Semester-Wise Programme structure for Btech Biotechnology (4 years)								
Sr. No.	**Year 1**		**Year 2**		**Year 3**		**Year 4**	
	Semester 1	**Semester 2**	**Semester 3**	**Semester 4**	**Semester 5**	**Semester 6**	**Semester 7**	**Semester 8**
1	Basic Physics -I for Biosciences (PHY102) [CU:3,L-2, P-1] {BSC}	Mathematics for Life Sciences-II [CU:3,L-3] {BSC}	Applied Chemistry [CU:4,L-3 ,P-1] {BSC}	Genetics [CU:4,L-3, P-1] {BSC}	Recombinant DNA Technology [CU:4,L-3 ,P-1] {CC}	Downstream Processing [CU:4,L-3 ,P-1] {CC}	Economics for engineers [CU:2,L-2] {HSSMC}	Research Project [CU:18,P-18] {NTCC}
2	Environmental Studies –I (ENV101) [CU:2,L-2] {BSC}	Business Organisation & Management [CU:4,L-4] {HSSM}	Signal Transduction [CU:3,L-3] {CC}	Fluid Mechanics [CU:2,L-2] {ES}	Molecular Biology: Genes to Proteins [CU:4,L-4] {CC}	Bioprocess Engineering [CU:4,L-3 ,P-1] {CC}	Sociology for engineers [CU:1,L-1] {HSSMC}	OE2- [CU:3,P-3] {OE}
3	Fund. of Cell Biol. & Biomolecules (BTY102) [CU:4,L-3, P-1] {BSC}	Basic Physics-II for Biosciences [CU:3,L-3] {BSC}	OOPs using C++ [CU:4,L-3 ,P-1] {ES}	Analytical Techniques in Biosciences [CU:4,L-4] {CC}	Animal Biotechnology [CU:4,L-3 ,P-1] {CC}	Introductory Computational Biology [CU:4,L-3 ,P-1] {CC}	Law for Engineers [CU:2,L-2] {HSSMC}	OE3- [CU:3,P-3] {OE}
4	Mathematics for Life Sciences -I (MAT103) [CU:3,L-3] {BSC}	Biochemistry [CU:4,L-3 ,P-1] {BSC}	Fundamentals of Python [CU:3,L-2 ,P-1] {ES}	Principles of Enzymology [CU:4,L-3 ,P-1] {CC}	Engineering course (Physics dept.) [CU:3,L-3] {EC}	Environmental Biotechnology [CU:2,L-2] {CC}	Aspects of Indian History for Engineers [CU:1,L-1] {HSSMC}	-
5	Basic Electrical Engineering -I (PHU110) [CU:4,L-3, P-1] {ES}	Basic Electrical Engineering -II [CU:4,L-3 ,P-1] {ES}	Microbiology [CU:4,L-3 ,P-1] {CC}	Statistics for Life Sciences [CU:3,L-3] {CC}	Professional ethics [CU:2,L-2] {VAC}	SE2- [CU:3 ,L-3] {SE}	SE4 [CU:4,L-3 , P-1] {SE}	-

6	Introduction to Computers & Programming (UG) (CSE103) [CU:5,L-3, P-2] {ES}	Data base management system [CU:4,L-3 ,P-1] {ES}	Immunology and Immunotechnology [CU:4,L-4] {CC}	Principles of Chemical Engineering [CU:3,L-3] {CC}	SE1- [CU:3,L-3] {SE}	SE3- [CU:3,L-3] {SE}	SE5 [CU:4,L-3 , P-1] {SE}	-
7	Foreign Business Language (FOL101/ FOL102) [CU:1,L-1] {VAC}	Behavioural Skills [CU:1,L-1] {VAC}	Material Science [CU:2,L-2] {CC}	Personal Finance and Planning [CU:4,L-4] {HSSMC}	SEC1- Entrepreneurship and New Venture Creation [CU:4,L-4] {SEC}	SEC2- Big data for life sciences [CU:4,L-3 ,P-1] {SEC}	SE6 [CU:4,L-3 , P-1] {SE}	-
8	Communication Skills (ENG101) [CU:1,L-1] {VAC}	Foreign Business Language [CU:1,L-1] {VAC}	-	-	-	-	OE-I [CU:3,L-3] {OE}	-
9	Behavioural Skills (PSY101) [CU:1,L-1] {VAC}	-	-	-	-	-	Project Work [CU:3,P-3] {NTCC}	-
Credits	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**24**
Total Programme Credits								**192**

AC	**Allied Course**	**BSC**	**Basic Science Course**
AEC	**Ability Enhancement Course**	**ES**	**Engineering Science**
CC	**Core Course**	**EC**	**Engineering Course**
GE	**General Elective**	**HSSMC**	**Human Social Sciences & Management Courses**
OE	**Open Elective**	**SEC**	**Skill Enhancement Course**
SC	**Skill component**	**VAC**	**Value Added Course**
SE	**Specialization Elective Course**	**NTCC**	**Non Teaching Credit Course**

CU	Credit Unit	L;T; P	Lecture ; Tutorial ; Practical
H	Honours		

Programme structure for B.Tech. Biotechnology- 4 years (1st Semester)

Sr. No	Course Code	Course Title	Course Type	Credit					Credit Units
				L	T	PS	FW	SW	
1	PHY102	Basic Physics -I for Biosciences	Basic Science Course	2	0	1	0	0	3
2	ENV101	Environ. Studies -I	Basic Science Course	2	0	0	0	0	2
3	BTY102	Fundamentlals of CellBiol. & Biomolecules	Basic Science Course	3	0	1	0	0	4
4	MAT103	Mathematics for Life Sciences	Basic Science Course	3	0	0	0	0	3
5	PHU110	Basic Electrical Engineering	Engineering Science	3	0	1	0	0	4
6	CSE103	Introduction to Computers & Programming (UG)	Engineering Science	3	0	2	0	0	5
7	FOL101/ FOL102	Foreign Business Language	Value Added Course	1	0	0	0	0	1
8	ENG101	Communication Skills	Value Added Course	1	0	0	0	0	1
9	PSY101	Behavioural Skills	Value Added Course	1	0	0	0	0	1
		Total Credits		**24**					

PHY102: Basic Physics-I for Biosciences

L	T	P	Total Credits
2	0	1	3

Course Contents/Syllabus:

	Teaching hours
Unit I: Interference	**9 hrs**
Huygen's wave theory, Superposition principle, Conditions for sustained interference, Interference by division of Wavefront - Young's double slit experiment, Interference in thinparallel and wedge-shaped films, Newton's rings	
Unit II: Diffraction	**9 hrs**
Fresnel and Fraunhofer diffraction, Fraunhofer diffraction at a Single Slit, and N Slits, Plane Transmission grating, Rayleigh criterion and Resolving power and dispersive powerof grating.	
Unit III: Polarization	**9 hrs**
Polarization of Light, Law of Malus, Brewster's Law, Birefringence, Nicol prism, Productionand Analysis of Plane, Circularly and Elliptically Polarized Light, Half and Quarter Wave Plates, Optical and Specific Rotation, Laurent half shade and Bi-quartz polarimeter.	
Unit IV: Lasers and fiber optics	**9 hrs**
Introduction of Lasers, Induced Absorption, Spontaneous and Stimulated Emission, EinsteinCoefficients, Population inversion, Fundamental of Lasers, Types of Pumping, Concept of Three and Four Level Lasers, Construction and Working Lasers, Properties of Laser and its applications, Fundamental ideas about optical fibers, Classification of optical fibers , Propagation of light through fiber, Properties and Applications of Fiber Optics	

List of Experiments: (Time: 30 hours)

- To determine the wavelength of sodium light by Newtons's rings method
- To determine the angle of prism with the help of a spectrometer
- To determine the dispersive power of the material of prism with the help of a spectrometer
- To determine the specific rotation of sugar by Bi-quartz or Laurent half shade polarimeter
- To determine the width of a narrow slit using diffraction phenomena
- To determine the wavelength of a laser using diffraction grating
- To determine the wavelength of sodium source using Michelson's interferometer
- To determine the attenuation, numerical aperture and acceptance angle of the given optical fiber

Course Learning Outcomes:

- Understand the fundamental principles underlying wave phenomena related to interference anddiffraction and their effects
- Understand linear and circular polarization and applications
- Understanding on the properties of laser and construction with its applications in various

fields

- Understand Fiber optics and optical fiber communication.

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Halliday, Resnickand Walker	Fundamentals ofPhysics	Wiley India Pvt Ltd	2006	978-8126514427
Brijlal, Subramanyam &Subrahmanyam	Principle of Optics	S. Chand publishing,25th edition, 2012	2006	978-8121926119
Ghatak, Ajay	Optics	Tata McGraw-Hill	4th Edition	978-9339220907
Jenkins F A, White H E	Fundamentals ofoptics	Mcgraw hill	4th Edition	978-0072561913

ENV101 (Environmental Studies)

Course content and syllabus

L	T	P	Total Credits
2	0	0	2

	Teaching hours
Unit-1- Multidisciplinary nature of environmental studies and Natural Resources-1	**9 hrs**
Multidisciplinary nature of environmental studies: Definition, scope and importance; components of environment –atmosphere, hydrosphere, lithosphere and biosphere. Concept of sustainability and sustainable development. *Natural resources*: Land resources and land use change, land degradation, soil	

erosion and desertification.	
Unit-2- Natural Resources-2	**9 hrs**
Deforestation: causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal population. Water Resources-Use and over-exploitation of surface and groundwater, floods, drought, conflicts over water (international and inter-state). Heating of earth and circulation of air; air mass formation and precipitation. Energy resources- renewable and non-renewable energy sources, use of alternate energy sources, Growing energy needs, Case studies.	
Unit-3-Ecosystems	**9 hrs**
Ecosystem: What is an ecosystem; Structure and function of an ecosystem; Energy flow in the ecosystem; Food chains, food webs and ecological succession. Case studies of the following ecosystems: Forest ecosystem; Grassland ecosystem; Desert ecosystem; Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).	
Unit-4- Biodiversity and its conservation	**9 hrs**
Biodiversity: Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; biodiversity patterns and global biodiversity hot spots. India as a mega–biodiversity nation; endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; conservation of biodiversity: *in-situ* and *ex-situ* conservation of biodiversity. Ecosystem and biodiversity services: ecological, economic, social, ethical, aesthetic and information value.	

Course Learning Outcomes:

- Understand natural resources and evaluate limitations surrounding renewable and non-renewable resources
- Understand the nuances of ecosystem and learn about behaviour of various ecosystem
- Learn about the types, services and threats to our biodiversity and importance of conserving it.

Text/Reference Books

AUTHOR	TITLE	Publisher	Year of publication	ISBN	Pages

William P. Cunningham, Mary Ann Cunningham	Principles of Environmental Science	McGraw-Hill	2019	9781260219715	--
Dash and Dash	Fundamentalsof ecology	Tata McGraw-Hill Education	2009	978-0070083660	--
William P. Cunningham, Mary Ann Cunningham, Barbara Woodworth Saigo	Environmental Science: A global concern,	McGraw-Hill	2021	9781260363821	--
Gaston K.J. and Spicer, J. I.	Biodiversity – An Introduction 2nd edition	Blackwell Publishing	2004	978-1-405-11857-6	--

BTY102: Fundamentals of Cell Biology and Biomolecues

Course content and syllabus

L	T	P	Total Credits
3	**0**	**1**	**4**

	Teaching Hours
Unit I: Introduction to the Cell and Cellular Organelles	**13 hrs**
Cell: The cell theory, Broad Classification of cells, Structure and function of cell organelles, Cytoskeletal structures (actin, microtubules etc.). Cell wall and Cell Membrane, Cell division and cell cycle, Cellular communication	
Unit II: Energetics and Biomolecules (Carbohydrates and Proteins)	**14 hrs**

Water and its Properties: Dissociation and association constants, pH and buffers. pI, pKa,Hasselbach Hendersson equation and its implications. **Bioenergetics:** Laws of thermodynamics. Concepts of ΔG, ΔH and ΔS.	
Carbohydrates: Introduction, Structural and functional properties, storage. **Proteins:** Physico-chemical and structure of properties of amino acids, non-protein andrare amino acids. **Protein Structure:** Primary, Secondary, Tertiary, Quaternary, structure of proteins, Forces stabilizing Primary, Secondary and Tertiary protein structures.	
Unit III: Lipids and Vitamins	**13 hrs**
Lipids: Classification, structure and function. **Vitamins:** Types and significance in human health	
Unit IV: DNA and RNA: Genetic Material	**14 hrs**
Conformation of Nucleic acids: Structural characteristics of A, B and Z-DNA. RNA structure and types, and roles.	

List of Practicals with basic instructions (total teaching hours = 30 hrs)

1. Study of Cells:

(a) Prokaryotic cells

(b) Eukaryotic cells

- Study of permanent slides of various tissues (gut region, liver, lung, spleen, kidney, pancreas, testis, ovary, tongue, skin etc.).
- Barr body observation in human squamous epithelial cells.
- Verification of Beer Lamberts Law for P-nitrophenol or cobalt chloride.
- Estimation of carbohydrate in given solution by anthrone method.
- Study the presence of reducing/non-reducing sugars in biological samples.
- Protein estimation by Lowry's method, Bradford method, Biuret method.
- The determination of acid value and saponification value of a fat.

Course Learning Outcomes:

- Understand types of cells and cellular organelles.
- Determine the structure and properties of carbohydrates and lipids.
- Comparing the structure of various types of lipids, and role of vitamins in health.
- Evaluate the structure and functional properties of proteins and nucleic acids.

Text/Reference Books

1. De-Robertis, F.D.P. and De-Robertis Jr. E.M.F. Cell and Molecular Biology (Lippincott Williams &Wilkins)
2. Zubay, G.L., Parson, W.W., and Vance, D.E. Principles of Biochemistry (Wm. C. Brown)
3. Plummer, D.T. An Introduction to Practical Biochemistry (Tata McGraw Hill)

MAT103 (Mathematics for Life Sciences)

Course content and syllabus

L	T	P	Total Credits
3	0	0	3

Module I: Sets, Relations and Functions	**Teaching Hours**
Sets, Types of Sets, Subsets, Complement of Sets, union and Intersection of Sets, Difference of Sets, Demorgan's Law, Cartesian product of Sets, relations, functions and their types	**11 hrs**
Module II: Permutations & Combinations and Sequences & Series	
Concept of factorial, Principle of counting, Permutations and Combinations, Binomial Theorem for positive integral index, General Term and middle term, Application problems, Arithmetic Progression (A.P.), Geometric Progression (G.P.)	**12.5 hrs**
Module III: Matrix Algebra	
Matrices, Types of Matrices, Addition of matrices, Subtraction of matrices and Product of matrices. Properties of Matrix Multiplication. Transpose of Matrix, Symmetric and Skew-symmetric Matrices, Inverse of Matrix.	**12.5 hrs**
Module IV: Differential Calculus	
Algebra of limits, Continuity, Derivative of a function, Fundamental rules for differentiation, Derivatives of Implicit function, Inverse trigonometric function, Exponential and Logarithmic function, Parametric form, Logarithmic Differentiation, Successive Differentiation, Introduction to Partial derivatives and related theorems.	**11 hrs**

Course Learning Outcomes:

- After going through this course, students will be able to:
- Students will demonstrate the ability to distinguish corresponding sets as representations of relations or functions by the analysis of graphical, numeric, or symbolic data
- Students will demonstrate the ability to distinguish various arrangements, binomial theorem and representations of series
- Students will demonstrate the ability to apply the concept of matrices in real life situations
- Students will understand the concepts of Limits, Continuity and Differentiability and their applications

Text/Reference Books

1. George B. Thomas Jr., Joel Hass, Christopher Heil, and Maurice D. Weir. Thomas Calculus (Pearson)
2. James Stewart. Multivariable Calculus (Cengage)

PHU110 (Basic Electrical Engineering)

L	T	P	Total Credits
3	0	1	4

Course Contents/syllabus:

	Teaching hours
Unit I: DC circuits and Network	**11 hrs**
Electrical circuit elements (R, L and C), Ohm's law, Series and parallel connections of resistance and capacitance, voltage and current sources, Kirchoff current and voltage lawanalysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems., Time-domain analysis of first-order RL and RC circuits	
Unit II: Alternating current circuits	**11 hrs**
Generation of alternating voltages and currents, Peak, Average and RMS values for alternating currents, Form and Peak factor, Power calculation, reactive power, active power, Complex power, power factor, Ac through resistance, capacitance and inductance and LCR circuit, impedance, reactance, conductance, susceptance Series and Parallel circuits, Resonance: series Resonance, parallel resonance, basic definitionof Q factor & Band-width., Power in choking coil.	
Unit III: Transformers	**11 hrs**
Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuitlosses in transformers, regulation and efficiency, Auto-transformer and three-phase transformer connections	
Unit IV: Electrical Machines	**12 hrs**
Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiencstarting and speed control of induction motor, Single-phase induction motor. Constructioworking, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators	

Lab/ Practical details: **(Time: 30 hours)**

List of Experiments -with basic instructions

1. To determine an unknown Low Resistance using Potentiometer
2. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
3. To verify the Thevenin and Norton theorems. In digital meters
4. To verify the Superposition, and Maximum power transfer theorems
5. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b)

Impedance is not available at resonance, (c) Quality factor Q, and (d) Band width.

6. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
7. Determine a high resistance by leakage method using Ballistic Galvanometer
8. To determine the frequency of A.C. mains using sonometer
9. To study B-H curves for different ferromagnetic materials using C.R.O. w/o CRO
10. Studies based on LCR Board: Impedance of LCR circuit and the phase and between voltage and current.

Course Learning Outcomes: At the end of this course, the students will be able to develop basic understanding of various fundamental Laws and theorems related to electrical engineering and different electrical machine mechanisms.

- An ability to apply fundamental and advance knowledge of mathematics, science and engineering to solve and analyze the electrical and magnetic circuits
- To understand the fundamentals and applications of Alternative currents
- Learning of advanced machines applicable in day today practice such as transformers and motors

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
V.K Mehta Rohit Mehta	Basic Electrical Engineering	S.Chand Publication	2006	978-8121908719
D. P. Kothari and J. Nagrath	Basic Electrical Engineering: 4th edition	Tata McGraw Hill	2010	978-9353165727
L. S. Bobrow	Fundamentals of Electrical Engineering	Oxford University Press	2011	978-0195105094
E. Hughes	Electrical and Electronics Technology	Pearson	2010	978-8131733660
V.N Mittle and Arvind Mittle	Basic Electrical Engineering: 2nd edition	TMG publication	2017	978-0070593572

CSE103 (Introduction to Computers and Programming)

L	T	P	TOTAL CREDIT UNITS
3	0	2	5

Course Contents/Syllabus:

	Teaching Hours
Unit I:Introduction to Computers	13 hrs
Introduction to Computer, history, Generations of Computer Systems, Von-Neumann architecture, Basic block diagram and functions of various components of computer, memory system (hierarchy, characteristics and types), H/W concepts (I/O Devices), S/W concepts (System S/W & Application S/W, utilities).	
Unit II: Data Representation and Programming Languages	14 hrs
Data Representation: Number systems, character representation codes, Binary, octal, hexadecimal and their inter-conversions. Binary arithmetic, floating point arithmetic,signed and unsigned numbers, Memory storage unit Concepts of Machine level, Assembly level and high level programming, Algorithms, Flow Charts and pseudo code with examples. Introduction to Operating System with its types and significance.	
Unit III: Programming Constructs	**13 hrs**
From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code. Arithmetic expressions and precedence, Conditional Branching and Loops. Writing and evaluation of conditions and consequent branching, Iteration and loops. Concepts of array, one and two dimensional arrays, Structures	
Unit IV: Functions & Pointers	14 hrs
Functions (including using built in libraries), Parameter passing in functions, call byvalue, call by reference. Recursion as a different way of solving problems. Example programs, such as findingfactorial, Fibonacci series, sum of natural numbers etc. Basics of pointers, Defining pointers, pointer to pointer, pointer and arrays.	

Note: Programming may be taught in C or any other high level language.

Course Learning Outcomes:

i) Demonstrate the hardware components and software concepts of computer system alongwith their significance.

ii) Design various functions and use them to improve of efficiency of program.

Lab/Practicals (total teaching hours = 60 hrs)

a) Familiarization with programming environment including file extension, header files etc.
b) Write a program for addition and subtraction of 02 numbers given by user.
c) Write a program to calculate simple interest and compound interest.
d) Write a program to interchange two numbers without using third variable.
e) Write a program to read marks of a student from keyboard whether the student is pass or fail (using if else)
f) Write a program to read three numbers from keyboard and find out maximum out of these three. (nested if else)
g) Write a program to find whether the number is odd or even.
h) Write a program for sum of n natural numbers
i) Write a program to print nth number of Fibonacci series.
j) Write a program to take 10 numbers from the user and find out the maximum and minimum number.
k) Write a program to find the position of a given number in array.
l) Write a program for matrix addition.
m) Write a program for calculating simple interest with the help of function.
n) Write a program to demonstrate the difference between call be value and call by reference.
o) Write a program to print Fibonacci series using recursion.
p) Write a program to demonstrate use of pointers.

