Course Curriculum (in light of NEP 2020) for B. Tech in Biosciences and Bioengineering

In

Department of Biotechnology

National Institute of Technology Arunachal Pradesh

P.O.: Jote, Dist.: Papumpare, Arunachal Pradesh, Pin–791113
www.nitap.ac.in

Table1: Exit system and corresponding credit requirements

Semesters	1	2	3	4	5	6	7	8	
Minimum Credits	**20**	**40**	**60**	**84**	**100**	**125**	**140**	**160-172**	
Multiple Entry	ENTRY		ENTRY		ENTRY		ENTRY	ENTRY	
Student Support Programs	Intensive Orientation	Finishing School	Bridge Course	Finishing School	Bridge Course	Finishing School	Bridge Course	Finishing School	Finishing School
Degree/ Certification		Certificate		Diploma		B.Sc. Degree		B. Tech	B. Tech Honors
Multiple Exit Points		EXIT		EXIT		EXIT		EXIT	EXIT

Table2: Course structure and credit requirements

Description	**Details**	**Total Credits**	**Comments**	**Exit Degree**			
Mathematics + Science + Humanities + Arts	SMASH	26	Science+ Mathematics + Arts + Social Science + Humanities (SMASH) Basket	Eligible for Diploma in	Eligible for B. S. in Engineering Degree with Major in	Eligible for B. Tech. Degree (4-Year) with Major in	
Major	MA1	50	Major for 2-year Diploma				
Project and Internship	AP1	6	If opting for 2-year course				
Electives	E1	3	If opting for 2-year course				
Total (D)	SMASH + MA1 + AP1 + E1	**85**	Mandatory Credits for 2 Year Course				
Humanities	SMASH	3	Science+ Mathematics + Arts + Social Science + Humanities (SMASH) Basket				
Major	MA2	MA1+15 = 65	Major Basket - 1				
Project and Internship	AP2	AP1+5 =10					

Electives	E2	E1+18= 21	Electives			
Total (B1)	SMASH + MA2 + AP2 + E2	**126**	Mandatory Credits for 3 Year Course			
Major/ Elective	MA3	27	Electives			
Project & Internship	AP3	7				
Total (B2)	SMASH + MA2+MA 3 + AP2 + AP3+E2	**160**	Mandatory Credits for 4 Year Course			
Honours*	Theory	12	Additional Subjects			
Total (B3)	Total	**172**				

1.0 Semester wise Credit point distribution

Sl. No.	Year	Credit Point	
		ODD	EVEN
1	First	20	22
2	Second	22	21
3	Third	20	21
4	Fourth	22	12
Total Credit Point		**84**	**76**
		160	

Year	SMASH	Project	Major	Electives	Open Electives	Honours	Total	Cumulative Credit	Exit Degrees
1st	21	2	19	0	0		42	42	
2nd	5	4	31	3	0		43	**85**	**Diploma**
3rd	3	5	15	12	6	6*	41/47*	**126/132***	**BS (Engg.)**
4th	0	7	6	21	0	6*	34/40*	**160/172***	**B.Tech**
Total	**29**	**18**	**71**	**36**	**6**	**12***	**160/172***		-

•	• **With 172 Credit Student will get B. Tech with Hons.**

Semester Wise Break-up for credit requirements							
1st Semester Structure		**2nd Semester Structure**		**3rd Semester Structure**		**4th Semester Structure**	
Course Category	**Credits**	**Course Category**	**Credits**	**Course Category**	**Credits**	**Course Category**	**Credits**
SMASH	13	SMASH	8	SMASH	5	SMASH	0
MAJOR	7	MAJOR	12	MAJOR	16	MAJOR	15
AP01	0	AP01	2	AP01	1	AP01	3
						ELECTIVE	3
Total	**20**	**Total**	**22**	**Total**	**22**	**Total**	**21**

Semester Wise Break-up for credit requirements							
5th Semester Structure		**6th Semester Structure**		**7th Semester Structure**		**8th Semester Structure**	
Course Category	**Credits**	**Course Category**	**Credits**	**Course Category**	**Credits**	**Course Category**	**Credits**
SMASH	3	SMASH	0	SMASH	0	SMASH	0
MAJOR	8	MAJOR	7	MAJOR	6	MAJOR	0
AP02	2	AP02	3	AP03	4	AP03	3
ELECTIVE	4	ELECTIVE	8	ELECTIVE	12	ELECTIVE	9
OPEN ELECTIVE	3	OPEN ELECTIVE	3				
Total	**20**	**Total**	**21**	**Total**	**22**	**Total**	**12**

2.0 Course Structure

Ist Semester							
Sl No	**Course Code**	**Subject Category**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-1101	SM1-SC1	Engineering Mathematics-I	2	0	0	2
2	BS-1102	SM2-SC2	Engineering Chemistry	2	0	0	2
3	BS-1103	SM3-SC3	Engineering Physics	2	0	0	2
4	BT -1101	MA1-DSC1	Fundamentals of Biosciences and Bioengineering	3	0	0	3
5	MH-1101	SM4-SECC1	Communication Skill	2	0	0	2
6	EE-1102	SM5-ESA1	Basic of Electrical and Electronics Engineering	2	0	0	2
7	CS-1102	MA2-ESA2	Coding Laboratory	0	1	2	2
8	EE-1103	SM6-ESA3	Basic of Electrical and Electronics Engineering Laboratory	0	0	2	1
9	BS-1104	SM7-SC4	Engineering Physics Lab	0	0	2	1
10	ME-1102	MA3-ESA4	Engineering Drawing	0	0	2	1
11	BT-1102	MA4-DSC2	Fundamentals of Biosciences and Bioengineering Laboratory	0	0	2	1

12	MH-1102	SM8- SECC2	Language Laboratory	0	0	2	1
13	MH-1103	VAC1	NSS/NCC/Yoga (Audit Pass)	0	0	0	0
			Contact Hours	13	1	12	
			Total Credits				20

II[nd] Semester

Sl No	Course Code	Subject Category	Course Title	L	T	P	C
1	BS-1201	SM9-SC5	Engineering Mathematics-II	2	0	0	2
2	BT-1201	SM10-ESA5	Biology for Engineers	2	0	0	2
3	CS-1201	MA5-ESA6	Programming and Data Structure	3	0	0	3
4	CS-1202	MA6-ESA7	AI in Engineering	2	0	0	2
5	ME-1201	MA7-ESA8	Engineering Mechanics	3	0	0	3
6	BT-1202	MA8-DSC3	Biochemistry	3	0	0	3
7	MH-1201	SM11-ESA9	Law and Financial Aspects in Engineering	2	0	0	2
8	BT-1203	AP1-01-VAC2	Do It Yourself (DIY)/Industry Exposure	0	0	4	2
9	BS-1202	SM12-SC6	Engineering Chemistry Laboratory	0	0	2	1
10	CS-1205	MA9-ESA10	Programming and Data Structure Laboratory	0	0	2	1
11	MH-1202	SM13-VAC3	Indian Knowledge System (IKS)	0	0	2	1
			Contact Hours	17	0	10	
			Total Credits				22

III[rd] Semester

Sl No	Course Code	Subject Category	Course Title	L	T	P	C
1	BS-2101	SM14-SC7	Engineering Mathematics-III	3	0	0	3
2	BT-2101	MA10-DSC4	Microbiology	3	0	0	3
3	BT-2102	MA11-DSC5	Cell Biology and Genetics	3	0	0	3
4	BT-2103	MA12-DSC6	Molecular Biology	3	0	0	3
5	BT-210A	MA13-DSC7	Bioprocess Calculations	3	1	0	4
6	MH-2101	SM15-ESA11	Introduction to Innovation and Creativity	2	0	0	2
7	BT-2104	MA14-LAB 1	Microbiology Laboratory	0	0	2	1
8	BT-2105	MA15-LAB 2	Biochemistry Laboratory	0	0	2	1
9	BT-2106	MA16-LAB 3	Cell Biology and Genetics Laboratory	0	0	2	1
10	BT-2107	AP1-02-SECC3	Skilled development course (Internship)-01	0	0	2	1
			Contact Hours	17	1	8	
			Total Credits				22

IV[th] Semester

Sl No	Course Code	Subject Category	Course Title	L	T	P	C
1	BT-2201	MA17-DSC8	Immunology	3	0	0	3

2	BT-2202	MA18-DSC9	Recombinant DNA Technology	3	0	0	3
3	BT-2203	MA19-DSC10	Plant Biotechnology	3	0	0	3
4	BT-2204	MA20-DSC11	Biophysics	3	0	0	3
5	BT-220A	ELE1-DSE1	Biothermodynamics	3	0	0	3
	BT-220B	ELE1-DSE1	Industrial Biotechnology				
6	BT2205	AP1-03-VAC4	Minor project	0	0	4	2
7	BT2206	MA21-LAB4	Immunotechnology laboratory	0	0	2	1
8	BT2207	MA22-LAB5	Recombinant DNA Technology Laboratory	0	0	2	1
9	BT2208	MA23-LAB6	Plant Tissue Culture Laboratory	0	0	2	1
10	BT2209	AP1-04-SECC4	Skill development course (Internship)-02	0	0	2	1
			Contact Hours	15	0	12	
			Total Credits				21

Vth Semester

Sl No	**Course Code**	**Subject Category**	**Course Title**	**L**	**T**	**P**	**C**
1	BT-3101	MA24-DSC12	Biochemical Engineering	3	0	0	3
2	BT-3102	MA25-DSC13	Computational Biology and Bioinformatics	3	0	0	3
3	BT-3103	ELE2-DSE2	Analytical Biotechnology	3	0	0	3
	CS-210A	ELE2-DSE2	Computer organization and architecture				
4	BT-310X	**OE**	**OE1*** (Microbes in Human Health)	3	0	0	3
5	MH3101	SM16-ESA12	Entrepreneur essential and early stage start up	3	0	0	3
6	BT-3104	AP2-01-AECC-1	Internship-I	0	0	2	1
7	BT-3105	MA26-LAB7	Biochemical Engineering Laboratory	0	0	2	1
8	BT-3106	MA27-LAB8	Computational Biology and Bioinformatics laboratory	0	0	2	1
9	BT-3107	ELE3-LAB9	Analytical Biotechnology Laboratory	0	0	2	1
	CS-2103	ELE3-LAB9	Computer organization and architecture laboratory				
10	BT-3108	AP2-02 SECC5	Skilled development course (Internship)-03	0	0	2	1
11	BT-3109	HONS1	Secondary metabolite in plants				3*
			Contact Hours	15	0	10	
			Total Credits				20
			Total Credits with Honours				23 *

VIth Semester

Sl No	**Course Code**	**Subject Category**	**Course Title**	**L**	**T**	**P**	**C**
1	BT-3201	MA28-DSC14	Animal Biotechnology	3	0	0	3
2	BT-3202	MA29-DSC15	Indigenous Technical Knowledge of North East India	3	0	0	3
	CS-2203						

3	BT-3203	ELE4-DSE4	Nanotechnology	3	0	0	3
	CS-320A	ELE4-DSE4	Database Management System				
4	BT-320A	ELE5-DSE5	Enzyme Technology				3
	CS-2203	ELE5-DSE5	Design Analysis of Algorithm				
5	BT-320X	OPEN ELE1	**OE2*** (Biosensors and Biotronics)	3	0	0	3
6	BT-3204	AP2-03VAC5	Minor Project	0	0	4	2
7	BT-3205	MA30-LAB10	Indigenous Technical Knowledge of North East India	0	0	2	1
8	BT-3206	ELE6-LAB11	Nano-Biotechnology Laboratory	0	0	2	1
	CS-3207	ELE6-LAB11	Database Management System				
9	BT-3207	ELE7-LAB12	Enzyme Technology Laboratory	0	0	2	1
	CS-2203	ELE7-LAB12	Design Analysis of Algorithm Laboratory				
10	BT-3208	AP2-04-SECC 6	Skilled development course (internship)-04	0	0	2	1
11		HONS2	Gene Therapy				3*
			Contact Hours	15	1	12	
			Total Credits				21
			Total Credits with Honours				24 *

VIIth Semester

Sl No	Course Code	Subject Category	Course Title	L	T	P	C
1	BT-4101	MA31-DSC 16	Pharmaceutical Biotechnology	3	0	0	3
2	BT-4102	MA32-DSC17	Biostatistics	3	0	0	3
3	BT-410A	ELE8-DSE6	Product design and development	3	0	0	3
	BT-410B	ELE8-DSE6	Introduction to Biomedical Engineering & Bio-tronics				
4	BT-411A	ELE9-DSE7	Systems Biology	3	0	0	3
	ME-2103	ELE9-DSE7	Fluid mechanics				
5	BT-412A	ELE10-DSE8	Bio-mass and Biofuels	3	0	0	3
	ME-412B	ELE10-DSE8	Tissue Engineering and Biomaterials				
6	BT-413A	ELE11-DSE9	Cancer Biology and Therapeutics	3	0	0	3
	BT-413B	ELE11-DSE9	Engineering ethics and IPR in Bioengineering				
7	BT-4103	AP2-05-AECC -2	Internship-II	0	0	2	1
8	BT-4104	AP2-06-VAC6	Major Project-I	0	0	6	3
	BT-4105	HONS3	Bioseparation Technology				3*
			Contact Hours	21	0	10	
			Total Credits				22
			Total Credits with Honours				25 *

VIIIth Semester

Sl No	Course Code	Subject Category	Course Title	L	T	P	C
1	BT-420A BT-XXX	ELE12-DSE10	Medicinal Plant Chemistry/ (Swayam/NPTEL)	3	0	0	3
2	ME-324A BT-XXX	ELE13-DSE11	Sustainable Energy Conversion/ (Swayam/NPTEL)	3	0	0	3
3	BT-421A BT-XXX	ELE14-DSE12	Human Biology and Diseases /(Swayam/NPTEL)	3	0	0	3
4	BT-4201	AP2-07-VAC7	Major Project-II	0	0	6	3
5		HONS3	Fermentation Technology	3	0	0	3*
			Contact Hours	12	0	6	
			Total Credits				12
			Total Credits with Honours				15 *

3.0 Open Electives OEs (Offered for other departments)

Sl No	Course Code	Subject category	Course title	L	T	P	C
1	BT-310X	OE1	Microbes in Human Health	3	0	0	3
2	BT-320X	OE2	Biosensors and Biotronics	3	0	0	3
3	BT-320Y	OE3	Statistics and Applications	3	0	0	3

4.0 Minor degree in Biotechnology (course open for other departments)

Sl No	Course Code	Subject category	Course title	L	T	P	C
1	BT-12MX	Minor degree	Structures and functions of Biomolecules	3	0	0	3
2	BT-22MX	Minor degree	Immune systems	3	0	0	3
3	BT-22MY	Minor degree	Genetic Engineering	3	0	0	3
4	BT-22MZ	Minor degree	Herbal Technology	3	0	0	3
5	BT-32MX	Minor degree	Biomedical sensing technology	3	0	0	3
5	BT-4202	Minor degree	Project				5
			Total credits				20

Note: If any student initiates start up/incubation, two theory courses will be waived off.

7.0 Internship

- Internship - I: Student will go for internship during summer vacation (after 4th semester) for a period of 4 weeks. The assessment will be done on 5th semester
- Internship - II: Student will go for internship during summer vacation (after 6th semester) for a period of 4 weeks. The assessment will be done on 7th semester

8.0 Institute Vision

To transform into an acclaimed institution of higher learning with creation of an impact on the north eastern region in terms of innovation and entrepreneurship.

9.0 Institute Mission

1. To generate new knowledge through state of the art academic program and research in multidisciplinary field.
2. To identify regional, Indian and global need to serve the society better.
3. To create an ambience to flourish new ideas, research and academic excellence to produce new leaders and innovators.
4. To collaborate with other academic, research institutes and industries for holistic growth of the students.
5. Utilization of available big resources to encourage entrepreneurship through formation of start- ups.

10.0 Departmental Vision

- To achieve global standards of teaching and research to create excellent bioengineers with a potential to innovate, invent and disseminate knowledge for the benefit of society.
- To preserve traditional wisdom and exploring the rich bioresources of Northeast India by linking with modern technologies to bring sustainable development.

11.0 Departmental Mission

Empowering students by enriching entrepreneurship skills and enabling them to devise different strategies for Biotechnology start-ups through multidisciplinary programs and courses of relevance.

12.0 Programme Outcomes (POs)

PO1	Science & Engineering knowledge: To apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization in biological systems, comprehensive understanding of biological systems and recent advancement in the field.
PO2	Problem analysis: To identify, formulate, research literature, and analyze problems involving biological systems using the principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/development of solutions: To provide solutions to biological problems by designing and developing a product or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO4	Conduct investigations of complex problems: To investigate complex problems by using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tools usage: To gain expertise in handling modern equipment as well as computational tools which can be used in prediction and analysis of complex problems in biosciences and bioengineering.
PO6	Societal cause: To apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and to serve the cause of relevant sectors in the society

PO7	Sustainable development: To understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: To apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and Team Work- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication: To communicate efficiently about the engineering problems related to bioengineering to the larger society with the aid of effective reports, documentation and presentation.
PO11	Project management and finance: to utilize the knowledge of engineering and management principles to manage projects in multi-disciplinary set-up.
PO12	Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

13.0 Program Educational Objectives (PEOs)

PEO1	Graduates will be capable to work efficiently in industries and societies and bring solutions to complex problems.
PEO2	Graduates will be intellectually prepared to pursue higher studies in core as well as multidisciplinary programs.
PEO3	Graduates of the programme will be developed to be an individual with entrepreneurship and leadership skills.

14.0 Program Specific Outcomes (PSOs)

PSO1	To learn protocols and employ engineering principles to solve the problems relevant to today's industries in the field of biosciences and bioengineering and beyond.
PSO2	To design and develop different equipment, experiments and computational approaches related to biosciences and bioengineering.
PSO3	To be engaged professionally and ethically in industries or as an entrepreneur by incorporating technological and managerial skills and build the attitude of developing new concepts on emerging fields and pursuing advanced education.

2.0 Course Structure

Ist Semester							
Sl No	**Course Code**	**Subject Category**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-1101	SM1-SC1	Engineering Mathematics-I	2	0	0	2
2	BS-1102	SM2-SC2	Engineering Chemistry	2	0	0	2
3	BS-1103	SM3-SC3	Engineering Physics	2	0	0	2
4	BT -1101	MA1-DSC1	Fundamentals of Biosciences and Bio-engineering	3	0	0	3
5	MH-1101	SM4-SECC1	Communication Skill	2	0	0	2

6	EE-1102	SM5-ESA1	Basic of Electrical and Electronics Engineering	2	0	0	2
7	CS-1102	MA2-ESA2	Coding Laboratory	0	1	2	2
8	EE-1103	SM6-ESA3	Basic of Electrical and Electronics Engineering Laboratory	0	0	2	1
9	BS-1104	SM7-SC4	Engineering Physics Lab	0	0	2	1
10	ME-1102	MA3-ESA4	Engineering Drawing	0	0	2	1
11	BT-1102	MA4-DSC2	Fundamentals of Biosciences and Bioengineering Laboratory	0	0	2	1
12	MH-1102	SM8- SECC2	Language Laboratory	0	0	2	1
13	MH-1103	VAC1	NSS/NCC/Yoga (Audit Pass)	0	0	0	0
			Contact Hours	13	1	12	
			Total Credits				20

Subject Code: BS 1101
Subject Name: Engineering Mathematics- I
Credit Point: 2 [L=2, T=0, P=0]

A. Course Objectives:

The course is designed to meet with the objectives of:

1. providing high quality education in pure and applied mathematics in order to prepare students for graduate studies or professional careers in mathematical sciences and related fields,
2. imparting theoretical knowledge and to develop computing skill to the students in the area of Science and Technology,
3. providing teaching and learning to make the students competent to their calculating ability, logical ability and decision-making ability,
4. giving students theoretical knowledge of Calculus, Algebra and the practical applications in the various fields of Science and Engineering.

B. Course Content:

Matrix Algebra: Basic concept of matrices & Determinant, Jacobi's theorem. Rank of a matrix, rank nullity theorem, Introduction to Vector space, Linear dependent and independent, System of homogeneous and non-homogeneous linear equations, Eigen values and Eigen vectors of a square matrix, Cayley-Hamilton theorem and its applications.

Differential Calculus: Higher order derivatives, Leibnitz's theorem and its application, Rolle's theorem and its application, Mean Value theorems–Lagrange & Cauchy and their application, Taylor's theorem and its application, Expansions of functions by Taylor's and Maclaurin's theorem. Partial Derivatives, Differential calculus for two variables.

Integral Calculus: Double and triple integrals and evaluation of area and volume, change of variables.

C. Text Books:

1. Kreyszig E., Advanced Engineering Mathematics, John Wiley, 2010, 11th edition.
2. Grewal B. S., Higher Engineering Mathematics, Khanna Publishers, 2014, 43rd edition.
3. Marsden J., Tromba A. J. and Weinstein A., Basic Multivariable Calculus, Springer, India, Private Ltd, 2009.

D. Reference Books:

1. Finney R. L. and Thomas G. B., Calculus and Analytical Geometry (Linear Algebra), Narosa Publishing House, 2021, 9th edition.
2. Hofmann K. M. and Kunze R., Linear Algebra, Prenticehall, 2015, 2ndedition,.
3. Bartle and Sherbart, Introduction to Real Analysis, Wiley, 2014, 4thedition.
4. Apostol T. M., Calculus,Vol I and II, John Wiley and Sons Ltd;, 2007, 2nd edition.
5. Stewart J., Transcendental Calculus, Cengage; 2014, 2nd edition,.
6. Mappa S. K., Higher Algebra, Shrat book House, 2014.
7. Mappa S. K., Real Analysis, Shrat book House, 2013, 7th edition.
8. Wylie C. R. and Barrett L. C., Advanced Engineering Mathematics, McGraw Hill, 1995.

E. Course Outcomes:

The outcomes of course are following:

1. Students will be more confident about their computing skill, logical skill and decision making skill,
2. Students will find various applications of calculus and algebra in the practical fields of science and engineering,
3. Students will become more competent to analyze mathematical and statistical problems, precisely define the key terms, and draw clear and reasonable conclusions,
4. Student will be able to explain the importance of mathematics and its techniques to solve real life problems and provide the limitations of such techniques and the validity of the results.

Subject Code: BS 1102
Subject Name: Engineering Chemistry
Credit Point: 2 [L=2, T=0, P=0]

A. ***Course Objectives:***

1. To enable the students to acquire knowledge about basic chemistry and its technology.
2. To understand applicability of chemistry for engineering purposes.
3. To make them apply the knowledge of chemistry for analysis, evaluation and design system components or processes related to chemistry.

B. ***Course Content:***

Chemical thermo dynamics: first law, energy, enthalpy, Cp and Cv, second law, entropy, free energy, chemical kinetics: rate of elementary reactions, surface chemistry: surfactants and colloidal systems; electrochemistry: conductance, Kohlrausch's law, cell EMF.

Ligand, isomerism, valence bond theory, valence shell electron pair repulsion theory, crystal field theory, molecular orbital theory, charge transfer transition, d-d transition, John-Teller effect, magnetic properties, bioinorganic chemistry.

Hybridization, inductive effect, resonance, hyper conjugation, carbocation, carbanion and free radicals, substitution and addition reactions, introduction to instrumental methods (IR, UV-vis, NMR and Mass- spectroscopy).

Polymers and materials: addition and condensation polymers, degree of polymerization, thermoplastic and thermosetting plastics, conducting polymers, nanomaterials and ceramics, nanocomposites, corrosion, explosive materials.

C. Text Books:

1. Morrison R. T., Boyd R. N. and Bhattacharjee S. K., Organic chemistry, Pearson education, New Delhi, 2010, 7th Ed.,.
2. Rakshit P.C., Physical chemistry, Sarat book distributors, Kolkata, 2004, 7th Ed.
3. Huheey J. E., Keiter E. A., Keiter R. L., Inorganic chemistry: principles of structure and reactivity, Pearson Education, New Delhi, 2009, 4th Ed..

D. *Reference Books:*

1. Ray B. C., Das S. N. and Biswas S., Engineering chemistry, New Central Book Agency, Kolkata, 2008.
2. Gowariker V. R, Viswanathan N. V and Sreedhar J., Polymer science, New Agency International, Kolkata, 2012.
3. Malik W. U., Tuli G. D. and Madan R. D., Selected topics in inorganic chemistry, S. Chand, New Delhi, 2012.
4. Ahluwalia V. K. and Parashar R. K., Organic reaction mechanisms,, Narosa publishing house, Kolkata, 2013, 4th Ed.

E. *Course Outcomes:*

After studying this course, students will be able to

1. Acquire basic knowledge in engineering chemistry.
2. Apply their knowledge for various technological and engineering issues.
3. Select appropriate analysis, evaluation and methods for interpret the concern results.

Subject Code: BS 1103
Subject Name: Engineering Physics
Credit Point: 2[L=2, T=0, P=0]

A. Course Objectives:

1. Imparting theoretical & practical knowledge to the students in the area of engineering physics.
2. Providing teaching and learning to make students acquainting with modern state-of-art of Engineering.
3. Injecting the future scope and the research direction in the field of Physics with

specific specialization.
4. Making students competent to design & development of Engineering Physics.

B. Course Content:

Electricity and Magnetism:

Coulombs law in vector form, Electric field, Gauss's law (differential and integral form), Electric potential and energy, multipole expansion of electric potential, Boundary value problem (Poisson's Eqn. and Laplace's Eqn.). Dielectric, Polarization and Bound charges, Biot-Savart's law, Ampere's law (differential and integral form), Faraday's law of electromagnetic induction, Lenz's Law, Self and mutual Inductance, Maxwell'sfield equation in vacuum and matter.Wave solution of Electromagnetic waves.

Modern Physics and Quantum Mechanics:

Photo electric effect, Compton effect, Blackbody radiation (no derivations), Wave particle duality, two slit experiments, de-Broglie's hypothesis, Heisenberg's uncertainty principle, concept of wave function and wave packet, phase velocity and group velocity, Formulation of quantum mechanics and basic postulates, physical interpretation of wave function, Schrodinger's wave equation, Steady state of Schrodinger's wave equation, One dimensional quantum problems:Free particle, particle in a box, particle in a step potential, harmonic oscillator

C. ***Text Books:***

1. Griffiths J. D, "Introduction to Electrodynamics," Pearson Education India Learning Private Limited, 2015, 4th edition.
2. Griffiths J. D, "Introduction to Quantum Mechanics," Pearson Education, 2015, 2nd edition,.
3. Beise, A., Mahajan, S. and Choudhury S. R., "Concepts of Modern Physics," McGraw-Hill Education, 2017, 7th edition.

D. Reference Books:

1. Krane K., "Modern Physics", Wiley, 2016.
2. Jackson, J. D. "Classical Electrodynamics", Wiley, 1998, 3rd edition.
3. Feynman R. P., Leighton R. B. and Matthew S., "The Feynman Lectures on Physics Vol. 1 to Vol. 3" The New Millennium Edition, 2012.

E. Course Outcomes:

Students successfully completing this module will be able to:

1. Demonstrate competency and understanding of the basic concepts found in physics.
2. Utilize the scientific method for formal investigation and to demonstrate competency with experimental methods that are used to discover and verify the concepts related to content knowledge.
3. Understand advanced topics in engineering. apply quantum mechanics to engineering phenomena
4. Identify formula and solve engineering problems.

Subject Code: BT-1101
Subject Name: Fundamentals of Biosciences and Bioengineering

Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To understand the concept of cellular structures and processes
2. To examine the function of nutrients and the chemistry of metabolism
3. To understand the basics of inheritance and genetic engineering
4. To explore about the microbes and their impact on environment

B. Course content:

Cell concept:

Prokaryotic and eukaryotic cell, cell organelles and their functions, Cell division: Mitosis and meiosis, Immune cells, Plant cells vs Animal cells.

Nutrients and Bioenergetics: Proteins, carbohydrates, vitamins, minerals. Metabolic Processes – Catabolism and Anabolism. Basics of aerobic and anaerobic glycolysis and citric acid cycle.

Principles of Inheritance:

Principles of inheritance, Mendelian Genetics, Discovery of DNA as genetic material, DNA mutation and effects, Genetic engineering and its applications

Microbial world:

History and Scope of Microbiology. Introduction to microorganisms: bacteria, archaea, fungi, protozoa, and viruses. Pathogenecity and Immunity against microbes.

