. Drasar, B. S. (2003). Medical Microbiology—a Guide to Microbial Infections, Pathogenesis, Immunity, Laboratory Diagnosis and Control, David Greenwood, Richard CB Slack & John F. Peutherer (editors). Edinburgh: Churchill Livingstone, 2002. 728 pp.
2. Williams, P. H., Ketley, J., & Salmond, G. (1998). Bacterial pathogenesis. Academic Press.
3. Locht, C., & Simonet, M. (Eds.). (2012). Bacterial pathogenesis: molecular and cellular mechanisms. Horizon Scientific Press.
4. Groisman, E. A. (Ed.). (2001). Principles of bacterial pathogenesis.
5. Talaro, K. P., & Talaro, A. (1992). Foundations in Microbiology. WCB/McGraw-Hill.

Web-References:

1. Southwood, D., & Ranganathan, S. (2019). Host-pathogen interactions. In Encyclopedia of bioinformatics and computational biology: ABC of Bioinformatics (pp. 103-112). Elsevier.
2. Tsalik, E. L., Bonomo, R. A., & Fowler Jr, V. G. (2018). New molecular diagnostic approaches to bacterial infections and antibacterial resistance. Annual review of medicine, 69, 379-394.

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U18BTE0017 MEDICAL TEXTILES

L	T	P	J	C
3	0	0	0	3

Course Objectives:

At the end of the course the students would able to

- Provide the current market-scenario of medical textile industries
- Learn various types of Biopolymer, Principles of Tissue Engineering and wound-dressing.
- Understand Smart textiles and standard use of medical textile products testing.

Course Outcomes (COs):

After successful completion of the course, the students should be able to

CO1: Comprehend various aspects related to the emerging field of medical textiles
CO2: Classify biopolymers and their role in wound healing and drug-release kinetics.
CO3: Demonstrate the various stages in wound healing, its mechanism
CO4: Understand tissue engineering with various scaffolds
CO5: Understand various standards used for testing medical textile products
CO6: Identify bio-based products for smart textile development.

Pre-requisite:

1. Nil

CO/ PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
	PROGRAMME OUTCOMES (Pos)												PSOs	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		S		S	S							S	
CO2	S	M	S		S	S							S	
CO3	S	M	S		S	S							S	
CO4	S	M	S		S	S							S	
CO5	S	M	S		S	S							S	
CO6	S		S		S	S							S	

Course Assessment Methods	
Direct	
1	Continuous Assessment Test
2	Assignments
3	End Semester Examination

Course Content **45 hours**

1. **INTRODUCTION** **9 hours**

Medical textiles – classification, current market scenario in India and world, government initiatives on functional clothing; antimicrobial fibres and finishes; nano-fibrous materials and films; super absorbent polymers; operating room garments; personal health care and hygiene products applications of non-wovens in medicine; textiles in infection prevention control.

2. **BIOPOLYMERS, TESTING AND TISSUE ENGINEERING** **9 hours**

Biopolymers – classification and their properties, requirements, and applications, *In vitro* tests – direct contact, agar diffusion & elution methods, *in vivo* assessment of tissue compatibility. Tissue engineering – principles, properties and materials of scaffolds- relationship between textile architecture and cell behavior.

3. **IMPLANTABLES, NON-IMPLANTABLES AND DRUG DELIVERY**

9 hours

Bandages-types, properties and applications; sutures: types and properties; implantable textiles – hernia mesh, vascular prostheses, stents; Extra corporeal materials: Cartilage nerves – liver ligaments, kidney, tendons, cornea; Drug delivery textiles: classification, mechanism various fabrication methods, characterization & applications. Hydrogels – types, biopolymers used for hydrogel preparation, properties and drug release kinetics from hydrogels.

4. **WOUND CARE AND REUSABLE MEDICAL TEXTILES**

9 hours

Wound: types and stages in wound healing and mechanism, various types of wound dressings: bio-active dressing, anti microbial textiles dressing, composite dressing, testing of wound care materials; Wound compression textiles; Reusable medical textiles: types, advantages, physical properties and performance – reusable processing methods.

5. **SMART MEDICAL TEXTILES AND LEGAL ISSUES** **9 hours**

Smart textiles – types and characteristics – smart textiles in wound care; applications of phase change and shape memory materials – mobile health monitoring; electronics in medical textiles; textile sensors for healthcare; legal and ethical values involved in the medical textile materials.

Theory: 45 hours Tutorial: 0 hours Practical: 0 hours Project: 0 hours Total hours: 45

Textbooks:

1. Rajendran, S. (Ed.). (2018). Advanced textiles for wound care. Woodhead Publishing.
2. Bartels, V. (Ed.). (2011). Handbook of medical textiles. Elsevier.
3. Van Langenhove, L. (Ed.). (2007). Smart textiles for medicine and healthcare: materials, systems and applications. Elsevier.
4. Smith, R. (Ed.). (2005). Biodegradable polymers for industrial applications. CRC Press.

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