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN	Pages
V. Rajaraman	Fundamentals of Computer Science	PHI	6th Edition, 2015	9788120350670	626
Byron Gottfried	Schaum's Outline of Programming with C	Tata McGraw-Hill	3rd Edition, 2010	9780070145900	

ENG101 (Communication Skills-I)

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus:

	Teaching hours
Unit I: Basic Concepts in Communication	3.5 hrs
Definition of communication, Nature and process of communication, role and purpose of communication, types and channels of communication, communication networks/flow of communication: vertical, diagonal, horizontal, barriers to communication: physical, language, and semantic, socio-psychological, organizational, gateway to effective communication, towards communicative competence, choosing the appropriate channel and medium of communication, social communication: small talk and building rapport, barriers in communication.	
Unit II: Communication Types	5.5 hrs
Verbal communication: Oral Communication: Forms, Advantages & Disadvantages, Written Communication: Forms, Advantages & Disadvantages, Introduction of Communication Skills (Listening, Speaking, Reading, Writing), Nonverbal communication: functions and effective use, KOPPACT(Kinesics, Oculesics, Proxemics, Para-language, Artifacts, Chronemics, Tactilics). The implication of appropriate communication; effective ways of using social media, importance of digital literacy.	
Unit III: Reading and Writing Skills	3 hrs
Significance of reading; Reading Comprehension, gathering ideas from a given text, identify the main purpose and context of the text, evaluating the ideas, interpretation ofthe text, Paragraph development; essay writing.	
Unit IV: Speaking and Presentation Skills	6 hrs
Speaking skills: fluency, vocabulary, grammar, and pronunciation; effective speaking: selection of words, your voice, and non-verbal communication, functions of speaking: interaction, transaction, and performance; structuring the message; effective speaking strategies. Planning, preparation, practice, and performance; audience analysis, audio- visual aids, analyzing the non-verbal communication, methods of delivery: impromptu, extemporaneous, memorization, manuscript, and outlining.	

Course Learning Outcomes:

- Students will be able to understand the basic processes of communication, both verbal as well as non-verbal—nature, scope, and power of communication processes.
- Students will be able to demonstrate cultural sensitivity in communication and appreciation of cultural variations of diverse socio-cultural contexts.
- Students will be able to develop an awareness of the role of mass media in shaping public psyche, beliefs, and perceptions about social realities and build an informed and critical perspective.
- Students will be able to analyze situations and audiences to make right choices about the most effective and efficient ways to communicate and deliver messages.

- Students will be able to assess various barriers in communication and develop communicative competence thereby for effective communication.

Books/literature

AUTHOR	TITLE	Publisher	Year of publication	ISBN
P. D. Chaturvedi and Mukesh Chaturvedi	Business Communication: Concepts, Cases and Applications	Pearson Education	2006	9788131701720
Meenakshi Raman and Prakash Singh	Business Communication	Oxford University Press	2012	9780198077053
Jeff Butterfield	Soft Skills for Everyone	Cengage Learning	2017	9789353501051

FOL101 (Introduction to French Culture & Language)

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus:

	Teaching hours
Unit-I Introduction to French language	**3 hrs**
• Brief introduction of French and Francophone countries • Presenting oneself • Getting information about someone else • Greeting and taking leave • Asking/giving personal information	
Unit-II- A rendez-vous ; Visiting a place	**6 hrs**
• Pronouncing and writing numbers in French • Spell and count numbers • Telling the time	

• Temporal expressions • Communicating in class • Fixing an hour, place for a meeting. • Describing a person. • Identifying a person, object and place • Describing relation in a family • A specific person, object and place	
Unit-III- An interview	**4.5 hrs**
• Description of objects, people and places • Nationalities • Speaking about one's professions • Expressing Actions using regular –er ending verbs; avoir, être; reflexive verbs –usage, conjuagation • Interview of celebrity	
Unit-IV- At the discotheque	**4.5 hrs**
• Portrait by a journalist • Giving a positive or negative reply • Asking questions • Discussion with a person • Activities in a day	

Course Learning Outcomes: At the end of this course, the students will be able to express themselves in writing and orally in basic French. This course content focuses on the speech of the students in a lucid and a concurrent manner using appropriate vocabulary and pronunciation techniques. Extra stress will be given on their understanding of grammatical structures and the foreign accent of the language. At the end of the course, the student shall be able to :

- Understand information; Express in his own words; Paraphrase; Interpret and translate.
- Apply information in a new way in a practical context
- Analyse and break-down information to create new ideas
- Evaluate and express opinion in a given context

Text / Reference Books:

Author	Title	Publisher	Year	ISBN No
Christine Andant, Chaterine Metton, Annabelle Nachon, Fabienne Nugue	A Propos - A1 Livre De L'Eleve, Cahier D' Exercices	Langers International Private Limited	2010	978-9380 80 9069
Manjiri Khandekar and Roopa Luktuke	Jumelage - 1 Methode De Fraincais - French	Langers International Private Limited	2020	978-9380 80 9854

FOL102 (Introduction to German Culture & Language)

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus:

	Teaching hours
Unit-I Introduction to German Language (Einführung)	**3 hrs**
Introduction to German as a global language, Self-introduction and Greetings, Die Alphabeten, Phonetics: the sound of consonants and vowels, Wie buchstabieren Sie Ihren Name?	
Unit-II- Numbers and everyday conversation (die Zahl und Gespräche)	**6 hrs**
Counting in German from 1-100, Simple Calculation and verb 'kosten' - Wie viel kostet das? Plural Forms, Vocabulary: Wochentage, Monate, Jahreszeiten, Ordinal numbers and the question - Wann haben Sie Geburtstag?	
Unit-III- Regular verbs and nominative case: articles and pronouns (Regelmässige Verben und Nominativ Kasus: Artikel und Pronomen)	**4.5 hrs**
Introduction to all personal pronouns and conjugation of Regular verbs Detailed exercise on regular verbs. Reading a text on regular verbs. Introduction to definite. Vocabulary: Schulsachen und Getränke, Nominative case/ Articles (der, die, das) Nominative Pronouns: - Applicability of pronouns for both persons and things. Usage of nominative Personal Pronouns Introduction of nominative possessive pronouns usage of nominative possessive pronouns	
Unit-IV- The Family, Work-life and Professions (Familienmitglieder und Berufe) & Interrogative sentences (W-Fragen)	**4.5 hrs**
The Family, Work-life and Professions (Familienmitglieder und Berufe) Vocabulary: Professions and conjugation of the verb 'sein' Introduction to simple possessive pronouns with the help of the verb 'haben' Usage of possessive pronouns. Interrogative sentences (W-Fragen) W-Fragen: who, what, where, when, which, how,how many, how much, etc. Exercises on the question pronouns	

Course Learning Outcomes: At the end of this course, the students will be able to express themselves in writing and orally in basic German. This course content focuses on the speech of the students in a lucid and a concurrent manner using appropriate vocabulary and pronunciation techniques. Extra stress will be given on their understanding of grammatical structures and the foreign accent of the language. At the end of the course, the student shall be able to:

- Understand information; Express in his own words; Paraphrase; Interpret and translate.
- Apply information in a new way in a practical context
- Analyse and break-down information to create new ideas
- Evaluate and express opinion in a given context

Text / Reference Books:

Author	Title	Publisher	Year	ISBN
Rolf Bruseke	Starten Wir A 1	Langers International Pvt Ltd (Max Hueber Verlag)	2017	978-3190160006
Heimy Taylor, Werner Haas	Station en Deutsch Self Study Course German Guide	Wiley	2007	978-0470165515
Giorgio Motta	Wir Plus Grundkurs Deutsch fur Junge Lerner Book	Ernst Klelt Verlog	2011	978-8183072120

PSY101 (Behavioural Science: Understanding Self for Effectiveness)

L	T	P	Total Credits
1	0	0	1

Course Contents/syllabus:

	Teaching Hours
Unit I: Self: Core Competency	**4.5 hrs**
Understanding of Self, Components of Self – Self identity , Self concept, Self confidence , Self image , BIG5 Factors	
Unit II: Techniques of Self Awareness	**4.5 hrs**
Exploration through Johari Window, Mapping the key characteristics of self, Framing acharter for self Stages – self awareness, self acceptance and self realization	
Unit III: Self Esteem & Effectiveness	**4.5 hrs**
Meaning, Importance, Components of self esteem, High and low self esteem, Measuring your self esteem	
Unit IV: Building Positive Attitude and Emotional Competence	**4.5 hrs**
Meaning and nature of attitude, Components and Types of attitude ,Importance and relevance of attitude Emotional Intelligence – Meaning, components, Importance andRelevance Positive and negative emotions, Healthy and Unhealthy expression of emotions	

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

- The student will apply self-introspection as a tool for self-awareness.
- The student will understand self-concept for self-recognition, self-improvement and perception of other.
- The student will be able to analyze their physical self, social self, the competent self and psychological self.
- The student will be able to analyze what motivates his/her actions and the actions of others.

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Singh A.	Achieving Behavioural Excellence for Success	Wiley Publication	2012	9788126580 27
Towers, Marc	Self Esteem	American Media	1995	9781888492 6297
Pedler Mike, Burgoyne John, Boydell Tom	A Manager's Guide to Self-Development	McGraw-Hill	2006	978-0077114701
Covey, R. Stephen	Seven habits of Highly Effective People	Simon & Schuster Ltd	2013	978-1451639612
Khera Shiv	You Can Win	Macmillan	2005	978-0333937402
Gegax Tom	Winning in the Game of Life	Harmony Books	1999	978-0609603925
Singh, Dalip	Emotional Intelligence at Work	Publications	2006	9780761935322
Goleman, Daniel	Emotional Intelligence	Bantam Books	2007	9780553095036

Programme structure for B.Tech. Biotechnology- 4 years (2nd Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1	MAT110	Mathematics for Life Sciences-II	Basic Science	3	0	0	0	0	3
2	PHY115	Basic Physics-II for Biosciences	Basic Science	3	0	0	0	0	3
3	BCH103	Biochemistry	Basic Science	3	0	1	0	0	4
4	PHY116	Basic Electrical Engineering-II	Engineering Science	3	0	1	0	0	4
5	CSE106	Data Base Management System	Engineering Science	3	0	1	0	0	4
6	CBA102	Business Organisation and Management	HSSM	4	0	0	0	0	4
7	PSY106	Behavioural Science	Value Added Course	1	0	0	0	0	1
8	FOL103/ FOL104	Foreign Business Language	Value Added Course	1	0	0	0	0	1
				Total credits					**24**

MAT110: Mathematics for Life Sciences-II

L	T	P	Total Credits
3	0	0	3

Course content and syllabus

	Teaching Hours
Unit I: ANALYTIC GEOMETRY	**8 hrs**
Cartesian system of rectangular coordinates: Distance Formula, Section formula, Area of Triangle, slope of the line, intercepts with axis, various form of lines, Points of intersection of two lines, Line parallel and perpendicular to a given line. Circle: General equation of a circle. Diameter form of a circle, point of intersection of aline and a circle	
Unit II: ANALYTIC GEOMETRY	**7 hrs**
Parabola: Equation of parabola in standard form, Equation of parabola given its focus anddirectrix; Given the equation of a parabola, determination of its locus, vertex, axis, directrix and latus rectum Ellipse and Hyperbola: Standard equation of Ellipse and Hyperbola (without proof), Writing equations given the directrix, focus and eccentricity; Determination of focus, directrix, latus rectum, axes, eccentricity and vertex	
Unit III: INTEGRAL CALCULUS	**15 hrs**
Indefinite Integrals: Integration as an inverse process of differentiation, Fundamental Integration formulae, Standard results on integration, methods of Integration: Substitution, Special integrals, Parts, Partial Fractions *Definite Integrals:* Fundamental theorem of calculus, Properties of definite integralls Application of Integrals in finding area under the curve.	
Unit IV: ORDINARY DIFFERENTIAL EQUATIONS	**15 hrs**
Definition of Order and Degree of differential equation, Formation of ODEs, Solution of Differential Equation of 1st Order and 1^{st} Degree: Variable Separation, Homogeneous Differential Equations, Linear Differential Equations and Bernoulli's equation, Exact Differential Equations, General Linear ODE of Second Order, Solution of Homogeneous Equation	

An elementary introduction to Partial differential equations.	

Course Learning Outcomes:

After going through this course, students will be able to:

1. Students will demonstrate the ability to identify point in two-dimensional geometry along with understanding of the concepts of line, circle parabola ellipse and hyperbola.
2. Students will demonstrate the ability correlation the concept of Integration with the help of Differentiation and study its various applications
3. Students will demonstrate the ability to solve various problems of differential equation of first and higher order.

PHY115:Basic Physics-II

L	T	P	Total Credits
3	0	0	3

Course content and syllabus

	Teaching Hours
Unit I: Mechanical Properties of the Body	11 hrs
Kinematics, Muscular Action, Friction, Energetics, Review of Harmonic Motion, Pendulums, Moments of Inertia, Ballistic (or Pendulum) Model of Walking, Material Components of the Body, Bone, Ligaments and Tendons, Cartilage, Elastic Properties, Basic Stress-Strain Relationships Other Stress- Strain Relations.	
Unit 2: Fluids Dynamics	12 hrs
Characteristic Pressures in The Body, Definitions and Units ,Measuring Pressure , f of Pressure and Flow of Fluids, Law of Laplace, Fluids in Motion, Equation of Continuity, Bernoulli's Equation, Interaction among the Flow Parameters , Viscous Flow and Poiseuille's Law, Diffusion, Motion of Humans in Fluids, Swimming, Human Flight	
Unit 3: Thermodynamics	11 hrs
First and second laws of thermodynamics, activation energy. Biological systems as open, non- equilibrium systems, Concept of free energy, unavailable energy and entropy, heat content of food, bomb calorimetry.	
Unit 4: Physics of Sound Waves	11 hrs
Speed and Properties of Sound Waves, Intensity of Sound Waves, Sound propagation from one Mediumto Another, Speech Production, Types of Sounds, Hearing, Other Vibrations of the Body, Cardiac and Other Sources of Sounds	

Course Learning Outcomes:

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

1. Understand the material components of the body: bones, ligaments and Tendons, learning the mechanical properties of the body: stress-strain relationship, elastic behaviour as well as other mechanical aspects of bones
2. Understand the mechanism of fluid motion in the body, its function, Physics behind the fluid flow
3. Understanding of thermodynamics in biological systems.
4. Understand basics of sound with its impact on the body

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No
Irving P. Herman	Physics of the Human Body	Springer , ISSN 1618-721	2006	978-3540817062
W. HughesB	Aspects of Biophysics	John willey and sons	1979	978-0471019909
R.K. Hobbie	Intermediate Physics in Biologyand Medicine	Springer	2001	978-3319126814

BCH103: Biochemistry

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit I: Carbohydrate Metabolism	**18 hrs**
Glycolytic pathway, Gluconeogenesis, Citric acid cycle and it's regulation, Pentosephosphate pathway, Glyoxylate cycle, fate of absorbed carbohydrates,.	
Unit II: Lipid metabolism	**9 hrs**

Oxidation of fatty acids, Ketogenesis, Biosynthesis of saturated and unsaturated fatty acids, fate of absorbed dietary lipids	
Unit III Protein Metabolism	**9 hrs**
Catabolism of amino acids, urea cycle and it's regulation, , fate of dietary proteins	
Unit IV Nucleic Acid Metabolism & Integration of metabolic pathways	**18 hrs**
Catabolism and biosynthesis of nucleotides, de-novo synthesis and salvage pathways, Interrelationship among carbohydrate, protein and fat metabolism	

List of Experiments:

1. Qualitative identification of Amino acids
2. Saponification test for lipid
3. Determination of Iodine number of fatty acids
4. Estimation of cholesterol
5. Estimation of DNA by Di-phenyl amine (DPA) method
6. Estimation of RNA by Orcinol method

Course Learning Outcomes:

1. Students will understand the metabolic pathways linked with a series of chemical reactions occurring within a cell.
2. This course will describe the chemical changes catalyzed by cellular components and various intracellular controls.
3. Have knowledge of cellular metabolism, including central catabolic and anabolic pathways
4. Understand how different control mechanisms may be integrated to coordinate cell metabolism and function.
5. Understand how metabolism is coordinated in body systems and have knowledge of how disturbances in metabolism contribute to diseases

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
David L Nelson; and Michael M. Cox, W.H. Freeman	Lehninger's Principles of Biochemistry	WH Freeman	2012	0070492581, 9780070492585	957

Jeremy M. Berg, Lubert Stryer, John L Tymoczko, and Gregory J. Gatto,	Biochemistry	W.H. Freeman Company	2015	1319114652	1208

PHY116: Basic Electrical Engineering-II

L	T	P	Total Credits
3	0	1	4

Course content and syllabus:

	Teaching hours
Unit I: Magnetism and Electromagnetism	**11**
Elementary electrostatics, Magnetic Effect of Electric Current (wire and coil), Electromagnetic fields, Magnetic field due to electric current (straight wire and coil), Force on Current-carrying Conductor Placed in a Magnetic Field, Ampere's Circuital Law, Biot- Savart Law, torque experienced by a coil, Electromagnetic induction, methods of producing induced force, Generator and transformer emf, Eddy current loss	
Unit II: Magnetic circuits:	**11**
Magnetomotive force (m.m.f.), Reluctance, Permeance, theory of magnetic circuits and its analogy with electrical circuits, series and parallel magnetic circuits, Magnetic Leakage and Fringing, Kirchhoff's law for magnetic circuits	
Unit III: Fundamentals of reactive circuits	**11**
Inductance and capacitance, Self Inductance, mutual inductance, Growth of current and time constants in RL , RC and LCR circuits	
Unit IV: Materials for electrical engineering and devices	**12**
Elementary concepts of materials, Dielectric Properties of Insulators in Static and Alternating field, Magnetic Properties and Superconductivity, Semiconductor Materials	

Course Learning Outcomes:

At the end of this course, the students will be able to develop basic understanding of Physics phenomenon related to human health.

1. An ability to apply fundamental and advance knowledge of magnetism and electromagnetism to

understand the magnetic circuits
2. To understand the fundamentals and applications of magnetic circuits
3. Learning of Fundamentals of reactive circuits and time constants
4. Understanding the other materials and devices used in electrical engineering

List of Experiments

***Objective**:* To emphasize the role of Physics in day-to-day life.

1. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
2. To study C.R.O. as display and measuring device by recording sines and square waves, output from a rectifier, verification (qualitative) of law of electromagnetic induction and frequency of A.C. mains.
3. To plot the Lissajous figures and determine the phase angle by C.R.O
4. To determine self-inductance of a coil by Anderson's bridge
5. To determine the mutual inductance of two coils by Absolute method.
6. To measure thermo e.m.f. of a thermocouple as a function of temperature and find inversion temperature
7. To study the characteristics of a PN junction with varying temperature & the capacitance ofthe junction w/o CRO
8. To study the characteristics of a LED and determine activation energy
9. To study temperature-dependence of conductivity of a given semiconductor crystal using four probe method.

Text/Reference Books:

Author	Title	Publisher	Year	ISBN
V.K Mehta and Rohit Mehta	Basic Electrical Engineering	S.Chand publication	2006	978-8121908719
D. P. Kothari and I. J. Nagrath	Basic Electrical Engineering: 4th edition	Tata McGraw Hill	2010	978-9353165727
D. C. Kulshreshtha	Basic Electrical Engineering: 2nd edition	McGraw Hill	2009	978-9353167219
L. S. Bobrow	Fundamentals of Electrical Engineering	Oxford University	2011	978-0195105094
E. Hughes	Electrical and Electronics Technology	Pearson	2010	978-8131733660
V. D. Toro	Electrical Engineering Fundamental: 2nd edition	Prentice Hall India	2015	978-9332551763

V.N Mittle Arvind Mittle	sic Electrical Engineering: 2nd edition	TMG publication	2017	978-0070593572

CSE106: Data Base Management System

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit 1: Introduction	**15 hrs**
Descriptors/Topics Concept and goals of DBMS, Database Languages, Database Users, Database Abstraction. Database architecture, The Relational Data Model and Relational Database Constraints, Basic Concepts of ER Model, Relationship sets, Keys, Mapping, Design of ER Model	
Unit II: Relational Model	**8 hrs**
The relational model, The catalog, Types, Keys, Relational algebra, Domain relational calculus, Tuple relational calculus , Fundamental operations, Additional operations, SQL fundamentals, Integrity , Triggers , Views ,Relational database, Relational Algebra, Relational & Tuple Calculus	
Unit III: Relational Database Design	**15 hrs**
Normalization using Functional Dependency, Multivalued dependency and Join dependency. Query Processing and Optimization, and Database Tuning: Translating SQL Queries into Relational Algebra, Algorithms for External Sorting, Algorithms for SELECT and JOIN Operations, Algorithms for PROJECT and Set Operations, Combining OperationsUsing Pipelining, Using Heuristics in Query Optimization	
Unit IV: Transaction Processing, Concurrency Control, Recovery and new application	**7 hrs**
Introduction to Transaction Processing Concepts and Theory, Lock BasedTime Stamped Based Protocols, Deadlock Handling, Crash Recovery. Distributed Database, Objective Oriented Database, Multimedia Database, Data Mining, Digital Libraries.	