C. Text books:

1. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry, 7th Ed, Macmillan Worth, 2017.
2. M.J. Pelczar, E.C.S. Chan and N.R. Krieg, “Microbiology”, Tata McGraw Hill Education, New Delhi, 1993.
3. Molecular Cell Biology, Lodish, Harvey Krieger, Monty Kaiser, Chris A. Berk, Arnold, W H Freeman & C

D. Reference books:

1. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by Dr. P.S Verma and V.K Agarwal.
2. Molecular Biology of the cell by Bruce Albert.

E. Course Outcomes:

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

CO1	understand the characteristics of living organisms; appreciate the importance of diversity of life and their interaction with the environment.
CO2	explain the interrelationship between biomolecules and the living system and influences of biomolecules upon the structure and function of intracellular components.
CO3	interpret the role of Bioenergetics on living organisms.
CO4	understand the basis of inheritance and its technological aspects to tackle medical complications.
CO5	analyse the diversity of microbial world, and its positive and negative functional implications.

Subject Code: MH-1101
Subject Name: Communication skills
Credit Point: 2 (L=2, T=0, P=0)

A. Course Objectives:

1. To increase the student's ability to improve and utilize the skills necessary to be competent communicator.
2. To enhance the students' linguistic understanding of his or her own communication behaviour.
3. To improve the students' communication skills in both social and professional contexts.
4. To enhance language proficiency and thereby the employability of budding engineers and technologists.

B. Course Content:

Fundamentals of Communication-Concept and Meaning, Process of Communication, Communication Channels, Importance of Communication, Role of Cross-cultural Communication, Communication Cycle, Objectives and Barriers of Communication(linguistic and semantic, psychological, physical, mechanical, cultural), Importance of Audience and Purpose, Types of Communication, Styles of Communication, Verbal and Nonverbal Communication, Comparing General Communication and Technical Communication, Role of Communication in Technology, Persuasive Skills, Negotiation Skills, Language Skills (listening, speaking, reading, writing),Listening-Types of Listening, Writing- Writing Formal Letters, Résumés, Reports, User Manuals, Emails and Blogs, Essentials of Grammar-Sentence Formation, Common Errors and Misappropriations, Note Making, Oral and Poster Presentation Skills, Interview Skills and Etiquette, Language Usage in Social Media.

C. Text Books:

1. Salaria, R.S. and Kul Bhushun Kumar, Effective Communication Skills, Khanna Publishing, 2022.
2. Edwards, Vanessa Van. Cues: Master the Secret Language of Charismatic Communication, Penguin, 2022.
3. Kumar, Sanjay and Pushp Lata, Communication Skills: Workbook, Oxford University Press (OUP), 2018.
4. Mitra, Barun K. Personality Development and Soft Skills, Oxford University Press(OUP), 2016.

D. Reference Books:

1. Kumar, Sanjay and Pushpa Lata, English Language and Communication Skills for Engineers (as per AICTE Syllabus), Oxford University Press (OUP), 2018.
2. Raman, Meenakshi and Sangeeta Sharma, Technical Communication: Principles and Practice, Oxford University Press (OUP), 2017.
3. Quirk, Randolph, Sidney Greenbaum, Geoffrey Leech, Jan Svartvik. A Comprehensive Grammar of the English Language, Pearson Education India, 2010

E. Course Outcomes:

1. Display competence in oral, written, and visual communication.

2. Apply communication theories in various speech acts.
3. Practice the effective way of communication with good personality traits and etiquette.
4. Understand the process of communication and its effect on giving and receiving information.

Subject Code: EE-1102
Subject Name: Basic of Electrical and Electronics Engineering
Credit Point: 3 (L=3, T=0, P=0)

Course Objectives:

1. To understand the structure and properties of different type of electrical circuits, networks and sources.
2. To apply different mathematical tools & techniques for analysing electrical networks.
3. To apply circuit analysis techniques to simplify electrical networks.
4. To solve problems of electrical circuits.

A. Course Content:

Network Theorems: Formulation of network equations, Source transformation, Loop variable analysis, Node variable analysis. Superposition, Thevenin's, Norton's & Maximum power transfer theorem and its application in three phase unbalanced circuit analysis. Solution of Problems with DC & AC sources.

Coupled circuits: Magnetic coupling, Polarity of coils, Polarity of induced voltage, Concept of Self and Mutual inductance, Coefficient of coupling, Modelling of coupled circuits, Solution of problems. AC Fundamentals: RMS Values, Average Values, Peak Factor, Crest Factor, Resonance. Power in purely resistive, inductive, capacitive, RL, RC and RLC Circuits.

Number Systems: Decimal, Binary, Octal, Hexadecimal systems, conversion of a number from one base to another, complements of number systems and its addition and subtraction, Introduction to logic gates.

Boolean Algebra: Theorems and operations, Boolean expressions and truth tables, Duality and inversion, multiplying out and factoring expressions, Exclusive-OR and equivalence operations, Positive and negative logic.

B. Text Books:

1. Theraja B. L., Theraja A.K., A Textbook of Electrical Technology Vol 1, Shree Hari Publications, 2021.
2. Morris Mano M., Digital Logic and Computer Design, Pearson Education India, First Edition, 2016.

C. Reference Books:

1. Kumar Anand, Fundamentals of Digital Circuits, Prentice Hall, 3rd Edition, 2014.
2. Salivahanan.S., Pravin Kumar.S., Digital Electronics, Vikas Publishing House, 2011.

D. Course Outcomes:

After completion of this course, the learners will be able to

1. describe different type of networks, sources and signals with examples.
2. explain different network theorems, coupled circuit and tools for solution of networks.

3. apply network theorems and different tools to solve network problems.
4. select suitable techniques of network analysis for efficient solution.
5. estimate parameters of two-port networks.
6. design filter circuits.

Subject Code: CS1102
Subject Name: Coding Laboratory
Credit Point: 2 (L=0, T=0, P=4)

A. Course Objectives:

1. The student will gain a thorough understanding of the fundamentals of C programming.
2. A student can code, compile and test C programs.
3. Could take Systems programming or Advanced C programming course.
4. Although this course does not deal with object-oriented programming methodology, it will assist the student build the required foundations to undertake a course in OOP.

B. ***Course Content:***

Introduction: The von Neumann architecture, machine language, assembly language, high level programming languages, compiler, interpreter, loader, linker, text editors, operating systems, flowchart.

C Fundamentals: Introduction to C, Data types, Constants and variable declaration, Scope, Storage classes, Data input and output functions, Sample programs.

Operators & Expressions: Arithmetic, Relational, Logical, Bitwise operators, Conditional, Assignment, Library functions.

Decision making: Simple If statement, if-else statement, nested if else statement, Switch statement, nested switch, the operator, goto statement.

Decision making & branching: while statement, do-while statement, for statement. Array: Declaration, Initialization and processing One-dimension array, Two-dimension array and multi dimension array and their operations.

String & pointer: String: Operation on String without using library function and using library function. Pointer: Declaration of pointer variables, accessing the variable by using pointer, pointer increment and decrement operator, pointer and array

Functions: Basic functions, function type, function with no argument & no return value, function with no argument but return value, function with argument & return value, Storage class identifier, Call by reference, Recursive function. Pointer to function.

Structure & Union: Defining a structure, accessing of structure variable, structure and array, array within structure. Nested structure, structure & functions, Pointer & structure, Unions, Enum.

File management system: Advantage of using file, Open, close, read, write in the files, Operation on files.

Dynamic memory Allocation: use of malloc, calloc, realloc, free. Library functions,

Implementation of Linked list and their various operations.

The pre-processor: macro statements.

C. ***Text Books:***

1. Kerninghan and Ritchie, The 'C' programming language, 2nd Edition, Pearson, 2008.
2. Yashavant P. Kanetkar, Let Us C: Authentic guide to C programming language, 15th edition, BPB, 2021.
3. Balaguruswamy, Programming In ANSI C, 8th Edition, Tata McGraw-Hill Education, 2019

D. ***Reference Books:***

1. Zed A. Shaw, Learn C the Hard Way: Pratical Exercises on Computational Subjects You Keep Avoiding (Like C), 2015.
2. Deepali Srivastava and S.K Srivastava, C in Depth, BPB Publication, 2017.
3. Griffiths David and Dawn Griffiths, Head First C, A Brain Friendly Guide, 2012.
4. Grey Perry and Dean Miller, C Programming Absolute Beginner's Guide, 3rd Edition, 2013.

E. ***Course Outcomes:***

1. Understand the basic terminology used in computer programming.
2. Write, compile and debug programs in C language in different operating systems.
3. Design programs involving decision structures, loops and functions.
4. Use and apply the dynamics of memory by the use of pointers in engineering applications.

Use and apply the differences between structure oriented and function oriented programming in programming applications

Subject Code: EE-1103
Subject Name: Basic of Electrical and Electronics Engineering Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

1. To understand the structure and properties of different type of electrical circuits, networks and sources.
2. To apply different mathematical tools & techniques for analysing electrical networks.
3. To apply circuit analysis techniques to simplify electrical networks.
4. To solve problems of electrical circuits.

B. List of Practical:

1. V-I Characteristics of Carbon and Tungsten filament lamp.
2. V-I Characteristics of Fluorescence Lamp.
3. V-I Characteristics of RLC Series Circuit.
4. V-I Characteristics of RLC Parallel Circuit.
5. Verification of truth tables of different logic and universal gates.
6. Implementation of logic gates with the help of universal gates.

C. Course Outcomes:

After completion of this course, the learners will be able to

1. describe different type of networks, sources and signals with examples.
2. explain different network theorems, coupled circuit and tools for solution of networks.
3. apply network theorems and different tools to solve network problems.
4. select suitable techniques of network analysis for efficient solution.
5. estimate parameters of two-port networks.
6. design of filter circuits.

Subject Code: BS 1104
Subject Name: Engineering Physics Laboratory
Credit Point: 1 [L=0, T=0, P=2]

A. Course Objectives:

1. imparting practical knowledge to the students in the area of engineering physics.
2. student will have exposure to various experimental skills which is very essential for an engineering student.
3. to gain practical knowledge by applying the experimental methods to correlate with the physics theory.
4. to learn the usage of various areas of physics like electricity and magnetism systems for various measurements.

B. *List of Experiments:*

1. Determination of Planck's constant using photocell.
2. Verification of Stefan's radiation law.
3. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
4. Verification of Biot-Savart's law.
5. Charging and discharging of capacitor using RC circuit
6. Hall Effect.
7. To determine e/m ratio

C. *Reference Books:*

1. Arora C. L., "Practical Physics", S. Chand Publications, 2010.
2. Squires G. L., "Practical Physics", Cambridge University Press, 2014.

D. *Course Outcomes:*

Students successfully completing this module will be able to:

1. apply the various procedures and techniques for the experiments.
2. develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.
3. understand principle, concept, working and application of new technology and comparison of results with theoretical calculations.

Subject Code: ME-1102
Subject Name: Engineering Drawing
Credit Value: 1 [L = 0, T = 0, P = 2]

A. Course Objectives:

1. Increase ability to understand Engineering Drawing.
2. Learn to sketch and take field dimensions.
3. Learn to take data and transform it into graphic drawings.
4. Learn basic Auto Cad skills.
5. Learn basic engineering drawing formats.
6. Prepare the student for future Engineering positions.

B. Course Content:

Indian standards: Sheet layout, type of lines and their representations, scales. Principles of orthographic projection (multi view drawing): 1stand 3rd angle projection. Projections: Points, lines, surfaces and solids.

Projection of sections and intersections of solids: Isometric projection.

Use of drafting software

C. Reference Books:

1.Dhananjay, A. J., "Engineering Drawing", 1st Ed., 2017, TMH.

2.Bhatt, N.D. and Panchal, V.M., "Engineering Drawing", 43rd ed., 2014, Charotar Publishing House Pvt.Ltd.

3.Venugopal, K. and Prabhu,V. R., "Engineering Graphics", 15th Ed., 2018, New Age International Pvt. Ltd.

D. Course Outcomes:

Upon completion of the subject student's ability to:

1. Understand orthographic projections and sections.
2. Basic understanding of Indian standards of Engineering drawing.
3. Utilize AutoCAD towards developments of drawings.
4. Develop engineering drawings by projection techniques.

Course Code: BT-1103
Course Name: Fundamentals of Biosciences and Bioengineering Laboratory
Credit Point: 1 (L=), T=0, P=2)

A. Course Objectives:

1. To familiarize oneself with basic labwares and equipment in Biosciences and Bioengineering
2. To understand the basic biosafety practices, tools and reagents preparation
3. To develop proficiency in basic handling techniques of cell cultures
4. To explore basic molecular biology tools like PCR and Gel electrophoresis.

B. Course content:

1. Introduction to basic lab wares and equipment of Biotechnology
2. Biosafety lab practices and biological waste disposal: tools, techniques and demonstration
3. Buffers in biology: tools, techniques and demonstration
4. Observing cellular surface or cellular contents in microscope
5. Microbial culture tools and techniques: tools, techniques and demonstration
6. Mammalian and plant cell culture methods: tools, techniques and demonstration

7. Basic molecular biology techniques: tools, techniques, demo for PCR and DNA isolation
8. Protein and DNA visualization techniques: Demo for SDS PAGE, agarose gel electrophoresis

C. Text books:

1.Principles & Techniques of Biochemistry & Molecular Biology by Keith Wilson & John Walker

D. Reference books:

1. Practical manual on Basics of Reproductive Biotechnology by Dr. Satya Nidhi Shukla and Dr. Shivika Chouksey
2. WHO Laboratory biosafety manual, 4th edition

E. Course Outcomes:

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

CO1 understand the basic tools and equipment used in Biosciences and Bioengineering.

CO2 handle biosafety tools and maintain aseptic conditions for microbial culture and cell culture inside biosafety cabinets.

CO3 utilize reagents and microscopic tools for various Biosciences and Bioengineering practical.

CO4 apply the tools and techniques used in molecular biology and recombinant DNA Technology.

Subject Code: MH-1102
Subject Name: Language Laboratory
Credit Point:1 (L=0, T=0, P=2)

A. Course Objectives:

1. To facilitate computer-assisted multi-media instruction enabling individualized and independent language learning
2. To sensitize students to the nuances of English speech sounds, word accent, intonation and rhythm
3. To bring about a consistent accent and intelligibility in students' pronunciation of English by providing an opportunity for practice in speaking
4. To improve the fluency of students in spoken English and neutralize their mother tongue influence
5. To train students to use language appropriately for public speaking and interviews

B. Course Content:

Basics of Phonetics, Speech Sounds – Vowels and Consonants, Word Stress and Rhythm, Accent, Intonation, Phonetics Drills, Developing Effective Listening Skills-Listening Comprehension Drills, Speaking - Conversations, Dialogues, and Debates, Role Play, Situational Dialogues, Expressions in Various Situations, Making Requests

and Seeking Permissions, Formal Presentations. Telephone Etiquette, Building Advanced Vocabulary and English Grammar Exercises.

C. **Text Books:**

1. Words Worth English Language Software
2. Kumar, Rajesh, English Language Communication Skills: Lab Manual Cum Workbook with CD, Cengage Learning India, 2014

D. Reference Books:

1. Jones, Daniel. English Pronouncing Dictionary, Cambridge University Press, 2011.
2. Bansal, R. K. & J. B. Harrison. Spoken English with CD, Orient Blackswan, 2013.

E. Course Outcomes:

By the end of this course, you will be able to:

1. Understand of nuances of English language through audio - visual experience and group activities.
2. Reach the neutral intelligibility.
3. Attain the clarity and confidence to enhance their employability skills.
4. Express themselves fluently and appropriately in social and professional contexts.

NSS/NCC/Yoga (Audit Pass)

IInd Semester							
Sl No	**Course Code**	**Subject Category**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-1201	SM9-SC5	Engineering Mathematics-II	2	0	0	2
2	BT-1201	SM10-ESA5	Biology for Engineers	2	0	0	2
3	CS-1201	MA5-ESA6	Programming and Data Structure	3	0	0	3
4	CS-1202	MA6-ESA7	AI in Engineering	2	0	0	2
5	ME-1201	MA7-ESA8	Engineering Mechanics	3	0	0	3
6	BT-1202	MA8-DSC3	Biochemistry	3	0	0	3
7	MH-1201	SM11-ESA9	Law and Financial Aspects in Engineering	2	0	0	2
8	BT-1203	AP1-01-VAC2	Do It Yourself (DIY)/Industry Exposure	0	0	4	2
9	BS-1202	SM12-SC6	Engineering Chemistry Laboratory	0	0	2	1
10	CS-1204	MA8-ESA10	Programming and Data Structure Laboratory	0	0	2	1
11	MH-1202	SM13-VAC3	Indian Knowledge System (IKS)	0	0	2	1
			Contact Hours	17	0	8	
			Total Credits				22

Subject Code: BS 1201
Subject Name: Engineering Mathematics- II
Credit Point: 2 [L=2, T=0, P=0]

A. Course objectives:

1. The course is designed to meet the following objectives:
2. imparting theoretical knowledge to the students about three and more dimensional objects in space and to improve their capability of visualizing of objects in space.
3. Making student competent enough to construct a differential equation/mathematical modeling for every real life situation with its solution.
4. Giving students theoretical knowledge of vectors with the flavor of Calculus.
5. Introduce the concepts of Laplace and Fourier transforms and its application to the solution of differential equations (ODE &PDE) to the students.

B. Course Content:

Vector Calculus: Basics of vector calculus, Line integral, Surface integral and Volume integral, Path independence, Fundamental theorem of Calculus, Green's, Gauss' and Stokes' theorems (without proofs) and their simple applications**.**

Ordinary Differential Equations: First order ODEs, Higher order linear differential equation with constant coefficients, Euler's homogeneous equation, Series solutions of linear differential equations with variable coefficients (Ordinary point).

Partial Differential Equations: Basic of PDEs (order, degree, Linear, Non-Linear, homogeneous, non-homogeneous), Classification of 2nd Order PDEs; boundary and initial value problems (Dirichlet and Neumann type) involving wave equation, D'Alembert method, heat conduction equation, Laplace's equations and solutions by method of separation of variables (Cartesian coordinates).

C. Text Books:

1.Kreyszig E., Advanced Engineering Mathematics, John Wiley, 2010, 11thedition.

2.Ross S. L., Ordinary Differential Equation, Wiley and Sons Ltd., 2010, 3rd edition.

3.Farlow S. J., Partial Differential Equation for Scientists and Engineers, Dover Publications, 1993, 1st edition.

D. Reference Books:

1. Boyce and Diprima R. C., Elementary Differential Equations and Boundary value Problems, Wiley publications, 2009, 9th edition.
2. Sneddon I. N., Elements of Partial Differential Equations, Dover Publications Inc., 2013, 2nd edition.
3. Jeffrey A., Advanced Engineering Mathematics, Academic Press, 2001, 1st edition.
4. Coddington E., and Levinson N., Introduction to Ordinary Differential Equations McGraw Hill Education, 2017, 1st edition.

E. Course Outcomes:

1. Students will have strong visualizing capability in their mind about any object.
2. Students are so trained that they will recognize various real life situation/problem and able to solve them by constructing a differential equation/ mathematical model.
3. Students will be able to find the Laplace representation as transforms of functions of one/two variable.

Subject Code: BT-1201
Subject Name: Biology for Engineers

Credit Point: 2 (L=2, T=0, P=0)

A. Course Objectives:

1. To understand the basic components of life and their functions
2. To analyze the various applications of biomolecules
3. To apply nature and its potential for engineering designs
4. To inspire learners for cultivating innovative mindset

B. Course content:

Origin of Life: Theories of origin of life, Classification of various forms of life (virus, bacteria, fungi, plantae, Animalia), Macromolecules (DNA, RNA, proteins, lipids, carbohydrates), Central dogma.

Application of biomolecules: Carbohydrates in cellulose-based water filters production, PHA and PLA in bioplastics production, Nucleic acids in vaccines and diagnosis, Proteins in food production, lipids in biodiesel and detergents production, Enzymes in biosensors fabrication, food processing, detergent formulation and textile processing.

Engineering designs inspired by examples in Biology

Echolocation, Photosynthesis. Bird flying, Lotus leaf effect, Plant burrs, Shark skin, Kingfisher beak. Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perflourocarbons (PFCs).

Engineering aspects of some Nobel Prizes in Physiology and Medicine 2 & Chemistry

C. Text books:

1. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry, 7th Ed, Macmillan Worth, 2017.
2. J. Pelczar, E.C.S. Chan and N.R. Krieg, "Microbiology", Tata McGraw Hill Education, New Delhi, 1993.
3. N.A. Campbell, J.B. Reece, "Biology" Person Education, Inc& Dorling Kinderley Publishing, Inc.
4. Molecular Cell Biology, Lodish, Harvey Krieger, Monty Kaiser, Chris A. Berk, Arnold, W H Freeman & C

D. Reference books:

1. Handbook of Biomolecules: Fundamentals, Properties and Applications. Jaya V. Gade, Anshul Singh, Bhawana Jain
2. Biomimicry: Innovations inspired by nature by Janine M. Benyus
3. Clinical Applications of Biomolecules in Disease Diagnosis: A Comprehensive Guide to Biochemistry and Metabolism. Ram Lakhan Singh, Pankaj Singh, Neelam Pathak
4. Nature did it first. Engineering through Biomimicry by Karen Ansberry.

E. Course Outcomes:

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

CO1	Understand the basic ideas and theories about origin of life and the macromolecules involved in it.
CO2	interpret the importance of biomolecules and its applications in day to day life.
CO3	apply the wonders of nature and implement the interference of biological systems in various machines, structures, process and instrumentation
CO4	develop keen interest in applying basic engineering skills to solving problems related to biological systems through their concepts in biology

Subject Code: CS - 1201
Subject Name: Programming and Data Structure
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. Designing principles of algorithms and data structures
2. Learning efficiency and scaling of algorithms
3. Learning essential algorithms in computing
4. Understanding generic data structures for common problems

B. Course Content:

Performance of algorithms: Basic concepts, Mathematical Background, Complexity Analysis, space and time complexity, asymptotic notations, Types of Date Structure

Linear Data Structures: Arrays: one dimensional, multi-dimensional, Sparse Matrix, Elementary Operations

Stacks: Representation, elementary operations and applications such as infix to postfix, postfix evaluation, parenthesis matching

Queues: Simple queue, circular queue, de-queue, elementary operations and applications.

Linked lists: Linear, circular and doubly linked lists, elementary operations and applications such as polynomial manipulation

Non-Linear Data Structures: Trees: Binary tree representation, tree traversal, complete binary tree, heap, binary search tree, height balanced trees like AVL tree and 2-3 tree, tries, red-black tree, B-tree, B+ tree, m-way Search tree, other operations and applications of trees

Graphs: representation, Adjacency list, graph traversal, path matrix, connected components, topological sort, Spanning tree, BFS, DFS.

Sorting and Searching: Sorting: Selection sort, bubble sort, quick sort, merge sort, heap sort, insertion sort, selection sort, radix sort.

Searching: linear and binary search,

Hashing: hash tables, hash functions, and open addressing.

File structures: Introduction, data file types, file organization, file access methods**.**

C. Text Books:

1. Lipschutz S., Data Structure, McGraw Hill Education, 2014.
2. Deshpande P.S., Kakde O.G., C & Data Structures, Charles River Media, 2004.
3. Balagurusamy E., Data Structures Using C, McGraw Hill Education, 2017.
4. Srivastava S.K., Srivastava D., Data Structures Through C In Depth, BPB Publications, 2004.

D. Reference Books:

1. Drozdek A., Data Structures and Algorithms in C++, Cengage Learning, 2012.
2. Radhakrishnan M., Srinivasan V., Data Structures Using C, BPB Publications, 2008.
3. Gupta P., Aggarwal V., Varshney M., Data Structure Using C, Laxmi Publications, 2011.
4. Aho A.V., Hopperoft J.E., UIlman J.D., Data Structures and Algorithms, Pearson, 1998.
5. Tanenbaum A.M., Data Structures using C, Pearson Education, 2009.
6. Agarwal A., Data structure Through C, Cyber Tech Publications, 2005.
7. Bandyopadhyay S.K., Data Structures Using C, Pearson Education India, 2009.
8. Thareja R., Data Structures Using C, Oxford University Press, 2011.

E. Course Outcomes:

1. After successfully completion of this module students will be able to:
2. Assess performance efficiency of sequential algorithms.
3. Design data structures to enable algorithms and design sequential algorithms for performance.
4. Implement designing algorithms and corresponding data structures using object oriented programming languages.
5. Demonstrate deployment of essential data structures such as lists, stacks, queues, and trees.

Subject Code: CS-1202
Subject Name: AI in Engineering
Credit Value: 2 (L = 2, T = 0, P = 0)

Syllabus will be incorporated as per update from concerned department

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Subject Code: ME-1201
Subject Name: Engineering Mechanics
Credit Point:3 (L=3, T=0, P=0)

A. Course Objectives:

1. Ability to utilise scalar and vector analytical techniques for analysing forces in statically determinate structures.
2. Ability to apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems.
3. Student gets a basic idea of Centre of gravity, moment of inertia, mass moment of inertia, friction.

B. B. Course Content:

Forces and Moments: Force, moment and couple, wrench, equivalent force and moment, forces in space equilibrium, FBD, general equations of equilibrium-Lami's theorem, analysis of forces in truss and frames, brief introduction to vector approach.
Friction: Introduction to dry friction, laws of friction, friction of simple machines, inclined planes, screw jacks, clutch, and collar pivot bearing (uniform wear and

uniform pressure assumptions).

Centre of gravity and moment of inertia: Centre of gravity, volume and composite bodies, area moment of inertia and mass moment of inertia for plane figures and bodies.

Virtual work and energy method: Virtual displacement; principle of virtual work; applications of virtual work principle to machines.

Kinematics of particle: Introduction, rectilinear motion, plane curvilinear motion, rectangular coordinates (x-y), normal and tangential coordinates (r-θ).

Kinetics of particle: Review of force, mass, acceleration, work and energy, impulse, momentum, linear impulse and linear momentum, angular impulse and angular momentum, impact, central-force and motion, and relative motion,

Kinetics of system of particles: Introduction, generalized Newton's second law, work-energy, impulse-momentum, conservation of energy and momentum, steady mass flow, variable mass.

Plane kinematics of rigid bodies: Introduction, rotation, absolute motion, relative velocity, instantaneous center of zero velocity, relative acceleration, motion relative to rotating axes.

Plane kinetics of rigid bodies: Introduction, general equation of motion, translation, fixed axis rotation, general plane motion, work energy relations, acceleration from work-energy, virtual work, impulse-momentum equation.

C. C. Text Books:

1. Timoshenko S. and Young D.H., "Engineering Mechanics", 5th Ed., 2017, MGH.
2. Beer and Johnston, "Vector Mechanics for Engineers: Statics and Dynamics", 10th Ed., 2012, TMGH.

D. D. Reference Books:

1. Meriam, J. L. and Kraige, L. G., "Engineering Mechanics, Volume 1: Statics", 8th Ed., 2017, Wiley.
2. Meriam, J. L. and Kraige, L. G., "Engineering Mechanics, Volume 2: Dynamics", 5th Ed., 2006, Wiley.
3. Shames, I. H. and Rao,G. K., "Engineering Mechanics: Statics and Dynamics'", 4thEd., 2006, Pearson.
4. Nelson A., "Engineering Mechanics: Statics and Dynamics", 1st Ed., 2017, TMGH.

E. Course Outcomes:

Upon completion of the subject, students should have the knowledge of:

1. Basic understanding of different type of forces, moments and resolving them.
2. Evaluation of centre of gravity, moment of inertia and mass moment of inertia for various figures & bodies.

   Apply principles of kinematics, kinetics and effects of friction for solving problems.

Subject Code: BT-1202
Subject Name: Biochemistry
Credit Point: 3 (L=3, T=0, P=0)

A. Course objectives:

1. To understand the fundamental principles governing life and the chemistry behind it
2. To analyze of the structures, functions, and interactions between biological molecules
3. To understand the central metabolic pathway governing life such as the energy production and respiratory pathway.
4. To explore the metabolism of macromolecules and the disorders that can arise from disruption in pathways.

B. Course content:

Scope and importance of biochemistry, Fundamental principles governing life; structure of water; acid base concept and buffers; pH; hydrogen bonding; hydrophobic, electrostatic and Van der Waal forces; general introduction to physical techniques for determination of structure of biopolymers; fundamentals of thermodynamics applicable to biological processes;

Central metabolic pathway and regulation: Solute transport: Primary and Secondary transport: Introduction, Kinetics, ABC transporters, Phosphotransferase system, Drug export systems, amino acid transport. Glycolysis, PPP, ED pathway, Citric acid cycle: Branched TCA and Reverse TCA, glyoxylate cycle. Utilization of sugars other than glucose and complex polysaccharides.