List of Experiments:

1. Write a query in SQL to display the last name and job title of all employees who do not have a manager
2. Write a query in SQL to display the last name, salary, and commission of all employees who earn commissions. Sort data in descending order of salary and commissions.
3. Write a query in SQL that prompts the user for a manager ID and generates the employee ID, last name, salary, and department for that manager's employees. The HR department wants the ability to sort the report on a selected column.
4. Write a query in SQL to Display all employee last names in which the third letter of the name is a.
5. Write a query in SQL to Display the last name of all employees who have both an a and an e in their lastname
6. Write a query in SQL to Display the last name, job, and salary for all employees whose job is sales representative or stock clerk and whose salary is not equal to $2,500, $3,500, or $7,000.
7. Write a query in SQL to display the employee number, last name, salary, and salary increased by 15.5% (expressed as a whole number) for each employee. Label the column New Salary.
8. Create a report that produces the following for each employee: <employee last name> earns <salary> monthly but wants <3 times salary>. Label the column Dream Salaries.
9. Create a query to display the last name and salary for all employees. Format the salary to be 15 characters long, left-padded with the $ symbol. Label the column SALARY.
10. Display each employee's last name, hire date, and salary review date, which is the first Monday after six months of service. Label the column REVIEW. Format the dates to appear in the format similar to "Monday, the Thirty-First of July, 2000."
11. Display the last name, hire date, and day of the week on which the employee started. Label the column DAY. Order the results by the day of the week, starting with Monday.

Course Learning Outcomes:

After completion of this course the students will be able to

1. Create a conceptual schema from real world problem, and to define program-data independence, data models for database systems, database schema and database instances.
2. Construct relational model and create database for querying with the help of relational algebra and SQL.3.Design and modify a database such that it is free from anomalies using normalization techniques.
4. Apply query processing techniques for optimizing queries and database tuning.
5. Compare various concurrency control techniques and database security and recovery methods for various types of databases.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages

Korth, Silberschatz	Database System Concepts	TMH	6th Ed, 2011	978 - 9390727506	1376
Steve Bobrowski	Oracle & Architecture	TMH	2000	-	
Date C. J	An Introduction to Database Systems	Narosa Publishing	7th Ed., 2004	978-0201385908	938

CBA102: Business Organisation and Management

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Business and Management	**18 hrs**
Introduction to business, Business firms - Forms of organization - sole proprietors, Partnership, Joint-Hindu family, Joint stock Company, Co-operative organizations - Public Enterprises, BPO, E-commerce and M-commerce. Entrepreneurship – Concept & Nature. Meaning, nature and characteristics of Management - Scope and functional areas of management - Social responsibility of management and Ethics. Organizational Structure & Functions (Production, Marketing, Human resource development and finance functions)	
Unit II: Planning, Organising and Staffing	**18 hrs**

Nature importance and purpose of planning - Planning process, Objectives - Types of plans (Meaning only) - Decision-making – importance & steps. Nature and purpose of organization, Principles of organization - Types of organization - Departmentation, Committees - Centralization Vs decentralization of authority and responsibility - Span of Control - MBO and MBE (Meaning only) – Nature and importance of staffing - Process of selection & recruitment (in brief) – retaining (training and compensation).	
Unit III: Directing and Controlling	**18 hrs**
Meaning and nature of directing - Leadership styles - Motivation theories (Maslow's, Herzberg, McGregor's X & Y theory), Ouchi's Theory- Communication meaning and importance, barriers to communication, types of communication - Coordination meaning	
and importance. Case Discussion (GE). Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief) – Balance score card, Economic value added, Market value added.	
Unit IV: Management in Perspective	**18 hrs**
Change Management, Knowledge Management, Learning organization, Managing Diversity, Corporate Governance.	

Course Learning Outcomes:

After going through this course, students will be able to:

1. Distinguish and explain each form of business
2. Explain principles and functions of management implemented in the organization
3. Analyze the concept of Delegation of Authority, coordination, and control
4. Identify the managerial skills used in business.

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN	Pages
Harold Koontz, Cyril O'Donnell	Principles of Management	McGraw-Hill Education	2018	9781307285598	300
Peter Ferdinand Drucker	Management: Tasks, Responsibilities, Practices	Routledge	2015	9781138129467	576

C. R. Basu	Business Organisation and Management	McGraw-Hill Education (India) Pvt Limited	1998	9780074620847	490
S. A. Sherlekar, Dr. Virendra Sharad Sherlekar	Modern Business Organisation and Management	Himalaya Publishing House	2019	9789352021864	1122
Jagdish Prakah	Business Organisation	Kitab Mahal	1999	9788122500288	851
	and Management				

BHA103: Individual, Society and Nation

L	T	P/S	TOTAL CREDIT UNITS
1	0	0	1

Course Contents/syllabus:

	Teaching hours
Unit-1- Individual differences & Personality	**4 hrs**
• Personality: Definition& Relevance • Importance of nature & nurture in Personality Development • Importance and Recognition of Individual differences in Personality • Accepting and Managing Individual differences Intuition, Judgment, Perception & Sensation (MBTI) BIG5 Factors	
Unit-2- Managing Diversity	**5 hrs**
• Defining Diversity • Affirmation Action and Managing Diversity • Increasing Diversity in Work Force • Barriers and Challenges in Managing Diversity	
Unit-3- Socialization, Patriotism and National Pride	**5 hrs**

• Nature of Socialization • Social Interaction • Interaction of Socialization Process • Contributions to Society and Nation • Sense of pride and patriotism • Importance of discipline and hard work	
Unit-4- Human Rights, Values and Ethics	**4 hrs**
• Meaning and Importance of human rights • Human rights awareness • Values and Ethics- Learning based on project work on Scriptures like- Ramayana, Mahabharata, Gita etc.	

List of Professional Skill Development Activities (PSDA):

- Project on Understanding Diversity
- Term Paper on Patriotism among Youth

Course Learning Outcomes: On completion of the course:

- To recognize individual differences
- To mange individual differences
- To develop patriotic feelings
- To recognized their self in relation to society & nation

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN	Pages
Department of English, University of Delhi	The Individual & Society	Pearson Education	2010	978-8131704172	266
Umang Malhotra	Individual, Society, and the World	iUniverse	2004	978-0595662401	188
Tonja R. Conerly &Kathleen Holmes	Introductionto Sociology3e	Openstax	2015	9781711493978	458
Daksh Tyagi	"A Nation of Idiots"	Every Protest	2019	978-8194275015	350

FOL103: French Grammar

L	T	P	Total Credits
1	0	0	1

Course content and syllabus

	Teaching Hours
Unit I: My Family and My House	**4 hrs**
Descriptors/Topics • Talk about your family members • Usage of possessive adjectives • Describe your house/apartment • Prepositions of location • Negation	
Unit II: Lifestyle	**3 hrs**
Descriptors/Topics • Talk about your hobbies and pastimes • Usage of appropriate articles : definite and contracted • Talk about your daily routine • Usage of pronominal verbs	
Unit III: In the City	**3 hrs**
Descriptors/Topics • Filling up a simple form • Ask for personal information • Usage of interrogative adjectives • Give directions about a place • Ordinal numbers • Usage of demonstrative adjectives	
Unit IV: Week-End	**3 hrs**

Descriptors/Topics • Talk about your week-end plans • Usage of disjunctive pronouns • Usage of Near Future tense • Talk about weather • Write a simple post card	

Course Learning Outcomes: At the end of this course, the students will be able to interact in a simple way on everyday topics. This course content focuses on the speech of the students in a lucid and a concurrent manner using appropriate vocabulary and pronunciation techniques. Extra stress will be given on their understanding of grammatical structures and the foreign accent of the language. At the end of the course,the student shall be able to:

- Understand information; Express in his own words; Paraphrase; Interpret and translate.
- Apply information in a new way in a practical context
- Analyze and break-down information to create new ideas
- Evaluate and express opinion in a given context

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Christine Andant, Catherine Metton, Annabelle Nachon, Fabienne Nugue	A Propos - A1, Livre de l'élèveet Cahier d'exercices.	Langers International Pvt. Ltd.	2010	978-9380809069	---
Collins Dictionaries	Easy Learning French Complete Grammar, Verbs and Vocabulary	Collins	2016	978-0008141721	---
Nikita Desai, Samapita Dey Sarkar	Apprenons La Grammaire Ensemble - French	Langers International Pvt. Ltd.	2017	978-8193002681	---

FOL104: German Grammar

L	T	P	Total Credits
1	0	0	1

Course content and syllabus

	Teaching Hours
Unit I: Time (Uhrzeit); People and the World: Land, Nationalität und Sprache	**5 hrs**
• Introduction of time • Read text related to time and teach the students the time expressions • Exercises related to Time • Adverbs of time and time related prepositions • Vocabulary: Countries, Nationalities, and their languages • Negation: “nicht/ kein” • Ja/Nein Fragen. • All the colors and color related vocabulary, adjectives, and opposites • Exercises and comprehension for the same	
Unit II: Irregular verbs (unregelmässige Verben)	**4 hrs**
• Introduction to irregular verbs and their conjugation e.g. fahren, essen, lesen etc • Read a text related to the eating habits of Germans • Vocabulary: Obst, Gemüse, Kleiderstück with usage of irregular verbs • Free time and hobbies • Food and drinks	
Unit III: Accusative case: articles and pronouns (Akkusativ Kasus: Artikel und Pronomen)	**4 hrs**
• Introduction to the concept of object (Akkusativ) • Formation of sentences along with the translation and difference between nominative and accusative articles • Usage of accusative Definite articles • Usage of accusative Indefinite articles	
Unit IV: Accusative case: possessive pronouns (Akkusativ Kasus: Possessivpronomen) Family and Relationship	**5 hrs**
• Accusative Personal Pronouns: - Revision of the nominative personal pronouns and introduction of accusative. Applicability of pronouns for both persons and things. • Usage of accusative Personal Pronouns • Introduction of accusative possessive pronouns • Difference between nominative and accusative possessive pronouns • usage of accusative possessive pronouns	

Course Learning Outcomes: After completing these modules, the students will be capable of constructingsentences with possessive and demonstrative adjectives in German. In addition, they will be proficient in formulating meaningful sentences as they will be capable of applying their knowledge of all the irregularverbs they have learnt during the session. They will also have an idea of German culture by studying aboutvarious German festivals.

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

- Understand information; Express in his own words; Paraphrase; Interpret and translate.
- Apply information in a new way in a practical context
- Analyse and break-down information to create new ideas
- Evaluate and express opinion in a given context

Text / Reference Books:

Author	Title	Publisher	Ed/ year	ISBN No	Pages
Dora Schulz, Heinz Griesbach	Deutsche Sprachlehre Fur Auslander	Max Hueber Verlag	1984	978-3190010066	---
Hartmut Aufderstrasse, Jutta Muller, Helmut Muller	Themen Aktuell: Glossar Deutsch	Max Hueber Verlag	2003	978-3190816903	---
Giorgio Motta	Wir Plus Grundkurs Deutsch fur Junge Lerner Book German Guide	Goyal Publishers	2011		248

Programme structure for B.Tech. Biotechnology- 4 years (3rd Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1	CHE205	Applied Chemistry	Basic Science	3	0	1	0	0	4
2	CSE205	OOPs using C++	Engineering Science	3	0	1	0	0	4
3	CAS210	Fundamentals of Python	Engineering Science	2	0	1	0	0	3
4	BTY203	Signal Transduction	Core course	3	0	0	0	0	3
5	MBO202	Microbiology	Core Course	3	0	1	0	0	4
6	IMM201	Immunology and Immunotechnology	Core course	4	0	0	0	0	4
7	PHY205	Material Science	Core Course	2	0	0	0	0	2
				Total credits					**24**

CHE205: Applied Chemistry

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours

Unit I: Water Technology	**18 hrs**
Introduction and specifications of water, Hardness and its determination (EDTA method only), Alkalinity, Boiler feed water, boiler problems – scale, sludge, priming & foaming: causes & prevention, caustic embrittlement & corrosion : causes & prevention, Carbonate & phosphate conditioning, colloidal conditioning & calgon treatment, Water softening processes : Lime – soda process, Zeolite, Ion exchange method, Water for domestic use.	
Unit II: Fuels	**9 hrs**
Classification, calorific value of fuel, (gross and net), Determination of calorific value of fuels, bomb calorimeter, Solid fuels - Proximate and ultimate analysis, Numericals on combustion.	
Unit III: Instrumental Methods of analysis	**9 hrs**
Introduction; Principles of spectroscopy; Laws of absorbance, IR : Principle, Instrumentation, Application, UV : Principle, Instrumentation, Application, NMR : Principle, Instrumentation, Application	
Unit IV: Lubricants and Corrosion	**18 hrs**
Lubricants : Introduction; Mechanism of Lubrication; Types of Lubricants, Properties of lubricants; Viscosity and Viscosity Index; Iodine Value; Aniline Point; Emulsion number; Flash Point; Fire Point; Drop, Point; Cloud Point; Pour Point. Corrosion: Introduction, Mechanism of dry and wet corrosion, Types of corrosion-Galvanic, Concentration cell, soil, pitting, intergranular, waterline. Passivity, Factors influencing corrosion, Corrosion control	

List of Experiments:

1. To determine the ion exchange capacity of a given cation exchanger.
2. To determine the temporary, permanent and total hardness of a sample of water by complexometric titration method.
3. To determine the type and extent of alkalinity of given water sample.

4. Determination of amount of oxalic acid and H_2SO_4 in 1 L of solution using N/10 NaOH and N/10 $KMnO_4$ solution.
5. To prepare and describe a titration curve for phosphoric acid – sodium hydroxide titration using pH-meter.
6. To find the cell constant of conductivity cell.
7. Determine the strength of hydrochloric acid solution by titrating it against standard sodium hydroxide solution conductometrically.
8. Determination of Dissolved oxygen in the given water sample
9. To determine the total residual chlorine in water.
10. Determination of viscosity of given oil by means of Redwood viscometer I.
11. To determine flash point and fire point of an oil by Pensky Martin's Apparatus.

Course Learning Outcomes:

The student will be able to

1. Apply the knowledge of water treatment processes for water quality monitoring.
2. Calculate the calorific value based on fuel composition
3. Propose a suitable control method to combat corrosion in daily life
4. Choose lubricants based on their properties for a particular application.
5. Interpret the structure of molecules based on the spectral data.

Text / Reference Books:

Author	Title	Publisher	Ed/ year	ISBN No	Pages
V. K. Ahluwalia,	Comprehensive Experimental Chemistry.	New Age Publication, Delhi.	1997	978-8122410655	376
Sunita Rattan	Experiments in Applied Chemistry	Kataria & Sons	2011	978-8188458059	400

CSE205: OOPs using C++

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction	**9 hrs**
Difference between C and C++, Procedure Oriented and Object-Oriented Approach, Basic Concepts: Objects, classes, Principals like Abstraction, Encapsulation, Inheritance and Polymorphism. Dynamic Binding, Message Passing, Characteristics of Object-Oriented Languages	
Unit II: Classes & Objects	**18 hrs**
Abstract data types, Object & classes, attributes, methods, C++ class declaration , Local Class and Global Class, State identity and behaviour of an object , Local Object and Global Object, Scope resolution operator, Friend Functions, Inline functions, Constructors and destructors, instantiation of objects, Types of Constructors, Static Class Data, Array of Objects, Constant member functions and Objects, Memory management Operators	
Unit III: Inheritance and Polymorphism	**18 hrs**
Inheritance, Types of Inheritance, access modes – public, private & protected, Abstract Classes, Ambiguity resolution using scope resolution operator and Virtual base class, Aggregation, composition vs classification hierarchies, Overriding inheritance methods, Constructors in derived classes, Nesting of Classes. Polymorphism, Type of Polymorphism – Compile time and runtime, Function Overloading, Operator Overloading (Unary and Binary), Polymorphism by parameter, Pointer to objects, this pointer, Virtual Functions, Pure virtual functions.	
Unit IV: Strings, Files and Exception Handling	**9 hrs**
Manipulating strings, Streams and files handling, Formatted and Unformatted Inputoutput Exception handling Generic Programming – function template, class Template Standard Template Library: Standard Template Library, Overview of Standard Template Library, Containers, Algorithms, Iterators, Other STL Elements, the Container Classes.	

List of Experiments:

1. Creation of objects in programs and solving problems through them
2. Different use of private, public member variables and functions and friend functions.
3. Use of constructors and destructors.
4. Operator overloading
5. Use of inheritance in and accessing objects of different derived classes.
6. Polymorphism and virtual functions (using pointers).

Course Learning Outcomes:

The student will be able to

1. Articulate the principles of object-oriented problem solving and programming.
2. Outline the essential features and elements of the C++ programming language.
3. Explain programming fundamentals, including statement and control flow and recursion.
4. Apply the concepts of data abstraction, function abstraction, inheritance, overriding, overloading, and polymorphism.
5. Apply the concepts using objects and data abstraction, class, and methods in function abstraction.
6. Analyze, write, debug, and test basic C++ codes using the approaches introduced in the course.
7. Analyze problems and implement simple C++ applications using an object-oriented software engineering approach.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
A.R. Venugopal, Rajkumar, T. Ravishanker	Mastering C++	TMH	1997	978-0074634547	804
R. Lafore	Object Oriented Programmingusing C++	BPB Publications	2004	978-8131722824	1040
Schildt Herbert	C++: The Complete Reference	Wiley DreamTech	2005	978-0070411838	832

CAS210: Fundamentals of Python

L	T	P	Total Credits
2	0	1	3

Course content and syllabus

	Teaching Hours
Unit I: Introduction and basic programming with Python	**9 hrs**
History of Python, Need of Python Programming, Applications, Basics of Python Programming, Running Python Scripts, Installation of Jupyter Notebook, Variables, Assignment, Keywords, Input-Output, statement, Indentation, comments.	
Unit II: Datatypes and Operators	**9 hrs**
Datatypes :- Integers, Strings, Booleans; Operators- Arithmetic, Comparison (Relational),Assignment, Logical, Bitwise, Membership, Identity, Operator Precedence.	
Unit III: Control Flows and Loops	**9 hrs**
Control Flows and conditional statements in Python- if, if-elif-else, break, continue, loops,types of loops: for, while.	
Unit IV: Python Strings, Lists, Tuples, Sets, Dictionary	**9 hrs**
Strings, Lists - Operations, Slicing, Methods; Tuples: Creating, Printing, properties oftuples, Sets, Dictionaries, Sequences and their properties.	

List of Experiments:

1. Perform installation of python, of jupyter notebook
2. Execute a basic python program with a print message.
3. WAP to Check the Python version on command line
4. WAP to display the current date and time.
5. WAP to get Multiple inputs From a User in One Line.
6. WAP which accepts the user's first and last name and print them in reverse order with a spacebetween them.
7. WAP to implement show Operators Precedence and different types of operators.
8. WAP to declare, access and print a dictionary
9. WAP to check whether a given key already exists in a dictionary.
10. WAP to declare, access and print a list with 10 elements

11. WAP to declare, access and print a tuple.
12. WAP to declare, access and print a set of values.

Course Learning Outcomes:

The student will be able to

1. Understand the basics of programming and implement basic python programs, input output functions, datatypes.
2. Learn the use of various types of operators and their precedence.
3. Develop programs using conditional statements and branching.
4. Implement the concept of control flows and iterations in python programs.
5. Develop an application using the fundamentals of list, dictionary, tuples and solve scientific
6. problems.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No
Paul Barry	Head First Python	O'Reilly Media, Inc.	2016	9781491919538
Mark Lutz, David Ascher	Learning Python	O'Reilly	2007	978-9351102014
Kenneth A. Lambert	Fundamentals of Python	Cengage	2019	9789353502898

BTY203: Signal Transduction

L	T	P	Total Credits
3	0	0	3

Course content and syllabus

The objective of this course is to provide an in-depth knowledge of the physiological functions and aberrations of disease-related signaling pathways	Teaching Hours
Unit I: Structural and functional Basis of Signaling	**12 hrs**
Cell signaling modes, signaling molecules, extracellular and membrane events, second messengers, nuclear receptors, Modular Protein Interaction, phosphorylation and dephosphorylation events ,signal downregulation/Signal dampening	
Unit II: G-Protein and JAK–STAT Organization and Signaling	**15 hrs**

G-Protein Molecular Organization, Structural Features of G Protein Activation, Structural Determinants of Receptor–G-Protein Specificity; JAK-STAT pathway, Cytokine Signaling Proteins: JAK Structure and Localization, STAT Structure and Function Inhibition of Cytokine Signaling	
Unit III: Other major signaling pathways	**15 hrs**
Integrins, cadherins, Ras-MAPK pathway, Hedgehog,PI3K , Notch,, Serine/Threonine pathways, lipid signaling	
Unit IV: Aberrant signaling effectors and Cytosolic events in diseases	**12 hrs**
Cancer, Notch signaling dependent Diseases, Hedgehog signaling dependent Diseases, Diabetes, signaling in aging	

Course Learning Outcomes:

- Understand the basic concepts of signal transduction.
- Appreciate the impact of signal transduction on physiology
- Describe pathways of cellular signaling, cross-talk and regulation.
- Discuss how disruptions in cellular signaling may lead to disease, and illustrate with selected examples.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Bruce, Alberts and Alexander Johnson and Julian Lewis, and Martin Raff	Molecular biology of the cell	Garland Science;	6th	978-0815344322	1342
Rakesh Srivastava	Apoptosis,cell signalling and human diseases	Humana Press	1st	9781588298829	395
Berg J.M., Tymoczko J.L., Stryer L.	Biochemistry	WH Freeman & Company	5th	13: 978-1-4641-2610-9	1023
Ralph A. Bradshaw and Edward A. Dennis	Handbook of Cell Signaling	Academic Press		0121245462	2576

MBO202: Microbiology

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction, History and basic Principles of Microbiology	**9 hrs**
Introduction to Microbiology. Impact of microorganisms on humans. Historical perspective: Contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Martinus Beijerinck, Sergei Winogradsky. Microbial nutrition. Culture media, pure culture techniques, culture preservation. Sterilization.	
Unit II: Microbial cell structure and diversity	**18 hrs**
Bacteria: Prokaryotic cell structure and function overview, cytoplasmic membrane, cell wall, cell surface structures, surface appendages (flagella, pili and fimbriae), cytoplasmic inclusions, nucleoid, endospores. Archaea: Cell wall, cell membrane, characteristics of major archaeal groups. Algae, Protozoa and Fungi: Structure and general characteristics. Viruses: Bacteriophage T4 and lambda (structure and life cycle), Retroviruses, Viroids, Prions	
Unit III: Microbial growth and metabolism	**18 hrs**
Microbial growth: Concept of microbial growth, mathematical expression of growth, growth curve, measurement of growth, batch and continuous culture, environmental factors affecting growth, synchronous cultures. Microbial metabolism: Phototrophy, chemolithotrophy (hydrogen oxidation and nitrification), anaerobic respiration (nitrate reduction), fermentation (lactic and ethanolic), methanogenesis, nitrogen fixation.	
Unit IV: Microbial systematics and Genetics	**9 hrs**
Microbial taxonomy: Overview of polyphasic taxonomy, classical and molecular approaches to taxonomy, importance of 16S rRNA gene sequence in taxonomy. Gene transfer in bacteria: Conjugation, transformation and transduction. Plasmids, Hfr Strains.	

List of Experiments:

1. Laboratory safety and instrumentation, aseptic techniques, preparation of culture media.
2. Isolation of microorganisms from air, water and soil: Streak plate method, Spread plate method, Serial

dilution and pour plate method.

3. Staining techniques: Simple staining, Gram staining, endospore staining, lactophenol cotton blue staining for fungi, negative staining.
4. Biochemical tests –Indole test. Methyl red test. Voges proskaeur test, Citrate utilization test(IMViC), starch hydrolysis test, catalase test.
5. Generation of bacterial growth curve.
6. Antibiotic susceptibility testing.

Course Learning Outcomes:

The student will be able to

1. The student will be able to Define the concept of microbial nutrition, culture preservation, sterilization and contribution of different scientists to the field of microbiology.
2. The student will be able to Describe details of bacterial and archaeal cell structure and discuss general characteristics of Algae, fungi, protozoa, viruses, viroids and prions and discuss about concepts of microbial growth and metabolism.
3. The student will be able to Determine about classical and molecular methods in microbial taxanomy and methods of gene transfer in bacteria and examine the role of microorganisms in various fermentation products and processes.
4. The students will be able to Discuss about several microbial diseases and antimicrobial drugs.
5. The student will be able to Expand and Justify further study, teaching, research and employment in microbial research or the practical applications of microbiology

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Willey, Sherwood, Woolverton	Prescott, Harley and Klien's Microbiology 7th edition	McGraw Hill Higher Education	2011	978-0697013729	1056
Madigan, Martinko, Stahl, Clark	Brock Biology of Microorganisms, 13th edition	Benjamin Cummings.	2013	978-9332586864	1024

IMM201: Immunology and Immunotechnology

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction and Immune Cell Types	**18 hrs**
Immune system, Concept of Innate and Adaptive immunity, Hematopoietic stem cells, Lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), Granulocytes and Monocytes, Cell participation in innate and adaptive Immunity	
Unit II: Antigens, Antibodies and Major Histocompatibility Complex	**18 hrs**
Characteristics of an antigen (Foreignness, Molecular size, and Heterogeneity), Haptens,Epitopes (T & B cell epitopes), T-dependent and T-independent antigens, Factors responsible for immunogenicity, Adjuvants, Super-antigens, Structure and function of antibody, Antibody classes, VDJ rearrangements, Monoclonal and chimeric antibodies, Major Histocompatibility: Structure and Functions of MHC I & II molecules, Antigen processing and presentation, Inflammatory response, Complement System	
Unit III: Generation of Immune Response and Vaccines	**18 hrs**
Primary and Secondary Immune Response, Generation of Humoral Immune Response (Plasma and Memory cells), Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals), Killing Mechanisms by CTL and NK cells, Types of autoimmunity and hypersensitivity with examples, Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, tumor antigens, Vaccines: Active and passive immunization, Vaccine types (Live but attenuated, Killed, Subunit, Recombinant, DNA and Peptide)	
Unit IV: Immunological Techniques	**18 hrs**
Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, Immunoassays, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, fluorescence activated cell sorting analysis, microarrays to assess gene expression	

Course Learning Outcomes:

1. Students will be able to explain the role of immune cells and their role in body defense mechanism
2. Students will be able to devise strategies to combat infection or diseases produced by altered self.
3. Students will develop ability to use this knowledge in the processes of immunization, antibody engineering, vaccine development, transplantation, and diseases.
4. Students will be able to demonstrate immunological techniques

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
J. Owen, J. Punt, S. Stranford	Kuby Immunology (8th Edition)	WH Freeman and Company, USA	2012	978-1319114701	944
D. Male, J. Brostoff, D. Roth, I. Roitt	Immunology (8th Edition)	Saunders, Elsevier, USA	2012	978-0702045486	482
K. Murphy	Janeway's Immunobiology (8th Edition)	Garland Science, USA	2011	978-0815342908	887
A. Abbas, A. Lichtman, S. Pillai	Cellular and Molecular Immunology (8th Edition)	Saunders, Elsevier, USA	2014	978-8131264577	-

PHY205: Material Science

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
Unit I: Introduction	**9 hrs**
Introduction : Historical perspective, importance of materials. Fundamentals Of crystal Structure, Crystal lattice: BCC, FCC and HCP, Concept of unit cell, space lattice, Atomic packing factor and Density Miller indices. Xray crystallography techniques. Crystallography and Imperfections::- Defects & Dislocations , Mechanism of Plastic Deformation : by twinning and by slip.	
Unit II: Mechanical properties and testing	**9 hrs**
Mechanical properties and Testing: Stress strain diagram, Ductile & brittle material, Stress vs strength. Toughness, Hardness, Fracture, Fatigue and Creep. Testing such as Strength testing, Hardness testing, Impact Testing Non-destructive testing (NDT).	
Unit III:	**9 hrs**
Iron-carbon equilibrium diagram. Ferrous materials : Various types of carbon steels, alloy steels and cast irons, its properties and uses Heat Treatment : Various types of heat treatment such as Annealing, Normalizing,Quenching, Tempering and Case hardening. Time Temperature Transformation (TTT) diagrams	
Non-Ferrous metals and alloys : Non-ferrrous metals such as Cu, Al, Zn, Cr, Ni etc. andits applications. Various type Brass, Bronze,. Other advanced materials/alloys	
Unit IV:	**9 hrs**
Electric properties : Energy band concept of conductor, insulator and semi-conductor Intrinsic & extrinsic semi-conductors. P-n junction and transistors. Basic devices and itsapplication. Super conductivity and its applications Ceramics : Structure types and properties and applications of ceramics. Plastics : Various types of polymers/plastics and its applications. Future of plastics	

Course Learning Outcomes:

1. Demonstrate knowledge of fundamental concepts of material science.
2. Identify various components of mathematics, and perform basic operations and apply safetyprocedures.
3. Design and analyze problems relating to Material science.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
William Smith, Javad Hashemi and Ravi Prakash	Materials Science and Engineering	McGraw Hill	2013		
V. Raghavan	Material Science & Engineering	Prentice Hall India Ltd.	2015	978-8120350922	488
S.K. Hazra Chaudhuri	Material Science & Processes	Indian Book Publishers, Calcutta,	1983	978-0906216002	629

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Programme structure for B.Tech. Biotechnology- 4 years (4th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1	HGM203	Genetics	Basic Sciences	3	0	1	0	0	4
2	PHY211	Fluid Mechanics	Engineering Science	2	0	0	0	0	2
3	BTY208	Analytical Techniques in Biosciences	Core Course	4	0	0	0	0	4
4	BCH202	Principles of Enzymology	Core course	3	0	1	0	0	4
5	STA202	Statistics for Life Sciences	Core Course	3	0	0	0	0	3
6	BTY205	Principles of Chemical Engineering	Core Course	3	0	0	0	0	3
7	CBA103	Personal Finance and Planning	HSSMC	4	0	0	0	0	4
				Total credits					**24**

HGM203: Genetics

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit I: Mendelian Genetics	**9 hrs**
Mendelian inheritance. Gene interaction. Chi-square and probability. Penetrance and expressivity. Qualitative and quantitative inheritance. Sex linkage. Linkage and crossingover. Chromosome mapping in eukaryotes.	
Unit II: Extranuclear Inheritance	**18 hrs**
Extranuclear inheritance and maternal effect. Variegation in Four o' clock plant, Chlamydomonas, Mitochondrial mutations in Neurospora /yeast, shell coiling in snails. Sigma virus in Drosophila, Kappa particles in Paramecium, Petite mutants in yeast. Contributions by Dr. Nüsslein-Volhard	
Unit III: Characteristics of Chromosomes and Gene Mutations	**9 hrs**
Structure of DNA. Gene mutation-Transition, Transversion and Frame shift mutation, Molecular mechanism of mutation by chemical mutagen: tautomerisation, alkylation,deamination, base analogue incorporation.	
Unit IV: Chromosomal Aberrations	**18 hrs**
Types and meiotic behaviour of: Deletion, Duplication, Translocation, Inversion. Aneuploidy and polyploidy: Types, examples, meiotic behaviour and importance. One Gene–one polypeptide concept, Complementation test (rII locus), Split gene,Overlapping genes, Transposons. Genetic Counselling	

List of Experiments:

1. Mendelian laws and gene interaction studies.
2. Determination of goodness of fit in normal and modified mono-and dihybrid ratios (3:1, 1:1, 9:7, 13:3, 15:1, 9:3:3:1, 1:1:1:1) by Chi-square analysis and comment on the nature of inheritance .
3. Study of Human /Phlox/ Allium Karyotype.
4. Pedigree analysis of some human inherited traits

Course Learning Outcomes:

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

1. Define basic concepts of heredity and learn genetic mapping techniques
2. Describe central role of genes in the inheritance of traits and the complex variations in inheritance pattern.
   Develop skills in genetics techniques, genetic calculations and interpretation.
   Assess the role of mutations in phenotypic variations, account explain the role of genetic information in pedigree analysis and to inform at-risk individuals about individual's inherited syndromes
3. Justify further study, teaching and research

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Snustad, D.P., Simmons, M.J	Principles of Genetics. V Edition	John Wiley and Sons Inc	2009	978-0470388259 0470388250	-
Klug, W.S, Cummings, M.R , Spencer,C. A. and Palladino, M.A.	Concept of Genetics	Pearson education	2019	978-9353940409	
Gupta, P.K.	Genetics - Classical to Modern	Rastogi Publication	2007	978-8171338962	984
Brown TA	Genetics- A Molecular Approach.	Garland	2011	978-0815365099	554

PHY211: Fluid Mechanics

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

Unit I: Introduction	**9 hrs**
Basic concepts of fluid mechanics. Fundamental terms. Physical values. Fluids and their properties. Forces inside fluid	
Unit II: Fluid Statistics and Kinematics	**9 hrs**
Pascal's law. Euler's equation of fluid statics. Measurement of pressure. Relative statics of fluid – constant acceleration, rotation. Forces of hydrostatic pressure. Buoyancy. Flotation. Stability. Euler and Lagrangian specification of fluid flow. Streamlines. Pathlines. Stream surface. Stream tube. Mass/volume flow. Control volume	
Unit III: Fluid Dynamics	**9 hrs**
Continuity equation. Basic laws of fluid dynamics – conservation of mass, conservation of linear momentum, conservation of energy. Ideal fluid flow. Application of Bernoulli's equation. Real fluid flow. Viscosity. Determination of losses. Reynolds experiment. Laminar and turbulent flow. Boundary layer. Velocity profile. Losses in pipes. Frictional losses. Nikuradse experiments. Moody's diagram. Local losses. Coefficients of resistance.	
Unit IV: Hydraulic Design of Pipeline	**9 hrs**
Different approaches in designing the pipeline– pressure drop, mass/volume low, diameter of pipeline. Graphical view. Energy properties of pumps and hydraulic machines. Dimensional analysis. Theory of similarity. Flow of fluid in open channels. Non- stationary flow and hydraulic shock.	

Course Learning Outcomes:

The student will be able to:

1. Define basic terms, values and laws in the areas of fluids properties, statics, kinematics and dynamics of fluids, and hydraulic design of pipes,
2. Describe methods of implementing fluid mechanics laws and phenomena while analysing the operational parameters of hydraulic problems, systems and machines.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Granger, R.A	Fluid Mechanics	Dover Publications, New York	2nd ed./1995	9780486683560	928
Douglas, J.F. Gasiorek, J.M. Swaffield, J.A	Fluid Mechanics	Prentice Hall, NJ	5th ed./ 2005	0131292935	-

BTY208: Analytical Techniques in Biosciences

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I-Chromatography Techniques	**18 hrs**
Introduction to Chromatographic Techniques, Background and Classification, Partition/distribution coefficient, Planar chromatography: Principles, working and applications of Paper and Thin Layer Chromatography, Column Chromatography: Principles, working and applications Adsorption, Ion exchange, Affinity, Molecular exclusion, and Gas chromatography. Working principle and applications of High Performance Liquid Chromatography, Normal and Reverse phase HPLC, and Fast Protein Liquid Chromatography	
Unit II: Spectroscopic Techniques	**18 hrs**

Basics of Spectroscopy, Introduction to UV-Visible Spectroscopy, Atomic Absorption Spectroscopy, Vibrational Spectroscopy: RAMAN and Infrared, Fluorescence Spectroscopy, X-Ray Diffraction, Nuclear magnetic resonance, Mass spectroscopy.	
Unit III: Centrifugation and Electrophoretic Techniques	**18 hrs**
Background to sedimentation, working principle centrifuge, Relative Centrifugal Forces, types of centrifuges and rotors: fixed angle, swinging bucket and vertical rotors, types of centrifugation: differential and density gradient centrifugation, Working principle of analytical ultracentrifuge. Electrophoresis: principles and applications of paper, cellulose, acetate, Native and SDS PAGE, PFGE, Electroporation.	
Unit IV: Microscopy Techniques	**18 hrs**
Working and applications of Optical microscopy: bright field, dark field, phase contrast, Concept of Resolution, Introduction to Electron Microscopy, Scanning Electron Microscopy and Transmission Electron Microscopy, Sample preparation for electron microscopy, staining techniques.	

Course Learning Outcomes:

Students will be able to

- Demonstrate a deep understanding of the principles and theoretical foundations of a variety of bioanalytical techniques.
- Discriminate between various techniques with respect to their applications.
- Describe suitable analytical techniques to characterize and quantify biological molecules.
- Apply analytical thinking, problem-solving skills, and scientific inquiry to innovate and contribute to advancements in bioscience research, industry, healthcare, or other related fields.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Karp, Gerald	Cell and Molecular Biology: Concepts	John Wiley and Sons, Inc	6th edition/2010	978-1118886144	832

	and Experiments				
Wilson K., Walker J.	Principle and Techniques of Biochemistry and Molecular Biology	Cambridge University Press	6th edition/2006	978-0521178747	744
Rana, SVS	Biotechniques: Theory and Practice	Rastogi Publications	2018		376
Plummer, David	An Introduction to Practical Biochemistry	Tata Mc Graw Hills	3rd edition/2017	978-0070994874	250

BTY205: Principles of Enzymology

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit I: Enzymes and Coenzymes	**9 hrs**
Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme. IUBMB classification of enzymes. Features of enzyme catalysis Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, catalysis, reaction rates and thermodynamics of reaction. Catalytic	

power and specificity of enzymes (concept of active site), Koshland's induced fithypothesis. Involvement of coenzymes in enzyme catalysed reactions: Mechanism of action of TPP, FAD, NAD, pyridoxal phosphate, biotin, coenzyme A, tetrahydrofolate, lipoic acid.	
Unit II: Enzyme Kinetics and Inhibition	**18 hrs**
Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant – mono-substrate reactions.Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. Km and Vmax, Kcat and turnover number. Effect of pH, temperature and metal ions on the activity of enzyme. Bi-substrate reactions: Types of bi bi reactions (sequential – ordered and random, ping pong reactions). Enzyme inhibition: Reversible inhibition and irreversible (competitive, uncompetitive, noncompetitive, mixed type). Mechanism based inhibitors - antibiotics as inhibitors.	
Unit III: Mechanisms of Enzyme catalysed reactions	**18 hrs**
General features - proximity and orientation, strain and distortion, acid base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes, transition state analogues. Regulation of enzyme activity : Control of activities of enzymes (end product inhibition) and metabolic pathways, feedback inhibition (aspartate transcarbomoylase), reversible covalent modification (phosphorylation). Proteolytic cleavage- zymogen. Multienzyme complexes (pyruvate dehydrogenase, fatty acid synthase) and Enzyme regulation	
Unit IV: Application of Enzymes	**9 hrs**
Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), enzyme immunoassay (HRPO), enzyme therapy (Streptokinase). Immobilized enzymes. Isoenzymes Enzyme Inhibitors as drugs. Drug Design	

List of Experiments

1. Partial purification of acid phosphatase from germinating mung bean.
2. Assay of enzyme activity and specific activity, e.g. acid/alkaline phosphatase.
3. Effect of pH on enzyme activity
4. Effect of temperature on enzyme activity
4. Determination of Km and Vmax using Lineweaver-Burk plot
5. Enzyme inhibition - calculation of Ki for competitive inhibition.
6. Continuous assay of lactate dehydrogenase.
7. Coupled assay of glucose-6-phosphate dehydrogenase.

Course Learning Outcomes:

At the end of the course, the students will learn

1. Types of enzymes, classification and their importance
2. Enzyme kinetics and enzyme inhibitors
3. Mechanisms of enzyme action
4. Application of enzymes in diagnostics and drug discovery

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
David Nelson	Lehninger: Principles of Biochemistry	WH Freeman	2017	9781319108243	1328
Nicholas C.P. and Lewis S.	Fundamentals of Enzymology	Oxford University Press	3rd Ed	978-0198064398	-
Voet, D., Voet, J.G.	Biochemistry	Wiley	4th Ed	978-0071737074	-

STA202: Statistics for Life Sciences

L	T	P	Total credits
3	0	0	3

Course Contents/syllabus:

	Teaching Hours
Unit I	**13 H**
Data collection and graphical presentation, Descriptive Statistics: Measures of centraltendency, Measures of dispersion, Skewness and Kurtosis, Correlation and regression	
Unit II	**14 H**
Definitions of Probability, Conditional Probability, Bayes' theorem, random variables: discrete and continuous, density and mass functions. Expected values and moment generating functions.	
Unit III	**14 H**
Discrete distributions: Uniform, Bernoulli, Binomial, Poisson, Continuous distributions: Uniform, Exponential, Normal and their applications in life sciences Random sample and sampling distributions	

Unit IV	13 H
Hypothesis testing, one and two-tail test, Z-test, Chi test, t-test, F-test, analysis of variance and regression, ANOVA	

Course Learning Outcomes: On the successful completion of this course the student will be able tounderstand the

1. Basics of descriptive statistics
2. Basics of the probability and random variable
3. Statistical distributions and their applications in the real-world problems
4. Application of various statistical tests

Text / Reference Books:

AUTHOR	TITLE	Publisher	Year of publication	ISBN
Ronald E. Walpole, Raymond H. Myers, SharonL. Myers, KeyingE. Ye	Probability and Statisticsfor Engineers and Scientists	Pearson; 9th edition	2010	978-0321629111
G Shanker Rao	Probability and Statisticsfor Science and Engineering	Universities Press	2011	9788173717444
SC Gupta, VK Kapoor	Fundamentals of Mathematical Statistics	Sultan Chand & Sons Private Limited	2000	9788180545283
Rohatgi V. K. and Saleh, A.K. Md. E.	An Introduction to Probability and Statistics	2nd Edition, John Wiley and Sons	2009	9788126519262, 9788126519262
Casella G. andBerger R. L.	Statistical Inference	2nd Edition, Cengage Learning India	2002	9788131503942, 9788131503942

Hogg R. V., Mckean J. and Craig A. T	Introduction to Mathematical Statistics	7th Edition, Pearson Education India	2013	9789332519114, 9789332519114
ukhopadhyay P	Mathematical Statistics	Books and Allied	2016	9788187134930

BTY205: Principles of Chemical Engineering

L	T	P	Total Credits
3	0	0	3

Course content and syllabus

	Teaching Hours
Unit I: Introduction to engineering calculations	**14 hrs**
Physical variables, dimensions, and units, force and weight, measurement conventions, standard conditions and ideal gases, physical and chemical property data, stoichiometry, methods for checking and estimating results, presentation and analysis of data, errors in data and calculations, presentation of experimental data, data analysis, graph paper with logarithmic coordinates, general procedures for plotting data, process flow diagrams, etc.	
Unit II: Chemical Reaction Engineering	**13 hrs**
Kinetics of homogenous reactions: Concepts of reaction rate, order of reaction and molecularity, Analysis of batch reactors for kinetic interpretation of data and isothermal reactor design for single and multiple reactions, Design equations for CSTR, fed batch and plug flow reactors.	
Unit III: Process Instrumentation	**13 hrs**
Principles of measurement: error, accuracy, and sensitivity; Measurement of flow, pressure, temperature, liquid level, pH, viscosity, and chemical composition etc**.**	
Unit IV: Material and Energy Balances	**14 hrs**

	Material balances, thermodynamic preliminaries, laws of conservation of mass, procedure for material balance calculations, material balance worked out examples, Simple problems on material balance calculations involving unit processes and reactive systems; Units and dimensions, Dimensional analysis; Basic energy concepts – enthalpy changes in chemical reactions and in non-reactive processes, Energy balance calculations, basic energy concepts, general energy balance equations, enthalpy calculation procedures, enthalpy change in nonreactive processes, steam tables, procedure for energy balance calculations without reaction, energy balance worked examples, without reaction.	