Metabolism of fats, proteins, carbohydrates and nucleic acids:

Biosynthesis and degradation of lipids, hydrocarbon utilization, PHA synthesis and degradation. Carbohydrate metabolism.

Metabolism of amino acids: Amino acid biosynthesis and utilisation, lysine and glutamine overproduction, stringent response, polyamine biosynthesis and regulation.

Purine and pyrimidine biosynthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide synthesis.

Disorders of macromolecule metabolism:

Disorders of amino acid metabolism - phenylketonuria, albinism. Disorders of nucleic acid metabolism, Disorders of carbohydrate metabolism: Diabetes mellitus, ketone bodies.

Disorders of lipid metabolism- Sphingo- lipidosis and multiple sclerosis.

C. Text books:

1. Conn, E.E., Stumpf, P.K., Bruening, G. and Doi, R.H. 1997. Outlines of Biochemistry, John. Wiley & Sons Inc., New York and Toranto.
2. Finar, I.L. 1993. Organic Chemistry, Vol. I, II, 6th edn. Longman, London and New York.
3. Nelson, D.L. and Cox, M.M. 2000. Lehninger Principles of Biochemisitry,3rd edn. Printed in India by Replika Press Pvt. Ltd., New Delhi for WorthPublishers, New York.
4. Stenesh, J. 1998. Biochemistry, Vol. I (Foundation of Biochemistry),Vol. II (Biomolecules), Vol. Ill (Metabolism), Plenum Press, New Yorkand London.

D. Reference books:

1. Voet, D., Voet, J.G. and Pratt, C.W. 1999. Fundamentals of Biochemistry, John Wiley and Sons Inc., New York and Toranto.
2. Zubay, G.L. 1998. Biochemistry, 4th edn. W.C. Brown Publishers.
3. Textbook of Medical Biochemistry By MN Chatterjea and Rana Shinde, Jaypee Brothers.

E. Course outcomes:

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

CO1 **demonstrate** an understanding of the structures, functions, and interactions of biological molecules, forming a foundational basis for the field of biochemistry.

CO2 **gain clarity** on central metabolic pathways and their significance in living organisms, supporting advanced research in biosciences and bioengineering.

CO3 **comprehend** the synthesis, degradation, and interrelationship of biomolecules, including how disruptions in these pathways can lead to system-level disorders.

CO4 develop the ability to think critically, work experimentally, and communicate effectively as scientists—preparing students for graduate studies or professional roles in research and the health sciences.

Subject code: MH-1201
Subject name: **LAW AND FINANCIAL ASPECTS IN ENGINEERING**
Credit Point: 2 (L=2, T=0, P=0)

Syllabus to be updated by concerned department

Subject Code: BT-1203
Subject Name: Do It Yourself (DIY)/ Industry Exposure
Credit Point: 2 (L=0, T=0, P=4)

A. Course Objectives:

1. To inculcate in the mind of students the real meaning of electronics,
2. To learn various electronics components along with their pin configuration,
3. To give practical knowledge, on building circuits.

B. Course Content:

Improving soldering skill, Practicing soldering Learning electronics concepts, Getting to know various electronics components and learning how they are working in the complete circuit, Learning how to properly use various electronics components Learning about the right pin configuration, and a lot of other beneficial reasons. Learning about circuit schematic diagrams

C. Text Books:

1. Alan R Winstanley, The Basic Soldering Guide Handbook: Learn to solder electronics successfully, CreateSpace Independent Publishing Platform, 2014
2. Manoj Yadav, Electronic Components: A must read for all beginners, students and those interested in electronics, Notion Press, 1st edition, 2021

D. Reference Books:

1. Oyvind Nydal Dahl, A Beginner's Guide To Circuits: Nine Simple Projects with Lights, Sounds, and More, No Starch Press, 2018
2. Stan Gibilisco, Beginner's Guide to Reading Schematics, McGraw Hill TAB; 4th Edition, 2018

E. Course Outcomes:

1. Acquainted with soldering mechanism.
2. Acquainted with the methods of designing of innovative circuit using electronic components.
3. Substantially prepared to learn about techniques of schematic diagrams

Subject Code: BS 1202
Subject Name: Engineering Chemistry Laboratory
Credit Point: 1 [L=0, T=0, P=2]

A. Course Objectives:

1. To enable the students to acquire knowledge about chemistry practical and its technological importance towards research works.
2. To understand applicability of chemistry for engineering and research purposes.
3. To make them apply the knowledge of fundamental chemistry for design system components or processes and researches considering the public health and safety, and the cultural, societal, and environmental considerations.

B. <u>List of Experiments:</u>

1. Determination of the concentration of NaOH solution.
2. Standardization of KMnO4 solution by Mohr's salt.
3. Estimation of hardness of water using EDTA titration.
4. Conductometric titration for
5. Determination of the strength of a given HCl solution by titration against a standard NaOH solution.
6. Analysis of a mixture of strong and weak acid by strong base.
7. Estimation of available chlorine in bleaching powder.
8. Determination of pH value of the solution by digital pH meter and pH paper.

C. *Reference Books:*

1. Rao M. V. B., Laboratory Mannual for Engineering and Physical Chemistry, Studium Press (India) PVT. Ltd. 2013.
2. Israel V. A., Vogel's Qualitative Inorganic Analysis, Publisher: Pearson Education Limited, ISBN: 9780582218666, 0582218667

D. *Course Outcomes:*

1. An ability to function on research areas in multidisciplinary subjects.
2. Design economically, environmental friendly and new methods of synthesisfor various needful products.
3. A knowledge of titration for various kinds of acid-base for new experimental aspects.

Subject Code: CS1205
Subject Name: Programming and Data Structure Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. *Course Objectives:*

1. To implement linear and non-linear data structures
2. To understand the different operations of search tree
3. To implement graph traversal algorithms
4. To get familiarized to sorting and searching algorithms

B. ***Course Content:***

Laboratory assignments will be based on the implementation of the basic operations and application algorithms (as mentioned below) using various data structures. Programs are to be implemented using any preferable language such as C, C++, Java.

Array implementation of Stack and Queue ADTs. Array implementation of List ADT.

Linked list implementation of List, Stack and Queue ADTs. Applications of List, Stack and Queue ADTs.

Implementation of Binary Trees and operations of Binary Trees. Implementation of Binary Search Trees.

Implementation of AVL Trees.

Implementation of Heaps using Priority Queues. Graph representation and Traversal algorithms. Applications of Graphs.

Implementation of searching and sorting algorithms. Hashing – any two collision techniques.

C. ***Text Books/ Reference Books:***

1. Mehta D.P., Sahni S., Handbook of Data Structures and Applications, Chapman and Hall, 2020.
2. Goodrich M.T., Tamassia R., Mount D. M., Data Structures and Algorithms in C++, Wiley, 2011.
3. Langsam Y., Augenstein M.J., Tenenbaum A.M., Data Structures Using C and C++, Pearson Education, 2011.

D. ***Course Outcomes:***

1. Write functions to implement linear and non-linear data structure operations.
2. Suggest appropriate linear / non-linear data structure operations for solving a given problem.
3. Appropriately use the linear / non-linear data structure operations for a given problem
4. Apply appropriate hash functions that result in a collision free scenario for data storage and retrieval

Subject Code: MH-1202

Subject Name: Indian Knowledge System

Credit Point:1 (L=0, T=0, P=2)

Syllabus will be updated by concerned department and will be following accordingly

IIIrd Semester

Sl No	Course Code	Subject Category	Course Title	L	T	P	C
1	BS-2101	SM14-SC7	Engineering Mathematics-III	3	0	0	3
2	BT-2101	MA9-DSC4	Microbiology	3	0	0	3
3	BT-2102	MA10-DSC5	Cell Biology and Genetics	3	0	0	3
4	BT-2103	MA11-DSC6	Molecular Biology	3	0	0	3
5	BT-210A	MA12-DSC7	Bioprocess Calculations	3	1	0	4
6	BT-210X	SM15-ESA11	Introduction to Innovation and Creativity	2	0	0	2
7	BT-2104	MA13-LAB 1	Microbiology Laboratory	0	0	2	1
8	BT-2105	MA14-LAB 2	Biochemistry Laboratory	0	0	2	1
9	BT-2106	MA15-LAB 3	Cell Biology and Genetics Laboratory	0	0	2	1
10	BT-2107	AP1-02-SECC3	Skilled development course (Internship)-01	0	0	2	1
			Contact Hours	17	1	8	
			Total Credits				22

Subject Code: BS 2101
Subject Name: Engineering Mathematics- III
Credit Point: 3 [L=3, T=0, P=0]

A. Course objectives:

The course is designed to meet the objectives of:

1. imparting theoretical knowledge and practical application to the students in the area of Stochastic Process,
2. introducing the basic notions of probability theory and develops them to the stage where one can begin to use probabilistic ideas in statistical inference and modeling, and the study of stochastic processes,
3. providing confidence to students in manipulating and drawing conclusions from data and provide them with a critical frame work for evaluating study designs and results,
4. injecting future scope and the research directions in the field of stochastic process.

B. Course Content:

Probability: Random Experiment, Sample space; Events; Probability of events, Frequency Definition of probability; Axiomatic definition of probability; Finite sample spaces, Probability of Non-disjoint events (Theorems). Conditional probability; General Multiplication Theorem; Independent events; Bayes'theorem and related problems.

Random variables: Probability mass function; Probability density function and distribution function. Distributions: Binomial, Poisson, Uniform, Exponential, Normal, t and $\chi 2$. Expectation and Variance (t and $\chi 2$ excluded); Moment generating function; Transformation of random variables (One variable); Central limit theorem (Statement only).

Basic Statistics: Measures of Central tendency: Moments, skew-ness and Kurtosis – Probability distributions: Binomial, Poisson and Normal -

evaluation of statistical parameters for these three distributions, Correlation and regression– Rank correlation.

Statistics: Population; Sample; Statistic; Estimation of parameters (consistent and unbiased); Sampling distribution of sample mean and sample variance (proof notrequired).

Estimation: Maximum likelihood estimate of statistical parameters (Binomial,Poissonand Normal distribution). Interval estimation (Normal distribution). Testing of hypothesis and $\chi 2$ goodness of fit.

Curve fitting: Linear and Nonlinear

C. Text Books:

1. Rohatgi V. K. and Saleh A. K. Md E., An Introduction to Probability and Statistics, Willy, 2008, 2nd edition.
2. Gupta S. C., & Kapoor V. K., Fundamental of Mathematical Statistics, Sultan Chand &Sons, 2014.

D. Reference Books:

1. Ross S. M., Introduction to Probability Models, Academic Press, 2014, 14th edition.
2. Cramer H., Random Variables and Probability Distributions, Cambridge University Press, 2014, Revised ed.
3. Spiegel M. R., Probability and Statistics, McGraw-Hill, 2017, 3rdedition.
4. Mayer P. L., Introductory Probability and Statistical Applications, Oxford & IBH, 1970, 2nd ed.
5. Feller W., An Introduction to Probability Theory and Its applications, Vol I, Jon Willy and Sons, 2008, 3rd edition.
6. Chung K. L., A course of Probability Theory, Academic Press, 2000, 3rd edition.

E. Course Outcomes:

Upon Completion of the subjects:

1. Students will add new interactive activities to fill gaps that we have identified by analyzing student log data and by gathering input from other college professors on where students typically have difficulties,
2. Students will add new simulation-style activities to the course in Inference and Probability, Student s will be able to take up prospective research assignment

Subject code: BT-2101
Subject Name: Microbiology
Credit Point: 3 [L=3, T=0, P=0]

A. Course objectives:

1. To explore the evolution of microbiology, understanding different class of microorganism
2. To understand different culture techniques and their growth kinetics using different methods and nutritional groups
3. To apply different techniques for microbial estimations and sterilizations.

4. To examine the basic metabolism and genetics of microbes and their mode of reproduction
5. To investigate the pathogenicity of microbes and various factors associated with it and to study the varied applications of microbes.

B. Course content:

Introduction to Microbiology: Characterization, Classification and Identification of microorganisms,

Structure and taxonomy: Microscopic examination of Microorganisms morphology and fine structure of bacteria. Microbial taxonomy: classical and molecular approach. Gram nature of bacteria.

Nutrition, growth and culturing: Microbiological media, composition and types; selective and differential media; growth curve, growth kinetics; influence of environmental factors on microbial growth; nutritional groups of bacteria; overview estimation of microbes - direct microscopic count, turbidometric assay; indirect method - CO2 liberation, protein estimation; sterilization and disinfection.

Microbial metabolism and genetics: Microbial metabolism, energy production, utilization of energy & biosynthesis, Fermentation; Aerobic and anaerobic respiration. Bacterial genetics, plasmids, transformation, conjugation, transduction. Introduction to metagenomics; Scope and applications of genomics and metagenomics;

Microbial diseases and pathogenicity: Host pathogen interactions, mechanism of pathogenicity, emerging and re-emerging pathogens (coliforms, SARS virus, prions, AIDS, Lyme diseases etc), Anti-microbial drugs and their resistance. Applications of microbes in agriculture; environment; industry; health.

C. Text books:

1. Michael J. Pelczar, Jr., E.C.S. Chan, Noel R. Krieg: Microbiology, Tata McGraw Hill, 5th Edition, 2006.
2. L. M. Prescott, J. P. Harley and D. A. Klein, Microbiology, 6th Ed, McGraw Hill, 2005.

D. Reference books:

1. Thomas D. Brock, Michael T. Madigan, John M. Martinko.12th edition Pearson
2. John L. Ingraham, Catherine A. Ingraham: Introduction to Microbiology, A case History Approach, Thomson Brooks/Cole, 3rd Edition, 2004.

E. Course outcomes:

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

CO1 compare different theories and postulates of microbiology and analyze different types of bacteria based on different methods studied.

CO2 understand the nutrition, growth kinetics of bacteria and factors affecting their growth

CO3 apply their knowledge on fermentation and bacterial genetics for various applications of biotechnology.

CO4 analyze the work and response of microbes on diseases, drugs and resistance and will have the motivation for antimicrobial research.

Subject Code: BT-2102
Subject Name: Cell Biology and Genetics
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To understand the formation of cell constituents and their functions.
2. To explore the mechanisms of cell transportations, movement and cell signaling.
3. To analyze how disruptions of cell signaling and cell cycle affect normal functions.
4. To understand the Principles of inheritance and apply the knowledge in analyzing genetic data .
5. To examine how genetic variation can lead to abnormalities and thereby learning how to prevent it.

B. Course content:

Overview of cells: Origin and evolution of cells, biosynthesis of cell constituents and their functions. Cell membrane, Nucleus, Endoplasmic reticulum, Golgi apparatus and Lysosomes, Mitochondria, chloroplasts, Peroxisomes.

Signaling and Cell cycle :Signaling molecules and their receptors, functions, pathways of intracellular signal transduction, the Cell Cycle – Mitosis and Meiosis –Cell death and cell renewal-Programmed cell death, Stem cells, Cytoskeleton and cell movement, cell surface – transport of small molecules, Endocytosis, cell –cell interactions- Adhesion junctions-Tight junctions-Gap junctions- Plasmodesmata, cancer cells.

Organism reproduction and Principles of Heredity: Gamete formation from Meiosis, random fertilization and genetic variation, formation of male and female (eg in human) in sexually reproducing organisms. Mendel's principles of inheritance: Three laws, dominant and recessive alleles, homozygous and heterozygous alleles. Deviation from Mendel's laws, test cross, back cross. Types of genetic crosses and their uses. Sex-influenced traits, cytoplasmic inheritance, genomic imprinting.

Pedigrees and Eukaryotic gene mapping: Pedigree chart, pedigree analysis and types, mating outcomes, hemophilia in royal family of England. Linkage, Linked genes, effect of linkage on crossing over, recombination. Recombination frequencies and genetic map. Use genetic maps to predict gametic and mating outcomes.

Chromosome and DNA as genetic material: Chromosome and DNA structure, DNA as genetic material, Chromosome abnormalities causes and outcome, DNA mutation, causes and outcomes.

C. Text books:

1. The Cell: A molecular approach by Geoffrey M.Cooper.ASM Press, Pages:673
2. Molecular Cell Biology, Lodish, Harvey Krieger, Monty Kaiser, Chris A. Berk, Arnold, W H Freeman & C.
3. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by Dr. P.S Verma and V.K Agarwal.

D. Reference books:

1. Molecular Biology of the Cell Edition 4, Roberts, Keith Alberts, Bruce Johnson, Alexander Raff, Martin Walter, Peter Lewis, Julian, Garland.
2. Lewin's GENES XII by Jocelyn E Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick.

E. Course outcomes:

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

CO1 understand the basic concept of cell structure, membrane, cellular functions of different types of cell.

CO2 examine how cell divides and signal the body and also various detrimental effects upon disruption of cell signaling processes.

CO3 analyze the basis of variation as a result of meiosis and cross-over and develop interest in genetic research.

CO4 correlate inheritance pattern and will be able to predict mating outcomes using Mendelian laws.

CO5 interpret genetic abnormalities, causes and effects with respect to the stability or change in genetic structure.

Subject Code: BT-2103
Subject Name: Molecular Biology
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course objectives:

1. To understand the characteristics of the gene and the genetic material and the effect caused by its mutation
2. To apply the concept of central dogma; replication, transcription and translation process used by prokaryotes and eukaryotes.
3. To explore the role of signal sequence in protein sorting to various organelles
4. To analyze and appreciate the discovery of genetic code and regulation of gene which is central to the normal functioning of living organisms

B. Course content:

Introduction to molecular biology - dna and rna: Scope and History. Structure of DNA, Double Helix, features of Watson and Crick model, DNA Supercoiling- twist, writhe and linking number. Forms of DNA,

Structure and function of mRNA, rRNA, tRNA. Secondary structures in RNA. Gene mutation.

Replication and repair: Types and functions of DNA polymerases in Prokaryote and Eukaryote. Replication in prokaryote and Eukaryote. Proof reading activity, 5'□ 3' exonuclease activity, topoisomerase activity, Telomeric DNA replication and Plasmid Replication-theta model, strand displacement model and rolling circle model. DNA Repair- Nucleotide excision repair, base excision repair, mismatch repair, photo-reactivation, recombination repair and SOS repair.

Transcription and post transcriptional modifications: Fine structure of prokaryotic and eukaryotic gene, structure and function of the promoters in mRNA, rRNA, tRNA genes. RNA polymerases in prokaryote and eukaryote, types and function. Transcription of mRNA, rRNA, and tRNA genes in Prokaryote and eukaryote. Post transcriptional processing of mRNA – 5'capping, splicing (including different types), polyadenylation and RNA editing.

Translation and post translational processing: Genetic code and Wobble hypothesis. Translation in and eukaryote. Post translational modifications. Principles protein sorting and targeting into endoplasmic reticulum, mitochondria, chloroplast, and nucleus.

Gene regulation: Principles of gene regulation- Transcriptional and post transcriptional gene regulation-activators, co-activators, suppressors, co-suppressors, moderators, silencers, insulators, enhancers. Operon-*lac* operon, *trp* operon, *ara* operon and *gal* operon.

C. Text books:

1. Molecular Biology of Gene – Watson
2. Lewin's GENES XII by Jocelyn E Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick
3. Molecular and Cellular Biology- Stefen Wolfe

D. Reference books:

1. B. Alberts, A. Johnson, J.Lewis and M.Raff, Molecular Biology of the Cell, Garland Science; 5th edition.
2. H. Lodish, A Berk, C.A. Kaiser and M.Krieger, Molecular Cell Biology, W. H. Freeman, 6th edition, 2007.

E. Course outcomes:

Upon completion of the program, students will be able to:

CO1 develop clear understanding on the work of genetic material as to how different characters are formed.

CO2 understand what causes different abnormalities and also ageing as a result of mutation and replication error.

CO3 apply the concept on the central dogma and the repair mechanism and appreciate the sophistication of living organisms.

CO4 interpret the genetic code and gene regulation and develop innovative ideas for genetic manipulations.

Subject Code: BT-210A
Subject Name: Bioprocess calculations
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To introduce the fundamental principles of units, dimensions, mole concept, and chemical composition relevant to bioprocess calculations.
2. To develop the ability to apply material and energy balance concepts to biological and chemical process systems.
3. To enable students to formulate and solve material balance problems for unit operations with and without chemical reactions.
4. To build competency in analyzing gas systems, combustion processes, and fuel analysis relevant to bioprocess industries.

B. Course content

Fundamentals of Units and dimensions: Chemical arithmetic: Mole concept, atomic weight, molecular weight and equivalent weight. Use of mole concept in biological and chemical reactions. Chemical composition: Methods of expressing compositions of mixtures and solutions- mole percent, mass percent, volume percent, molarity, molality, normality, ppm, density and specific gravity, specific gravity scales. Gas systems: Ideal gas laws, gaseous mixtures, real gas laws, gas constant; calculations of pressure, volume and temperature.

Fundamentals of material balances and energy balances: Definition of unit operations and unit processes. Law of conservation of mass, types of material balance problems – total and component balances, steady and unsteady state processes, batch and continuous processes. Concept of tie element, basis for calculations, independent material balance equations, degrees of freedom and steps for solving material balance problems. Fundamentals of energy balances: Law of conservation of energy, qualitative study of components of energy balance equations.

Material balances without chemical reactions: Material balances for unit operations like evaporation, crystallization, drying, leaching, extraction, absorption and distillation. Qualitative study of bypass, recycle and purging operations.

Material balances with chemical reactions: Definition of terms like limiting reactant, excess reactant, percentage yield and selectivity, extent of reaction: - simple numerical examples. Combustion of solid, liquid and gaseous fuels, heating value of fuels, proximate and ultimate analysis of coal.

C. Text Books

1. K.V. Narayanan, B. Lakshmikutty, Stoichiometry and Process Calculations, Prentice Hall of India, 2006
2. Michael L Shuler &Fikret Kargi – Bioprocess Engg. Basic Concepts – Prentice – Hall India.

D. Reference Books

1. B.I. Bhatt, S.M. Vora, Stoichiometry, Fourth edition, Tata McGraw Hill, 2004.
2. Venkataramani & N.N. Ananthraman – Process calculation – Prentice Hall India.
3. David M. Himmelblau, James B. Riggs, Basic Principles and Calculations in Chemical Engineering, Prentice Hall, 2012.
5. Pauline M Doran, Bioprocess Engineering Principles, 2/e, Elsevier- Academic Press, 2013

F. Course Outcomes:

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

CO1**:** apply the concept of units, dimensions, mole concept, and chemical composition methods in solving bioprocess calculations.

CO2: analyse the principles and methods of material and energy balances in steady-state and unsteady-state biological and chemical processes.

CO3: to solve material balance problems for various unit operations with and without chemical reactions.

CO4: to analyse the fundamentals of gas systems and combustion processes, inclu ding calculations related to fuel properties and heating values.

Subject Code: MH-120X
Subject Name: Introduction to Innovation and Creativity (3-0-0-3)
Credit Point:3 (L=3, T=0, P=0)

A. Course Objectives:

1. To involve themselves in the innovation and creative activities
2. Starting innovative practices in their entrepreneurial activities.
3. Developing their skills on the traits that they want to carry forward.
4. Starting activities based on the search of new ideas.

B. Course Content:

Introduction to innovation and creativity, opportunity identification: the search for new idea, entrepreneurial imagination and creativity, The role of creative thinking, Components of creativity, Indication of creativity, Developing your creativity, the creative thinking process, Two approaches to creative problem-solving, the most common idea killers, Arenas in which people are creative, the creative climate, Innovation and entrepreneur, the innovation process, types of innovation, Proof of Concept(PoC), product development, the major misconceptions of innovation, principles of innovation, Methods to initiate ventures, creating new ventures: new-new approach & new-old approach, ways to develop personal creativity: recognise relationships, develop a functional perspective, use your brains, and eliminate muddling mind –sets, design thinking, design innovation, technological innovation and designing entrepreneurship, creative design. Case study on startup/unicon

C. Text Books:

1. Donald F. Kuratko, Entrepreneurship: Theory, Process, Practice Cengage Learning 2017
2. Cynthia, L. Greene, Entrepreneurship Ideas in Action. Thomson Asia Pvt. Ltd., Singapore. 2004

D. Reference Books:

1. Barringer Entrepreneurship: Successfully Launching New Ventures, Pearson Education Publishing 2015
2. Timmons, Jerry A., and Spinelli, Stephen, 2009. New Venture Creation: Entrepreneurship for the 21st Century, 8th Edition, Boston, MA: IrwinMcGraw- Hill
3. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001

E. Programme Outcomes:

1. Start their venture more scientifically.
2. Start their venture by linking with the all the stakeholders.
3. Enable to identify various opportunity mapping
4. Explore many possibilities of generating new idea leading to enterprise.

Subject Code: BT-2104
Subject Name: Microbiology Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course objectives:

1. To learn the sterilization techniques and aseptic handling of lab wares and cultures in microbiology
2. To learn the basic microbial characterization, staining and culture techniques

B. Course content:

1. Sterilization techniques

2. Media preparation
3. Microscopy and Micrometry
4. Isolation, size and shape of microbes from a given sample
5. Staining Techniques (Simple, Gram staining, spore staining)
6. Motility test by Hanging drop method
7. Biochemical Characterization of Bacteria
8. Oxidation/Fermentation Test
9. Catalase, Oxidase and Urease Tests
10. IMViC test

C. Text books:

1. *Microbiology by Pelczar, JR E.C.S Chan and noel R.Krieg. Fifth edition Tata Mc GrawHill -2006*
2. *Thomas D. Brock, Michael T. Madigan, John M. Martinko.12th edition Pearson*

D. Reference books:

1. Hand Book of Practical Microbiology (2021) by Apurba S Sastry and Sandhya Bhat.
2. Principles & Techniques of Biochemistry & Molecular Biology by Keith Wilson & John Walker.

E. Course outcomes:

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

CO1	perform sterilization techniques and aseptic handling of lab wares and preparation of culture media on their own
CO2	identify bacteria based on microscopic visualization, morphological structure, colony structure and staining techniques
CO3	characterize bacteria using various biochemical and physical methods
CO4	demonstrate the equipment and lab wares used in the course

Subject Code: BT-2105
Subject Name: Biochemistry Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course objectives:

1. To understand and apply the techniques of buffer preparation
2. To utilize chromatographic method for separation amino acids and lipids
3. To estimate sugar, vitamins, proteins, oil and nitrogen using different methods

B. Course content:

1. Preparation of buffers
2. Separation of amino acids by TLC
3. Estimation of proteins
4. Estimation of sugar
5. Estimation of vitamins
6. Extraction of lipids and their separation on TLC
7. Estimation of oils
8. Nitrogen estimation by different methods

C. Text books:

1. Principles & Techniques of Biochemistry & Molecular Biology by Keith Wilson & John Walker
2. A Practical book on Biochemistry by Mr. Bakshi Rahman, Dr. Rageeb, Dr. Sufiyan Ahmad Raees

D. Reference books:

1. Nelson, D.L. and Cox, M.M. 2000. Lehninger Principles of Biochemisitry,3rd edn. Printed in India by Replika Press Pvt. Ltd., New Delhi for WorthPublishers, New York.

E. Course outcomes:

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

CO1 prepare buffer of various types and range
CO2 operate TLC and separate amino acids and lipids by TLC
CO3 apply their practical knowledge for estimation of biomolecules

Subject Code: BT-2105
Subject Name: Biochemistry Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

F. Course objectives:

4. To understand and apply the techniques of buffer preparation
5. To utilize chromatographic method for separation amino acids and lipids
6. To estimate sugar, vitamins, proteins, oil and nitrogen using different methods

G. Course content:

1. Preparation of buffers
2. Separation of amino acids by TLC
4. Estimation of proteins
4. Estimation of sugar
5. Estimation of vitamins
6. Extraction of lipids and their separation on TLC
7. Estimation of oils
8. Nitrogen estimation by different methods

H. Text books:

3. Principles & Techniques of Biochemistry & Molecular Biology by Keith Wilson & John Walker
4. A Practical book on Biochemistry by Mr. Bakshi Rahman, Dr. Rageeb, Dr. Sufiyan Ahmad Raees

I. Reference books:

1. Nelson, D.L. and Cox, M.M. 2000. Lehninger Principles of Biochemisitry,3rd edn. Printed in India by Replika Press Pvt. Ltd., New Delhi for WorthPublishers, New York.