Course Learning Outcomes:

The student will be able to:

1. understand the basic concept of material and energy balance equations of various chemical. /Biochemical processes
2. analyze the concepts of kinetics, contacting pattern and performance equations ofdifferent reactors.
3. relate the performance characteristics of a measuring system critical to the process of selection.
4. integrate the knowledge to design in providing control, process monitoring, and functions in both everyday life and chemical engineering applications.
5. Overall, the student will be able to demonstrate the performance of different chemical Processes.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
O. Levenspie	Chemical Reaction Engineering	John Wiley and Sons	2021	978-9354244605	860
G. Stephanopoulos	Chemical Process Control, An introduction to Theory and Practice	Pearson Education India	2015	978-9332549463	720

CBA103: Personal Finance and Planning

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Financial Planning	**18 hrs**
Financial goals, Time value of money, steps in financial planning, personal finance/loans, education loan, car loan & home loan schemes. Introduction to savings, benefits of savings, management of spending & financial discipline, Net banking and UPI, digital wallets, security and precautions against Ponzi schemes and online frauds such as phishing, credit card cloning, skimming.	
Unit II: Investment Planning; Personal Tax Planning	**18 hrs**
Process and objectives of investment, Concept and measurement of return & risk for various assets class, Measurement of portfolio risk and return, Diversification & Portfolio formation. Gold Bond; Real estate; Investment in Greenfield and brownfield Projects; Investment in fixed income instruments-financial derivatives & Commodity market in India. Mutual fund schemes including SIP; International investment avenues. Tax Structure in India for personal taxation, Scope of Personal tax planning, Exemptions and deductions available to individuals under different heads of income and gross total income. Comparison of benefits - Special provision u/s 115BAC vis-à-vis General provisions of the Income-tax Act, 1961, tax avoidance versus tax evasion.	
Unit III: Insurance Planning	**18 hrs**
Need for Protection planning. Risk of mortality, health, disability and property. Importance of Insurance: life and non-life insurance schemes. Deductions available under the Income-tax Act for premium paid for different policies.	
Unit IV: Retirement Benefits Planning	**18 hrs**
Retirement Planning Goals, Process of retirement planning, Pension plans available in India, Reverse mortgage, New Pension Scheme. Exemption available under the Income-tax Act, 1961 for retirement benefits.	

Course Learning Outcomes:

The student will be able to:

1. Understand the framework for financial planning to comprehend the overall role finances play in his/her personal life.
2. Apply economic models & decision-making framework to a range of managerial problems.
3. Analyze the comparative merits of savings & investment options in terms of risk, return and tax implications.
4. Evaluate savings and investment strategies to achieve financial goals.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Indian Institute of Banking & Finance	Introduction to Financial Planning	Taxmann Publication	2017	978-9386394552	392
Pandit, A.	The Only Financial Planning Bookthat You Will Ever Need	Network 18 Publications Ltd.	2014	978-9380200606	230
Sinha, M.	Financial Planning: A Ready Reckoner	McGraw Hill Education	2008	978-9385965562	288
Halan, M.	Let's Talk Money: You've Worked Hard for It, Now Make It Workfor You.	HarperCollins Publishers.	2018	978-9352779390	204
Tripathi, V.	Fundamentalsof Investment	Taxmann Publication	2017	9789390609093	628

Programme structure for B.Tech. Biotechnology- 4 years (5th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1	BTY207	Recombinant DNA Technology	Core Course	3	0	1	0	0	4
2	HGM303	Molecular Biology: Genesto Proteins	Core Course	4	0	0	0	0	4
3	BTY302	Animal Biotechnology	Core Course	3	0	1	0	0	4
4	BTY301	Fundamentals of Biochemical Engineering	Engineering Course	3	0	0	0	0	3
5	CBA702	Professional Ethics	Value Added Course	2	0	0	0	0	2
6	HGM304 HGM305	*Students will choose anyone course** 1. Essentials of Genomicsand Proteomics 2. Biology of Cancer	Specializatio n Elective Course	3	0	0	0	0	3
7	CBA302	Entrepreneurship and New Venture Creation	Employabilit y/Skill Enhanceme nt	4	0	0	0	0	4
				Total credits					**24**

*****The Specialization Elective Courses of 5th and 6th Semesters will be pooled together.

BTY207: Recombinant DNA Technology

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

Course Objective: To teach methods of DNA manipulations, cloning and gene editing.

	Teaching Hours
Unit I: Gene Cloning and DNA Analysis	**18 hrs**
Polymerase chain reaction, DNA modifying enzymes: polymerases, kinases, ligases, phosphatases; Primers designing, Purification of DNA fragments, Restriction enzymes, DNA ligation, Vectors, DNA Transformation, GENOMic DNA and Plasmid Isolation, Restriction digestion and DNA Analysis by gel electrophoresis.	
Unit II: Vectors for Gene Cloning and DNA Manipulation	**9 hrs**
Cloning vectors based on E. coli plasmids, Plasmid copy number control, Cloning vectors based on M13 bacteriophage, Cloning vectors based on 8 bacteriophage, 8 and other high-capacity vectors enable genomic libraries to be constructed, Vectors for other bacteria, Bacterial Artificial chromosomes (BACs); Vectors for yeast and other fungi, Yeast artificial chromosomes (YACs), Cloning vectors for higher plants, Tobacco Mosaic Virus (TMV); Cloning vectors for animals. Problem of Plasmid incompatibility, The problem of selection, Direct selection, Identification of a clone from a gene library, Methods for clone identification.	
Unit III: Cloning a Specific Gene	**18 hrs**
Transduction, conjugation and transfection, Types of plasmids, Recombinant Bacterial strains for bioremediation; online servers/software for DNA and protein analysis: Acquiring DNA sequence encoding the protein of interest (for example GFP) from online database like PUBMED and PDB. Analysis of DNA sequence for presence of internal restriction digestion sites etc.	
Unit IV: Advanced Cloning Techniques	**9 hrs**
Homologous recombination, Molecular mechanism of RecBCD, RecA, RuvA-B, Holliday Model; Non-homologous End Joining (NHEJ) versus Homologous DNA recombination; Positive and negative selection, Zinc finger nucleases (ZFN), Transcription activator-like effector nucleases (TALENs), Discovery of adaptive immunity, The CRISPR-Cas9 (clustered regularly interspaced short palindromic repeats) system, Methods to create gene-knock out animal model systems. Cre-LoxP recombination system	

List of Experiments

1. Acquiring DNA sequence encoding the protein of interest (for example GFP) from online database like Genbank and Uniprot. Analysis of DNA sequence for presence of internal restriction digestion sites etc using softwares like gene runner.
2. Primer designing: Designing of 5' forward and 3' reverse complementary primers containing appropriate restriction digestion sites, affinity tags (penta-His etc.).
3. PCR amplification of the DNA segment of interest from a suitable source, purification of the PCR product.
4. Restriction digestion, and subsequent ligation into the suitable bacterial expression vector (also containing an antibiotic resistant marker) of interest.
5. Preparation of competent cells and transformation into suitable competent cells (BL21 etc.).
6. Selection of the antibiotic resistant single colony.
7. Plasmid isolation from the transformed cells and sequencing it to confirm the sequence of cloned DNA segment of interest.

Course Learning Outcomes:

Students will be able to:

1. Understand basic concepts of DNA manipulation.
2. Understand the procedure of gene cloning.
3. Have a thorough understanding of vectors.
4. Perceive knowledge of advanced gene editing methods

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
J. Sambrook, E. F. Fritsch, and T. Maniatis, 2nd Edn.,	Molecular cloning: a laboratory manual,	Cold Spring Harbor Laboratory Press	3rd Ed	978-0879695767	2344
T.A. Brown	Gene Cloning and DNA Analysis - An introduction	Wiley - Blackwell	2010	9781405181730	338

HGM303: Molecular Biology: Genes to Proteins

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

Course Objective: To understand the process of DNA replication, transcription and protein translation.

	Teaching Hours
Unit I: Introduction	**18 hrs**
The History and Birth of Molecular Biology. Relationships between genotype and phenotype. Contributions of Nobel Laureates in the area of Molecular Biology Genes and Genomes: Molecular definition of gene. Organization of genes on chromosomes. Repetitive DNA. Simple sequence DNA. Interspersed-Repeat DNA and mobile DNA elements. Chromosome structure: Bacterial chromatin and specific proteins to condense bacterial DNA. Nucleosomes. Chromatin organization in eukaryotes. Functional Rearrangements in chromosomal DNA. Extra-nuclear genomes, Specific notations, conventions and terminologies used in genetics	
Unit II: DNA Replication	**18 hrs**
DNA replication is semi-conservation and bi-directional. DNA replication in bacteria: Initiation, elongation and termination of bacterial DNAreplication. Enzymes involved in DNA replication. Eukaryotic DNA replication machinery. Initiation, elongation and termination of replication. Telomeres and Telomerase. Leading strand problem in replication. DNA replication in Archaea DNA damage and repair mechanisms	
Unit III: Transcription	**18 hrs**
RNA Transcription in bacteria and eukaryotes RNA and Transcription: Types of RNA. Types of RNA polymerase and structure; Molecular apparatus and events during prokaryotic and eukaryotic RNA synthesis. Post— transcriptional modifications of transcripts. Processing of different types of RNA. RNA editing. Formation of spliceosome complex. Inhibitors of RNA metabolism and their mechanism of action; RNA degradation.	
Unit IV: Protein Translation	**18 hrs**

Genetic code: Its deciphering, degeneracy and general features. tRNA, aminoacylation of tRNA, tRNA identity and aminoacyl tRNA synthetases. Structure of ribosomes, and its assembly and disassembly. Codon: anti-codon base pairing, Wobble hypothesis Translation in Prokaryotes: formation of initiation complex, initiation factors, elongation, elongation factors, and termination. Translation in Eukaryotes: formation of initiation complex, initiation factors, elongation, elongation factors and termination. Translation proof-reading, translation inhibitors. Post-translation modifications of proteins and their effect on their structure and function. Protein targeting: Signal sequence and targeting of proteins to specific cellular locations.	

Course Learning Outcomes: At the end of this course, students will learn about:

1. History and development of molecular biology, structure of genome and terminologies used in molecular genetics.
2. DNA replication in bacteria, archaea and eukaryotes
3. Mechanism of transcription in bacteria and eukaryotes.
4. Protein translation and sorting in bacteria and eukaryotes.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Watson, JD., Baker, TA., Stephen, PB., Alexander, G., Levine, M., Losick R.	Molecular Biology of the Gene	Pearson Education	7th Ed	978-9332585478	912
Tropp, B.E.	Molecular Biology Genes to Proteins	Jones and Bartlett	4th Ed	978-93-80853-49-9	1096
Lewin, B.	Genes XI	Jones and Bartlett	2013	978-9380853710	-

BTY302: Animal Biotechnology

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Animal Tissue Culture	**9 hrs**
Background to animal tissue culture, Advantages, Limitations, Application, Culture environment, Cell adhesion, Cell proliferation, Differentiation. Layout of animal tissue culture laboratory. Media: Role of Physicochemical properties, Introduction to the balanced salt solutions and simple growth medium, Complete Media, Role of serum and supplements. Serum free media, Advantages, disadvantages, and their applications	
Unit II: Primary Culture and Culture of Specific Cell Types	**18 hrs**
Isolation of tissue, Steps involved in primary cell culture, Subculture and propagation, Cell lines, Nomenclature, Cell line designations, Routine maintenance, Immortalization of cell lines, Cell transformation. Cell cloning and Cell separation, Cell synchronization. Epithelial, Mesenchymal, Tumor cell culture. Measurement of viability and cytotoxicity	
Unit III: Characterization, Contamination and Cryopreservation of Cell Line	**9 hrs**
Morphology, Chromosome Analysis, DNA Content, RNA and Protein, Enzyme Activity, Antigenic Markers, Tumorigenicity, Cell counting, Plating Efficiency, Labeling Index, Generation Time, Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Cell banks, Transporting cells	
Unit IV: Gene Transfer Technology and Animal Cloning	**18 hrs**
Gene transfer techniques in mammalian cells, Viral and non-viral methods, Production of transgenic animals, ES and microinjection, retroviral method and molecular pharming, applications of transgenic animal technology. Animal cloning: Animal cloning basic concept, Techniques, relevance and ethical issues, embryo transfer, SCNT, embryo- spliting, embryo sexing, embryos, in situ and ex situ preservation of germplasm, in utero testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, gene knock out technology and animal models for human genetic disorders. Different methods for characterization of animal genomes, SNP, STR, QTL, RFLP, RAPD	

List of Experiments:

1. Laboratory Design & Instrumentation in Animal tissue culture
2. Quality Assurance in Animal tissue culture facility
3. Preparation of Animal Cell Culture media
4. Isolation and Culturing Peripheral Blood Lymphocytes

5. Viability assay
6. Cryopreservation technique
7. Sub-culturing and maintenance of Cell line
8. In vitro anticancer assay (MTT Assay)
9. Genomic DNA Isolation from Blood/Tissue.

Course Learning Outcomes:

Students will be able to

1. explain the fundamental scientific principles that underlie cell culture.
2. acquire knowledge for isolation, maintenance, and growth of cells.
3. develop proficiency in establishing and maintaining of cell lines.
4. acquire knowledge in animal cloning and its applications.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
R. Ian Freshney	Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications	Wiley-Blackwell	7th/2015	978-1118873656	
Ranga, M.M	Animal Biotechnology	Agrobios	2nd/2007	978-8177543094	210
Masters, J.R. W	Animal Cell Culture- A Practical Approach	Oxford	3rd/2000	978-0199637966	334
Lanza	Essentials of Stem Cell Biology	Cold Spring Harbor Publication	2001	978-0124095038	712

BTY301: Fundamentals of Biochemical Engineering

L	T	P	Total Credits
3	0	0	3

Course content and syllabus

	Teaching Hours
Unit I: Growth kinetics and reactor design	**15 h**
Microbial growth: Kinetics of microbial growth; substrate utilization and product formation; Structured and unstructured model of growth; Equations for substrate utilization and product formation and related numerical. **Reactor design**: Bioreactor configurations; Stirred tank; Airlift reactor; Packed bed; Monitoring and control of bioreactors; Ideal reactor operation; Batch operation of a mixed reactor; Total time for batch reaction cycle; Fed-batch operation of a mixed reactor; Continuous operation of a mixed reactor; Chemostat cascade; Continuous operation of a plug flow reactor; Detailed studies on the batch, continuous and fed-batch bioreactor, instrumentation, and control of bioprocesses and numerical thereof	
Unit II: Sterilization, aeration, and agitation	**12 h**
Sterilization of air and medium: Different methods of sterilization; Kinetics of sterilization; batch and continuous sterilization; advantages and disadvantages thereof; Calculation of del factor and solving of numerical. Agitation: Need of agitation in aerobic fermentation; mixing, micro and macro mixing, mixing equipment, Effect of agitation; How agitation helps aeration; Different types of agitational methods; impeller design and relationship with the characteristics of the fluid; fluid flow behavior etc. Aeration: Need of aeration in aerobic fermentation; effect of aeration; how aeration helps agitation; different types of aeration methods; aeration in high density fermentation; aeration in qualescence and non-qualescence medium; flow behavior etc.	
Unit III: Mass and heat transfer in bioreactors	**15 h**
Mass transfer: Mass transfer principle, two film theory, Fick' law of diffusion in microbial processes; Resistance encountered in fermentation medium by the oxygen molecule; Role of Dissolved oxygen concentration in the mass transfer; Determination of mass transfer co-efficient (KLa), Factors affecting KLa and their relationship, numerical on mass transfer. Heat transfer in bioreactors: Mechanisms of heat transfer; heat transfer between fluids, Calculation of heat transfer coefficients; Heat transfer equipment; Steady state conduction; LMTD calculation; Relationship between heat transfers; cell mass concentration and stirring conditions, numerical thereof.	

Unit IV: Dimensional analysis and scale up	12 h
Dimensional analysis: Various types of dimensionless analysis in terms of mass transfer; heat transfer and momentum transfer; Importance of dimensionless number in designing the bioreactors, heat exchangers etc. Scale-up: Principles and criteria; Different methods of scale up and the detailed analysis with case studies.	

Course Learning Outcomes:

Students will be able to

1. Apply unit operations of Biochemical Engineering and be able to describe the kinetic parameters for batch process.
2. Describe, interpret, and analyze media sterilization and air sterilization for large scale production process.
3. Examine the understanding on mass transfer and various scale-up parameters.
4. Compile and integrate the steps of kinetics of cell recycle and multistage continuous culture system.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Stanbury, P.F., Whitaker, A., and Hall, S. J	Principles of Fermentation Technology	Pergamon	2nd Ed./ 1997	9780750645010	376
Doran, P. M	Bioprocess EngineeringPrinciples	Academic Press, California	2009	0122208560	439
Baily, J.E. and Oillis, D. F	Biochemical Engineering Fundamentals	McGraw Hill Education Pvt. Ltd	2nd Ed./2012	0130819085	-

CBA702: Professional Ethics

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Professional Ethics	**9 hrs**
Basic Concepts, Governing Ethics, Personal & Professional Ethics, Ethical Dilemmas, Life Skills, Emotional Intelligence, Thoughts of Ethics, Value Education, Dimensions of Ethics, Profession and professionalism, Professional Associations, Professional Risks, Professional Accountabilities, Professional Success, Ethics and Profession.	
Unit II: Basic Theories	**9 hrs**
Basic Ethical Principles, Moral Developments, Deontology, Utilitarianism, Virtue Theory, Rights Theory, Casuist Theory, Moral Absolution, Moral Rationalism, Moral Pluralism, Ethical Egoism, Feminist Consequentialism, Moral Issues, Moral Dilemmas, Moral Autonomy.	
Unit III: Professional Practices in Engineering	**9 hrs**
Professions and Norms of Professional Conduct, Norms of Professional Conduct vs. Profession; Responsibilities, Obligations and Moral Values in Professional Ethics, Professional codes of ethics, the limits of predictability and responsibilities of the engineering profession, Central Responsibilities of Engineers - The Centrality of Responsibilities of Professional Ethics; lessons from 1979 American Airlines DC-10 Crash and Kansas City Hyatt Regency Walk Away Collapse.	
Unit IV: Workplace Rights and Responsibilities	**9 hrs**
Ethics in changing domains of Research, Engineers and Managers; Organizational Complaint Procedure, difference of Professional Judgment within the Nuclear RegulatoryCommission (NRC), the Hanford Nuclear Reservation. Ethics in changing domains of	

research - The US government wide definition of research misconduct, research misconduct distinguished from mistakes and errors, recent history of attention to research misconduct, the emerging emphasis on understanding and fostering responsible conduct, responsible authorship, reviewing & editing. Global issues in Professional Ethics: Introduction – Current Scenario, Technology Globalization of MNCs, International Trade, World Summits, Issues, Business Ethics and Corporate Governance, Sustainable Development Ecosystem, Energy Concerns, Ozone Deflection, Pollution, Ethics in Manufacturing and Marketing, Media Ethics; War Ethics. Bio Ethics, Intellectual Property Rights	

(Total Teaching = 36 hrs)

Course Learning Outcomes:

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

1. Understand basic purpose of profession, professional ethics and various moral and social issues.
2. Awareness of professional rights and responsibilities of an Engineer, safety and risk benefit analysis ofan Engineer.
3. Acquire knowledge of various roles of Engineer In applying ethical principles at various professionallevels.
4. Professional Ethical values and contemporary issues.
5. Excel in competitive and challenging environment to contribute to industrial growth.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
R. Subramanian	Professional Ethics	Oxford University Press	2nd edition/ 2017	9780199475070	472
Caroline Whitbeck	Ethics in Engineering Practice and Research	Cambridge University Press	2nd edition/ 2012	9780511976339	414

HGM304: Essentials of Genomics and Proteomics

L	T	P	Total Credits
3	0	0	3

Course content and syllabus

	Teaching Hours
Unit I: Genomics Overview	**13 hrs**
Genome definition, Genomics and its diversifications – Structural Genomics, Functional Genomics, Pharmacogenomics, Personal Genomics, Genome organization – Differences in prokaryotes, eukaryotes and viruses, Repeat content of the genome, C value paradox; Model Genomes (*E. coli*, *Arabidopsis*, C. elegans).	
Unit II: Whole Genome Sequencing Techniques and Annotation	**14 hrs**
Massively parallel Genome Sequencing Techniques – Common features of Second Generation Sequencing Techniques, Pyrosequencing, Whole Genome Sequencing strategies – De novo sequencing and assembly strategies - Whole Genome Shotgun and Hierarchical Shotgun, Genome finishing – Gaps and their resolution, Human Genome Project - findings and impact, Reference based assembly and alignment algorithms for short reads, Genome Annotation – concepts of Open Reading Frame, in silico annotation approaches – de novo, homology based annotation – common gene finding algorithms and wet lab confirmation methods – mRNA, ESTs	
Unit III: Molecular Markers and Transcriptome analyses	**13 hrs**
Variations in genomes and Molecular markers – Concepts, assays and Applications – Dominant and codominant markers, RFLP, AFLP, CAPS, SSRs, RAPDs, SNPs, Copy number variations (CNVs), Variations and diseases. Transcriptome analysis, Microarray Chips and applications- ChIPSeq, ChIP-chip, protein-DNA interactions - (Co-IP, Y2H approaches, Phage display)	
Unit IV: Elucidation of Proteomes	**14 hrs**
Proteomes and Sub- proteomes (structure, function and expression correlations Quantitative Proteomics, Proteomic technologies -Gel based proteome investigations (1D/ 2D- GE, IEF,DIGE); Sequence based technologies - Mass spectrometry (ESI, MALDI and hybrid); LC/MS-MS; Protein sequence determination – Edman versus Peptide sequencing and mass fingerprinting; Identification of post- translational modifications; Protein de novo sequencing and top down proteomics; Proteomic analysis of protein-protein, Proteome interaction maps, Proteomics experimental workflows; Protein Engineering Techniques; Protein databases and bioinformatics processing; Proteomics applications	

(Total Teaching = 54 hrs)

Course Learning Outcomes:

1. Learn the key concepts of high throughput techniques used in genomics.
2. Understand the Genome annotation and infer significance of genomic variations in disease, forensics, and evolution.
3. Understand Omics sciences followed in biological research.
4. Identify the modalities of proteomic studies that are applied in latest research in life sciences.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Campbell AM& Heyer LJ	Discovering Genomics, Proteomics and Bioinformatics	Benjamin Cummings, CSH Press, NY	2007	978-8131715598	464
R.M Twyman	Principles of Proteomics	Garland Science	2013	978-0815344728	260
Primrose S &Twyman R	Principles of Gene Manipulation and Genomics	Blackwell	7th Edition 2006	978-1405135443	-

HGM305: Biology of Cancer

L	T	P	Total Credits
3	0	3	3

Course content and syllabus

	Teaching Hours

Unit I: Introduction to Cancer	**9 hrs**
Basics of cancer, Theories of cancer development, classification, types of cancer Differences between benign tumor and malignant forms of cancer, multi-step and multi-stage processes – initiation, promotion and progression, Overview of the hallmarks ofcancer, cancer stem cells	
Unit II: Molecular Basis of Carcinogenesis	**18 hrs**
Mutagens, carcinogens, Tumor viruses, Proto-oncogenes, cellular and viral Oncogenes and tumor suppressor genes and their mechanism of action, Genetic abnormalities incancer, Angiogenesis, invasion and metastasis.	
Unit III: Role of Cell Cycle and Apoptosis and Autophagy	**9 hrs**
Cell cycle regulation and cell death, Cellular senescence, telomeres and immortalization, Autophagy in Cancer.	
Unit IV: Cancer Epigenetics and Metabolism	**18 hrs**
Role of DNA methylation, histone modifications and non-coding RNAs in cancer development, Cancer metabolism.	

(Total Teaching = 54 hrs)

Course Learning Outcomes:

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

1. Demonstrate basic understanding of cancer biology.
2. Acquire knowledge on molecular mechanisms involved in initiation as well as progression ofcancer.
3. Understand the application of cancer diagnosis and therapy.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Bruce, Albertsand Alexander Johnson and Julian Lewis, and Martin Raff	Molecular biology of thecell	Garland Science;	6th	978-0815344322	1342

Rakesh Srivastava	Apoptosis, cell signaling and human diseases	Humana Press	1st	9781588298829	395
Berg J.M., Tymoczko J.L., Stryer L.	Biochemistry	WH Freeman & Company	5th	13: 978-1-4641-2610-9	1023

CBA302: Entrepreneurship and New Venture Creation

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Entrepreneurial Ecosystem	**18 hrs**
Concept of entrepreneurship, entrepreneur's role, task and personality, theoretical perspective of entrepreneurship, entrepreneurial intention, entrepreneurial orientation, type of entrepreneurship, Understanding the entrepreneurial perspective in individuals, developing creativity and understanding innovation, Importance of entrepreneurship	
Unit II: Evaluating Entrepreneurial Options and Understanding Start up Financial Requirements	**18 hrs**
Understanding the idea and an opportunity. The opportunity creating, shaping, recognizing and seizing. Screening venture opportunities, gathering information and analyzing. Evaluating venture opportunities and develop startup strategy. Feasibility analysis sand risk taking ability-An overview of startup finance and sources of finance. Understanding the business model and financial projections, how to forecast expenses and revenue. Gathering the resources developing entrepreneurial marketing and operational plan. Role of government institutions.	
Unit III: Launching and Managing New Venture -Developing Team and Business Plan	**18 hrs**

The importance of team, forming and building team. Examining sample business plans and writing business plan. Understanding the investor's perspective and presenting the business plan. Valuation of business plan and the elevator pitch. Entrepreneurial challenges as an individual and as an entrepreneur Skills of managing business risk and enhancing success.	
Unit IV: Emerging trends, Technologies and Practices in Startups - Legal Aspects ofBusiness	**18 hrs**
Legal form of new venture. Legal issues and other formalities related to venture. Technology-enabled trends that will help shape businesses and the economy, technical intelligence in business- understanding technology threats and opportunities, Technology Business Incubators, emergence and growth of new technology–based companies	

Course Learning Outcomes:

At the end of this course, the students will be able to identify motivations of an entrepreneur for starting the business, demonstrate entrepreneurial skill set, identify sources of financing, Map the technological trends for new start-ups and Develop business plan.

1. Develop the abilities needed to formulate a business plan for an original venture concept.
2. Apply knowledge and skills from live case studies of successful entrepreneurs and business experience.
3. Enhance the ability to conduct sectoral study for a new venture creation/Start-up.
4. Evaluate and develop potential business opportunities and Legal aspects of starting new venture.

Text / Reference Books:

Author	Title	Publisher	Year of publication	ISBN	Pages
David H. Holt	Entrepreneurship: New Venture Creation	Prentice Hall	1991	978-0132826747	448

Leon Megginson, Mary Jane Byrd, William L. Megginson	Small Business Management: An Entrepreneur's Guidebook	McGraw-Hill Education	2005	978-0071244640	544
Jeffry Timmons, Stephen Spinelli	New Venture Creation: Entrepreneurship for the 21st Century	McGraw-Hill Education / Asia	2008	978-0071276320	704

Programme structure for B.Tech. Biotechnology- 4 years (6th Semester)

	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1	BTY304	Downstream Processing	Core Course	3	0	1	0	0	4
2	BTY306	Bioprocess Engineering	Core Course	4	0	0	0	0	4
3		Introductory Computational Biology	Core course	3	0	1	0	0	4
4	BTY305	Environmental Biotechnology	Core course	2	0	0	0	0	2
5		*Students will choose anytwo courses** 1. Biomaterials 2. Chemical Biology 3. Introductory Biophysics 4.Environmental Toxicology &Health	SE	3 3	0 0	0 0	0 3	0 0	3 3
6.	BIF302	Big Data for Life Sciences	Employability& Skill enhancement	3	0	1	0	0	4
				Total credits					**24**

*The Specialization Elective Courses of 5th and 6th semesters will be pooled together.

BTY304: Downstream Processing

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Downstream processing	**18 hrs**
Role and importance of Downstream processing in biotechnological processes. Characteristics of products, Economics, process design criteria for various classes of byproducts, physico-chemical basis of different bio-separation processes.	
Unit II: Primary separation, Recover process, Adsorption and Extraction	**9 hrs**
Cell disruption methods, Filtration, Centrifugation, Adsorption, Protein Precipitation, Liquid-liquid Extraction, ATPS	
Unit III: - Membrane Separations	**9 hrs**
Membrane Separation Processes: Basic principle, Classification of membrane separation processes, advantages and disadvantages. Retention or rejection coefficient. Concentration polarization and fouling. Membrane types, applications in various industries. Outline of RO, MF, UF and dialysis	
Unit IV: Product Resolution and Fractionation, Final Product Formulation and finishing operations	**18 hrs**
Gel filtration, Affinity, Chromatographic separation processes, Principles of electrophoresis-SDS- PAGE, 2D gel electrophoresis, capillary electrophoresis, Crystallization: Principle, crystallization equipment and its applications in Bioprocessing. Drying: Various types of drying methods, principles of drying, drying curves, various types of industrial dryers and their criteria for choice. Freeze drying technique and its advantages over other methods. Applications in bioprocessing	

List of Experiments:

1. Conventional filtration of bioproduct
2. Protein precipitation
3. Aqueous two-phase separation
4. Ion exchange chromatography / Gel Permeation chromatography
5. Electrophoresis
6. Assays for desired bioproduct at each step of bioseparation to calculate the experimental yield.

Course Learning Outcomes:

Students will be able to

1. Understand the strategy for economic process design criteria by using different combination of downstream processing techniques for a desired bio product.
2. Identify and understand the basic unit operations and primary separation techniques involved indownstream process.
3. Learn how to apply various methods to purify biologically processed materials. 4.Analyze the estimation of operating parameters for membrane separation processes.
5. Appraise the best techniques used for the purification of bioproducts.

Create and design the final and finishing separation approaches for different bioproducts.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
B Sivasanka	Bioseparations - Principles and techniques	Prentice Hall of India, New Delhi	2010	978-8120326491	280
Robert K. Scopes	Protein purification: Principle and practice	Springer	2008	978-0387940724	380
F. Stanbury, A. Whitaker, and S.J. Hall	Principles of Fermentation Technology	Elsevier	2008	978-8181478085	-
Paul A. Belter, E. L. Cussler, Wei-Shou Hu	Bioseparations: Downstream Processing for Biotechnology	Wiley Publication	2011	978-0471847373	384

BTY306: Bioprocess Engineering

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Bioprocess Engineering, Media Design and optimization process	**18 hrs**
Bioprocess vs chemical engineering, advantages, disadvantages, Substrates for bioconversion process, Isolation, Preservation Techniques and Maintenance methods of Industrial Microorganisms, Cell culture technique, Media composition and design, Media type, Inoculum development and transfer, Media optimization techniques and advantages.	
Unit II: Process Technology for Production of Primary Metabolites	**18 hrs**
Ethanol: production by batch and continuous process by various technologies. Determination of fermentation efficiency, distillation efficiency and overall efficiency of ethanol production, recovery, uses, glucose effect etc. Power alcohol – definition, uses, merits and demerits of various technologies for its production. Amino Acid: Lysine: Indirect and direct fermentation.	
Unit III: Unit Operations for Bio-based products	**18 hrs**
Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, Chromatographic techniques, Electrophoresis techniques.	
Unit IV: Applications of enzyme technology	**18 hrs**
Mechanism of enzyme function and reactions in processing techniques; enzymatic bioconversions e.g. starch and sugar conversion processes; high-fructose corn syrup; interesterified fat; hydrolyzed protein etc; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases.	

Course Learning Outcomes:

- Recall the concepts of design and formulation of production media for fermentation.
- Explain various technologies for production of primary metabolites.
- Identify unit operations required for basic methods in production technique for bio-based products.
- Compare different microbial/enzymatic industrial processes in food and fuel industry.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
M.L. Shuler and Fikret.Kargi, 2nd edition,	Bioprocess Engineering Basic Concepts,	Pearson Education Limited.	2013	9780136 06 0659	957
W. Crueger and A. Crueger,	Biotechnology:A Textbook of Industrial Microbiology,	Sinauer Associates.	1990	0878931 31 7	541

Introductory Computational Biology

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction and Overview	**9 hrs**
String view of DNA and Proteins: Basic file formats, codon-genetic code-transcription &translation in parallel to computational biology, sense/coding as anti-sense/template strands. Sequence Data Bases and their types, detailed study of GenBank of NCBI- typical Gen Bank (DDBJ+EMBL) entry and for DNA and RNA, concepts of similarity-homologous, orthologous and paralogous sequences.	
Unit II: Sequence Alignment	**18 hrs**
Global and local alignments, statistical significance of alignments, Pair-wise sequence alignment, scoring matrices for amino acid sequence alignment, PAM, BLOSUM, Needleman-Wunch algorithm, position specific scoring matrices, BLAST, FASTA, Smith – Waterman algorithm for local alignment; Multiple sequence alignment- Progressive, Iterative and Block based MSA. Applications of Alignments-Patterns, Profiles, PSI-BLAST.	
Unit III: Molecular Phylogeny	**18 hrs**

Concept of phylogenetics –Application of Phylogenetic trees- Basic terminology-taxa, taxonomy, clade, root, leaf, node graph & tree, Dendogram, cladogram, rooted tree, unrooted tree, scaled trees- Molecular clock hypothesis, Distance based methods- UPGMA, NJ algorithm, Character based methods-Maximum parsimony and ML methods. Newick format of trees. Validating phylogenetic trees – jack knifing and bootstrapping Tools for Phylogenetic analysis-MEGA6, PHYLIP etc. Structural and Functional Annotation of DNA/Proteins. Computational Gene Prediction in Prokaryotes and Eukaryotes. Tools based on different strategies. Promoter Prediction, Transcription factor binding sites prediction, Prediction of Restriction sites on DNA/Proteins, Prediction of vector contamination.	
Unit IV: Molecular Modeling and Basics of Tools & Databases in Bioinformatics	**9 hrs**
Molecular modeling – PDB and MMDB, structure file formats, visualizing structural information, advance structure modeling, Internal and external co-ordinate system, cartesian and cylindrical polar co-ordinate system. Protein secondary and tertiary structure prediction: JPred, 3DPSSM, 123D, Modeller, Procheck, ITASSER; Protein visualization tools- Swiss PDB Viewer, Pymol, Rasmol.	

List of Experiments:

1. Biological databases: NCBI, EMBL, DDBJ, iHOP, PDB, UniProt, KEGG, Ensembl, STRING; Sequence file formats: GenBank, FASTA, EMBL, PDB format
2. DotPlot Analysis: DOTPLOT, DOTTER, DOTMATCHER., Pairwise Sequence Alignment programs: LALIGN, EMBOSS NEEDLE, EMBOSS Water, Clustalw, Muscle, T-Coffee, Similarity Searching: BLAST, Variants of Blast.
3. Phylogenetic analysis software: MEGA, PHYLIP.
4. Primer Designing: PRIMER3, Gene Identification Programs: GENSCAN, ORF finder. Fgenesh, Glimmer, Protein Identification and characterization: Protparam, Peptide cutter, Motif and Patterns program: Prosite, InterProScan, Pfam.
5. Modelling software: Swiss Model workspace, ArgusLab, Model Evaluation: PRocheck. Docking-Hex

Course Learning Outcomes:

Students will be able to

1. Gain knowledge about biological data submission and retrieval from databases.
2. Acquire skills to analyze biological data and produce and interpret the predictions of the software.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages

Des Higgins (Editor)	Bioinformatics : Sequence, Structure and Databanks: A Practical Approach (The Practical Approach Series, 236)	Willie Taylor. 1st edition, Oxford University Press	2000	978-0195667530	300
David W. Mount	Bioinformatics : Sequence and Genome Analysis	Cold spring harbor laboratory press	2nd edition/2004	978-8123912417	692

BTY305: Environmental Biotechnology

L	T	P	Total Credits
2	0	0	2

Course content and syllabus

	Teaching Hours
Unit I: Environmental Pollution	**9 hrs**
Definitions, various types of pollution and their effects, e.g. biomagnification, acid rain, global warming, global ozone problem	
Unit II: Renewable Energy Resources	**9 hrs**
Non-Renewable and renewable energy resources: Bioethanol, biohydrogen, biodiesel and biogas production	
Unit III: Bioremediation of Pollutants	**9 hrs**

Biodegradation and Bioremediation of major pollutants using microbes and plants; Useof microbial technology for mining of metals from ores, extraction of petroleum	
Unit IV: Waste Management	**9 hrs**
Various methods of solid waste management, Treatment of municipal wastewater andindustrial effluents	

Course Learning Outcomes:

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

1. Remember and comprehend the complexity of environment and ecosystems.
2. Understand the evolving field of biofuels.
3. Identify the role of microorganisms in biological wastewater treatment.
4. Analyze the potential of microbes and biomass for bioenergy production.
5. Evaluate the roles of EA and EIA in national and global scenario.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
RC Dubey/ PKGupta	Textbook of Biotechnology	S Chand andCo Ltd	2014	978-8121926089	616
Allen	Environmental Biotechnology	CBS	2016	978-8123928326	624

Biomaterials

L	T	P	Total Credits
3	0	0	3

Course content and syllabus

	Teaching Hours
Unit I: Introduction	**9 hrs**
Materials-Bulk properties and surface properties	

Unit II: Material Classes	**18 hrs**
Class of materials used in biomedical applications	
Unit III: Cell-Material Interactions	**18 hrs**
Biological interactions with materials-Proteins, cells, and tissues, biological responses: Inflammation, immunity, toxicity, coagulation, tumorigenesis. Biofilms, Pathological calcification, Biocompatibility	
Unit IV: Applications	**9 hrs**
Applications of biomaterials: drug delivery, tissue engineering, cardiovascular, orthopedic, dental, functional tissues, etc.	

Total teaching hours: 54 hrs

Course Learning Outcomes:

- Students will be able to understand the fundamentals and classes of materials.
- Describe interactions between biomaterials, proteins and cells.
- Explain methods to modify surfaces of biomaterials and choose material for desired biologicalresponse.
- Analyse the interactions between biomaterial and tissue for short term and long-termimplantations, distinguish between reactions in blood and in tissue.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen,Jack E. Lemons	Biomaterials Science: An Introduction to Materials in Medicine	Academic Press, USA	2004	978-0123746269	1573
J.B. Park and J.D. Bronzino	Biomaterials: Principlesand Applications	CRC Press	2002	978-0849314919	264
K.C. Dee, D.A. Puleo and R.Bizios	An Introduction to Tissue-Biomaterial Interactions	Wiley	2002	978-047125 3945	248

Chemical Biology

L	T	P	Total Credits
3	0	0	3

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Course content and syllabus

	Teaching Hours
Unit I: Principles of Chemical Biology	**18 hrs**
Chemistry of glycosylation, phosphorylation, sulphonylation, methylation of proteinsand nucleic acids, Chemistry of enzymatic digestion of nucleic acids and proteins.	
Unit II: Principles of Chemical Biology	**9 hrs**
Specificity of DNA polymerase action, chemical modifications of RNA and biological.	
Unit III: Applied Chemical Biology	**9 hrs**
Cellular Receptors for drug action, methods for identifying the cellular targets for naturalproducts with special emphasis given to paclitaxel and vancomycin	
Unit IV: Chemical Tools in Biology	**18 hrs**
Chemical method of synthesis peptides, Hydrogen/Deuterium exchange reaction and its application in monitoring biological Processes. Nano particles mediated monitoring of protein conformational studies for folding unfolding pathway.	