J. Course outcomes:

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

CO1 prepare buffer of various types and range
CO2 operate TLC and separate amino acids and lipids by TLC
CO3 apply their practical knowledge for estimation of biomolecules

Subject Code: BT-2106
Subject Name: Cell Biology and Genetics Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course objectives:

1. To observe and understand cells and cell organelles using microscope
2. To perform fractionation different cellular contents and organelles
3. To practice technique and preparation of histological slides
4. To apply staining method of DNA and study different mitotic stage

5. To assess number of sex chromosome number using basic cytogenetic methods
6. To perform agarose gel electrophoresis for separation of DNA
7. To demonstrate karyogram using chromosome spread

B. Course content:

1. Microscopic study of cell and cell organelles
2. Cell fractionation
3. Histology: Fixation, Dehydration, embedding and sectioning of tissues
4. Nuclear staining
5. Mitosis in onion root tip
6. Barr body preparation and staining
7. Agarose gel electrophoresis
8. Preparation of chromosome spreads
9. Preparation of karyogram using chromosome spread

C. Text books:

1. Principles of Genetics

1. *The Cell: A molecular approach by Geoffrey M.Cooper*

D. Reference books:

2. Practical laboratory manual- CELL BIOLOGY Amit Gupta and Bipin Kumar Sati.

3. Practicals of Cell Biology & Genetics by Vilas Parmar

E. Course outcomes:

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

CO1	demonstrate the use of light microscope for routine microscopic observation
CO2	explain cells and cell organelles morphology from microscopic observation.
CO3	fractionate different cellular parts and organelles, section tissues and prepare histological slides.
CO4	interpret different stages of mitosis using nuclear staining and explain the changes in chromosome behavior.
CO5	demonstrate chromosome spread and karyogram using metaphase chromosome.
CO6	prepare barr body staining and interpret the result.
CO7	perform agarose gel electrophoresis and visualize of DNA.

SKILLED AND DEVELOPMENT COURSE (INTERNSHIP)-01

Subject Code: BT-2106
Subject Name: Cell Biology and Genetics Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course objectives:

1. To observe and understand cells and cell organelles using microscope
2. To perform fractionation different cellular contents and organelles
3. To practice technique and preparation of histological slides
4. To apply staining method of DNA and study different mitotic stage
5. To assess number of sex chromosome number using basic cytogenetic methods
6. To perform agarose gel electrophoresis for separation of DNA
7. To demonstrate karyogram using chromosome spread

B. Course content:

1. Microscopic study of cell and cell organelles
2. Cell fractionation
3. Histology: Fixation, Dehydration, embedding and sectioning of tissues
4. Nuclear staining
5. Mitosis in onion root tip
6. Barr body preparation and staining
7. Agarose gel electrophoresis
8. Preparation of chromosome spreads
9. Preparation of karyogram using chromosome spread

C. Text books:

1. Principles of Genetics

1. *The Cell: A molecular approach by Geoffrey M.Cooper*

D. Reference books:

2. Practical laboratory manual- CELL BIOLOGY Amit Gupta and Bipin Kumar Sati.

3. Practicals of Cell Biology & Genetics by Vilas Parmar

E. Course outcomes:

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

CO1	demonstrate the use of light microscope for routine microscopic observation
CO2	explain cells and cell organelles morphology from microscopic observation.
CO3	fractionate different cellular parts and organelles, section tissues and prepare histological slides.
CO4	interpret different stages of mitosis using nuclear staining and explain the changes in chromosome behavior.
CO5	demonstrate chromosome spread and karyogram using metaphase chromosome.
CO6	prepare barr body staining and interpret the result.
CO7	perform agarose gel electrophoresis and visualize of DNA.

SKILL DEVELOPMENT COURSE (INTERNSHIP)-02

IVth Semester						
Course Code	**Subject Category**	**Course Title**	**L**	**T**	**P**	**C**
BT-2201	MA17-DSC8	Immunology	3	0	0	3
BT-2202	MA18-DSC9	Recombinant DNA Technology	3	0	0	3
BT-2203	MA19-DSC10	Plant Biotechnology	3	0	0	3
BT-2204	MA20-DSC11	Biophysics	3	0	0	3
BT-220A	ELE1-DSE1	Biothermodynamics	3	0	0	3
BT-220B	ELE1-DSE1	Industrial Biotechnology				
BT2205	AP1-03-VAC4	Minor project	0	0	4	2
BT2206	MA21-LAB4	Immunotechnology laboratory	0	0	2	1
BT2207	MA22-LAB5	Recombinant DNA Technology Laboratory	0	0	2	1
BT2208	MA23-LAB6	Plant Tissue Culture Laboratory	0	0	2	1
BT2209	AP1-04-SECC4	Skill development course (Internship)-02	0	0	2	1
		Contact Hours	15	0	12	
		Total Credits				21

Subject Code: BT-2201
Subject Name: Immunology
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To provide a foundational understanding of the human immune system, its components, and functional mechanisms in innate and adaptive immunity.
2. To explain the structural and functional aspects of immunoglobulins, antigenic determinants, monoclonal antibodies, cytokines, and the complement system.
3. To familiarize students with various antigen-antibody interaction techniques and their applications in diagnostics and research, such as ELISA, Western blotting, and flow cytometry.
4. To introduce the development and functional specialization of immune cells, including T and B cell maturation, activation, and differentiation.
5. To explore the immune system's role in health and disease, including mechanisms of immune defense, inflammation, hypersensitivity, and the basis of vaccine-induced immunity.

B. Course Contents:

Overview of the immune system:
Innate Immunity, adaptive immunity, comparative immunity cells and organs the immune system – Antigens.
Immunoglobulin structure and functions:

Basic structures of Immunoglobulins – Ig classes and biological activities, Antigenic determinants on Ig, B Cell receptor, Monoclonal antibodies – cytokines – complement system

Antigen – antibody interactions:

Antibody Affinity and activity – Precipitation reactions- agglutination reactions- Radio immunoassay-ELISA-Western blotting, Immunoprecipitation, Immunofluroscence, immunoelectron microscopes, flow cytometers-MHC Antigen processing & presentations.

Cell & b cell maturation, activation & differentiation

T Cell receptor, T Cell maturation, activation and differentiation B Cell generation, activation and differentiation cell mediated effectors responses. Immune system in health & disease: Leukocyte migration and inflammation, hypersensitive reactions, immune response to infection diseases vaccines.

C. Text Books

1. Kuby Immunology by Richard A. Golds by Tharmas J. kindt fourth edition 2000 and Barbara Osborne. W.H.freeman and company
2. Immunobiology 6th Edition, Janeway, Travers, Walport, Shlomchik, Garland, 2005.

D. Reference Books

1. Abbas, A. H. Lichtman and S. Pillai, Cellular and Molecular Immunology, 7th Updated Edition, Saunders, 2011.
2. M. Roitt, J. Brostoff and D. K. Male, Immunology, 6th Edition, Mosby, 2001.

E. Course Outcomes:

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

CO1: understand the components and functions of the innate and adaptive immune systems, including the roles of immune cells, organs, and antigens.

CO2: explain the structure, classes, and biological functions of immunoglobulins.

CO3: interpret antigen-antibody interactions and apply various immunological techniques such as ELISA, Western blotting, immunoprecipitation, immunofluorescence, and flow cytometry.

CO4: understand and evaluate the maturation, activation, and differentiation of T and B cells, and the mechanisms of cell-mediated immune responses.

CO5: analyze immune responses in health and disease, including leukocyte migration, inflammation, hypersensitivity reactions, and the immune response to infectious diseases and vaccines.

Subject Code: BT-2202
Subject Name: Recombinant DNA Technology
Credit Point: 3 (L=3, T=0, P=0)

A. Course objectives:

1. To understand the concept of recombinant DNA technology and cloning as a means of genetic manipulation
2. To explore different techniques used in recombinant DNA technology such as gel electrophoresis, blotting and micro arrays
3. To comprehend the concept of PCR and types and recent molecular techniques
4. To examine the methods involved in library construction and sequencing
5. To investigate strategies for over-expressing recombinant protein and their purification methods
6. To apply different techniques for analysis protein-DNA and protein-protein interaction

B. Course content:

Basics of DNA cloning: Simple cloning and cloning using linkers and adaptors. Cloning into various kinds of vectors – plasmids, phages lambda and M13, phagemids, cosmids, P1 phage, PACs, BACs and YACs. Selection and screening of clones.

Methods of DNA and protein analysis: Agarose, polyacrylamide and pulsed field gel electrophoresis of DNA. Southern and Northern Blotting. Radiolabelling probes. RFLP and RAPD analysis. DNA fingerprinting and its application in forensics, in disease diagnosis and in identification of strains. Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins. Western Blotting analysis, DNA Micro array.

Polymerase Chain Reaction: Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers. Cloning PCR products. Long PCR, Inverse PCR, Vectorette PCR, RT-PCR, 5' and 3' RACE, qPCR, Real Time PCR using SYBR Green, Scorpion primers and TaqMan probes, Multiplex PCR, Differential Display PCR. Ligation Chain Reaction, Overlap PCR, CRISPR technology

Construction of cDNA and genomic DNA libraries: Vectors used in the construction of cDNA versus genomic DNA libraries. Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries. Screening libraries by colony hybridization and colony PCR. DNA sequencing by Sanger's method, Physical mapping by restriction fragment fingerprinting of BAC clones and STS mapping. Whole genome shotgun sequencing. Array CGH.

Overexpression of recombinant proteins: Overexpression and tagging of recombinant proteins in *E.coli,* driven by lac, T7 and Tet-regulatable promoters. Mammalian cell overexpression system.
Analysis of protein-DNA and protein-protein interactions: Gel retardation assay, DNA footprinting by DNase I, Yeast hybrid assays, Co-immunoprecipitations, pull-downs and Far-Westerns. GFP and FRET. Phage display.

C. Text books:

1. Principles of Gene Manipulation and Genomics" by Primrose and Twyman

2. Molecular Biology by David P. Clarke, 1st edition; Elsevier Academic Press; 2005.
3. DNA Technology: The Awesome Skill by I. Edward Alcamo, 2nd edition; Hardcourt Academic Press; 2001.

D. Reference books:

1. Molecular Biology of the Gene by James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine & Richard Losick , 6th Edition; CSHL Press; 2007.
2. Gene Cloning and DNA Analysis: An Introduction" by T.A. Brown
3. Molecular Cloning: A laboratory manual by Joseph Sambrook & David Russell, 3rd edition; CSHL press; 2001.

E. Course outcomes:

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

CO1 explain the steps of gene cloning process and apply in genetic manipulation procedures.

CO2 demonstrate different techniques like electrophoresis, blotting and fingerprinting, DNA microarray used in recombinant DNA technology and various applications.

CO3 design primers and demonstrate and analyse different PCR methods.

CO4 understand and evaluate the strategy of library construction and DNA sequencing .

CO5 demonstrate over-expression and purification recombinant protein.

CO6 interpret interaction between protein-DNA or protein-protein.

Subject Code: BT-3101
Subject Name: Plant Biotechnology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To provide a strong foundation in modern techniques and tools used in plant biotechnology
2. To understand the molecular basis of plant growth, development, and responses
3. To develop hands-on skills in plant tissue culture, genetic transformation, and molecular analysis
4. To explore applications of biotechnology in agriculture, food security, and environmental sustainability

B. Course content:

Introduction to Plant Biotechnology: History and scope, Basic plant cell structure and genome organization, Totipotency.
Plant Tissue Culture: Nutritional media, Callus culture, Somatic embryogenesis, Micropropagation, Protoplast isolation and fusion
Genetic Engineering in Plants: Agrobacterium-mediated transformation, Biolistics, Selection markers, Reporter genes
Genomics and Molecular Markers: Genomics in plants, DNA markers (RAPD, RFLP, AFLP, SSR), Marker-assisted selection
Transgenic Plants and Applications: GM crops, Biofortification, Biopesticides, Bioherbicides, Edible vaccines
Plant Biotechnology in Agriculture and Industry: Molecular farming, Stress resistance, Bioreactors, IPR, Biosafety and ethical issues

C. Text books:

1. B. D. Singh – *Plant Biotechnology*
2. S. S. Bhojwani& M. K. Razdan – *Plant Tissue Culture: Theory and Practice*
3. S. B. Primrose & R. Twyman – *Principles of Gene Manipulation and Genomics*
4. C. Neal Stewart Jr. – *Plant Biotechnology and Genetics*
5. A. Slater, N. W. Scott, M. R. Fowler – *Plant Biotechnology: The Genetic Manipulation of Plants*

D. Reference books:

1. Adrian Slater et al. – *Principles of Plant Biotechnology*
2. R. J. Henry – *Practical Plant Biotechnology*
3. O. P. Dhawan – *Plant Tissue Culture and Molecular Markers*
4. James D. Watson et al. – *Recombinant DNA: Genes and Genomes*

A. Course Outcomes:

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

CO1 describe the key concepts and advancements in plant biotechnology.
CO2 explain the role of molecular techniques in plant improvement.
CO3 perform plant tissue culture and molecular biology techniques independently.
CO4 analyze and interpret experimental results related to plant genetic engineering.
CO5 discuss ethical, legal, and societal aspects of plant biotechnology.

Subject Code: BT-2204
Subject Name: Biophysics
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To understand the fundamental physical principles governing biological systems
2. To explore the structure and function of biomolecules through physical methods
3. To analyze physiological processes using models from physics
4. To gain practical experience with instrumentation and experimental methods in biophysics

B. Course content:

Introduction to Biophysics: Definition, scope, historical background, relevance to engineering

Molecular Biophysics and Molecular Interactions: Bonding, thermodynamics, kinetics in biomolecules, Forces in biology: van der Waals, hydrogen bonding, electrostatics

Enzyme Biophysics and Membrane Biophysics: Enzyme kinetics, thermodynamics of enzyme action, Lipid bilayers, membrane potentials, ion channels.

Biomechanics and Bioelectricity: Mechanical properties of cells, muscle contraction, biopolymers. Nerve impulses, action potentials,

Biophysical techniques and applications: X-ray Chrystallography, NMR, Electron Microscopy, MS. Molecular Modelling and simulation

C. Text books:

1. Cotterill, R. *Biophysics: An Introduction*. Wiley.
2. Nelson, P. *Biological Physics: Energy, Information, Life*. W. H. Freeman.
3. Alberts, B. et al. *Molecular Biology of the Cell*. Garland Science.

D. Reference books:

1. Glaser, R. *Biophysics: An Introduction*. Springer.
2. Tuszynski, J. A., & Dixon, J. M. *Biomedical Applications of Biophysics*. CRC Press.
3. Weiss, T. F. *Cellular Biophysics*. MIT Press.
4. Voet, D., Voet, J. G., & Pratt, C. W. *Fundamentals of Biochemistry*. Wiley.

C. Course Outcomes:

Upon completion, students will be able to:

CO1: apply physical principles to understand and analyze biological systems.

CO2: explain the structure and behavior of biomolecules using theoretical and experimental approaches.
CO3: operate modern biophysical instruments and interpret the data to investigate biological processes.
CO4: develop mathematical and computational models to simulate physiological phenomena.
CO5: demonstrate skills in experimental design and data analysis in a biophysics laboratory setting.
CO6: critically evaluate recent advances in biophysical research and its application in biotechnology and medicine.

Subject Code: BT-220A
Subject Name: Biothermodynamics
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To understand the principles of classical thermodynamics and their relevance to biological systems
2. To evaluate how thermodynamic laws govern energy transformations and molecular processes in living organisms
3. To analyze biological reactions, protein folding, enzyme activity, and transport phenomena using thermodynamic models
4. To develop competency in applying thermodynamic tools for evaluating and optimizing biochemical processes

B. Course content:

Introduction to Thermodynamics: Concepts of Energy and Energy Transfer, First Law of Thermodynamics, Entropy and Disorder in Biological Systems

Second & Third Law of Thermodynamics: Gibbs Free Energy, Thermodynamic equations for mass, energy, and entropy in closed and open systems, Interrelation of thermodynamic properties (ideal and real gases, equations of state), Steam tables, thermodynamic properties of mixtures, Gibbs phase rule

Biothermodynamics: Heat generation and energy dissipation in cell growth, Thermodynamic prediction of kinetic parameters (yield coefficients, growth rate, affinity constants),Metabolic heat production, Gibbs energy dissipation in aerobic, fermentative, and autotrophic systems, Biocalorimetry and its applications

Thermodynamics of Metabolism: Theoretical product yields, alkali consumption, osmotic stress, ionic strength, ATP synthesis, thermodynamic feasibility analysis of metabolic pathways

C. Text books:

1. Alberty, R. A. – *Thermodynamics of Biochemical Reactions*, Wiley
2. Voet, D. &Voet, J. G. – *Biochemistry*, Wiley (for biological context)
3. Nelson, D. L., & Cox, M. M. – *Lehninger Principles of Biochemistry*, W.H. Freeman
4. Atkins, P. & de Paula, J. – *Physical Chemistry for the Life Sciences*, Oxford University Press

D. Reference books:

1. Nicholls, D. G., & Ferguson, S. J. – *Bioenergetics 4*, Academic Press
2. Schnell, S. – *Thermodynamics in Biology*, CRC Press
3. Haynie, D. T. – *Biological Thermodynamics*, Cambridge University Press
4. Peters, M. S., &Timmerhaus, K. D. – *Plant Design and Economics for Chemical Engineers* (for process applications)

E. Course Outcomes:

CO1: Explain fundamental thermodynamic principles including energy transfer, entropy, and the laws of thermodynamics.
CO2: Apply thermodynamic concepts to estimate properties in biological and chemical systems using real and ideal models.
CO3: Analyze thermodynamic behavior of biological processes such as microbial growth and metabolism.
CO4: Evaluate metabolic efficiency and energy dissipation using models and Gibbs free energy.
CO5: Assess metabolic pathways and process yields thermodynamically for biotechnological optimization.
CO6: Utilize tools like biocalorimetry to measure and enhance biological process efficiency.

Subject Code: BT-320B
Subject Name: Industrial Biotechnology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives

1. To provide an understanding of the role of biotechnology in industrial processes.
2. To introduce microbial and enzymatic systems in large-scale bioprocessing.
3. To explore the development and optimization of bioproducts including enzymes, antibiotics, biofuels, and organic acids.
4. To explore the production and uses of primary and secondary metabolites for industrial purposes
5. To learn the various downstream processing techniques and purification methods of bioproducts for industrial uses.

A. Course Content

Introduction to Industrial Biotechnology: Scope and importance of industrial biotechnology; comparison with traditional chemical processes; microbial diversity in industry; selection and improvement of industrial strains.

Industrial Microorganisms and Enzymes: Screening and selection of industrial microorganisms; genetic and metabolic manipulation for enhanced production; production, recovery, and applications of industrial enzymes; amylases, proteases, cellulases, and lipases.

Production of Primary and Secondary Metabolites: Production processes for alcohols (ethanol, butanol), organic acids (citric, lactic), amino acids (glutamic acid, lysine), and vitamins. Antibiotic production (penicillin, streptomycin); factors influencing secondary metabolism; strategies for yield improvement.

Case studies, regulatory and safety considerations in industrial biotechnology.

C. Textbooks

1. Industrial Microbiology – L.E. Casida
2. Principles of Fermentation Technology – P.F. Stanbury, A. Whitaker
3. Industrial Biotechnology – Wulf Crueger and Anneliese Crueger

D. Reference Books

1. Bioprocess Engineering: Basic Concepts – Michael L. Shuler and Fikret Kargi
2. Biotechnology – B.D. Singh
3. Biochemical Engineering – James E. Bailey and David F. Ollis

E. Course Outcomes

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

CO1	explain the role and importance of biotechnology in industrial production.
CO2	have clear concept on role of microbes and enzymes for industrial use and be able to apply their concept on selection and manipulation of industrial microbes for enhanced productivity.
CO3	understand the importance of primary and secondary metabolites and have the curiosity to invest their ideas on improvement of yield and quality.
CO4	apply downstream processing techniques for product recovery and purification.
CO5	analyse current innovations and challenges in industrial biotechnology applications

BT2205:-MINOR PROJECT

Subject Code: BT-2206
Subject Name: Immunotechnology Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. To provide practical knowledge of basic and advanced immunological techniques.
2. To understand antigen-antibody interactions in various assay formats.
3. To apply immunological methods for disease diagnosis and research.

B. Course content:

1. Preparation of Buffers and Reagents used in Immunological Techniques
2. Assays based on agglutination reactions - Blood typing
3. Separation of Serum from Blood
4. Ouchterlony Double Immunodiffusion Assay
5. Enzyme-Linked Immunosorbent Assay (ELISA) – Direct and Sandwich Format
6. Demonstration of Lateral Flow Assay
7. Western blotting-demonstration

C. Text books

1. Kuby Immunology- Jenni Punt, Sharon Stranford, Patricia Jones, Judy Owen, 4^{th}/7^{th} edition.
2. Manual of Clinical Laboratory Immunology by Noel R. Rose (Author), Herman Friedman (Author), John L. Fahey (Editor).

D. Reference books

1. Practical Immunology by Frank C. Hay (Author), Olwyn M. R. Westwood (Author)
2. Handbook for Practicals in Immunology, Editor: H. Mahmutefendić. The University of Rijeka, Faculty of Medicine, 2014. (e-edition), 2015 (printed edition).

E. Course Outcomes:

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

CO1: perform and interpret results of common immunological assays.
CO2: understand the principles behind antibody-based diagnostics.
CO3: analyse the importance of immunological techniques in disease detection and therapeutic development.

Subject Code: BT-2207
Subject Name: Recombinant DNA Technology Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course objectives:

1. To acquire skills in isolating genomic DNA and visualizing in agarose gel electrophoresis
2. To demonstrate competent cells preparation, a critical step in recombinant DNA technology
3. To understand the principle and hands-on training on thermal cycler
4. To understand and execute the fundamental steps and cycles of DNA cloning
5. To interpret positive and negative clones from LB agar antibiotic plates

B. Course content:

1. Genomic DNA isolation and visualization using Agarose Gel Electrophoresis
2. Polymerase Chain Reaction of DNA using Thermal Cycler
3. Preparation of competent cells from bacteria
4. Plasmid isolation from bacterial cells
5. Restriction digestion of DNA using restriction enzymes
6. Ligation of recombinant gene into plasmid
7. Transformation of bacteria
8. Screening of colonies in LB agar plates

C. Text books:

1. Principles of Gene Manipulation and Genomics" by Primrose and Twyman
2. Molecular Biology by David P. Clarke, 1st edition; Elsevier Academic Press; 2005.
3. DNA Technology: The Awesome Skill by I. Edward Alcamo, 2nd edition; Hardcourt Academic Press; 2001.

D. Reference books:

1. Molecular Biology of the Gene by James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine & Richard Losick , 6th Edition; CSHL Press; 2007.
2. Gene Cloning and DNA Analysis: An Introduction" by T.A. Brown.
3. Molecular Cloning: A laboratory manual by Joseph Sambrook & David Russell, 3rd edition; CSHL press; 2001.

F. Course outcomes:

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

CO1 isolate genomic DNA from bacterial cells and independently run agarose gel electrophoresis to visualize the DNA

CO2 apply the concept of PCR and operate thermal cycler for amplification of DNA

CO3 demonstrate the preparation of competent cells from bacteria. They will also understand the importance of gentle handle and operation of pipette to make viable competent cells.

CO4 explain and demonstrate the steps and cycle involved in gene cloning such as plasmid isolation, restriction digestion, ligation and transformation.

CO5 analyze and evaluate results from bacterial colonies and identify positive and negative clones.

Subject Code:BT-3108
Subject Name: Plant Tissue Culture Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course objectives:

1. To provide hands-on training in fundamental techniques of plant tissue culture
2. To understand aseptic techniques and media preparation for in vitro plant propagation
3. To explore the applications of plant tissue culture in micropropagation, genetic modification, and secondary metabolite production
4. To train students in the maintenance and handling of plant culture systems under controlled conditions

B. Course content:

Laboratory Setup and Aseptic Techniques: Introduction to plant tissue culture lab infrastructure, Sterilization techniques (autoclaving, filtration, alcohol), Preparation and sterilization of culture media (MS medium)

Culture Initiation and Callus Induction: Surface sterilization of explants (leaf, stem, node), Inoculation and incubation, Observation of callus formation

Micropropagation and Shoot Multiplication: Subculturing of callus for shoot induction, Use of plant growth regulators (auxins and cytokinins), Clonal propagation techniques

Somatic Embryogenesis and Organogenesis: Somatic embryo induction, Shoot and root formation, Regeneration from non-meristematic tissues

Protoplast Isolation and Fusion: Enzymatic digestion for protoplast extraction, Viability testing using fluorescent dyes, Protoplast fusion demonstration

Hardening and Acclimatization: Transfer of plantlets to soil, Acclimatization in greenhouse or controlled environments, Monitoring survival and growth

C. Text books:

1. Bhojwani, S. S., &Razdan, M. K. – *Plant Tissue Culture: Theory and Practice*
2. Smith, R. H. – *Plant Tissue Culture: Techniques and Experiments*
3. Reinert, J., & Yeoman, M. – *Plant Cell and Tissue Culture: A Laboratory Manual*

D. Reference books:

1. George, E. F., Hall, M. A., & De Klerk, G.-J. – *Plant Propagation by Tissue Culture*
2. Thorpe, T. A. – *In Vitro Culture of Higher Plants*
3. Trigiano, R. N., &Gray, D. J. – *Plant Tissue Culture, Development, and Biotechnology*
4. Kartha, K. K. – *Cryopreservation of Plant Cells and Organs*

A. Course Outcomes:

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

CO1 demonstrate proficiency in aseptic techniques and media preparation for plant tissue culture.
CO2 initiate and maintain callus and organogenic cultures from different explants.
CO3 carry out micropropagation and understand its commercial relevance.
CO4 perform protoplast isolation and evaluate its viability.
CO5 understand the acclimatization process and transfer of in vitro grown plantlets to natural conditions.
CO6 appreciate the use of plant tissue culture for research and industrial applications such as genetic transformation and secondary metabolite production.

SKILLED DEVELOPMENT COURSE (INTERSHIP)-02

Vth Semester

Course Code	Subject Category	Course Title	L	T	P	C
BT-3101	MA24-DSC12	Biochemical Engineering	3	0	0	3
BT-3102	MA25-DSC13	Computational Biology and Bioinformatics	3	0	0	3
BT-3103	ELE2-DSE2	Analytical Biotechnology	3	0	0	3
CS-210A	ELE2-DSE2	Computer organization and architecture				
BT-310X	**OE**	**OE1*** (Microbes in Human Health)	3	0	0	3
MH3101	SM16-ESA12	Entrepreneur essential and early stage start up	3	0	0	3
BT-3104	AP2-01-AECC-1	Internship-I	0	0	2	1
BT-3105	MA26-LAB7	Biochemical Engineering Laboratory	0	0	2	1
BT-3106	MA27-LAB8	Computational Biology and Bioinformatics laboratory	0	0	2	1
BT-3107	ELE3-LAB9	Analytical Biotechnology Laboratory	0	0	2	1
CS-2103	ELE3-LAB9	Computer organization and architecture laboratory				
BT-3108	AP2-02 SECC5	Skilled development course (Internship)-03	0	0	2	1
BT-3109	HONS1	Secondary metabolite in plants				3*
		Contact Hours	15	0	10	
		Total Credits				20

	Total Credits with Honours		23*

Subject Code: BT-3201
Subject Name: Biochemical Engineering
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To understand the fundamental principles of biochemical processes and their engineering aspects.
2. To study bioreactor design and scaling principles for microbial and enzymatic systems.
3. To explore the kinetics of cell growth, substrate utilization, and product formation.
4. To introduce downstream processing techniques.

B. Course contents:

Introduction to Biochemical Engineering- Overview of biochemical engineering and its role in industry. Historical development of fermentation technology. Microbial culture requirements, media composition (molasses, CSL, whey, synthetic media), and sterilization methods. Isolation and maintenance of industrial microorganisms.

Microbial Growth and Kinetics-Kinetics of microbial growth, product formation (primary/secondary metabolites). Substrate utilization kinetics, death kinetics, and growth models (Monod model, etc.). Inoculum development and aseptic operations. Introduction to metabolic flux and pathway analysis.

Bioreactor Engineering- Design and construction of bioreactors and ancillary systems. Bioreactor types: batch, fed-batch, continuous, CSTR, PFR, air-lift, fluidized bed, and photo-bioreactors. Fermentation parameters: pH, temperature, DO, foam control, agitation and aeration. Control strategies and instrumentation in bioprocessing.

Transport Phenomena and Scale-Up- Heat and mass transfer in bioreactors (oxygen transfer, mixing, rheology). Scale-up principles: geometric, kLa, power, and mixing-time based. Residence Time Distribution (RTD), concentration and temperature gradients. Bioreactors with microbial flocs and biofilms.

Industrial Bioprocesses and Downstream Processing- Production processes: ethanol, citric acid, penicillin, enzymes (amylase, protease), vitamins (e.g., B12), vaccines, and steroids.