Total teaching hours: 54 hrs

Course Learning Outcomes:

Students will

- be able to demonstrate a clear understanding of the theoretical aspects of Bio-organic chemistryand biology.
- be able to analyse the chemical knowledge to explain the biological problems.
- be able to integrate the knowledge of chemical biology into clinical application.
- be able to apply the basics of chemical biology towards industry.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Andrew D. Miller, Julian Tanner	Essentials of Chemical Biology: Structure and Dynamics of Biological Macromolecules	Wiley	2008	978-0470845301	592
Edited by: H Gobind Khorana	Chemical Biology	World Scientific Series in 20th Century Biology	2000	978-9810233310	632

Introductory Biophysics

L	T	P	Total Credits
3	0	0	3

Course content and syllabus

	Teaching Hours
Unit I: Atomic Structure, Physical Units and Bonding	**9 hrs**
Structure of atoms and molecules, Pauli's exclusion principle, units of cell shape and size, cell organelle and biomolecules, Brownian motion and diffusion, overview of physics of biomolecules, ionization energy, electron affinity, physical properties of covalent bond and weak non-covalent interactions.	
Unit II: Electrical Properties of Cell	**18 hrs**
Cell surface charge, resting membrane potential, action potential and its properties, Permeability changes during action potential, ion channels, The Nernst equation, the	

Goldman equation, The Nernst-Planck equation, The Hodgkin-Katz experiments, role of K+ and Na+.	
Unit III: Biophysics of Proteins, Lipids, DNA and Membrane	**18 hrs**
Concepts of thermodynamics, protein binding, protein and DNA folding, cooperative transitions (helix coil transitions and denaturation), Physical properties of biological membrane (elasticity and plasticity), physical properties of lipids the building blocks of membrane, elastic constants and its importance, thermodynamics of membranes, electrostatics, hydrophobic effect, elastic theory and lipid-protein interactions.	
Unit IV: Techniques of Physics in Medicine	**9 hrs**
Principle, instrumentation and applications of X-Ray diffraction, magnetic resonance Imaging (MRI), and nuclear magnetic resonance (NMR).	

Course Learning Outcomes:

Students will be able to

1. Understanding physical principles that underlies the dynamics of life.
2. Examine electrical properties of the cell and its usefulness.
3. Apply physical techniques in biology and medicine.
4. Apply the principle of thermodynamics to biological systems.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
P Narayanan	Essentials of Biophysics	New Age International Publication, New Delhi	2007	978-8122420807	564
HG Bohr	Handbook of Molecular Biophysics (Methods & Application)	Wiley	2009	978-3527407026	1074
P. K. Srivastava	Elementary Biophysics: An Introduction	Physics For the Biological Sciences	2005	978-1842651933	252

(by Hallett etal)					

Environmental Toxicology and Health

L	T	P	Total Credits
3	0	0	3

Course content and syllabus

	Teaching Hours
Unit I:	**9 hrs**
Principles of toxicology and classification of pollutants, Environmental fate of pollutants: Toxicant Transport and Their Fate into the Environment (including air, water, & soil)	
Unit II:	**18 hrs**
Surface Pollutants, Heavy metal toxicity (lead, Cadmium, Cesium and Mercury) Biomagnification, Bioradiation, Biomedical Waste management, Use of Cosmetics and itseffect on human health	
Unit III:	**18 hrs**
Absorption of Toxins, Distribution of Toxins, Metabolism of Toxins and Elimination of Toxins in humans, Toxicant Interactions with Major Body Systems (respiratory, cardiovascular and Gastrointestinal systems, Endocrine Disruptors and Carcinogenesis, Synergistic effects of toxin mixtures.	
Unit IV:	**9 hrs**
Occupational and industrial toxicology (waste Discharge, Occupation, Noise, etc),Clean- up Strategies (focusing on bioremediation and biodegradation), Industrial Waste management and Biomedical Waste management.	

Course Learning Outcomes:

Students will be able to

1. Have a comprehensive knowledge of the fundamentals of toxicology and ecotoxicology.
2. Apply toxicology principles to the fate of toxicants and contaminants in the environment.
3. Characterize the biological impacts of toxins and contaminants on “organic life”.

4. Be able to critically evaluate, discuss, explain, and present current topics in environmental. toxicology.
5. Identify and apply the clean-up strategies for bioremediation of the major xenobiotics.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
David Wrightand Pamela Welbourn	Environmental Toxicology	Cambridge University Press	2002	978-0521588607	658
Mcgrill Lange, Bertram G. Katzung, Susan B. Masters, Anthony J. Trevor	Basic and Clinical Pharmacology	McGraw & Hill	2020	978-1264258635	1328

BIF302: Big Data for Life Sciences

L	T	P	Total Credits
3	0	1	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction of Big Data	**9 hrs**
Introduction – distributed file system – Big Data Skills, Exploring, managing and cleaning Big Data, Importance of Big Data, Four Vs, Drivers for Big data, big data privacy and security issues, Significance of Big data in personalized or precision medicine, Revolutionizing big data approaches for Precision medicine, new hope for cancer	

treatment with big data analytics and personalized medicine, Opportunities for Clinicalbig data, Big Data with Python, Big Data with R, Big Data with Artificial Intelligence.	
Unit II: Hadoop Framework	**18 hrs**
Introduction to Hadoop, HDFS, HDFS Components, Linux commands, Hadoop commands, Hadoop architecture, NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map and Reduce tasks, Method of Map-Reduce life cycle, Custom Partitioner & Combiner in Map-Reduce, Job, Task trackers. Hadoop Eco System, Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce.	
Unit III: Hive and HBASE	**9 hrs**
Hive Architecture, HBASE vs RDBMS, HBASE vs Hadoop, Comparison with Traditional Database, HiveQL - Querying Data - Sorting And Aggregating, Map Reduce Scripts, Joins & Subqueries, HBASE concepts, CRUDE with HBASE, Hbasing with Java,HQL, NOSQL, HShell ,Hive HBASE Integration.	
Unit IV: Computing for Big Data Analysis	**18 hrs**
Data classification, Tabulation, Frequency and Graphic representation, Measures of central tendency, Measures of central dispersion, Normal Probability Distribution, Hypothesis Testing, Correlation, Linear Regression Analysis, Examples using data from lifesciences.	

List of Experiments:

1. Installation of java.
2. Installation of Hadoop framework.
3. Configuring Hadoop.
4. Running Job in Hadoop.
5. Linux commands.
6. Hadoop commands.
7. Installation of HBASE framework.
8. Execution of DDL command of HBASE
9. Execution of DML command of HBASE.
10. Word-Count Example with Map-Reduce.
11. Analyzing Temperature dataset using Map-Reduce.
12. Creating the tables in the hive and storing the huge amount of data in the tables created in the hive.
13. Loading the data in the tables by running commands in the hive.
14. Putting the data into the Hadoop server.
15. Single table insertion and multiple table insertion.
16. Implementation of HBASE with Java Code.
17. Find the number of occurrences of the word using Map Reduce in a text file.
18. We have to import data present in the file into an HBASE table by creating it through Java API.

Course Learning Outcomes:

Students will be able to

1. Apply the principles of Big Data with reference to Life Science.
2. Evaluate the principles of HDFS and Map-Reduce paradigm in Big Data.
3. Identify the techniques of Big Data using HBASE and Hive.
4. Demonstrate the concept of statistical analysis with the help of Big Data Analytics.
5. Illustrate the various pipelines in Big Data Analytics

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Boris lublinsky, Kevin t. Smith, AlexeyYakubo vich	Professional Hadoop Solutions	Wiley	2015	9788126551071	504
Chris Eaton, Dirk deroos	Understanding Big data	McGraw Hill	2012	--	
Sima Acharya, Subhashini Chhellappan	BIG Data and Analytics	Willey	2019	978-8126579518	
Tom White	HADOOP: The definitive Guide	O Reilly	2012	978-9352130672	

Programme structure for B.Tech. Biotechnolgy- 4 years (7th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1		Economics for Engineers	HSSMC	2	0	0	0	0	2
2		Sociology for Engineers	HSSMC	1	0	0	0	0	1
3		Law for Engineers	HSSMC	2	0	0	0	0	2
4		Aspects of Indian History for Engineers	HSSMC	1	0	0	0	0	1
5	BTY602	*Students will choose any three courses:*							
		1. Nanobiotechnology	SE	4	0	0	0	0	4
		2.Bioprocess Plant Design							
		3.Bioinformatics	SE	4	0	0	0	0	4
		4.IPR, Biosafety and Bioethics	SE	4	0	0	0	0	4
		5.Fundamentals and Applications of Pharmaceutical Biotechnology	SE	4	0	0	0	0	4
			SE	3	0	1	0	0	4
		6.Artificial Intelligence and Machine learning	SE	3	0	1	0	0	4
6.		*Students will choose any one course** 1. Genome Engineering 2. Introductory Biosensors 3. Medical Biochemistry	OE	3	0	0	0	0	3
13		Project Work	NTCC	0	0	3	0	0	3
				Total credits					**24**

*The Open Elective Courses of 7th and 8th Semesters will be pooled together.

Economics for Engineers

L	T	P	Total Credits
2	0	0	2

	Teaching Hours
Unit I Overview	**9 hrs**
Definition of economics, nature of economic problem, relation between science, engineering, technology and economics. Concepts and measurement of utility, law of diminishing marginal utility-its practical applications and importance. Law of demand, elasticity of demand (price, income and cross)-Measurement, practical importance and applications.	
Unit II Supply and Elasticity of Supply	**9 hrs**
Law of supply, elasticity of supply and its practical applications, market equilibrium Production, factors of production, production functions (one variable, two variables, all variable and Cobb-Douglas)	
Unit III: Concepts of Revenue and cost	**9 hrs**
Costs, various concepts of cost and revenue in short and long run. Cost and revenue curves Meaning of market, types-Perfect, Monopoly, Oligopoly, Monopolistic (Main features)	
Unit IV: Concepts of National Income	**9 hrs**
Concepts of GDP, GNP, NI and Disposable income. Aggregate demand and supply (Both open and closed economies)	

Basic concepts of inflation, deflation, stagflation, business cycles and BOP	

Course Learning Outcomes:

1. Students should be able to define the various economic concepts of Utility, demand, production function, cost and revenue curves and business cycles.
2. Compare different market structures.
3. Students should be able to explain practical importance and applications of various economic tools.
4. Students should be able to interpret basic macroeconomic concepts in existing economic structure of the country.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
H.L. Ahuja	Microeconomics	S. Chand & Co. Ltd., New Delhi	2019	978-9352837311	872
Samuelson &Nordhaus	Economics,	Tata Mc-GrawHill Publishing Co. Ltd., New Delhi.	2019	978-9389538038	994

Sociology for Engineers

L	T	P	Total Credits
1	0	0	1

Course contents and syllabus	Teaching Hours
Unit I Overview	**9 hrs**

Sociological perspective; Sociology as a science; Sociology and other social Sciences, Society, community, Institution, Association, Social Structure, Social Function, Status and Role and its Elements.	
Unit II Sociological Concepts	**9 hrs**
Introduction to sociological concepts- social institutions, Culture social stratification(caste, class, gender, power), Social Change.	

Course Learning Outcomes:

Understanding of professional and ethical Responsibility

1. To discuss the dynamics and nature of Indian Society.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Giddens, A.	Sociology,	Polity	6th/2009	978-1509539222	1152
Haralambos M,RM Heald, M Holborn	SOCIOLOGY:THEMES AND PERSPECTIVES,	Collins	2000	978-0007583195	

Law for Engineers

L	T	P	Total Credits
2	0	0	2

Course contents and syllabus	Teaching Hours
Unit I: Introduction to Law and Law Making	**9 hrs**

Law: its meaning, sources and concepts; Constitutional Law with emphasis on Fundamental Rights, Directive Principles of State Policy and Fundamental Duties; Law making in India. **General Principles of Contract under Indian Contract Act, 1872:** Sec. 1 to 75 of Indian Contract Act and including Government as contracting party, Kinds of government contracts and dispute settlement, Standard form contracts; Promissory Estoppel and Legitimate Expectations.	
Unit II: Adjudicatory System in India	**9 hrs**
Adjudicatory System in India as under the Constitution and statutes; Tribunals and Commissions like Competition Tribunal and Consumer Protection Commissions; Alternative Dispute Resolution: Nature, Scope and Types; Arbitration and Conciliation Act, 1996; Legal Services Authority Act, 1986.	
Unit III: Law Relating to Intellectual Property	**9 hrs**
Concept of Property, Types of Property; Introduction to IPR; Types of IPR: Copyrights, Patents, Trademarks, Designs, Trade Secrets, Plant Varieties and Geographical Indications; Infringement of IPRs and Remedies available under the Indian Law.	
Unit IV: Privacy in Governance and Transparency	**9 hrs**
Confidentiality in Government Business/Administration: Official Secrets Act, 1923; Right to Information Act, 2005 covering, Evolution and concept; Practice and procedures; Privileged Communications under the Indian Evidence Act, 1872; Offences under the Information Technology Act, 2000 with special reference to Protected Systems; Labour Disputes and the Settlement – Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Payment of Wages Act, 1936.	

Course Learning Outcomes:

On successful completion of course, students will

1. Gain exposure to the students about the elementary knowledge of law that would be of utility in their profession.
2. Enable the students to appreciate the importance of law and its impact on business and society.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
D.D. Basu	Shorter Constitution of India	Prentice Hall of India	1996	978-8131265284	
M.P. Jain	Indian Constitutional Law	Wadhwa & Co	2005	978-9386515049	2320

Aspects of Indian History for Engineers

L	T	P	Total Credits
1	0	0	1

Course contents and syllabus	Teaching Hours
Unit I Ancient India: The beginning (2600- 600 BCE)	**4.5 hrs**
• Salient features of Harappan Culture ○ Town planning, Drainage system, Great Bath, Buildings, Seals, Social and economic condition, Reasons of decline • Vedic Period- Vedic literature, Social, Political and Economic conditions Rise of Buddhism and Jainism	
Unit II From states to empires	**4.5 hrs**
Early kingdoms & republics: Sixteen Mahajanpadas & ten Republics The Mauryan Empire: Origin & growth, Administration, Achievements of Chandragupta, Ashokan Dhamma policy	
Unit III: The Golden Period	**4.5 hrs**
Achievements of Kanishka, Samudragupta and Chandragupta II, The Gupta administration & its decline. Main features of the Golden Era.	
Unit IV: Scientific Achievements in Ancient India	**4.5 hrs**

• Astronomy in ancient India • Mathematics in ancient India • Civil engineering & architecture in ancient India • Science, Medicine, Technology in ancient India • Agriculture Development and ecological balance in ancient	

Course Learning Outcomes:

1. Identify major dynasties.
2. Examine social, economic and cultural conditions.
3. Analyze the scientific achievements.
4. Recognize the ancient heritage.
5. Examine the past and present scenario.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Upinder Kaur	A History of Ancient and Early Medieval India: From the Stone Age to the 12th Century	Pearson	2016	978-8131774748	728
Romila Thapar	guin History of Early India	Penguin	2003	978-0143029892	555

Nanobiotechnology

L	T	P	Total Credits
4	0	0	4

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Nanomaterials	**18 hrs**
Importance of "Nano" dimension, size matters: bulk vs nanomaterials, nanotechnology exists in nature, brief history of nanotechnology, concept of dimensionality of nanomaterials, effect of 'nano' scale on material properties (electrical, thermal, mechanical, optical, chemical), quantum structures, quantum confinement, classification of nanostructured materials, surface effects of nanomaterials, nanocomposites	
Unit II: Synthesis and Characterization of Nanomaterials	**18 hrs**
Bottom-up and top-down approaches, physical and chemical methods: mechanical milling, laser ablation, arc discharge, chemical vapor deposition, physical vapor deposition, wet chemical synthesis of nanoparticles, self-assembly, biological synthesis of nanomaterials	
Unit III: Bionanotechnology	**18 hrs**
Surface functionalization of nanomaterials for biological applications, nano-antimicrobials, viral nanotechnology, Biological nanomachines: protein and DNA, peptide nanotechnology, DNA nanotechnology, cellular uptake mechanisms of nanomaterials	
Unit IV: Nanomaterials Applications in Biology and Nanotoxicity	**18 hrs**
Polymeric biomaterials, lipid nanoparticles for drug delivery applications, nanoparticles for bioimaging, cancer therapeutics, and tissue engineering applications, stimuli- responsive nanoparticles, nano-artificial cells, nanomaterials for organ printing, nanotoxicology	

Course Learning Outcomes:

Students will be able to

1. Comprehend the concept of "nanotechnology" and its interdisciplinary aspects.

2. Learn various approaches of synthesizing nanomaterials, their advantages, and limitations.

3. Gain knowledge about various techniques used for characterizing nanomaterials.

4. Comprehend the importance of engineered nanomaterials for biomedical, and therapeutic applications.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
G. Cao	Nanostructures and Nanomaterials: Synthesis, Properties and Applications	Imperial College Press	2004	978-9814324557	596
C. M. Niemeyer, C. A. Mirkin	Nanobiotechnology; Concepts, Applications and Perspectives	Wiley-VCH	2004	978-8126538409	-
G. J. Leggett, R. A. L. Jones	Bionanotechnology: In Nanoscale Science and Technology	John Wiley &Sons	2005	-	-
B. S. Murthy, P. Shankar, B. Raj, B. B. Rath and J. Murday	Textbook of Nanoscience and Nanotechnology	Universities Press-IIM	2012	978-3642280290	244
T. Pradeep	Nano: The Essentials	Tata McGraw-Hill Publishing Company Ltd.	2007	978-0070617889	978-0070617889

Bioprocess Plant Design

L	T	P	Total Credits
4	0	0	4

Course contents and syllabus	Teaching Hours
Unit I General Design Consideration	**18 hrs**
Introduction; General design information; Mass and energy balance of Biochemical Processes; Flow sheeting; Piping and instrumentation.	
Unit II Fluid Handling Systems & Bioreactor Configuration	**18 hrs**
Materials of construction for bioprocess plants; Mechanical design of process equipment; Vessels for biotechnology application. Selection and specification of equipment for handling fluids and solids	
Unit III: Heat Transfer Equipment Design	**18 hrs**
Design considerations for maintaining sterility of process streams and processing equipments; Design of heat transfer equipments used in bioprocess industries.	
Unit IV: Cleaning, Facilities & Process Economics	**18 hrs**
Design of facilities for cleaning of process equipments; Process economics	

Course Learning Outcomes:

1. Develop a basic understanding for general design consideration, and apply these principles for flow sheeting, piping and instrumentation.
2. Identify the parameters that characterize the selection of equipment for handling fluids and solids.
3. Able to Decide the Materials of construction for bioprocess plants.
4. Employ the appropriate Design considerations for maintaining sterility of process streams and processing equipment.

5. Evaluate and able to Design of heat transfer equipment used in bioprocess industries.
6. Identify various factors affecting the profitability of the bioprocess industries.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
M. Peters and K. Timmerhaus	Plant Design and Economics for Chemical Engineers	McGraw-Hill.	6th/2008	0072392665	480
E. Bausbacher, R. Hunt,	Process PlanLayout and Piping Design	Prentice Hall PTR	6th/2011	0-13-138629-8	--
R.H. Perry and D.W. Green	Chemical Engineers Handbook	McGraw-Hill.	2008	0-07-142294-3	800
R.K. Sinnott, J.M. Coulson and J.F. Richardsons	Chemical Engineering	Prentice-Hall India Pvt. Ltd., New Delhi	1999	8120309499 978-8120309494	-

Bioinformatics

L	T	P	Total Credits
4	0	0	4

Course contents and syllabus	Teaching Hours
Unit I: Introduction to Bioinformatics and Biological Databases	**18 hrs**

Introduction to Bioinformatics. Historical background. Scope of bioinformatics in modern research Introduction to biological databases - primary, secondary and composite databases, NCBI, PubMed, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (UniProt-Swiss-Prot, PDB), Structure visualization softwares (RasMol, PDBviewer), file formats (FASTA, ASN Genbank).	
Unit II: Sequence Alignment	**18 hrs**
Concepts of sequence similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, amino acid substitution matrices(PAM and BLOSUM). Programs for pairwise and multiple sequence alignment (CLUSTALW), Introduction to database searchusing BLAST.	
Unit III: Protein Structure Prediction	**18 hrs**
Hierarchy of protein structure - primary, secondary and tertiary structures Structural Classes, Motifs, Folds and Domains. Protein secondary structure prediction Protein tertiary structure prediction in presence and absence of structure template.Energy minimizations and evaluation by Ramachandran plot. Protein structure and rational drug design.	
Unit IV: Genome Organization and Analysis	**18 hrs**
Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes. Genome, transcriptome, proteome, 2-D gel electrophoresis, MALDI- TOF spectrometery.Major features of completed genomes: *E. coli, S.cerevisiae, Arabidopsis,* Human.	