B. Text Books:

1. Microbes & Fermentation, A. Lel and Kotlers Richard J. Mickey, Oriffin Publication
2. Industrial Fermentations- Leland, N. Y. Chemical Publishers

3. Biochemical Engineering Fundamentals by James E. Bailey and David F. Ollis second edition.
4. H. W. Blanch and D. S. Clark, Biochemical Engineering, Marcel Dekker, 1996.

D. Reference Books:

1. Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA. Okafor N. (2007).

2. Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001).

3. Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company Glaze A.N. and Nikaido H. (1995).

E. Course Outcomes:

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

CO1	understand biochemical processes, microbial kinetics, and their industrial relevance.
CO2	analyze bioreactor configurations and scale-up criteria used in industrial bioprocesses.
CO3	evaluate the kinetics of cell growth, substrate consumption, and product formation.
CO4	apply engineering principles to fermentation process design and operation.
CO5	examine downstream processing methods.

Subject Code: BT-3102
Subject Name: Computational Biology and Bioinformatics
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To introduce the theoretical foundations of bioinformatics and computational biology.
2. To understand the basic computational tools and programs with relevance to bioinformatics
3. To know various algorithms and their use in sequence analysis, databases search and phylogenetic tree construction
4. To utilize public biological databases and tools for data retrieval, sequence alignment and homology modelling

B. Course Content:

Introduction to Bioinformatics and Computational Biology: Definition, scope, and interdisciplinary nature. Historical development and milestones. Applications in genomics, proteomics, drug design, and systems biology.

Computational Tools and Programming: Introduction to Python and R. BioPython and BioConductor. Sequence parsing and file handling. Basic data visualization and statistics. Overview of machine learning in bioinformatics.

Biocomputing and sequence analysis: Introduction to String Matching Algorithms, Graph matching algorithms, Database Search Techniques, types of databases. Tools for sequence retrieval: Entrez, BLAST interface. Sequence formats: FASTA, GenBank, and PDB. Sequence Comparison and Alignment Technique: Global vs. local alignment. Dynamic programming algorithms: Needleman-Wunsch, Smith-Waterman. Heuristic methods: BLAST, FASTA. Multiple sequence alignment: ClustalW, MUSCLE. Scoring matrices: PAM, BLOSUM. Phylogenetic tree basics: UPGMA, Neighbor-Joining. Applications in Automated genome comparison, gene prediction.

Homology modelling and Molecular dynamics: Levels of protein structure. Homology modelling and structure refinement: SWISS-MODEL, MODELLER. Structure visualization: PyMOL, Chimera. Molecular docking basics. Brief introduction to molecular dynamics (GROMACS overview). Applications of homology modelling and molecular dynamics.

C. Text books:

1. Bioinformatics: Sequence and Genome Analysis – David W. Mount
2. Introduction to Bioinformatics – Arthur Lesk
3. Fundamentals of Bioinformatics and Computational Biology – Gautam B. Singh

D. Reference Books:

1. Biological Sequence Analysis – Richard Durbin et al.
2. An Introduction to Computational Systems Biology – Karthik Raman
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins – Andreas D. Baxevanis & B. F. Francis Ouellette

E. Course Outcomes:

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

CO1 understand the role and scope of computational biology and bioinformatics in modern biotechnology.
CO2 apply their programming knowledge to develop bioinformatics tools.
CO3 have clear concept behind sequence alignment, database search and phylogenetic tree construction and they will be able to apply their concept on improving the existing algorithms.
CO4 understand the concept of genome and gene sequences prediction and they will enjoy the use of bioinformatics tools in biological research.
CO5 apply their bioinformatics skills to solve real-world problems in diagnostics, drug design, and synthetic biology.

Subject Code: BT-3103
Subject Name: Analytical Biotechnology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To introduce fundamental principles and applications of analytical techniques in biotechnology.
2. To provide hands-on experience with modern analytical instruments used in biological research.
3. To develop skills in data interpretation and troubleshooting of analytical methods.
4. To understand the role of analytical techniques in diagnostics, therapeutics, and bioprocessing.

B. Course content:

Fundamentals of Analytical Techniques: Understanding accuracy, precision, sensitivity, specificity, limit of detection (LOD), and limit of quantification (LOQ). Emphasis on calibration methods, standard curve preparation, and method validation in accordance with regulatory standards.

Spectroscopic Methods: UV-Visible spectroscopy, fluorescence spectroscopy, infrared (IR) spectroscopy, and circular dichroism (CD) for analyzing biomolecules.

Chromatographic Techniques: Study of paper chromatography, thin-layer chromatography (TLC), ion-exchange chromatography, gel filtration chromatography, affinity chromatography, high-performance liquid chromatography (HPLC), and gas chromatography (GC) for separation and analysis of biomolecules.

Electrophoresis and Centrifugation: Principles and applications of agarose gel electrophoresis, SDS-PAGE, isoelectric focusing, and two-dimensional electrophoresis for nucleic acid and protein analysis. Overview of centrifugation techniques, including differential and density gradient centrifugation, for subcellular fractionation.

Advanced Analytical Techniques: Introduction to mass spectrometry (e.g., MALDI-TOF, ESI) and nuclear magnetic resonance (NMR) spectroscopy for biomolecular characterization. Basics of X-ray crystallography for structural analysis. Discussion on biosensors, enzyme-linked immunosorbent assay (ELISA), flow cytometry, and real-time PCR in biotechnology applications. Atomic absorption spectroscopy (AAS).

C. Text books:

1. Wilson, K., & Walker, J. *Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge University Press.

2. Skoog, D. A., West, D. M., & Holler, F. J. *Fundamentals of Analytical Chemistry*. Cengage Learning.

D. Reference books:

1. Meyer, V. R. *Practical High-Performance Liquid Chromatography*. Wiley.

2. Robyt, J. F., & White, B. J. *Biochemical Techniques: Theory and Practice*. Waveland Press.
3. Gupta, P. K. *Elements of Biotechnology*. Rastogi Publications.

E. Course outcomes:

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

CO1 comprehend the fundamental principles of various analytical techniques used in biotechnology.

CO2 apply spectroscopic and chromatographic methods for the qualitative and quantitative analysis of biomolecules.

CO3 utilize electrophoretic and centrifugation techniques for the separation and analysis of biological samples.

CO4 interpret data obtained from advanced analytical instruments such as mass spectrometers and NMR spectrometers.

CO5 Integrate analytical techniques in the development and optimization of biotechnological processes and products.

Subject Code: CS-210A
Subject Name: Computer Organization & Architecture
Credit Point: 3 **(**L=3, T=0, P=0)

A. ***Course Objectives:***

1. To understand the structure, function and characteristics of computer systems.
2. To understand the design of the various functional units and components of computers.
3. To identify the elements of modern instructions sets and their impact on processor design.
4. To explain the function of each element of a memory hierarchy,
5. To identify and compare different methods for computer I/O.

B. ***Course Content:***

Fundamentals of Computers: Digital computers, layers in computer system, types of computers, history of computers

Data representation and computer arithmetic: Data types, complement, fixed point representation, floating point representation, multiplication and division of sign and unsigned integers.

Micro operation and design of arithmetic logic unit: Register transfer micro operation, bus transfer, memory transfer, arithmetic micro operation, logic micro operation, logic unit, shift unit, design of arithmetic and logic unit.

Instruction set: Instruction code, register, computer instruction, timing and control, instruction cycle, instruction formats, CPU organization, instruction length, addressing standard, addressing mode, instruction set, RISC, CISC.
Design of control unit: hardware control design, micro programmed control.

Memory organization: memory hierarchy, main memory, cache memory, virtual memory.

Input-output organization: peripheral device, I/O interface and I/O driver, synchronous and asynchronous data transfer, modes of data transfer, priority interrupt, DMA, input- output processor.
Parallel processing: performance measurement of computer, parallel computer structure, general classification of computer architecture, pipelining, vector processing, multiprocessor system, flow computers.
Introduction to Microprocessor: Microcomputer structure and operation, 8086 microprocessor family, Overview, Architecture of processor 8085 and 8086.

C. ***Text Books:***

1. W. Stallings, Computer Organization and Architecture: Designing for Performance,
   Pearson Education India, 2019.
2. A. Patterson and J. L. Hennessy, Computer Organization and Design, Morgan Kaufmann, 2013.
3. S. Tanenbaum, Structured Computer Organization, 5th Ed., Prentice Hall of India, 2013.

D. ***Reference Books:***

1. C. Hamacher, Z. Vranesic, Computer Organisation‖, Tata Mcgraw Hill, 2011.
2. M. Jain, S.Jain, V. Pillai, Computer Organization and System Software, BPB Publications, 2003.
3. P. Pal Chaudhuri, Computer Organisation & Design, PHI Learning Private Ltd., 2009.

E. ***Course Outcomes:***

1. Identify various components of computer and their interconnection
2. Identify basic components and design of the CPU: the ALU and control unit.
3. Compare and select various Memory devices as per requirement.
4. Compare various types of IO mapping techniques
5. Critique the performance issues of cache memory and virtual memory

Subject Code: BT-310X
Subject Name: Microbes in Human Health
Credit Point: 3(L=3,T=0, P=0)

A. Course Objectives

1. To comprehend the diversity and ecological roles of microbes in human health.
2. To analyse the molecular basis of microbial pathogenesis and host-microbe interactions.
3. To explore the application of microbes in therapeutics, probiotics, and personalized medicine.
4. To evaluate emerging microbial challenges and devise innovative biotechnological solutions.

B. Course Content

Introduction to Microbes and Human Health

Overview of microbial diversity: Bacteria, viruses, fungi, and protozoa. Human microbiome: Composition, establishment, and role in health (gut, skin, oral). Beneficial vs. pathogenic microbes: Symbiosis, commensalism,

and opportunism. Historical perspectives: Koch's postulates, germ theory, and modern microbiology.

Microbial Pathogenesis

Mechanisms of microbial virulence: Adhesion, invasion, toxin production, and immune evasion. Pathogenic bacteria (e.g., *Mycobacterium tuberculosis*, *Staphylococcus aureus*). Viral pathogenesis (e.g., Influenza, SARS-CoV-2). Fungal and parasitic infections (e.g., *Candida albicans*, *Plasmodium falciparum*). Case studies: Antibiotic resistance and superbugs (MRSA, VRE).

Host-Microbe Interactions

Innate and adaptive immune responses to microbial infections. Role of microbiota in immune system development and homeostasis. Dysbiosis and its link to diseases (e.g., inflammatory bowel disease, obesity). Microbial manipulation of host signalling pathways.

Beneficial Microbes and Applications

Probiotics and prebiotics: Mechanisms and health benefits (*Lactobacillus*, *Bifidobacterium*). Microbial production of therapeutics: Antibiotics, vaccines, and biologics. Fermented foods and their role in nutrition and gut health.

C. Text Books

2. Nelson, D. L., & Cox, M. M. (2017). *Lehninger Principles of Biochemistry* (7th ed.). W.H. Freeman.
3. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2019). *Microbiology* (Tata McGraw-Hill).
4. Madigan, M. T., et al. (2021). *Brock Biology of Microorganisms* (16th ed.). Pearson Education.

D. Reference Books

2. Prescott, L. M., Harley, J. P., & Klein, D. A. (2020). *Microbiology* (10th ed.). McGraw-Hill Education.
3. Turnbaugh, P. J., & Gordon, J. I. (2019). *The Human Microbiome: Advances and Challenges*. Springer.
4. Wilson, M. (2019). *Bacteriology of Humans: An Ecological Perspective*. Wiley-Blackwell.

E. Course Outcomes:

CO1	Students will understand microbial diversity and their critical role in human health
CO2	Students will be able to explain the interplay between microbial pathogenesis and host immunity
CO3	Students will be able to apply laboratory techniques to study microbial interactions
CO4	Students will be able to evaluate the biotechnological potential of microbes in health applications
CO5	Students will be able to design innovative solutions to address microbial health challenges

Subject Code: MH-3101
Subject Name: Entrepreneur Essential and Early-stage Start-up
Credit Point: 3 (L=3, T=0, P=0)

A. ***Course Objectives:***

The course is designed to meet the objectives of:

1. To involve themselves in the business activities
2. Starting innovative practices in their entrepreneurial activities.
3. Developing theirs kills on the traits that they want to carry forward.

B. ***Course Content:***

Introduction to Entrepreneurship Meaning, Role of Entrepreneur, Entrepreneur Process: different approaches, Qualities of successful Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur, Issues & Problems Entrepreneurial Practices, Motivation for becoming an Entrepreneur. SME Concept, its role, status, prospects and policies for promotion of SMEs. Importance of Entrepreneurship: innovations, Qualities of successful Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneurs, Issues &Problems Entrepreneurial Practices. Identifying and Assessing the Idea, Identifying Target Segment & Market Sizing, Analysing Environment & Competitive Advantage, Choosing the right legal structure, Permits, Registrations & Compliances, Components of a Business Plan, Creating an Effective B-Plan Part, Valuation, Investor pitch. Importance of Entrepreneurship: Entrepreneurship and Innovations, Converting Innovation to Economic Value which includes, Growth Strategies, value position, Market Segments, Value Chain Structure, Revenue Model, Contribution of Entrepreneurs: Towards R&D, creates Wealth of Nation & Self prospect with Challenge. Characteristics of Entrepreneurship idea generation techniques, Business plan, Strategic Plan etc.

C. ***Text Books:***

1. Donald F. Kuratko, Entrepreneurship: Theory, Process, Practice Cengage Learning 2017
2. Desai, Vasant, Small Scale Industries and Entrepreneurship. Himalaya Publishing House, Delhi.2008
3. Kaulgud, Aruna Entrepreneurship Management. Vikas Publishing House, Delhi.2003
4. Cynthia, L. Greene. Entrepreneurship Ideas in Action. Thomson Asia Pvt. Ltd., Singapore. 2004

D. ***Reference Books:***

1. Barringer Entrepreneurship: Successfully Launching New Ventures, Pearson Education Publishing 2015
2. Timmons, Jerry A., and Spinelli, Stephen, New Venture Creation: Entrepreneurship for the 21st Century, 8th Edition, Boston, MA: Irwin McGraw-Hill 2009.
3. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001

E. ***Programme Outcomes:***

1. Start the venture more scientifically.
2. Start the venture by linking with the financial institutions.
3. Seeking for a start-up idea
4. To be an entrepreneurs

BT-3104:-INTERNSHIP-1

Subject Code: BT-3105

Subject Name: Biochemical Engineering Laboratory

Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

1. To provide hands-on training on techniques used in microbial cultivation and bioprocess operations.
2. To conduct experimental determination of microbial growth kinetics and analysis of fermentation parameters.
3. To provide training on product purification using chromatography.

B. List of Laboratory Experiments:

1. Optimization of Microbial Culture Media
2. Growth Kinetics Study – Determination of specific growth rate (μ), generation time, and growth curve plotting.
3. Effect of pH and Temperature on Microbial Growth – Optimizing environmental parameters for maximal biomass.
4. Centrifugation and cell disruption methods.
5. Cell immobilization technique
6. Demonstration of fermenter

C. Text Books

1. J. E. Bailey and D. F. Ollis. Biochemical Engineering Fundamentals, 2nd Edition, New York, McGraw Hill, 1986.
2. H. W. Blanch and D. S. Clark, Biochemical Engineering, Marcel Dekker, 1996.
3. Najafpour, Ghasem. Biochemical engineering and biotechnology. Elsevier, 2015.

D. Reference Books

1. Levenspiel O, Chemical Reaction Engineering, Wiley India Pvt Ltd, 3rd ed., 2007
2. Endo WB, Enfors SO, Fiechter A, Hoare M, Mattiasson B, Sahm H, Schiigerl K, Stephanopoulos G, yon Stockar U. Advances in biochemical engineering/biotechnology. Springer; 2009.

E. Course Outcomes (COs):

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

CO1 perform microbial cultivation, sterilization, and aseptic operations effectively.
CO2 analyze microbial growth and substrate utilization kinetics through experimental data.
CO3 acquire knowledge on purification of bioproducts.
CO4 examine preparation of different fermented products.
CO5 interpret bioprocess data and correlate experimental outcomes with theoretical models.

Subject Code: BT-3106
Subject Name: Computational Biology and Bioinformatics laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course objectives:

B. To critically explore biological databases for use in learning and research
C. To understand how to retrieve gene sequence from chromatogram files and convert to acceptable formats
D. To apply sequence alignment and phylogenetic tools
E. To analyse and interpret gene and domain function using various tools
F. To understand how to predict protein structure and visualise using bioinformatic tools
G. To utilize tools used for docking studies
H. To practice basic scripting for bioinformatics such as Python/Perl.

B. Course content:

1. **Exploration of Biological Databases**
   Access and retrieve data from primary and secondary databases such as GenBank, UniProt, and Pfam.
2. **Gene Sequence Processing and Annotation**
   Open chromatogram files, extract FASTA sequences, annotate ORFs, and convert sequence formats.
3. **Sequence Alignment and Phylogenetic Analysis**
   Perform pairwise and multiple sequence alignments using BLAST, EMBOSS Needle, and Clustal Omega; construct phylogenetic trees using MEGA or Phylogeny.fr.
4. **Gene Function and Domain Analysis**
   Identify ORFs, translate in six frames, and detect conserved domains using NCBI CDD and InterProScan.
5. **Protein Structure Prediction and Visualization**
   Model protein structures using SWISS-MODEL and analyze them using PyMOL and validation tools.
6. **Molecular Docking and Drug Interaction Study**
   Carry out basic docking using AutoDock or SwissDock and interpret ligand binding.
7. **Basic Scripting in Bioinformatics**
   Write and execute simple Python/Perl scripts for sequence parsing, format conversion, and data filtering.

C. Text books:

1. Bioinformatics: Sequence and Genome Analysis – David W. Mount
2. Introduction to Bioinformatics – Arthur Lesk
3. Fundamentals of Bioinformatics and Computational Biology – Gautam B. Singh

D. Reference Books:

1. Biological Sequence Analysis – Richard Durbin et al.
2. An Introduction to Computational Systems Biology – Karthik Raman
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins – Andreas D. Baxevanis & B. F. Francis Ouellette

E. Course Outcomes

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

CO1: Explain key concepts and applications of computational biology and bioinformatics.

CO2: Retrieve, process, and analyze biological data using public databases and standard tools.

CO3: Perform sequence alignment, phylogenetic analysis, and functional annotation.

CO4: Predict and visualize biomolecular structures and perform basic molecular docking.

CO5: Develop and apply simple scripts for biological data analysis using Python or Perl.

Subject Code: BT-3107
Subject Name: Analytical Biotechnology Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

1. To provide hands-on training in techniques for qualitative and quantitative analysis of biomolecules.
2. To enable students to use advanced instruments in biotechnology for analytical purposes.
3. To develop data interpretation skills relevant to analytical tools used in biotechnology and bioengineering.

B. Course content:

1. Estimation of DNA concentration and purity using UV-Vis spectrophotometry
2. Separation of biomolecules by agarose gel electrophoresis and SDS-PAGE
3. Chromatographic separation of amino acids or plant pigments by thin-layer chromatography (TLC)
4. Analysis of a mixture of compounds using paper or column chromatography
5. Demonstration of high end equipments used in biotechnology

C. Text books:

1. Principles & Techniques of Biochemistry & Molecular Biology by Keith Wilson & John Walker.
2. Laemmli UK (1970), Cleavage of structural proteins during the assembly of the head of bacteriophage T4, Nature 227, 680–685.

D. Reference books:

1. S. B. Primrose & R. Twyman – *Principles of Gene Manipulation and Genomics*

C. Course Outcomes:

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

- CO1: Accurately quantify nucleic acids and proteins using spectroscopic methods.
- CO2: Separate and analyse biomolecules using electrophoresis and chromatography.
- CO3: Operate basic analytical instruments and understand their principles.
- CO4: Interpret data and troubleshoot common issues in analytical biotechnology workflows.

Subject Code: CS-2103
Subject Name: Computer Organization & Architecture Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. ***Course Objectives:***

1. Learn and understand the basics of Hardware description language and its use in designing electronic circuits.
2. This course deals with programming using Verilog for advanced digital design techniques.
3. Introduces students to gate, dataflow (RTL), behavioural, and switch level modelling.

B. ***Lab Content:***

Write a Verilog code to implement S-R flipflop and also implement the testbench to verify the outputs.

1. Write a Verilog code to implement D- latch and also implement the testbench to verify the outputs.
2. Write a Verilog code to implement D- latch with reset asynchronous and also implement the testbench to verify the outputs.
3. Write a Verilog code to implement D- latch with reset synchronous and also implement the testbench to verify the outputs.
4. Write a Verilog code to T- flipflop with asynchronous reset and also implement the testbench to verify the outputs.
5. Write a Verilog code to T- flipflop with synchronous reset and also implement the testbench to verify the outputs.
6. Write a Verilog code to implement JK flipflop and also implement the testbench to verify the outputs.
7. Write a Verilog code to implement Counter also implement the testbench to verify the outputs.
8. Write a Verilog code to implement 8-bit Ripple carry adder and also implement the testbench to verify the outputs.
9. Write a Verilog code to design an ALU and also implement

the testbench to verify the outputs.

C. *Reference Books:*

1. Michael D Ciletti, Advanced Digital Design with the VERILOG HDL, PHI, 2010.
2. Palnitkar Samir, Verilog HDL, Pearson Education, 2003.
3. Brown Stephen and Vranesic Zvonko - Fundamentals of Digital Logic with Verilog, TMH, 2013.
4. Z Navabi, Verilog Digital System Design, McGraw Hill, 2005.

D. *Course Outcomes:*

1. Understand the basics of Hardware Description Languages, Program structure and basic language elements of Verilog.
2. Understand types of modelling, modules, functions of Verilog and simulate and synthesize related Programs.
3. Design, Simulate and synthesize various Verilog descriptions for Combinational circuits.
4. Design, Simulate and synthesize various Verilog descriptions for Sequential circuits.

SKILLED DEVELOPMENT COURSE (INTERNSHIP)-03

VIth Semester							
Sl No	**Course Code**	**Subject Category**	**Course Title**	**L**	**T**	**P**	**C**
1	BT-3201	MA28-DSC14	Animal Biotechnology	3	0	0	3
2	BT-3202	MA29-DSC15	Indigenous Technical Knowledge of North East India	3	0	0	3
	CS-2203						
3	BT-3203	ELE4-DSE4	Nanotechnology	3	0	0	3
	CS-320A	ELE4-DSE4	Database Management System				
4	BT-320A	ELE5-DSE5	Enzyme Technology				3
	CS-2203	ELE5-DSE5	Design Analysis of Algorithm				
5	BT-320X	OPEN ELE1	**OE2*** (Biosensors and Biotronics)	3	0	0	3
6	BT-3204	AP2-03VAC5	Minor Project	0	0	4	2
7	BT-3205	MA30-LAB10	Indigenous Technical Knowledge of North East India	0	0	2	1
8	BT-3206	ELE6-LAB11	Nano-Biotechnology Laboratory	0	0	2	1
	CS-3207	ELE6-LAB11	Database Management System				
9	BT-3207	ELE7-LAB12	Enzyme Technology Laboratory	0	0	2	1
	CS-2203	ELE7-LAB12	Design Analysis of Algorithm Laboratory				
10	BT-3208	AP2-04-SECC 6	Skilled development course (internship)-04	0	0	2	1
11		HONS2	Gene Therapy				3*
			Contact Hours	15	1	12	
			Total Credits				21
			Total Credits with Honours				24 *

Subject Code:BT-3201
Subject Name: Animal Biotechnology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives

1. To impart foundational knowledge of animal cell culture techniques and their applications.
2. To explore the development and use of transgenic animals in research and industry.
3. To understand the production and application of biopharmaceuticals derived from animal systems.
4. To discuss ethical, regulatory, and biosafety considerations in animal biotechnology.

B. Course Content

Introduction to Animal Biotechnology: Historical background and scope of animal biotechnology. Overview of animal cell culture: types of culture media (natural and synthetic), serum-based and serum-free media, and growth supplements. Laboratory design, aseptic techniques, and biosafety measures.

Animal Cell Culture Techniques: Primary and secondary cell cultures, establishment and maintenance of continuous cell lines. Anchorage-dependent and suspension cultures. Cell growth kinetics, scaling up of cultures using bioreactors, and cryopreservation methods.

Genetic Manipulation and Transgenic Animals: Methods of gene transfer: microinjection, electroporation, viral vectors, and somatic cell nuclear transfer. Creation and applications of transgenic animals in agriculture and medicine. Knockout and knock-in technologies. Ethical and regulatory aspects of transgenic animal research.

Biopharmaceuticals and Therapeutic Proteins: Production of recombinant proteins, monoclonal antibodies, and vaccines using animal cell systems. Hybridoma technology for monoclonal antibody production. Downstream processing and purification techniques. Quality control and regulatory compliance in biopharmaceutical production.

Applications of animal biotechnology: Stem cell technology and regenerative medicine. Tissue engineering and organ culture. In vitro fertilization and embryo transfer techniques. Applications of animal biotechnology in disease modeling, xenotransplantation, and conservation biology.

C. Textbooks

1. Freshney, R.I. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell.
2. Spier, R.E., & Griffiths, J.B. Animal Cell Biotechnology. Academic Press

D. Reference Books

3. Portner, R. Animal Cell Biotechnology: Methods and Protocols. Humana Press.
4. Mather, J.P., & Roberts, P.E. Introduction to Cell and Tissue Culture: Theory and Technique. Springer.
5. Glick, B.R., & Pasternak, J.J. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.

E. Course Outcomes:

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

CO1 understand the principles and practices of animal cell culture and their applications.

CO2 demonstrate proficiency in techniques for genetic manipulation and the development of transgenic animals.

CO3 analyze the processes involved in the production and purification of biopharmaceuticals using animal cell systems.

CO4 evaluate the ethical, regulatory, and biosafety considerations in animal biotechnology research and applications.

CO5 explore advanced applications of animal biotechnology in medicine, agriculture, and conservation.

Subject Code: BT-3202
Subject Name: Indigenous Technical Knowledge of Northeast India
Credit Point: 3 (L=3,T=0, P=0)

A. Course objectives:

1. To learn about the sustainable agriculture practices in Northeast India
2. To learn about the use of natural resources in crafting, weaving and making of utitilies for daily use
3. To study the different types of fermented food products and the techniques
4. To study the potential of bioresources of Northeast India for use in various applications

C. Course content:

Sustainable agriculture and resource management: Wetland rice cultivation, Jhum cultivation, Zabo system of rice cultivation, bamboo drip irrigation system of agriculture, Traditional mixed cropping, horizontal bamboo cultivation system

Biocrafts and sustainable skills: silk Weaving, bamboo cane and craft, pottery, organic bottles, organic basket making, wood carving, leather and rubber making

Food processing and preservation technology: milk based food products, grain based food products, meat based food products, functional foods: wine/beer making, fermented food products (fish, bean, bamboo shoot etc),

Bioprospecting of NE India: Medicinal plants, biomass resources for biofuel, pesticidal plants, fibre and dye yielding plants, endangered orchids, wild fruits, edible insects, algal wealth, endangered orchids, micromonospora. Challenges of technology transfer.

C. Text books:

1. Bioprospecting of Indigenous Bioresources of North-East India, edited by Jubilee Purkayastha.
2. Diversity of Traditional food in Northeastern Region of India: A Review, 2021 by G.Kadirvel et al., ICAR, Umiam.
3. Traditional knowledge practices of North East India for sustainable agriculture, Journal of Pharmacognosy and Phytochemistry, 2021 by LC De ICAR-NRC for Orchids, Pakyong, Sikkim, India.
3. Diversity of Traditional food in Northeastern Region of India: A Review

D. References:

1. Comparative Studies on the Ethnic Fermented Food Products and its Preservation Methods with Special Focus of North-East India, 2020, Journal of Ecology and Natural resources, by Chandra Nath P and Tiwari A.
2. TRADITIONAL KNOWLEDGE IN NORTH EAST INDIA: A PERFECT CASE FOR SUI GENERIS LEGISLATION, NLUA Journal of Intellectual property rights, July 2022 by Ravindra Singh

E. Course outcomes:

CO1 Students will have exposure to underlying traditional technologies practiced by indigenous people of Northeast India in terms of agriculture and water management systems.

CO2 Students will be able to identify and demonstrate traditional tools and techniques used for artistry, construction and utilities for day to day use.

CO3 Students will discover the rich and unique food processing and preservation techniques. Students will become an ambassador to Northeast delicacies and motivate them to venture into entrepreneurship

CO4 The course will give insight into a broader potential of Northeast technology in terms of applications in medicine, aesthetics, ornaments, food industry etc.

CO5 Students will also learn the cultural entity linked to the traditional technologies and develop an interest in preserving the technologies while it is also blend with modern technologies for its sustainability.

Subject Code: BT-3203
Subject Name: Nano-Biotechnology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To introduce the fundamental concepts of nanoscience, including the unique physical and chemical properties of nanomaterials compared to bulk materials.

2. To familiarize students with various nanoparticle synthesis techniques and their relevance in producing quantum dots, nanocrystalline phases, and surface-functionalized materials.

3. To explain the principles of nanoparticle characterization using modern analytical techniques such as UV-Visible spectroscopy, Fluorescence, XRD, DLS, SEM, AFM, TEM, and EDAX.

4. To explore the interaction of nanoparticles with biological molecules and their integration with natural biomaterials, biopolymers, ceramics, and implantable medical devices.

5. To emphasize the role of nanomaterials in tissue engineering, biosensing, and medical diagnostics, emphasizing their ability to cross biological barriers and function in complex physiological environments.

B. Course content

Fundamentals of Nanoscience and Nanomaterials: Dimensions of nanoscience, Size of bulk versus nanomaterials, Nanoparticle synthesis techniques, Speciality of nanomaterials, Quantum dots and size effect, Classification and properties of nanomaterials, Nanocrystalline phase, Electronic structure of nanoparticles, Physics of small systems & theoretical principles, Effects of surface functionalisation and optical properties, Role of surfaces in nanotechnology devices, Micelles, Colloids Surface active agents, Critical micellar concentration (CMC).

Characterization Techniques for Nanomaterials: Physical characterization of nanoparticles using UV-Visible, Fluorescence Spectrophotometers X-ray diffraction, DLS, Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Transmission Electron Microscope (TEM), EDAX analysis.

Biomaterials and Nanobiotechnology Interfaces: Applications of nanoparticles, Interaction between biomolecules and nanoparticle surface. Natural Biomaterials, Biopolymers & Ceramics, Some nanocomposite biomaterials, teeth and bone substitution, Natural nanocomposite systems as spider silk, bones, shells; Metallic, Ceramic and Polymeric implant materials, Biomaterials in Tissue Engineering, Nanoparticles to cross biology barriers, Biomaterials and device retrieval and analysis, Biomaterials and central nervous system, Biosensors, semi-conductor nanoparticle, CNT.

Nanotechnology in Diagnostics and Therapeutics: Current status of nanobiotechnology, Nanotechnology in Diagnostics applications, Materials used in Diagnostics and Therapeutic application, Anti-bacterial activity, Developing of Nanomedicines, Drug Carriers & Delivery System, Cancer treatment, Probes for bioimaging, Cardiovascular medical devices. Toxicological health effects caused by nanoparticles.

C. Text Books

1. Lindsay, S.M., Introduction to Nanoscience, Oxford University Press (2010).

2. Niemeyer C.M. and Mirkin, C.A., Nanobiotechnology: Concepts, Applications and Perspectives, Wiley-VCH (2004).

3. Balaji, S., Nanobiotechnology, MJP Publishers (2010).

4. Wang, Z.L., Characterization of Nanophase Materials, Wiley-VCH (2000).

D. Reference Books

1. Rao, C.N.R., Muller, A. and Cheetham, A.K., The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. 1&2, Wiley-VCH (2004).

2. Kumar, C.S.S.R., Hormes, J. and Carola, L., Nanofabrication towards biomedical applications, Wiley-VCH (2005).

3. Christof M. Niemeyer, Chad A. Mirkin Nanobiotechnology: Concepts, Applications and Perspectives, Wiley 2004.

E. Course Outcomes:

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

CO1 differentiate between bulk materials and nanomaterials based on size, properties, and behavior at the nanoscale, and understand the underlying principles such as the quantum size effect and surface phenomena.

CO2 understand various nanoparticle synthesis techniques and functionalization methods, and the classification, unique properties of nanomaterials.

CO3 analyze the structural, morphological, and optical properties of nanomaterials using advanced physical characterization tools such as UV-Vis, DLS, XRD, SEM, TEM, AFM, Fluorescence Spectroscopy, and EDAX.

CO4 identify the use of biopolymers, ceramics, and nanocomposites in medical and tissue engineering applications.

CO5 understand current applications of nanotechnology in diagnostics, therapeutics, drug delivery, bioimaging, and medical devices.

Subject Code: CS-320A
Subject Name: Database Management Systems
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. Introduction & Conceptual Modeling
2. Relational Model: Concepts, Constraints, Languages, Design and Programming
3. Database Design Theory and Methodology
4. Data Storage, Indexing, Query Processing and Physical Design
5. Transaction Processing Concepts
6. Database Security and Authorization

B. Course Content:

Introduction & Conceptual Modelling: Database and Database Users, Database System Concepts and Architecture, Data Modelling using ER Model, Enhanced ER Modelling.

Relational Model: Concepts, Constraints, Languages, Design and Programming: Relational Data Model and Relational Database Constraints, Relational Algebra and Relational Calculus, Relational Database Design by ER to & EER to Relational Mapping, SQL: Schema Definition, Basic Constraints, Queries, Assertions, Views and Programming Techniques.

Database Design Theory and Methodology: Functional Dependencies, Normalization, Relational Database Design Algorithms and Other Dependencies, Practical Database Design Methodology.

Data Storage, Indexing, Query Processing and Physical Design: Disk Storage, File Structures, Hashing, Indexing Structures for Files, Algorithms for Query Processing and Optimization, Practical Database Design and Tuning.
Transaction Processing Concepts: Transaction Processing Concepts and Theory, Concurrency Control Techniques, Database Recovery Techniques.

Database Security and Authorization: Database Security Issues, Discretionary Access Control, Mandatory and Role base Access Control, Statistical Database Security.

C. Text Books:

1. Avi Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, McGraw-Hill, 2020.
2. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of DatabaseSystems, Pearson, 2020.
3. Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-Hill, 2019.

D. Reference Books:

1. C.J.Date, An Introduction to Database Systems, Addison-Wesley ongman, 2014.
2. JeffreyD. Ullman, Principles of Database Systems, Galgotia Publication, 1994.
3. Wilfried Lemahieu, Seppe Vanden Broucke, Bart Baesens, Principles of Database

Management, Cambridge University Press, 2020.

E. Course Outcomes:

1. Ability to understand user requirements and develop ER model
2. Ability to map ER model into Relational model
3. Ability to normalize Relational model
4. Ability to implement Relational model using DBMS software
Ability to understand Transactions, Recovery

Subject Code: BT-320A
Subject Name: Enzyme Technology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives

1. To provide an in-depth understanding of enzyme structure, function, and kinetics.
2. To explore various enzyme immobilization techniques and their industrial applications.
3. To study the production, purification, and characterization of enzymes.
4. To examine the role of enzymes in industrial processes and clinical diagnostics

B. Course Content

Introduction to Enzymes: Introduction to Enzymes Overview of enzyme nomenclature, classification, and structure. Discussion on enzyme specificity, coenzymes, and cofactors. Understanding the mechanisms of enzyme action, including the lock and key model and induced fit hypothesis. Applications of enzymes in industries, clinical diagnosis and therapeutics.

Enzyme Kinetics and Inhibition Mechanisms: Enzyme Kinetics and Inhibition Study of enzyme kinetics, including Michaelis-Menten equation, Km and Vmax. Analysis of factors affecting enzyme activity such as pH, temperature, and substrate concentration. Exploration of enzyme inhibition types: competitive, non-competitive, uncompetitive, and irreversible inhibition.

Enzyme Immobilization and Industrial Utility: Enzyme Immobilization Techniques of enzyme immobilization: adsorption, covalent binding, entrapment, and encapsulation. Evaluation of the effects of immobilization on enzyme activity and stability. Applications of immobilized enzymes in industrial processes.

Enzyme Production and Purification Techniques: Methods for microbial production of enzymes, including fermentation techniques. Strategies for enzyme purification: precipitation, dialysis, chromatography, and electrophoresis. Determination of molecular weight, isoelectric point, and activity assays.

C. Textbooks

1. Trevan, M.D., Boffey, S., Goulding, K.H., & Stanbury, P.F. Biotechnology: Principles and Applications. Tata McGraw-Hill.
2. Palmer, T. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry. Horwood Publishing.

D. Reference Books

1. Price, N.C., & Stevens, L. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins. Oxford University Press.
2. Whitaker, J.R., Voragen, A.G.J., & Wong, D.W.S. Handbook of Food Enzymology. Marcel Dekker.
3. Chaplin, M.F., & Bucke, C. Enzyme Technology. Cambridge University Press.

E. Course Outcomes:

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

CO1 understand the fundamental concepts of enzyme structure and function.

CO2 analyse enzyme kinetics and the effects of various inhibitors.

CO3 apply enzyme immobilization techniques for industrial applications.

CO4 demonstrate proficiency in enzyme production, purification, and characterization methods.

CO5 evaluate the applications of enzymes in industrial processes and clinical diagnostics.

Subject Code: CS-2203
Subject Name: Design & Analysis of Algorithm
Credit Point: 3 **(**L=3, T=0, P=0)

A. ***Course Objectives:***

1. Learning specification of the concept of algorithm and analysis of its computational complexity,
2. Learning design principles of algorithms and their application to computing problems,
3. Making analysis accessible to all levels of readers.

B. ***Course Content:***

Models of computation: RAM, TM etc. time and space complexity

Asymptotic Notation: Big-O, omega, theta etc.; finding time complexity of well known algorithms like- heap sort, search algorithm etc.
Algorithm Design techniques: Recursion- Definition, Use, Limitations, and Examples: Hanoi problem. Tail Recursion, etc.

Divide and Conquer: Basic method, use, Examples: Merge sort, Quick Sort, Binary Search, etc.

Dynamic Programming: Basic method, use, Examples: matrix-chain multiplication, all pair shortest paths, single-source shortest path, travelling Salesman problem, etc.
Branch and Bound: Basic method, use, Examples: The 15-puzzle problem, etc.

Backtracking: Basic method, use, Examples: Eight queens problem, Graph coloring problem, and Hamiltonian problem, etc.
Greedy Method: Basic method, use, Examples: Knapsack problem, Job sequencing with deadlines, minimum spanning tree (Prim's and Kruskal's algorithms), etc.
Lower Bound Theory: Bounds on sorting and sorting techniques using partial and total orders.

Disjoint Set Manipulation: Set manipulation algorithm like UNION-FIND, union by rank, Path compression.

Matrix manipulation algorithms: Different types of algorithms and solution of simultaneous equations, DFT & FFT algorithm; integer multiplication schemes

Notion of NP-completeness: Non deterministic algorithm, COOK's theorem, P class, NP-hard class, NP-complete class, CNF Satisfiability problem, proof a problem to be NP hard, Clique Decision Problem.
Approximation algorithms: Necessity of approximation scheme, performance guarantee, Polynomial time approximation schemes: 0/1 knapsack problem

String Matching Algorithm

C. Text Books:

1. Cormen T H., Leiserson C E., Rivest R L., and Stein C., Introduction to Algorithms,
   Fourth Edition, MIT Press, 2022.
2. Knuth D E., The Art of Computer Programming: Fundamental Algorithms, Second Edition, Addison- Wesley Publishing Company, 1973.
3. Horowitz E., Sahni S., Rajasekaran S., Computer Algorithms, Second Edition, Silicon Press, 2008.
4. Goodman S E., Hedetniemi S T., Introduction to Design and Analysis Of Algorithms, McGraw-Hill, 1977.
5. Mehlhorn K., Data Structures and Algorithms 1: Sorting and Searching‖, Springer Science & Business Media, 2012.

D. *Reference Books:*

1. Mehlhorn K., Data Structures and Algorithms 2: Graph Algorithms and NP- Completeness, Springer Science & Business Media, 2012.
2. Baase S., Computer algorithms: introduction to design and analysis, Pearson Education India, 2009.
3. Horowitz E. and Shani S., Fundamentals of Computer algorithms, Galgotia Publications, 1984.
4. Reingold E M., Nievergelt J., Deo N. Combinational algorithms: Theory and Practice, Pearson Education Canada, 1977.
5. Borodin A., Munro I., The computational complexity of Algebraic and Numeric problems, American Elsevier Pub.Co., 1975.
6. Skiena S S., The Algorithm Design Manual‖, Springer Science & Business Media, 2009, 2, illustrated, reprint.
7. Aho A V., Hopcroft J E., Design and Analysis of Computer Algorithms‖, Pearson Education India, 1974.

E. *Course Outcomes:*

1. Design algorithms for difficult problems.
2. Analyse and understand their complexity.

3. Implement the algorithms in practice.

Subject Code: BT-320X
Subject Name: Biosensors and Biotronics
Credit Point: 3 **(**L=3, T=0, P=0)

Course Objectives:

- To introduce the basic idea of biosensors and their parts.
- To explain how biological materials like enzymes and antibodies are used in biosensors.
- To make students understand different types of sensors (transducers) used to detect signals.
- To show how nanomaterials help improve the performance of biosensors.
- To provide basic knowledge about electronic parts used in biosensors and how they are made small and portable.

Course content

Unit I- Basics of Biosensors: Biosensor – definition-Historical perspective; Components of a biosensor; Sensor characteristics; Applications in healthcare, environment, agriculture, and food industry

Unit II- Biorecognition Elements: Enzymes, antibodies, nucleic acids; Immobilization techniques; Key Concepts in Biorecognition- selectivity, sensitivity; Label free and Label based detection

Unit III- Types of Transducers: Transducer – definition- types – optical (absorbance, fluorescence, SPR), electrochemical, Electrochemical transducers (Amperometric, potentiometric, conductimetric); Mass – piezoelectric.

Unit IV- Nanomaterials in Biosensor: Definition and classification: Zero-, one-, two-, and three-dimensional nanomaterials; Unique physicochemical properties. Biosynthesis of nanoparticles - Metal: Silver, gold, Platinum. Metal oxide: cerium, titanium, iron and zinc oxide nanoparticles. Carbon-based nanomaterials: Carbon nanotubes (CNTs), graphene, graphene oxide (GO), reduced graphene oxide (rGO); Synthesis of nanocomposite and their role; Signal amplification in electrochemical biosensors.

Unit V- Bioelectronics: Fundamentals of bioelectronics; Bioelectronic interfaces; Wearable and implantable bioelectronics; Electrodes: Working, Reference, Counter. Fabrication and Miniaturization- Microfabrication techniques (photolithography, screen printing, inkjet printing), Lab-on-a-chip and microfluidic devices.

Text books and Reference books

1. Analytical Electrochemistry, 2nd edition. Joseph Wang
2. Biosensors an Introduction, First edition, Brian R Eggins
3. Zhang X. ZuH. Wang J. (2018). Electrochemical Sensors, Biosensors and their Biomedical applications. Elsevier Science and Technology Books

4. Jason J Davis. (2009). Engineering the bioelectronic interface.

Course Outcomes:

CO1: Explain the basic concepts and components of biosensors and identify their role in different sectors.

CO2: Describe the types and functions of biorecognition elements (e.g., enzymes, antibodies, nucleic acids) and immobilization strategies used in biosensor construction.

CO3: Differentiate among various types of transducers, including electrochemical, optical, and piezoelectric, and understand their underlying detection principles.

CO4: Demonstrate an understanding of nanomaterials used in biosensors, their synthesis (biosynthetic and chemical), and their role in improving sensitivity and detection limits.

CO5: Apply knowledge of bioelectronics to understand device fabrication, electrode interfaces, and the design of wearable/implantable diagnostic systems.

BT-3204:-MINOR PROJECT

Subject Code: BT-2204
Subject Name: Indigenous Technical Knowledge of Northeast India Laboratory
Credit Point:1 **(**L=0,T=0, P=2)

A. Course objectives:

1. To learn about the unique agriculture practices of Northeast India
2. To learn and practice the use of bamboo in crafting of day to day utilitites
3. To learn the technique of wine/beer making process of Arunachal Pradesh
4. To discover the rich biodiversity starting with local environment
5. To learn the traditional methods of basic wound and pain management

B. Course content:

1. Terrace farming and Horizontal bamboo agriculture system
2. Construction of sustainable garbage system using a bamboo
3. Production of anaerobic jar for fermentation and storage of food products
4. Preparation of traditional wine/beer of Arunachal Pradesh
5. Collection of medicinal plants in and around NIT Arunachal Pradesh campus
6. Demonstration of wound and pain management using medicinal plants using traditional methods

C. Text books:

1. Bioprospecting of Indigenous Bioresources of North-East India, edited by Jubilee Purkayastha.

2. Diversity of Traditional food in Northeastern Region of India: A Review, 2021 by G.Kadirvel et al., ICAR, Umiam.

3. Traditional knowledge practices of North East India for sustainable agriculture, Journal of Pharmacognosy and Phytochemistry, 2021 by LC De ICAR-NRC for Orchids, Pakyong, Sikkim, India.
3. Diversity of Traditional food in Northeastern Region of India: A Review

D. References:

1. Comparative Studies on the Ethnic Fermented Food Products and its Preservation Methods with Special Focus of North-East India, 2020, Journal of Ecology and Natural resources, by Chandra Nath P and Tiwari A.
2. TRADITIONAL KNOWLEDGE IN NORTH EAST INDIA: A PERFECT CASE FOR SUI GENERIS LEGISLATION, NLUA Journal of Intellectual property rights, July 2022 by Ravindra Singh

E. Course outcomes:

CO1	Students will experience the unique and beautiful agricultural practices of Northeast India. The experience will give innovative minds the thought of up scaling the practices for economic growth such as tourism.
CO2	Students will learn how to handle and fabricate bamboo for preparation of sustainable garbage bin
CO3	Students will be amazed how resources of vegetable origin can be of so much utilities. This will cultivate the thought of creativity, sustainability and enterpreneurship
CO4	Students will understand the science behind wine/beer preparation and will be able to explain the process and will develop ideas to improve for commercial readiness.
CO5	Students will be able to identify common medicinal plants and will have first aid alternative in managing wound and pain.

Subject Code: BT-3206

Subject Name: Nano-Biotechnology Laboratory

Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

1. To Understand the chemical reduction methods for synthesizing metallic nanoparticles such as gold (Au) and silver (Ag).
2. To explore the preparation techniques for polymeric and lipid-based nanoparticles designed for drug delivery applications.
3. To acquire expertise in developing electrochemical biosensors utilizing nanoparticle technology.
4. To perform and evaluate antibacterial activity assays to assess the efficacy of nanoparticles against microbial strains.

B. Course contents:

1. Synthesis of metallic nanoparticles (e.g., Au, Ag) by chemical reduction methods
2. Synthesis of metal oxide nanoparticles
3. Preparation of polymeric or lipid-based nanoparticles for drug delivery applications
4. UV-Visible spectroscopy analysis for nanoparticle optical property evaluation
5. Functionalization of nanoparticles with biomolecules
6. Demonstration of Electrochemical biosensor
7. Antibacterial activity assay

C. Text Books

1. Nanomaterials – An introduction to synthesis, properties and applications, D. Vollath, Wiley-VCH, Second Edition 2013.
2. Cao, Nanostructures and Nanomaterials – Synthesis, Properties and Applications, Imperial College Press 2006.
3. Ronkainen, Niina J., H. Brian Halsall, and William R. Heineman. "Electrochemical biosensors." Chemical Society Reviews 39, no. 5 (2010): 1747-1763.

D. Reference Books

1. Nanostructured materials: Processing, Properties and Potential Applications, Edited by Carl. C. Koch, Noyes Publications, 2002.
2. Materials Science and Engineering – An Introduction, William D Callister, 12th Edition, John Wiley

E. Course Outcomes:

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

CO1	perform synthesize metallic and metal oxide nanoparticles. Students can synthesis lipid-based nanocarriers for potential drug delivery applications.
CO2	develop and test electrochemical biosensors for biomedical diagnostics.
CO3	assess the antibacterial properties of nanomaterials through bioassays.

Subject Code: CS-3207
Subject Name: Database Management Systems Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

1. Create and use a database.
2. SQL: DDL, DML & DCL commands.
3. Advanced SQL queries.
4. Development of DBMS applications.

B. Course Content:

1. Data Definition Language (DDL) commands in RDBMS.
2. Data Manipulation Language (DML) and Data Control Language (DCL) commands in RDBMS.
3. High-level language extension with Cursors.
4. High level language extension with Triggers
5. Procedures and Functions.
6. Embedded SQL.
7. Database design using E-R model and Normalization.
8. Design and implementation of Payroll Processing System.
9. Design and implementation of Banking System.
10. Design and implementation of Library Information System.

C. Text Books:

1. Bob Bryla & Kevin Loney, Oracle Database 12C The Complete Reference, Oracle Press, 2020.
2. Steven Feuerstein &Bill Pribyl, ORACLE PL/SQL Programming, Shroff/O'Reilly, 2020.

D. Reference Books:

1. Oracle Database A Complete Guide, Oracle Press, 2021.

E. Course Outcomes:

1. Design database schema for a given application and apply normalization
2. Acquire skills in using SQL commands for data definition and data manipulation.
3. Develop solutions for database applications using procedures, cursors and triggers

Subject Code: BT-3207
Subject Name: Enzyme Technology Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

1. To develop basic laboratory skills for enzyme assay and kinetic analysis.
2. To introduce immobilization techniques and evaluate enzyme performance.
3. To understand enzyme behavior under various physicochemical conditions.

B. Course content:

1. Assay of enzyme activity
2. Effect of pH on enzyme activity and determination of optimum pH.
3. Effect of temperature on enzyme activity and thermal stability.
4. Estimation of kinetic parameters (Km and Vmax) using Lineweaver-Burk plot.
5. Enzyme de-activation kinetics
6. Enzyme immobilization

C. Course Outcomes:

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

CO1	perform basic enzyme activity assays and evaluate data.
CO2	assess the influence of pH and temperature on enzyme performance.
CO3	analyze kinetic behavior of enzymes using experimental data.
CO4	compare activity and stability of free versus immobilized enzymes.

Subject Code: CS - 2203
Subject Name: Design & Analysis of Algorithm Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. Learning specification of the concept of algorithm and analysis of its computational complexity,
2. Learning design principles of algorithms and their application to computing problems.

B. ***Course Content: Divide and Conquer:***

Implement Binary Search using Divide and Conquer approach Implement Merge Sort using Divide and Conquer approach Implement Quick Sort using Divide and Conquer approach, Find Maximum and Minimum element from an array of integer using Divide and Conquer approach

Greedy method:

Knapsack Problem, Job sequencing with deadlines, Minimum Cost Spanning Tree by Prim's Algorithm, Minimum Cost Spanning Tree by Kruskal's Algorithm

Dynamic Programming:

Find the minimum number of scalar multiplication needed for chain of

matrix Implement all pair of Shortest path for a graph (Floyed Warshall Algorithm) Implement Traveling Salesman Problem, Implement Single Source shortest Path for a graph (Dijkstra, Bellman Ford)

Brunch and Bound:

Implement 15 Puzzle Problems

Backtracking:

Implement 8 Queen Problem Graph Coloring Problem Hamiltonian Problem

Graph Traversal Algorithm:

Implement Breadth First Search (BFS) Implement Depth First Search (DFS)

C. *Text Books:*

1. Cormen T H., Leiserson C E., Rivest R L., and Stein C., Introduction to Algorithms, Fourth Edition, MIT Press, 2022.
2. Knuth D E., The Art of Computer Programming: Fundamental Algorithms, Second Edition, Addison- Wesley Publishing Company, 1973.
3. Horowitz E., Sahni S., Rajasekaran S., Computer Algorithms, Second Edition, Silicon Press, 2008.
4. Goodman S E., Hedetniemi S T., Introduction to Design and Analysis Of Algorithms, McGraw-Hill, 1977.
5. Mehlhorn K., Data Structures and Algorithms 1: Sorting and Searching‖, Springer Science & Business Media, 2012.

D. *Reference Books:*

1. Mehlhorn K., Data Structures and Algorithms 2: Graph Algorithms and NP- Completeness, Springer Science & Business Media, 2012.
2. Baase S., Computer algorithms: introduction to design and analysis, Pearson Education India, 2009.
3. Horowitz E. and Shani S., Fundamentals of Computer algorithms, Galgotia Publications, 1984.
4. Reingold E M., Nievergelt J., Deo N. Combinational algorithms: Theory and Practice, Pearson Education Canada, 1977.
5. Borodin A., Munro I., The computational complexity of Algebraic and Numeric problems, American Elsevier Pub.Co., 1975.
6. Skiena S S., The Algorithm Design Manual‖, Springer Science & Business Media, 2009, 2, illustrated, reprint.
7. Aho A V., Hopcroft J E., Design and Analysis of Computer Algorithms‖, Pearson Education India, 1974.

E. *Course Outcomes:*

1. Develop programs for sorting a given set of elements and analyse its time complexity.
2. Solve and analyse the problems using greedy methods.
3. Solve and analyse the problems using dynamic programming.
4. Apply backtracking method to solve various problems.
5. Apply branch and bound method to solve 0/1 knapsack problem.

BT-3208:-SKILLED DEVELOPMENT COURSE (INTERNSHIP)-4

VIIth Semester							
Sl No	**Course Code**	**Subject Category**	**Course Title**	**L**	**T**	**P**	**C**
1	BT-4101	MA31-DSC 16	Pharmaceutical Biotechnology	3	0	0	3
2	BT-4102	MA32-DSC17	Biostatistics	3	0	0	3
3	BT-410A	ELE8-DSE6	Product design and development	3	0	0	3
	BT-410B	ELE8-DSE6	Introduction to Biomedical Engineering & Bio-tronics				
4	BT-411A	ELE9-DSE7	Systems Biology	3	0	0	3
	ME-2103	ELE9-DSE7	Fluid mechanics				
5	BT-412A	ELE10-DSE8	Bio-mass and Biofuels	3	0	0	3
	ME-412B	ELE10-DSE8	Tissue Engineering and Biomaterials				
6	BT-413A	ELE11-DSE9	Cancer Biology and Therapeutics	3	0	0	3
	BT-413B	ELE11-DSE9	Engineering ethics and IPR in Bioengineering				
7	BT-4103	AP2-05-AECC -2	Internship-II	0	0	2	1
8	BT-4104	AP2-06-VAC6	Major Project-I	0	0	6	3
	BT-4105	HONS3	Bioseparation Technology				3*
			Contact Hours	21	0	10	
			Total Credits				22
			Total Credits with Honours				25 *

Subject Code: BT-4101
Subject Name: Pharmaceutical Biotechnology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To understand the fundamental principles and applications of biotechnology in the pharmaceutical industry
2. To explore the production of biopharmaceuticals, vaccines, and therapeutic proteins using microbial and mammalian systems
3. To comprehend recombinant DNA technology, cell culture techniques, and downstream processing related to drug development
4. To understand regulatory, quality control, and ethical issues in pharmaceutical biotechnology

B. Course content:

Introduction to Pharmaceutical Biotechnology: Definition, scope, and significance, Overview of biologics: therapeutic proteins, monoclonal antibodies, vaccines, biosimilars, Comparison of biopharmaceuticals vs conventional drugs

Microbial and Mammalian Cell Culture Systems: Cell lines used in pharmaceutical production, Growth kinetics

Recombinant DNA Technology in Drug Development: Production of recombinant proteins: insulin, growth hormone, interferons, Molecular biology tools (PCR, blotting, ELISA)

Vaccine Technology and Gene Therapy: Types of vaccines: live attenuated, subunit, DNA/RNA vaccines, Vaccine production and delivery systems, Gene therapy: vectors, delivery methods, clinical trials and challenges

Downstream Processing and Formulation: Protein purification: precipitation, chromatography, filtration, Formulation of biopharmaceuticals: stability, storage, delivery routes, Characterization and quality control of biotech drugs

Regulatory and Ethical Aspects:FDA, EMA, and CDSCO guidelines for biopharmaceutical approval, Good Manufacturing Practices (GMP) and biosafety, Intellectual Property Rights and ethical considerations

C. Text books:

1. Gary Walsh – Pharmaceutical Biotechnology: Concepts and Applications
2. Subramanian, S. – Biotechnology: Pharmaceutical Aspects
3. B. R. Glick & J. J. Pasternak – Molecular Biotechnology: Principles and Applications
4. Sambamurthy, K. – Pharmaceutical Biotechnology

D. Reference books:

1. Crommelin, D. J. A., Sindelar, R. D., &Meibohm, B. – Pharmaceutical Biotechnology: Fundamentals and Applications
2. Shanmugam, S. – Biopharmaceuticals: Biochemistry and Biotechnology
3. Thieman, W. J., &Palladino, M. A. – Introduction to Biotechnology
4. R. K. Jain – Textbook of Pharmaceutical Biotechnology

E. Course Outcomes:

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

CO1	comprehend the principles and applications of biotechnology in pharmaceutical sciences.
CO2	utilize microbial and mammalian systems for the production of biopharmaceuticals.
CO3	implement recombinant DNA technology and cell culture methods in therapeutic product development.
CO4	understand production, formulation, and characterization of vaccines and biotech drugs.
CO5	assess regulatory pathways, quality assurance, and ethical implications in drug development.
CO6	demonstrate basic laboratory skills relevant to pharmaceutical biotechnology.