Course Learning Outcomes:

1. Introduces students to bioinformatics which is an integral part of biomedical research.
2. Understand role of biological databases and download appropriate literature, sequences andother relevant information from biological databases.
3. Understand importance of sequence alignment
4. Predict structures of proteins
5. Understand organization of genomes and techniques used to study.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Xiong, J.	Essential Bioinformatics	Cambridge University Press	2006	0521706106	--

Ghosh, Z. and Mallick, B.	Bioinformatics – Principles and Applications	Oxford University Press	2008	9780195692303	-

BTY602: IPR, Biosafety and Bioethics

L	T	P	Total Credits
4	0	0	4

	Teaching Hours
Unit I: Introduction to IPR and Patent Database	**18 hrs**
Protection of New GMOs: International framework for the protection of IP. IPs of relevance to Biotechnology and few Case Studies. **Patent databases**: Invention in context of "prior art"; Searching national/International Databases; Analysis and report formation	
Unit II: Types of patents and patent application	**18 hrs**
Types of patents: Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application	
Unit III: Biosafety, GMOs and Biodiversity Act	**18 hrs**
Biosafety: Introduction; Historical Background: Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India. **Definition of GMOs & LMOs:** Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis. **Risk Assessment:** Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol. **Biodiversity Act 2002:** Agricultural biodiversity; International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA); Conservation strategies for seed gene bank; Climate change and conservation of plant genetic resources;	

Global efforts for management of crop genetic resources; Strategies on PVFR and Biodiversity Acts. **Biodiversity Legislation in India;** Indian Biodiversity Act and provisions on crop	
Unit IV: Bioethics, Ethics and the law issues	**18 hrs**
Bioethics: Concepts; Philosophical considerations; Epistemology of Science; Ethical Terms; Principles & Theories; Relevance to Biotechnology. **Ethics and the Law Issues:** types and policies; Research concerns; Emerging issues: Biotechnology's Impact on Society; DNA on the Witness Stand - Use of genetic evidence in civil and criminal court cases; Challenges to Public Policy – To Regulate or Not to Regulate; Improving public understanding of biotechnology products to correct misconceptions.	

Course Learning Outcomes:

- Understand IPR and its database.
- Evaluate different types of patents and policies.
- Compare the biosafety methods and differences between GMOs and LMOs.
- Perceive knowledge of Bioethics

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
D N Choudhary	Evolution of patent laws: "developing countries' perspective	Delhi Capital Law House	2006	OCLC Number: 255182178	476

Fundamentals and Applications of Pharmaceutical Biotechnology

L	T	P	Total Credits
3	0	1	4

Course contents and syllabus	Teaching Hours
Unit I Introduction to Pharmaceutical Biotechnology	**9 hrs**
Introduction to Different branches of Pharmacy, History of Pharmaceutical Biotehnology sector, Growth., Future of Pharmaceutical Industry and its Product, Types of drugs and formulations from natural and synthetic sources, Recombinant therapeutics,	
Unit II Pharmacodynamics and Pharmacokinetics	**18 hrs**
Principles of pharmacodynamics, Drug receptor interaction, Potency and therapeutic index, Pharmacodynamic models and biomarkers, General principles of pharmacokinetics, Route and timing of administration, Plasma concentration and its relationship to drug actions, Principles of bioavailability/bioequivalence , Adverse drug reactions.	
Unit III: Biological and Novel Therapies	**18 hrs**
Vaccines: Definition and Development of Vaccine, Classification of vaccines, DNA Vaccine, Monoclonal Antibodies based pharmaceuticals, Interferons, interleukins, growth factors, gene therapy and immunotherapy, Bioreductive drugs, Cancer vaccines.	
Unit IV: Quality Standards	**9 hrs**
Good Manufacturing Practice (GMP's), Good Lab Practices, Regulatory Issues and Drug Product, Approval for Biopharmaceuticals.	

List of Experiments:

1. Essential tools in the biotechnology laboratory

a. Using a micropipette

b. calibrating & using basic lab equipment.

2. Preparing solutions

3. isolating genomic DNA
4. Enzyme-linked immunosorbent assay
5. Bioinformatics of green fluorescent protein.
6. transformation of *E. Coli* with a recombinant GFP
7. Plasmid DNA isolation
8. Agarose gel electrophoresis of restriction digest DNA fragments

Course Learning Outcomes:

1. Describe the mechanism of drugs development and drug discovery.
2. Acquired knowledge regarding basic pharmacology.
3. Comprehensive knowledge regarding the development and use of vaccines.
4. Identify and appraise the guidelines and ethical concerns regarding the use of drugs.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Gray Walsh & B. Murphy	Biopharmaceuticals and industrial prospective	Springer	1999	978-8184892932	524
Gray Walsh,	Biopharmaceuticals	Wiley John & Sons, Inc	2003	978-8126530014	572
Camille G. Wermuth	The practice of Medicinal chemistry	Academic Press	2003	978-0124172050	902

Artificial Intelligence and Machine Learning

L	T	P	Total Credits
3	0	1	4

Course contents and syllabus	Teaching Hours
Unit I Introduction of Machine Learning	**18 hrs**
Introduction and Basic Concept, Basic Prediction Model, Definition of learning systems,Goals and applications of machine learning, Aspects of developing a learning system: training data, concept representation, function approximation, Data Cleaning, imputation, cross-validation, and interpreting results, Probability and Statistics. **Supervised & Unsupervised learning:** Unsupervised Methods, Clustering: Distance Metrics, K-Means, hierarchical clustering, Supervised Methods, Classification: K-NN, naïve Bayes, decision trees, boosting and bagging, Bayesian Learning: Probability theory and Bayes rule. Naive Bayes learning algorithm. Neural networks. Introduction to Deep learning, Active learning, Reinforcement learning, Genetic algorithms and genetic programming, Convolutional networks, RNNs, LSTM, Adam, Dropout, BatchNorm, Xavier/He initialization; Case studies in Health Care and Life Sciences. Probabilistic Neural Network, Conditional Random Fields. Deep Learning Tools: Caffe, Theano, Torch. Implementing Deep Learning Algorithms for solving real time health care and life sciences problem.	
Unit II Decision Tree	**9 hrs**
Decision Tree Learning: Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity. Occam's razor. Overfitting,noisy data, and pruning.	
Unit III: Artificial Intelligence	**9 hrs**

Artificial Intelligence: Issues, Techniques, Problems, Importance and areas of AI; Problem solving state space search; DFS; BFS Production: System, Problem characteristics; Heuristic Search Techniques; Generate and Test; Hill Climbing; Best First Search; Problem reduction. Knowledge representation: Mapping; Approaches; Issues; Representing simple facts in logic; Representing instance and relationships; Resolution and natural deduction.	
Unit IV: AI programming language	**18 hrs**
AI programming language: Prolog: Objects, Relationships, Facts, Rules, Variables, Syntax and Data Structures; Representing objects & Relationships by using "trees" and "lists"; Use of cut; I/O of characters and structures; Symbolic reasoning	

List of Experiments/Lab Practicals:

1. Install SciPy Libraries
2. Load The Data
3. Import libraries.
4. Peek at the Data
5. Statistical Summary
6. Class Distribution
7. Application of AI (R or Python based codes) on open-source Diabetes/Clinical Data Sets.
8. Deep learning applications in Vaccine Discovery Systems.
9. AI and Deep Learning in Breast Cancer diagnosis.
10. Standard AI and Deep Learning Systems- PyTORCH, IBM Watson; Arterys Cardio DL application; etc
11. NLP applications in Health Care
12. IOT and AI in health care

Course Learning Outcomes:

Apply the principles of Machine Learning with reference to Life Science.

1. Identify and demonstrate skills of Deep learning.

2. Interpret the concept of Bayes rule.
3. Conceptualize the principles of AI.
4. Apply the statistics analysis with the help of AI as a programming language.

Text / Reference Books

Author	Title	Publisher	Ed/year	ISBN No	Pages
S Mohagaonkar, A Rawlani, P Srivastava, A Saxena ,	HerbNet: Intelligent Knowledge Discovery in MySQL Database for Acute Ailments	Elsevier	2018		

Genome Engineering

L	T	P	Total Credits
3	0	0	3

Course contents and syllabus	Teaching Hours
Unit I Introduction to Genomes	**9 hrs**
Genome definition, Components of Genome, Genome organization in Prokaryotes and Eukaryotes, The evolution of Genomes, Methods of origin of new genes, the selfish DNA theory and current perspective on repeats	
Unit II Deciphering the Genome	**18 hrs**

The Human Genome Project – Hierarchical Shotgun Sequencing strategy, In silico Genome annotations, methods of wet lab validation, findings of the human genome project, Impact of the Human Genome – cataloguing variations, approaches to finding disease genes – candidate gene. approach and Genome Wide association studies, impact in medicine pharmacogenomics, toxicogenomics and personalized medicine, metagenomics, comparative genomics, identification of ultraconserved regions in the genomes, Human-Chimp comparisons	
Unit III: Genome engineering – From Restriction enzymes to CRISPR-CAS system	**9 hrs**
Simple DNA manipulations using DNA manipulating enzymes, the classical gene knockout strategy, Conditional knockout strategy - CRELOXP. and FLP-FRT system, Genome editing by Zn-Finger Nucleases and TALENS, the CRISPR-CAS system, Socio-legal implications of Genome editing	
Unit IV: The Omics era	**18 hrs**
The Next Generation Sequencing Technologies - Pyrosequencing, Virtual Terminator Sequencing, SOLID, SMRT, Third generation sequencing techniques – Nanopore and Ion torrent, Application of NGS in studying Transcriptomes (RNA Seq) and DNA Protein interactions – ChIP-Seq. Latest Trends in Genome Engineering	

Course Learning Outcomes:

1. Relate and comprehend the current advances in Genomics.
2. Compare and summarise the conventional and latest techniques involved in Genome engineering.
3. Model the various genome modification technologies and the linked social and legal issues.
4. Measure the impact of genome modulations as per the latest interventions.
5. Compile the genome engineering experiments and designs pertinent to human and industrial benefit.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Arushi Agarwal, Ankur Saxena	Discovering Genomics, Proteomics and Bioinformatics	Campbell AM& Heyer LJ, Benjamin Cummings	2nd/2007		
S R.M Twyman	Principles of Proteomics.	BIOS Scientific publishers	2018	978-0815344728	206

Introductory Biosensors

L	T	P	Total Credits
3	0	0	3

Course contents and syllabus	Teaching Hours
Unit I Introduction	**18 hrs**
Introduction to sensor systems, Basics of transducers and sensors, sensor classification and application. Fundamental characteristics: Selectivity, sensitivity, calibration etc., bio-sensing elements, biosensor designs and engineering aspects of biosensor devices.	

Unit II Electroanalytical and Optical Biosensors:	**9 hrs**
Electrochemical principles and transduction, charge transfer pathways in enzymes, Ionselective sensors, glucose biosensors -Glucometer. Optical principle for transduction: Absorption, luminescence Sensors, surface plasmonresonance (SPR), optical wave guide and sensor design; Example of photometric Sensors.	
Unit III: Other Sensors and Applications	**9 hrs**
BioMechanical Sensors: Pressure, Thermal Sensors, Acoustic Sensors (piezoelectricsensors). Application and market in various fields.	
Unit IV: Applications:	**18 hrs**
MEMS, Bio-MEMs fundamentals and application.	

Course Learning Outcomes:

1. To learn the basic concepts in biosensor technology, principles, and terminologies.
2. Understanding of quantitative measurement, techniques and fabrication engineering.
3. To understand the different types of sensors and biosensors systems.
4. Fundamentals of miniaturization & areas of application.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Robert R. Buck, et. al	Biosensor Technology Fundamentals and Applications	Dekke Publication, New York	1990	3-540-65555-7	408

Research Project

L	T	P	Total Credits
0	0	3	3

The student will undertake a research project under the supervison of a faculty member.

Programme structure for B.Tech. Biotechnology- 4 years (8th Semester)

Sr. No	Course Code	Course Title	Course Type	Credits					Credit Units
				L	T	PS	FW	SW	
1		Research Project	NTCC	0	0	18	0	0	18
2	BTY303	*Students will choose anytwo courses** 1. Gene Regulation 2. Plant Biotechnology 3. Clinical Trials 4. Synthetic Biology	OE	3 3	0 0	0 0	0 0	0 0	3 3
				Total credits					**24**

*The Open Elective Courses of 7th and 8th semesters will be pooled together.

Gene Regulation

L	T	P	Total Credits
3	0	0	3

Course content and syllabus

	Teaching Hours
Unit I: Regulation of Gene Expression in Prokaryotes	**16 hrs**
Regulation of Gene Expression in Prokaryotes: concept of operon, ORF. Control at initiation of transcription. Promoter strength and role of sigma factors. Lac Operon (Genetic and Biochemical aspects), araBAD operon. Catabolite repression. trp Operon. Regulation of genes for ribosomal RNA. Bacterial viruses (Lytic and Lysogenic modes). Riboswitches and bacterial two component system.	
Unit II: Regulation of Gene Expression in Eukaryotes	**13 hrs**
Regulation of Gene Expression in Eukaryotes: Gene regulation in Yeast (Galactosemetabolism, Gal 4 protein), role of mediators, enhancer elements. Chromatin remodelling: histone modification, epigenetic changes Post-transcriptional regulation. RNA silencing: siRNA, miRNA, transitive RNAi, ncRNA. Regulation at translational level	
Unit III: DNA-Protein Interaction	**14 hrs**
Structures of DNA binding domain: HTH, wHTH, zinc fingers, leucine zippers, HLH, Loop-sheet-helix. Specificity in DNA-protein interactions. Techniques to study DNA-protein interaction- DNA footprinting, DNA pull down, EMSA, Super-shift, ChIP, reporter assays, Co-crystal studies, yeast two hybrid system, FISH.	
Unit IV:	**11 hrs**
Genomic regulatory domains: Introduction to regulation of expression of gene clusters; locus control region (LCR): structure and function LCR of mouse globin gene cluster; Genomic imprinting of *Igf-2* and *H-19* genes	

Course Learning Outcomes:

- Will have the knowledge of structure and function of genes
- Concept and knowledge of different strategies in regulation of gene expression in prokaryotes and eukaryotes
- Understand structure of DNA-binding domains
- Learn various techniques to study DNA-protein interaction.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Watson, JD., Baker, TA., Stephen, PB., Alexander, G., Levine, M., Losick R.	Molecular Biology of the Gene	Pearson Education	7th Ed	978-93325 85478	912
Tropp, B.E.	Molecular Biology Genes to proteins	Jones and Bartlet	4th Ed.	978-93-80853-49-9	1096

BTY303:Plant Biotechnology

L	T	P	Total Credits
3	0	0	3

Course content and syllabus

	Teaching Hours
Unit I: Introduction to Plant Biotechnology	**18 hrs**
Plant tissue culture—its history, development and applications, Plant tissue culture media, Types of cultures, Callus cultures, Cell and suspension cultures, Single cell clones, Protoplast culture and somatic hybridization. Micropropagation: Techniques and various steps involved in micropropagation, Production of disease-free plants, Commercial aspects and limitations of micropropagation	
Unit II: Production of Haploid Plants and Embryo Culture	**9 hrs**
Production of haploid plants: Androgenesis and Gynogenesis and production of homozygous lines, Significance and uses of haploids. Embryo culture and embryo rescue and its applications in plant improvement.	
Unit III: Secondary Metabolite Extraction and Germplasm Conservation	**9 hrs**

Primary vs secondary metabolites, Production of secondary metabolites and other compounds using plant cell culture, Hairy root culture, Immobilized cell system, Elicitation and Biotransformation. Germplasm conservation: various approaches for Bioconservation, in vitro techniques especially cryopreservation in germ plasm conservation	
Unit IV: Recombinant DNA Technology and Molecular Farming	**18 hrs**
Recombinant DNA Technology and Manipulation of Phenotypic Traits: Strategies of molecular cloning of plant genes, Gene transfer methods—Vector mediated, Virus mediated and Vector less DNA transfer, rDNA approaches for introducing herbicide tolerance, pest resistance, plant disease resistance, Abiotic & biotic stress tolerance, Improvement of crop yield and quality, Molecular markers and marker assisted selection, Applications of plant transformations/ transgenics, Commercial transgenic crops. Molecular farming: of Alkaloids, Useful enzymes, Therapeutic proteins, custom- made Antibodies, Edible vaccines.	

Course Learning Outcomes:

Students will be able to:

1. Acquire the knowledge about the techniques of Plant Tissue Culture, Lab. organization and measures adopted for aseptic manipulation and nutritional requirements of cultured tissues.
2. Learn the techniques of culturing tissues, single cells, protoplasts & anther culture, germplasm conservation and cryobiology.

3. Learn the large-scale clonal propagation of plants through various micropropagation techniques, Production of secondary metabolites under in vitro conditions.

4. A good understanding of r-DNA technology, methods of gene transfer, molecular markers and markers assisted selection.

5. Develop transgenics resistant to biotic & abiotic stresses & quality characteristics and their role in crop improvement.

Text / Reference Books:

Author	Title	Publisher	Ed/ year	ISBN No	Pages

Slater, A., Scott, N.W., and Fowler, M.R.	Plant Biotechnology	Oxford University Press	2nd/2008	978-0199282616	400
Razdan, M.K.	Introduction to Plant Tissue Culture	Science Publishers	2nd/2003	978-8120417939	420
Primrose, S.B. and Twyman, R.M	Principles of Gene Manipulation and Genomics	Blackwell Publishing	2013	978-1405135443	

Clinical Trials

L	T	P	Total Credits
3	0	0	3

Course content and syllabus

	Teaching Hours
Unit I Basics of Clinical Trials	**18 hrs**
Fundamental principles of comparative clinical trials in investigating effectiveness, efficacy and safety of treatments, benefits, types, and phases of clinical trials. How to select and apply appropriate statistical methods to analyse data from clinical trials, presenting, interpreting, and discussing the analyses clearly and concisely	
Unit II Clinical Trials in Practice	**9 hrs**

Review systems applicable to clinical trial, various principles of Clinical trials as per ICMR guidelines, Key steps in implementing a clinical trial: Informed Consent Form, Budgeting of clinical trial, trial governance, clearances (including research and ethical clearance), Protocol development. Trial designs: use of different trial designs such as non-inferiority and equivalence, cross-over, factorial, multi-armed and cluster randomised trials and data collection and recruitment methods. Quality assurance and control, data processing, management issues including post-trial monitoring.	
Unit III: Project Management	**9 hrs**
Data management plan, Project management for the clinical data manager, Vendor selection and management, Data management standards in clinical research, Design and development of data collection, Edit check design principles.	
Unit IV: Case Report Forms & Quality Audits	**18 hrs**
CRF Completion Guidelines, CRF printing and vendor selection, Data validation, programming and standards, Laboratory data handling, External data transfer, Patient-reported outcomes, CDM presentation at investigator meetings, Metrics for clinical trials, Systems Software Validation Issues – Clinical Trials Database Environment Audit – Definition, types & procedures, Audit standards, Audit trail & its role in authenticity of data, Audit plan, Audit by regulatory authorities, GMP, GDP & logistics, Preparing and delivering audit reports, what makes a good audit, New product development & GxP Regulations.	

Course Learning Outcomes:

1. Demonstrate a reasonably good understanding about the basic aspects of clinical trial.
2. Translate knowledge and understanding about the conduct of the clinical trial to independently carry out the responsibilities related to it.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages

Richard K. Rondel, Sheila A. Varley, Colin F	Clinical Data Management	Dekke Publication ,New York	1990	978-0-470-85335-1	368
Susanne Prokscha	Practical Guide to Clinical Data Management	CRC Press	3rd/2011	9781439848296.	-

Synthetic Biology

L	T	P	Total Credits
3	0	0	3

Course content and syllabus

	Teaching Hours
Unit I: Fundamentals of Synthetic Biology	**9 hrs**
Modern techniques of DNA assembly – NEBuilder HiFi DNA Assembly, Gibson Assembly, BioBrick Assembly, Golden Gate Assembly. Synthetic bacterial chromosome, synthetic yeast chromosomes for modular metabolic engineering, Genomic engineering usingtransposable elements in vertebrates	
Unit II: Synthetic Networks	**18 hrs**
Biological parts – Sensor Proteins (switches), Regulatable promoters, Models of gene expression, artificial networks, production of simple networks capable of producing genetic oscillators and toggle switches, consequences of gene expression variability, examples of synthetic networks – Biofuels and green chemicals.	
Unit III: Fundamentals of System Biology	**18 hrs**

Stochastic gene expression in prokarytoes and eukaryotes- extrinsic and intrinsic noise, re-wiring of genetic networks to perform cellular functions, Identification of functional units ("network motifs") within large gene interaction networks, a classic study of variability in bacterial gene expression, a classic study of variability in cultured cells, and quantitative PCR-based methods to count mRNAs in individual cells	
Unit IV: Synthetic Proteins	**9 hrs**
Expanding the chemistry of life by cell free protein synthesis and incorporation of nonnatural amino acids, Engineering of membrane proteins that responds to physical stimuli and their applications: Light-gated channels and pumps for optogenetics, Mechanoreceptors, Temperature- and magnetic field-gated channels. Genetically encoded nanosensors, Ratiometric and intensimetric nanosensors. *In vivo* use of nanosensors	

Course Learning Outcomes:

1. Understand basic concepts of synthetic biology.
2. Learn to construct artificial gene networks and proteins.
3. Learn the techniques to re-wire genetic networks.
4. To know the areas of applications of synthetic biology.

Text / Reference Books:

Author	Title	Publisher	Ed/year	ISBN No	Pages
Nesbeth	Synthetic Biology:	CRC	2015	978-0367867720	336
Edited By: Paul S Freemont (Imperial College, UK) and Richard I Kitney (Imperial College, UK)	Synthetic Biology — A Primer	World scientific	2012	978-1-84816-863-3	196
Uri Alon,	An Introduction to Systems Biology: Design Principles of Biological Circuits	Chapman & Hall/CRC	2006	978-1439837177	342

Research Project

L	T	P	Total Credits
0	0	18	18

The student will undertake a research project under the supervison of a faculty member.