Subject Code: BT-4102
Subject Name: Biostatistics
Credit Point: 3 (L=3, T=0, P=0)

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1. Course Objectives:

1. To introduce students to statistical concepts used in biological science
2. To develop understanding of data visualization, probability, and inference
3. To apply hypothesis testing and data modelling to biological problems

B. Course content:

Biological Data Types and Descriptive Statistics: Types of biological data: categorical, continuous, time-series, spatial, omics data. Data scales: nominal, ordinal, interval, ratio. Descriptive statistics: mean, median, mode, range, quartiles, standard deviation, standard error. Data visualization: bar chart, pie chart, histogram, scatter plot, line graph. Error bars and variability; identifying outliers. Introduction to data normalization and transformation.

Probability and Probability Distributions: Basics of probability: events, sample space, rules of probability. Conditional probability and independence. Bayes' theorem and its applications in biological contexts. Discrete distributions: binomial, multinomial, Poisson. Continuous distributions: exponential, Gaussian (normal).

Statistical Inference and Hypothesis Testing: Concepts of statistical inference and p-value. Hypothesis testing: null and alternative hypotheses. Parametric tests: one-sample and two-sample t-test, Z-test. Chi-squared test. One-way and two-way ANOVA. Interpretation of statistical results in biological contexts.

Correlation, Regression, and Estimation: Pearson and Spearman correlation, Linear regression: simple and multiple regression, Non-linear regression, Assumptions of regression models and model diagnostics, Introduction to model fitting: least squares, residuals. Likelihood, concept of likelihood function, Maximum Likelihood Estimation (MLE): concept and examples

C. Text Books:

1. S. Ross, A First Course in Probability, 9th Edition, Pearson Education India, 2014.
2. R. C. Elston and W. D. Johnson, Basic Biostatistics for Geneticists and Epidemiologists: A Practical Approach, 1st Edition, Wiley, 2008.

D. Reference Books:

1. M. C. Whitlock, and D. Schluter, The Analysis of Biological Data, 2nd Edition, W. H. Freeman & Company, 2014.
2. G. P. Quinn, and M. J. Keough, Experimental Design and Data Analysis for Biologists, 1st Edition, Cambridge University Press, 2002.
3. M. D. Ugarte, A. F. Militino, and A. T. Arnholt, Probability and Statistics with R, 2nd Edition, CRC Press, 2016.

E. Course Outcomes:

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

CO1 classify and interpret different types of biological data and apply descriptive statistical measures for summarizing biological datasets.
CO2 understand how to apply fundamental concepts of probability and probability distributions to biological problems.
CO3 perform hypothesis testing using appropriate statistical methods (e.g., t-tests, ANOVA, chi-squared test) and interpret the biological significance of the results.
CO4 analyze relationships between biological variables using correlation and regression techniques.

Subject Code: BT-410A
Subject Name: Product design and development
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To understand the fundamentals of product design and development in the context of biotechnology.
2. To integrate biological sciences with engineering principles for innovation.
3. To develop skills for translating laboratory-scale innovations into commercially viable products.
4. To evaluate regulatory, ethical, and economic aspects of biotechnological product development.

D. Course Content:

Introduction to Product Design: Principles of product design; stages in product design and development; innovation pipeline; design thinking; need identification and market research in biotechnology.

Biotechnology Product Development: Overview of biotechnology products (diagnostics, therapeutics, industrial enzymes, biosensors, herbal, agri-products); formulation and delivery systems; case studies.

Prototyping and Validation: Design and fabrication of prototypes; biocompatibility; user feedback and validation testing; quality control and assurance; pilot scale-up.

Commercialization and Compliance: Intellectual property rights (IPR); regulatory approvals (FDA, CDSCO, EMA); GMP and GLP practices; business models and start-up ecosystems in biotechnology; funding and licensing.

C. Text Books:

1. Karl T. Ulrich and Steven D. Eppinger – *Product Design and Development*, McGraw-Hill.
2. Debasish Rath – *Biotechnology Product Development*, CBS Publishers.
3. Cynthia B. Phillips – *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*, Wiley.

D. Reference Books:

1. Robert Langer et al. – *Biomaterials and Biotechnology Design*, Academic Press.
2. Raphael C. Lee – *Biodesign: The Process of Innovating Medical Technologies*, Cambridge University Press.

E. Course Outcomes:

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

CO1	understand the process and challenges of designing biotechnological product.
CO2	analyze product development workflows and regulatory constraints.

CO3 translate research into commercial-ready prototypes.
CO4 identify opportunities in biotechnology entrepreneurship and innovation.

Subject Code: BT-410B
Subject Name: Introduction to Biomedical Engineering & Bio-tronics
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To introduce the foundational principles of biomedical engineering and biotronic systems.
2. To explain how biological systems interface with electronic devices for diagnostic and therapeutic applications.
3. To help students understand different bio signal acquisition methods and the role of bioinstrumentation.
4. To show how nanotechnology and materials science enhance biomedical devices and sensors.
5. To provide insight into device design, miniaturization, and development of wearable/implantable health technologies.

B. Course Content:

Fundamentals of Biomedical Engineering: Definition and scope of biomedical engineering; Historical background and milestones; Applications in healthcare, diagnostics.

Biocomponents & Biorecognition Systems: Biomolecules in diagnostics: Enzymes, antibodies, DNA/RNA; Immobilization strategies; Interaction principles – specificity, affinity, and selectivity; Signal generation in biological systems; Concepts of label-free and label-based detection; Examples from diagnostic kits and therapeutic devices.

Biomedical Signal Transduction: Transduction principles and classification: Optical (absorbance, fluorescence), Electrical (ECG, EEG), Electrochemical (potentiometric, amperometric, impedimetric); Mechanical (piezoelectric sensors); Signal acquisition and conditioning circuits.

Nanotechnology in Biotronics: Introduction to nanomaterials and classification: 0D to 3D nanostructures; Nanomaterial properties for biomedical use (biocompatibility, conductivity); Synthesis of biomedical nanomaterials: metallic (Au, Ag, Pt), metal oxides (ZnO, TiO_2, Fe_2O_3), carbon-based (CNTs, graphene); Hybrid nanocomposites; Use in bio-signal enhancement and drug delivery.

Bio-tronics & Biomedical Device Engineering: Introduction to bio-tronics and bioelectronic systems; Types of electrodes – Working, Reference, Counter; Biomedical interfaces; Wearable and implantable medical devices (pacemakers, insulin pumps, smart bands); Microfabrication methods: photolithography, screen printing, soft lithography; Lab-on-chip, microfluidics, and point-of-care devices.

C. Text books

1. Analytical Electrochemistry, 2nd edition. Joseph Wang
2. Biosensors an Introduction, First edition, Brian R Eggins

D. Reference books

1. Zhang X. ZuH. Wang J. (2018). Electrochemical Sensors, Biosensors and their Biomedical applications. Elsevier Science and Technology Books

2. Jason J Davis. (2009). Engineering the bioelectronic interface.

3. Egbo, Munonyedi Kelvin. "A fundamental review on composite materials and some of their applications in biomedical engineering." Journal of King Saud University-Engineering Sciences 33, no. 8 (2021): 557-568.

E. Course Outcomes:

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

CO1 describe the fundamental concepts and interdisciplinary scope of biomedical engineering and its role in modern healthcare solutions.

CO2 understand the types and functions of biorecognition elements (e.g., enzymes, antibodies, nucleic acids) and immobilization strategies.

CO3 differentiate among various types of transducers, including electrochemical, optical, and piezoelectric, and understand their underlying detection principles.

CO4 analyze the role of nanomaterials in improving the functionality, sensitivity, and miniaturization of biomedical devices.

CO5 demonstrate an understanding of bio-tronics, including wearable and implantable systems, and the fabrication technologies used in developing micro-scale biomedical devices.

Subject Code: BT-411A
Subject Name: Systems Biology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To introduce the fundamental principles and concepts of systems biology.
2. To develop mathematical and computational modeling skills for analyzing biological systems.
3. To understand the dynamics of biological networks and their regulatory mechanisms.
4. To apply systems biology approaches in interpreting high-throughput biological data.

B. Course content:

Introduction to Systems Biology: Definition, scope, and significance of systems biology. Key concepts: dynamic systems, networks, self-organization, emergent properties, homeostasis, and robustness in biological contexts.

Modeling of Biological Systems: Deterministic models using ordinary differential equations (ODEs); numerical methods for solving ODEs; graphical analysis including direction fields and phase planes; stability analysis of linear and nonlinear systems; bifurcation theory and its biological implications.

Molecular Networks and Network Motifs: Structure and function of molecular networks; identification and analysis of network motifs; mathematical modeling of elementary molecular processes such as ligand binding, enzymatic reactions, transcription, and translation; analysis of feedback loops, biochemical switches, and transcriptional circuits; concepts of bistability and hysteresis.

Stochastic Modeling in Biochemical Networks: Introduction to stochastic processes in biology; probability distributions relevant to biochemical systems (Binomial, Poisson, Exponential); Poisson processes and their applications; stochastic simulation algorithms

including Gillespie's algorithm; impact of noise on gene expression and cellular decision-making.

Case Studies illustrating the applications of systems biology in real world scenarios.

C. Text books:

1. Alon, U. *An Introduction to Systems Biology: Design Principles of Biological Circuits*. Chapman & Hall/CRC, 2006.
2. Murray, J.D. *Mathematical Biology: I. An Introduction*. Springer, 2002.

D. Reference books:

1. Wolkenhauer, O. *Systems Biology: Dynamic Pathway Modeling*. Springer, 2010.

2. Nowak, M.A. *Evolutionary Dynamics: Exploring the Equations of Life*. Belknap Press, 2006.

3. Klipp, E., Herwig, R., Kowald, A., Wierling, C., & Lehrach, H. *Systems Biology in Practice: Concepts, Implementation and Application*. Wiley-VCH, 2005.

E. Course outcomes:

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

- CO1 comprehend and articulate the fundamental concepts and significance of systems biology.
- CO2 develop and analyze mathematical models representing biological systems.
- CO3 interpret and simulate the behavior of molecular networks using computational tools.
- CO4 apply stochastic modeling techniques to understand variability in biological processes.
- CO5 integrate and analyze high-throughput biological data using systems biology approaches.

Subject Code: ME-2103
Subject Name: Fluid Mechanics
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. Illustrate the properties of fluids and the applications of fluid mechanics.
2. Understand the fundamental of kinematics and dynamics of fluid flows and the governing non-dimensional parameters of a fluid element.
3. Apply the concepts of mass, momentum and energy conservation to flows.
4. Describe the fundamentals of incompressible viscous flow, various flow measurement devices and boundary layer concepts.
5. Solve simplified problems analytically.

B. Course Content:

Review of fundamentals: Introductory concepts, properties and classification of fluids, basic hydrostatic equation, measurement of pressure, forces on submerged plane and curved surfaces, buoyancy and stability.

Kinematics of fluids: Streamline, pathline, streakline, scalar and vector fields, flow field and description of fluid motions, deformation of fluid element.

Conservation equations: integral and differential formulations - conservation of mass, conservation of momentum and conservation of energy; Bernoulli equation, stream function, velocity potential and vorticity, Euler equation.

Principles of physical similarity and dimensional analysis: Introduction, concept and type of physical similarity, applications of dynamic similarity, dimensional analysis.

Some incompressible viscous flows: Reynolds experiment, plane Poiseuille flow, Hagen Poiseuilleflow, Couetteflow, losses in pipes, friction factors, hydraulic diameter, pipes in series and parallel.

Flow measurement devices: Pilot tube, venturi meter, orifice meter, orifice and mouthpieces, pitot static tube.

Boundary layer concept: Introduction to laminar boundary layer for flow over a flat plate – boundary layer thickness, displacement and momentum thickness.

C. Text Books:

1. Som, S. K.,.Biswas, G and Chakraborty, S., “Introduction to

Fluid Mechanics and Fluid Machines", TMH, 2017, 3rd Ed.
2. Munson, B. R., Young, D. F., Okiish, T. H., "Fundamental of Fluid Mechanics", Wiley, 2012, 7th Ed.
3. Cengel Y. A. and Cimbala J. M., Fluid Mechanics: Fundamentals and applications, McGraw, 2019, 4th Ed.

D. Reference Books:

1. White, F. M., "Fluid Mechanics", TMH, 2014, 8th Ed.
2. Fox, R. W., McDonald, A. T., Pritchard, P. J., "Introduction to Fluid Mechanics", 2003, 6th Ed.

E. Course outcomes:

1. Understand the basics of fluid statics, kinematics and dynamics.
2. Describe the fundamentals of incompressible viscous flow, various flow measurement devices and boundary layer concepts.
3. Analyse fluid flow problems with the applications of mass and momentum.
4. Apply principles of dimensional analysis and similitude to simple problems and use dimensionless parameters.

Subject Code: BT-412A
Subject Name: Bio-mass and Biofuels
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To commend a foundational understanding of biomass resources and their conversion into biofuels
2. To explore various biochemical and thermochemical pathways for biofuel production
3. To understand the design and operation of biofuel production systems and related technologies
4. To evaluate the environmental, economic, and sustainability aspects of biomass energy

B. Course content:

Introduction to Biomass and Bioenergy: Definition and classification of biomass, Global and national biomass energy potential, Comparison of fossil fuels and biofuels, Biomass resources: lignocellulosic, algal, agricultural, and forest residues

Biomass Characterization and Pretreatment: Chemical composition: cellulose, hemicellulose, lignin, extractives, Physical and thermochemical characterization, Biomass densification (pellets, briquettes), Pretreatment methods: mechanical, chemical, biological

Biochemical Conversion Technologies: Anaerobic digestion: process, factors, and biogas production, Fermentation: ethanol production from sugars, starches, and lignocellulose, Biodiesel production: transesterification of oils/fats, Microbial and enzymatic routes in biofuel generation

Thermochemical Conversion Technologies: Pyrolysis types, bio-oil production, Gasification: syngas generation and applications, Combustion and co-firing, Hydrothermal liquefaction and torrefaction

Algal Biofuels and Advanced Biofuels: Algae as biomass: growth systems, harvesting, oil extraction, Drop-in biofuels: green diesel, bio-butanol, bio-jet fuels, Genetic engineering in biofuel-producing microbes, Current research and future prospects

Life cycle assessment of biofuels.

C. Text books:

1. Demirbas, A. – Biofuels: Securing the Planet's Future Energy Needs
2. S. N. Naik – Biomass to Biofuels: Strategies for Global Industries
3. Pandey, A., Larroche, C., et al. – Biofuels: Alternative Feedstocks and Conversion Processes
4. Kamm, B., Gruber, P. R., &Kamm, M. – Biorefineries – Industrial Processes and Products

D. Reference books:

1. Mital, K. M. – Biogas Systems: Principles and Applications
2. Boyle, G. – Renewable Energy: Power for a Sustainable Future
3. Kumar, A. &Yadav, G. – Biomass and Bioenergy Technologies
4. Sims, R. – The Brilliance of Bioenergy: In Business and in Practice

F. Course Outcomes:

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

CO1 understand the types and potential of biomass as a renewable energy source.
CO2 apply knowledge of biochemical and thermochemical pathways for converting biomass into usable energy.
CO3 analyze and operate basic biofuel production systems such as biodiesel, biogas, and ethanol.
CO4 evaluate biomass properties and their influence on energy conversion processes.
CO5 explore advanced technologies in algal and microbial biofuels and assess the environmental, social, and policy aspects of bioenergy deployment.

Subject Code: BT-412B
Subject Name: Tissue Engineering and Biomaterials
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To provide an in-depth understanding of the principles of tissue engineering and the role of biomaterials in regenerative medicine
2. To explore the types, design, and biocompatibility of biomaterials used in tissue scaffolding and implants
3. To emphasize cell–material interactions, scaffold fabrication techniques, and clinical applications
4. To train students in laboratory techniques for scaffold development, cell culture, and tissue characterization

B. Course content:

Introduction to Tissue Engineering: Concept and historical background of tissue engineering, Basic components: cells, scaffolds, signaling molecules, Tissue engineering triad and its integration

Biomaterials for Tissue Engineering: Classification of biomaterials: natural vs synthetic, Properties of biomaterials: mechanical, chemical, biological, Biodegradability and bioactivity, immunological response, Biomaterials used in orthopedics, cardiovascular, and skin regeneration

Scaffold Fabrication Techniques: Fabrication methods: solvent casting, electrospinning, freeze-drying, 3D printing, Surface modification and functionalization of scaffolds, Porosity, pore size, and interconnectivity in scaffold design

Cell Sources and Cell–Biomaterial Interaction: Types of cells used: stem cells, primary cells, iPSCs, Cell adhesion, migration, proliferation, and differentiation on scaffolds, Co-culture and organoid systems, Cell seeding strategies and dynamic culture systems (bioreactors)

Growth Factors and Bioreactors: Role of cytokines and growth factors in tissue regeneration, Controlled release systems and delivery mechanisms, Design and use of bioreactors for engineered tissues (perfusion, rotating wall, spinner flask)

Clinical Applications and Challenges: Case studies: skin, cartilage, bone, and vascular tissue engineering, FDA regulations and clinical trial procedures for engineered products, Ethical issues and commercialization in regenerative medicine

C. Text books:

1. Lanza, R. P., Langer, R., &Vacanti, J. – Principles of Tissue Engineering, Academic Press
2. Ratner, B. D. et al. – Biomaterials Science: An Introduction to Materials in Medicine, Elsevier
3. Palsson, B. O. & Bhatia, S. N. – Tissue Engineering, Pearson
4. Saltzman, W. M. – Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues

D. Reference books:

1. Hench, L. L., & Jones, J. R. – Biomaterials, Artificial Organs and Tissue Engineering
2. Temenoff, J. S., &Mikos, A. G. – Biomaterials: The Intersection of Biology and Materials Science
3. O'Brien, F. J. – Biomaterials & Scaffolds for Tissue Engineering
4. Bhat, S. V. – Biomaterials, Narosa Publishing House

A. Course Outcomes:

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

CO1 understand the foundational principles of tissue engineering and the role of biomaterials in regenerative therapies.

CO2 classify and evaluate biomaterials based on their properties and suitability for specific tissue engineering applications.

CO3 fabricate and characterize scaffolds using various techniques and assess their physicochemical and biological properties.

CO4 analyze cell–material interactions and implement strategies for effective tissue regeneration.

CO5 utilize knowledge of bioreactors, growth factors, and stem cells in tissue engineering designs.

CO6 assess clinical case studies and understand the regulatory and ethical landscape of regenerative medicine.

Subject Code: BT-413A
Subject Name: Cancer Biology and Therapeutics
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To introduce students to the cellular and molecular basis of cancer
2. To understand genetic, epigenetic, and environmental factors in cancer initiation and progression
3. To explore current and emerging cancer therapies, including chemotherapy, targeted therapy, and immunotherapy
4. To familiarize students with diagnostic tools and research approaches in oncology.

B. Course content:

Fundamentals of Cancer Biology: Definition, hallmarks of cancer, differences between normal and cancer cells, Types and stages of cancer, Cancer epidemiology and major risk factors

Molecular Mechanisms of Oncogenesis: Oncogenes, tumor suppressor genes, proto-oncogenes, Cell cycle regulation and checkpoints, Apoptosis and cancer; signal transduction in cancer

Tumor Microenvironment and Metastasis: Angiogenesis, tumorstroma, immune evasion, Invasion, metastasis, epithelial-mesenchymal transition (EMT), Role of inflammation and hypoxia in tumor progression

Diagnostic and Molecular Tools in Oncology: Tumor markers, biopsy, imaging techniques (MRI, CT, PET), Flow cytometry, immunohistochemistry, PCR, RT-PCR, next-generation sequencing, Biomarker discovery and liquid biopsy

Cancer Therapeutics – Conventional and Targeted: Chemotherapy, radiation therapy – mechanism and side effects, Targeted therapies (TKIs, PARP inhibitors), monoclonal antibodies, Hormone therapy and angiogenesis inhibitors

Cancer Immunotherapy and Emerging Approaches: Checkpoint inhibitors (PD-1, CTLA-4), CAR-T cell therapy, Cancer vaccines and oncolytic viruses, Personalized medicine and nanotechnology-based drug delivery

Case Studies and Ethical Considerations: Case discussions on breast, lung, and colorectal cancers, Ethical issues in cancer research and clinical trials, Access to treatment and palliative care

C. Text books:

1. Weinberg, R. A. – The Biology of Cancer
2. King, R. J. B. – Cancer Biology
3. Pecorino, L. – Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics
4. Abbas, A. K., &Lichtman, A. H. – Basic Immunology (for immunotherapy background)

D. Reference books:

1. DeVita, Hellman, & Rosenberg – Cancer: Principles and Practice of Oncology

2. Mukherjee, S. – The Emperor of All Maladies: A Biography of Cancer
3. Tannock, I. F. et al. – The Basic Science of Oncology
4. Darnell, J., Lodish, H., & Baltimore, D. – Molecular Cell Biology (selected chapters on cancer)

A. Course Outcomes:

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

CO1 explain the cellular and molecular basis of cancer initiation, progression, and metastasis.
CO2 identify key oncogenes, tumor suppressors, and signaling pathways involved in cancer.
CO3 distinguish between conventional and advanced cancer diagnostics and treatments.
CO4 analyze therapeutic strategies such as chemotherapy, targeted therapy, and immunotherapy.
CO5 demonstrate laboratory techniques relevant to cancer biology research.
CO6 discuss ethical, social, and clinical aspects of cancer care and drug development.

BT-413B:-ENGINEERING ETHICS AND IPR IN BIOENGINEERING

BT-4103:-INTERNSHIP-II

BT-4104:-MAJ

VIIIth Semester							
Sl No	**Course Code**	**Subject Category**	**Course Title**	**L**	**T**	**P**	**C**
1	BT-420A BT-XXX	ELE12-DSE10	Medicinal Plant Chemistry/ (Swayam/NPTEL)	3	0	0	3
2	ME-324A BT-XXX	ELE13-DSE11	Sustainable Energy Conversion/ (Swayam/NPTEL)	3	0	0	3
3	BT-421A BT-XXX	ELE14-DSE12	Human Biology and Diseases /(Swayam/NPTEL)	3	0	0	3
4	BT-4201	AP2-07-VAC7	Major Project-II	0	0	6	3
5		HONS3	Fermentation Technology	3	0	0	3*
			Contact Hours	12	0	6	
			Total Credits				12
			Total Credits with Honours				15 *

Subject Code: BT-420A
Subject Name: Medicinal Plant Chemistry
Credit Point: 3 **(**L=3,T=0, P=0)

A. Course Objectives:

1. To understand the chemical basis of medicinal compounds derived from plants
2. To explore traditional knowledge and its integration with modern medicinal chemistry
3. To learn techniques for extraction, purification, isolation, and characterization of phytochemicals
4. To evaluate the pharmacological relevance and therapeutic potential of phytopharmaceuticals

B. Course content:

Introduction to Medicinal Chemistry &Ethnopharmacology: Definition and scope of medicinal chemistry, Ethnopharmacology and its relevance to drug discovery, Role of traditional knowledge in identifying plant-based therapeutics.

Primary vs Secondary Metabolites: Classification and roles of Primary vs. Secondary metabolites, Functions of alkaloids, Terpenoids, Flavonoids in plant defence and human health.

Extraction and Purification Techniques: Methods: cold & hot extraction, Soxhlet extraction, Solvent-based purification of crude plant extracts.

Isolation and Structural Characterization Techniques: Chromatographic techniques: TLC, column chromatography, HPLC, UPLC,Spectroscopic techniques: IR, Mass Spectrometry, NMR.

Herbal Medicine Systems and Applications: Overview of Ayurveda, Siddha, and Unani medicine, Pharmacological action and clinical relevance of Indian medicinal plants.

C. Text books:

1. Tyler, V. E., Brady, L. R., & Robbers, J. E. *Pharmacognosy*.
2. Trease, G. E., & Evans, W. C. *Textbook of Pharmacognosy*.
3. Harborne, J. B. *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis*.
4. Dewick, P. M. *Medicinal Natural Products: A Biosynthetic Approach*.

D. Reference books:

1. Samuelsson, G. *Drugs of Natural Origin: A Textbook of Pharmacognosy*.
2. Wagner, H., &Bladt, S. *Plant Drug Analysis: A Thin Layer Chromatography Atlas*.
3. Kokate, C. K., Purohit, A. P., &Gokhale, S. B. *Pharmacognosy*.
4. Heinrich, M., et al. *Fundamentals of Pharmacognosy and Phytotherapy*.

E. Course Outcomes:

CO1: Understand the principles of plant-derived medicinal chemistry and ethnopharmacology.
CO2: Classify and explain the function of primary and secondary metabolites.
CO3: Identify major classes of bioactive plant compounds and their therapeutic potential.
CO4: Execute extraction and purification protocols for phytochemical isolation.
CO5: Analyze phytochemicals using chromatographic and spectroscopic tools.
CO6: Critically evaluate research literature in phytochemistry and natural product drug discovery.

Subject Code: ME-324A
Subject Name: Sustainable Energy Conversion
Credit Point: 3 (L=3,T=0,P=0)

B. Course Objectives:

1. To understand about energy systems and renewable energy resources.
2. To learn about scientific examination of the energy field with emphasis on alternative energy sources and their technology and application.

C. Course Content:

Introduction: Various non-conventional energy resources, potential of renewable energy sources, global as well as Indian scenario.

Solar energy: Solar radiation, measurement of solar radiation, solar thermal collector-flat plate and concentrating collector, solar applications, fundamentals of photo voltaic conversion, solar cells, solar PVS.

Wind energy: Principles of wind energy conversion, wind energy generators and its performance, wind energy storage, applications, hybrid systems.

Energy from bio-mass: Biomass, biogas, bio-mass conversion technologies, different types of bio gas plants, digesters, thermal gasification of biomass, ethanol production, bio diesel production and economics.

OTEC, tidal and wave, geothermal, hydel energy and hydrogen energy: Tidal energy, wave energy, ocean thermal energy conversion, open and closed OTEC cycles, hydropower energy, small hydro turbines, geothermal energy sources, production and storage of hydrogen energy, transport, applications, power plant and environmental issues, energy storage.

MHD power generation: Principles of MHD power generation, open and closed cycle systems.

Energy storage: Fuelcell.

D. Text Books:

1. Boyle, Godfrey, Renewable Energy, Oxford University Press, 2004, 2nd edition.
2. Schaeffer, John, Real Goods Solar Living Source book: The Complete Guide to Renewable Energy Technologies and Sustainable Living, Gaiam, 2007.

E. Reference Books:

1. Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A., Energy and the Environment, John Wiley, 2006, 2nd Edition.
2. Sukhatme,Solar Energy: Principles of Thermal Collection and Storage, McGarw-Hill.

F. Course Outcomes:

1. Explain the main sources of energy and their primary applications.
2. Understand the energy sources and scientific concepts/principles behind them.
3. Analyse the effects of using energy sources on environment and climate.
4. Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the impact on the environment.
5. Identify primary renewable energy resources and suitable technologies acting upon it.

Subject Code: BT-421A
Subject Name: Human Biology and diseases
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To provide foundational knowledge of human anatomy, physiology, and integrated biological systems
2. To understand the mechanisms of major human diseases at the cellular and systemic levels
3. To study pathophysiological changes associated with infections, genetic disorders, and non-communicable diseases
4. To develop basic diagnostic and analytical skills relevant to biomedical research and healthcare applications

B. Course content:

Introduction to Human Biology: Levels of biological organization: cells, tissues, organs, and systems, Overview of major human organ systems (digestive, respiratory, circulatory, nervous, excretory, endocrine, reproductive), Structure and function of cells and biomolecules

Blood, Immunity, and Homeostasis: Components and functions of blood, Hemostasis, blood groups, and transfusions, Immune system: innate and adaptive immunity, Immune disorders and inflammation

Infectious Diseases: Introduction to pathogens: viruses, bacteria, fungi, parasites, Mechanisms of infection and disease transmission, Case studies: tuberculosis, malaria, COVID-19, HIV/AIDS, Vaccination and antimicrobial therapy

Genetic and Congenital Disorders: Chromosomal abnormalities (Down syndrome, Turner syndrome),Inherited diseases (sickle cell anemia, cystic fibrosis, thalassemia), Molecular basis and diagnostic tools for genetic disorders, Genetic counseling and prenatal diagnostics

Metabolic and Lifestyle Diseases: Diabetes mellitus: types, causes, and treatment, Cardiovascular diseases: hypertension, atherosclerosis, Obesity and related metabolic syndromes, Cancer: causes, types, and therapies

Nervous and Mental Health Disorders: Structure and function of the brain and nervous system, Neurological diseases: Parkinson's, Alzheimer's, epilepsy, Mental health conditions: depression, anxiety, schizophrenia,Diagnostic and therapeutic strategies

C. Text books:

1. Elaine N. Marieb&KatjaHoehn – Human Anatomy & Physiology
2. Ross & Wilson – Anatomy and Physiology in Health and Illness
3. Muralidhar, D. &Madan, K. – Human Biology
4. Ananthanarayan&Paniker – Textbook of Microbiology (for infectious diseases)

C. Reference books:

1. Guyton & Hall – Textbook of Medical Physiology
2. Robbins & Cotran – Pathologic Basis of Disease
3. Tortora & Derrickson – Principles of Anatomy and Physiology
4. Nester, M. T. – Microbiology: A Human Perspective

E. Course Outcomes:

1. Describe the structure and function of human organ systems and biological processes.
2. Explain the causes, mechanisms, and progression of infectious, genetic, and metabolic diseases.
3. Analyze the pathophysiology of major human diseases using biological and diagnostic concepts.

4. Apply laboratory techniques to detect disease markers and understand human biology.
5. Evaluate the role of biotechnology in disease diagnosis, prevention, and therapy.
6. Develop awareness of current healthcare challenges and the importance of preventive medicine.

BT-4201:- MAJOR PROJECT-II

OR PROJECT –I

BT-4105:-BIOSEPARATION TECHNOLOGY

y Approach, Thomson Brooks/Cole, 3rd Edition, 2004.

F. Course outcomes:

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

ubject Code: BT-2102
Subject Name: Cell Biology and Genetics
Credit Point: 3 **(**L=3, T=0, P=0)

F. Course Objectives:

6. To understand the formation of cell constituents and their functions.
7. To explore the mechanisms of cell transportations, movement and cell signaling.
8. To analyze how disruptions of cell signaling and cell cycle affect normal functions.
9. To understand the Principles of inheritance and apply the knowledge in analyzing genetic data .
10. To examine how genetic variation can lead to abnormalities and thereby learning how to prevent it.

G. Course content:

Overview of cells: Origin and evolution of cells, biosynthesis of cell constituents and their functions. Cell membrane, Nucleus, Endoplasmic reticulum, Golgi apparatus and Lysosomes, Mitochondria, chloroplasts, Peroxisomes.

Signaling and Cell cycle :Signaling molecules and their receptors, functions, pathways of intracellular signal transduction, the Cell Cycle – Mitosis and Meiosis –Cell death and cell renewal-Programmed cell death, Stem cells, Cytoskeleton and cell movement, cell surface – transport of small molecules, Endocytosis, cell –cell interactions- Adhesion junctions-Tight junctions-Gap junctions- Plasmodesmata, cancer cells.

Organism reproduction and Principles of Heredity: Gamete formation from Meiosis, random fertilization and genetic variation, formation of male and female (eg in human) in sexually reproducing organisms. Mendel's principles of inheritance: Three laws, dominant and recessive alleles, homozygous and heterozygous alleles. Deviation from Mendel's laws, test cross, back cross. Types of genetic crosses and their uses. Sex-influenced traits, cytoplasmic inheritance, genomic imprinting.

Pedigrees and Eukaryotic gene mapping: Pedigree chart, pedigree analysis and types, mating outcomes, hemophilia in royal family of England. Linkage, Linked genes, effect of linkage on crossing over, recombination. Recombination frequencies and genetic map. Use genetic maps to predict gametic and mating outcomes.

Chromosome and DNA as genetic material: Chromosome and DNA structure, DNA as genetic material, Chromosome abnormalities causes and outcome, DNA mutation, causes and outcomes.

H. Text books:

4. The Cell: A molecular approach by Geoffrey M.Cooper.ASM Press, Pages:673
5. Molecular Cell Biology, Lodish, Harvey Krieger, Monty Kaiser, Chris A. Berk, Arnold, W H Freeman & C.
6. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by Dr. P.S Verma and V.K Agarwal.

I. Reference books:

3. Molecular Biology of the Cell Edition 4, Roberts, Keith Alberts, Bruce Johnson, Alexander Raff, Martin Walter, Peter Lewis, Julian, Garland.
4. Lewin's GENES XII by Jocelyn E Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick.

J. Course outcomes:

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

CO1 understand the basic concept of cell structure, membrane, cellular functions of different types of cell.
CO2 examine how cell divides and signal the body and also various detrimental effects upon disruption of cell signaling processes.
CO3 analyze the basis of variation as a result of meiosis and cross-over and develop interest in genetic research.
CO4 correlate inheritance pattern and will be able to predict mating outcomes using Mendelian laws.
CO5 interpret genetic abnormalities, causes and effects with respect to the stability or change in genetic structure.

Subject Code: BT-2103
Subject Name: Molecular Biology
Credit Point: 3 **(**L=3, T=0, P=0)

G. Course objectives:

5. To understand the characteristics of the gene and the genetic material and the effect caused by its mutation
6. To apply the concept of central dogma; replication, transcription and translation process used by prokaryotes and eukaryotes.
7. To explore the role of signal sequence in protein sorting to various organelles
8. To analyze and appreciate the discovery of genetic code and regulation of gene which is central to the normal functioning of living organisms

H. Course content:

Introduction to molecular biology - dna and rna: Scope and History. Structure of DNA, Double Helix, features of Watson and Crick model, DNA Supercoiling- twist, writhe and linking number. Forms of DNA, Structure and function of mRNA, rRNA, tRNA. Secondary structures in RNA. Gene mutation.

Replication and repair: Types and functions of DNA polymerases in Prokaryote and Eukaryote. Replication in prokaryote and Eukaryote. Proof reading activity, 5'□ 3' exonuclease activity, topoisomerase activity, Telomeric DNA replication and Plasmid Replication-theta model, strand displacement model and rolling circle model. DNA Repair- Nucleotide excision repair, base excision repair, mismatch repair, photo-reactivation, recombination repair and SOS repair.

Transcription and post transcriptional modifications: Fine structure of prokaryotic and eukaryotic gene, structure and function of the promoters in mRNA, rRNA, tRNA genes. RNA polymerases in prokaryote and eukaryote, types and function. Transcription of mRNA, rRNA, and tRNA genes in Prokaryote and eukaryote. Post transcriptional processing of mRNA – 5'capping, splicing (including different types), polyadenylation and RNA editing.

Translation and post translational processing: Genetic code and Wobble hypothesis. Translation in and eukaryote. Post translational modifications. Principles protein sorting and targeting into endoplasmic reticulum, mitochondria, chloroplast, and nucleus.

Gene regulation: Principles of gene regulation- Transcriptional and post transcriptional gene regulation-activators, co-activators, suppressors, co-suppressors, moderators, silencers, insulators, enhancers. Operon-*lac* operon, *trp* operon, *ara* operon and *gal* operon.

I. Text books:

4. Molecular Biology of Gene – Watson
5. Lewin's GENES XII by Jocelyn E Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick
6. Molecular and Cellular Biology- Stefen Wolfe

J. Reference books:

3. B. Alberts, A. Johnson, J.Lewis and M.Raff, Molecular Biology of the Cell, Garland Science; 5th edition.
4. H. Lodish, A Berk, C.A. Kaiser and M.Krieger, Molecular Cell Biology, W. H. Freeman, 6th edition, 2007.

K. Course outcomes:

Upon completion of the program, students will be able to:

CO1 develop clear understanding on the work of genetic material as to how different characters are formed.
CO2 understand what causes different abnormalities and also ageing as a result of mutation and replication error.
CO3 apply the concept on the central dogma and the repair mechanism and appreciate the sophistication of living organisms.
CO4 interpret the genetic code and gene regulation and develop innovative ideas for genetic manipulations.

Subject Code: BT-210A
Subject Name: Bioprocess calculations
Credit Point: 3 **(**L=3, T=0, P=0)

B. Course Objectives:

6. To introduce the fundamental principles of units, dimensions, mole concept, and chemical composition relevant to bioprocess calculations.
7. To develop the ability to apply material and energy balance concepts to biological and chemical process systems.
8. To enable students to formulate and solve material balance problems for unit operations with and without chemical reactions.
9. To build competency in analyzing gas systems, combustion processes, and fuel analysis relevant to bioprocess industries.

B. Course content

Fundamentals of Units and dimensions: Chemical arithmetic: Mole concept, atomic weight, molecular weight and equivalent weight. Use of mole concept in biological and chemical reactions. Chemical composition: Methods of expressing compositions of mixtures and solutions- mole percent, mass percent, volume percent, molarity, molality, normality, ppm, density and specific gravity, specific gravity scales. Gas systems: Ideal gas laws, gaseous mixtures, real gas laws, gas constant; calculations of pressure, volume and temperature.

Fundamentals of material balances and energy balances: Definition of unit operations and unit processes. Law of conservation of mass, types of material balance problems – total and component balances, steady and unsteady state processes, batch and continuous processes. Concept of tie element, basis for calculations, independent material balance equations, degrees of freedom and steps for solving material balance problems. Fundamentals of energy balances: Law of conservation of energy, qualitative study of components of energy balance equations.

Material balances without chemical reactions: Material balances for unit operations like evaporation, crystallization, drying, leaching, extraction, absorption and distillation. Qualitative study of bypass, recycle and purging operations.

Material balances with chemical reactions: Definition of terms like limiting reactant, excess reactant, percentage yield and selectivity, extent

of reaction: - simple numerical examples. Combustion of solid, liquid and gaseous fuels, heating value of fuels, proximate and ultimate analysis of coal.

C. Text Books

1. K.V. Narayanan, B. Lakshmikutty, Stoichiometry and Process Calculations, Prentice Hall of India, 2006
2. Michael L Shuler &Fikret Kargi – Bioprocess Engg. Basic Concepts – Prentice – Hall India.

D. Reference Books

1. B.I. Bhatt, S.M. Vora, Stoichiometry, Fourth edition, Tata McGraw Hill, 2004.
2. Venkataramani & N.N. Ananthraman – Process calculation – Prentice Hall India.
3. David M. Himmelblau, James B. Riggs, Basic Principles and Calculations in Chemical Engineering, Prentice Hall, 2012.

10. Pauline M Doran, Bioprocess Engineering Principles, 2/e, Elsevier- Academic Press, 2013

L. Course Outcomes:

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

CO1**:** apply the concept of units, dimensions, mole concept, and chemical composition methods in solving bioprocess calculations.

CO2: analyse the principles and methods of material and energy balances in steady-state and unsteady-state biological and chemical processes.

CO3: to solve material balance problems for various unit operations with and without chemical reactions.

CO4: to analyse the fundamentals of gas systems and combustion processes, inclu ding calculations related to fuel properties and heating values.

SUBJECT CODE:-
INTRODUCTION TO INNOVATION AND CREATIVITY

Subject Code: BT-2104
Subject Name: Microbiology Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course objectives:

1. To learn the sterilization techniques and aseptic handling of lab wares and cultures in microbiology
2. To learn the basic microbial characterization, staining and culture techniques

B. Course content:

1. Sterilization techniques
2. Media preparation
3. Microscopy and Micrometry
4. Isolation, size and shape of microbes from a given sample
5. Staining Techniques (Simple, Gram staining, spore staining)
6. Motility test by Hanging drop method
7. Biochemical Characterization of Bacteria
8.Oxidation/Fermentation Test
9. Catalase, Oxidase and Urease Tests
10. IMViC test

C. Text books:

1. *Microbiology by Pelczar, JR E.C.S Chan and noel R.Krieg. Fifth edition Tata Mc GrawHill -2006*
2. *Thomas D. Brock, Michael T. Madigan, John M. Martinko.12th edition Pearson*

D. Reference books:

1. Hand Book of Practical Microbiology (2021) by Apurba S Sastry and Sandhya Bhat.
2. Principles & Techniques of Biochemistry & Molecular Biology by Keith Wilson & John Walker.

E. Course outcomes:

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

CO1	perform sterilization techniques and aseptic handling of lab wares and preparation of culture media on their own
CO2	identify bacteria based on microscopic visualization, morphological structure, colony structure and staining techniques
CO3	characterize bacteria using various biochemical and physical methods
CO4	demonstrate the equipment and lab wares used in the course

Subject Code: BT-2105
Subject Name: Biochemistry Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

K. Course objectives:

7. To understand and apply the techniques of buffer preparation
8. To utilize chromatographic method for separation amino acids and lipids
9. To estimate sugar, vitamins, proteins, oil and nitrogen using different methods

L. Course content:

1. Preparation of buffers
2. Separation of amino acids by TLC
5. Estimation of proteins
4. Estimation of sugar
5. Estimation of vitamins
6. Extraction of lipids and their separation on TLC
7. Estimation of oils
8. Nitrogen estimation by different methods

M. Text books:

5. Principles & Techniques of Biochemistry & Molecular Biology by Keith Wilson & John Walker

6. A Practical book on Biochemistry by Mr. Bakshi Rahman, Dr. Rageeb, Dr. Sufiyan Ahmad Raees

N. Reference books:

1. Nelson, D.L. and Cox, M.M. 2000. Lehninger Principles of Biochemisitry,3rd edn. Printed in India by Replika Press Pvt. Ltd., New Delhi for WorthPublishers, New York.

O. Course outcomes:

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

CO1 prepare buffer of various types and range
CO2 operate TLC and separate amino acids and lipids by TLC
CO3 apply their practical knowledge for estimation of biomolecules

Subject Code: BT-2106
Subject Name: Cell Biology and Genetics Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course objectives:

1. To observe and understand cells and cell organelles using microscope
2. To perform fractionation different cellular contents and organelles
3. To practice technique and preparation of histological slides
4. To apply staining method of DNA and study different mitotic stage
5. To assess number of sex chromosome number using basic cytogenetic methods
6. To perform agarose gel electrophoresis for separation of DNA
7. To demonstrate karyogram using chromosome spread

B. Course content:

1. Microscopic study of cell and cell organelles
2. Cell fractionation

3. Histology: Fixation, Dehydration, embedding and sectioning of tissues
4. Nuclear staining
5. Mitosis in onion root tip
6. Barr body preparation and staining
7. Agarose gel electrophoresis
8. Preparation of chromosome spreads
9. Preparation of karyogram using chromosome spread

C. Text books:

1. Principles of Genetics
1. *The Cell: A molecular approach by Geoffrey M.Cooper*

D. Reference books:

2. Practical laboratory manual- CELL BIOLOGY Amit Gupta and Bipin Kumar Sati.
3. Practicals of Cell Biology & Genetics by Vilas Parmar

P. Course outcomes:

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

CO1 demonstrate the use of light microscope for routine microscopic observation
CO2 explain cells and cell organelles morphology from microscopic observation.
CO3 fractionate different cellular parts and organelles, section tissues and prepare histological slides.
CO4 interpret different stages of mitosis using nuclear staining and explain the changes in chromosome behavior.
demonstrate chromosome spread and karyogram using metaphase chromosome.
CO5 practically understand barr body and its effects on human biology.
CO6 perform agarose gel electrophoresis and visualize of DNA.

SUBJECT CODE:-

SKILL DEVELOPMENT COURSE

IVth Semester							
Sl No	**Course Code**	**Subject Category**	**Course Title**	**L**	**T**	**P**	**C**
1	BT-2201	MA16-DSC8	Immunology	3	0	0	3
2	BT-2202	MA17-DSC9	Recombinant DNA Technology	3	0	0	3
3	BT-2203	MA18-DSC10	Plant Biotechnology	3	0	0	3
4	BT-2204	MA19-DSC11	Biophysics	3	0	0	3

5	BT-220A	ELE1-DSE1	Biothermodynamics	3	0	0	3
	BT-220B	ELE1-DSE1	Industrial Biotechnology				
6	BT2205	AP1-03-VAC4	Minor project	0	0	4	2
7	BT2206	MA20-LAB4	Immunotechnology laboratory	0	0	2	1
8	BT2207	MA21-LAB5	Recombinant DNA Technology Laboratory	0	0	2	1
9	BT2208	MA22-LAB6	Plant Tissue Culture Laboratory	0	0	2	1
10	BT2209	AP1-04-SECC4	Skill development course (Internship)-02	0	0	2	1
			Contact Hours	15	0	12	
			Total Credits				21

Subject Code: BT-2201
Subject Name: Immunology
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

6. To provide a foundational understanding of the human immune system, its components, and functional mechanisms in innate and adaptive immunity.
7. To explain the structural and functional aspects of immunoglobulins, antigenic determinants, monoclonal antibodies, cytokines, and the complement system.
8. To familiarize students with various antigen-antibody interaction techniques and their applications in diagnostics and research, such as ELISA, Western blotting, and flow cytometry.
9. To introduce the development and functional specialization of immune cells, including T and B cell maturation, activation, and differentiation.
10. To explore the immune system's role in health and disease, including mechanisms of immune defense, inflammation, hypersensitivity, and the basis of vaccine-induced immunity.

B. Course Contents:

Overview of the immune system:
Innate Immunity, adaptive immunity, comparative immunity cells and organs the immune system – Antigens.
Immunoglobulin structure and functions:
Basic structures of Immunoglobulins – Ig classes and biological activities, Antigenic determinants on Ig, B Cell receptor, Monoclonal antibodies – cytokines – complement system
Antigen – antibody interactions:
Antibody Affinity and activity – Precipitation reactions- agglutination reactions- Radio immunoassay-ELISA-Western blotting, Immunoprecipitation, Immunofluroscence, immunoelectron microscopes, flow cytometers-MHC Antigen processing & presentations.
Cell & b cell maturation, activation & differentiation

T Cell receptor, T Cell maturation, activation and differentiation B Cell generation, activation and differentiation cell mediated effectors responses. Immune system in health & disease: Leukocyte migration and inflammation, hypersensitive reactions, immune response to infection diseases vaccines.

C. Text Books

3. Kuby Immunology by Richard A. Golds by Tharmas J. kindt fourth edition 2000 and Barbara Osborne. W.H.freeman and company
4. Immunobiology 6th Edition, Janeway, Travers, Walport, Shlomchik, Garland, 2005.

D. Reference Books

3. Abbas, A. H. Lichtman and S. Pillai, Cellular and Molecular Immunology, 7th Updated Edition, Saunders, 2011.
4. M. Roitt, J. Brostoff and D. K. Male, Immunology, 6th Edition, Mosby, 2001.

E. Course Outcomes:

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

CO1: understand the components and functions of the innate and adaptive immune systems, including the roles of immune cells, organs, and antigens.

CO2: explain the structure, classes, and biological functions of immunoglobulins.

CO3: interpret antigen-antibody interactions and apply various immunological techniques such as ELISA, Western blotting, immunoprecipitation, immunofluorescence, and flow cytometry.

CO4: understand and evaluate the maturation, activation, and differentiation of T and B cells, and the mechanisms of cell-mediated immune responses.

CO5: analyze immune responses in health and disease, including leukocyte migration, inflammation, hypersensitivity reactions, and the immune response to infectious diseases and vaccines.

Subject Code: BT-2202
Subject Name: Recombinant DNA Technology
Credit Point: 3 (L=3, T=0, P=0)

A. Course objectives:

1. To understand the concept of recombinant DNA technology and cloning as a means of genetic manipulation
2. To explore different techniques used in recombinant DNA technology such as gel electrophoresis, blotting and micro arrays

3. To comprehend the concept of PCR and types and recent molecular techniques
4. To examine the methods involved in library construction and sequencing
5. To investigate strategies for over-expressing recombinant protein and their purification methods
6. To apply different techniques for analysis protein-DNA and protein-protein interaction

B. Course content:

Basics of DNA cloning: Simple cloning and cloning using linkers and adaptors. Cloning into various kinds of vectors – plasmids, phages lambda and M13, phagemids, cosmids, P1 phage, PACs, BACs and YACs. Selection and screening of clones.

Methods of DNA and protein analysis: Agarose, polyacrylamide and pulsed field gel electrophoresis of DNA. Southern and Northern Blotting. Radiolabelling probes. RFLP and RAPD analysis. DNA fingerprinting and its application in forensics, in disease diagnosis and in identification of strains. Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins. Western Blotting analysis, DNA Micro array.

Polymerase Chain Reaction: Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers. Cloning PCR products. Long PCR, Inverse PCR, Vectorette PCR, RT-PCR, 5' and 3' RACE, qPCR, Real Time PCR using SYBR Green, Scorpion primers and TaqMan probes, Multiplex PCR, Differential Display PCR. Ligation Chain Reaction, Overlap PCR, CRISPR technology

Construction of cDNA and genomic DNA libraries: Vectors used in the construction of cDNA versus genomic DNA libraries. Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries. Screening libraries by colony hybridization and colony PCR. DNA sequencing by Sanger's method, Physical mapping by restriction fragment fingerprinting of BAC clones and STS mapping. Whole genome shotgun sequencing. Array CGH.

Overexpression of recombinant proteins: Overexpression and tagging of recombinant proteins in *E.coli,* driven by lac, T7 and Tet-regulatable promoters. Mammalian cell overexpression system.

Analysis of protein-DNA and protein-protein interactions: Gel retardation assay, DNA footprinting by DNase I, Yeast hybrid assays, Co-immunoprecipitations, pull-downs and Far-Westerns. GFP and FRET. Phage display.

C. Text books:

1. Principles of Gene Manipulation and Genomics" by Primrose and Twyman

2. Molecular Biology by David P. Clarke, 1st edition; Elsevier Academic Press; 2005.
3. DNA Technology: The Awesome Skill by I. Edward Alcamo, 2nd edition; Hardcourt Academic Press; 2001.

D. Reference books:

1. Molecular Biology of the Gene by James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine & Richard Losick , 6th Edition; CSHL Press; 2007.
2. Gene Cloning and DNA Analysis: An Introduction" by T.A. Brown
3. Molecular Cloning: A laboratory manual by Joseph Sambrook & David Russell, 3rd edition; CSHL press; 2001.

F. Course outcomes:

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

CO1 explain the steps of gene cloning process and apply in genetic manipulation procedures.
CO2 demonstrate different techniques like electrophoresis, blotting and fingerprinting, DNA microarray used in recombinant DNA technology and various applications.
CO3 design primers and demonstrate and analyse different PCR methods.
CO4 understand and evaluate the strategy of library construction and DNA sequencing .
CO5 demonstrate over-expression and purification recombinant protein.
CO6 interpret interaction between protein-DNA or protein-protein.

Subject Code: BT-2203
Subject Name: Plant Biotechnology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

5. To provide a strong foundation in modern techniques and tools used in plant biotechnology
6. To understand the molecular basis of plant growth, development, and responses
7. To develop hands-on skills in plant tissue culture, genetic transformation, and molecular analysis
8. To explore applications of biotechnology in agriculture, food security, and environmental sustainability

B. Course content:

Introduction to Plant Biotechnology: History and scope, Basic plant cell structure and genome organization, Totipotency.
Plant Tissue Culture: Nutritional media, Callus culture, Somatic embryogenesis, Micropropagation, Protoplast isolation and fusion
Genetic Engineering in Plants: Agrobacterium-mediated transformation, Biolistics, Selection markers, Reporter genes

Genomics and Molecular Markers: Genomics in plants, DNA markers (RAPD, RFLP, AFLP, SSR), Marker-assisted selection
Transgenic Plants and Applications: GM crops, Biofortification, Biopesticides, Bioherbicides, Edible vaccines
Plant Biotechnology in Agriculture and Industry: Molecular farming, Stress resistance, Bioreactors, IPR, Biosafety and ethical issues

C. Text books:

6. B. D. Singh – *Plant Biotechnology*
7. S. S. Bhojwani& M. K. Razdan – *Plant Tissue Culture: Theory and Practice*
8. S. B. Primrose & R. Twyman – *Principles of Gene Manipulation and Genomics*
9. C. Neal Stewart Jr. – *Plant Biotechnology and Genetics*
10. A. Slater, N. W. Scott, M. R. Fowler – *Plant Biotechnology: The Genetic Manipulation of Plants*

D. Reference books:

5. Adrian Slater et al. – *Principles of Plant Biotechnology*
6. R. J. Henry – *Practical Plant Biotechnology*
7. O. P. Dhawan – *Plant Tissue Culture and Molecular Markers*
8. James D. Watson et al. – *Recombinant DNA: Genes and Genomes*

E. Course Outcomes:
Upon completion of the course, students will be able to:

CO1 describe the key concepts and advancements in plant biotechnology.
CO2 explain the role of molecular techniques in plant improvement.
CO3 perform plant tissue culture and molecular biology techniques independently.
CO4 analyze and interpret experimental results related to plant genetic engineering.
CO5 discuss ethical, legal, and societal aspects of plant biotechnology.

Subject Code: BT-2204
Subject Name: Biophysics
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

5. To understand the fundamental physical principles governing biological systems
6. To explore the structure and function of biomolecules through physical methods
7. To analyze physiological processes using models from physics
8. To gain practical experience with instrumentation and experimental methods in biophysics

B. Course content:

Introduction to Biophysics: Definition, scope, historical background, relevance to engineering

Molecular Biophysics and Molecular Interactions: Bonding, thermodynamics, kinetics in biomolecules, Forces in biology: van der Waals, hydrogen bonding, electrostatics

Enzyme Biophysics and Membrane Biophysics: Enzyme kinetics, thermodynamics of enzyme action, Lipid bilayers, membrane potentials, ion channels.

Biomechanics and Bioelectricity: Mechanical properties of cells, muscle contraction, biopolymers. Nerve impulses, action potentials,

Biophysical techniques and applications: X-ray Chrystallography, NMR, Electron Microscopy, MS. Molecular Modelling and simulation

C. Text books:

4. Cotterill, R. *Biophysics: An Introduction*. Wiley.
5. Nelson, P. *Biological Physics: Energy, Information, Life*. W. H. Freeman.
6. Alberts, B. et al. *Molecular Biology of the Cell*. Garland Science.

D. Reference books:

5. Glaser, R. *Biophysics: An Introduction*. Springer.
6. Tuszynski, J. A., & Dixon, J. M. *Biomedical Applications of Biophysics*. CRC Press.
7. Weiss, T. F. *Cellular Biophysics*. MIT Press.
8. Voet, D., Voet, J. G., & Pratt, C. W. *Fundamentals of Biochemistry*. Wiley.

D. Course Outcomes:

Upon completion, students will be able to:

CO1: apply physical principles to understand and analyze biological systems.

CO2: explain the structure and behavior of biomolecules using theoretical and experimental approaches.

CO3: operate modern biophysical instruments and interpret the data to investigate biological processes.

CO4: develop mathematical and computational models to simulate physiological phenomena.

CO5: demonstrate skills in experimental design and data analysis in a biophysics laboratory setting.

CO6: critically evaluate recent advances in biophysical research and its application in biotechnology and medicine.

Subject Code: BT-220A
Subject Name: Biothermodynamics
Credit Point: 3 (L=3, T=0, P=0)

B. Course Objectives:

1. To understand the principles of classical thermodynamics and their relevance to biological systems
2. To evaluate how thermodynamic laws govern energy transformations and molecular processes in living organisms
3. To analyze biological reactions, protein folding, enzyme activity, and transport phenomena using thermodynamic models
4. To develop competency in applying thermodynamic tools for evaluating and optimizing biochemical processes

B. Course content:

Introduction to Thermodynamics: Concepts of Energy and Energy Transfer, First Law of Thermodynamics, Entropy and Disorder in Biological Systems

Second & Third Law of Thermodynamics: Gibbs Free Energy, Thermodynamic equations for mass, energy, and entropy in closed and open systems, Interrelation of thermodynamic properties (ideal and real gases, equations of state), Steam tables, thermodynamic properties of mixtures, Gibbs phase rule

Biothermodynamics: Heat generation and energy dissipation in cell growth, Thermodynamic prediction of kinetic parameters (yield coefficients, growth rate, affinity constants),Metabolic heat production, Gibbs energy dissipation in aerobic, fermentative, and autotrophic systems, Biocalorimetry and its applications

Thermodynamics of Metabolism: Theoretical product yields, alkali consumption, osmotic stress, ionic strength, ATP synthesis, thermodynamic feasibility analysis of metabolic pathways

C. Text books:

5. Alberty, R. A. – *Thermodynamics of Biochemical Reactions*, Wiley
6. Voet, D. &Voet, J. G. – *Biochemistry*, Wiley (for biological context)
7. Nelson, D. L., & Cox, M. M. – *Lehninger Principles of Biochemistry*, W.H. Freeman
8. Atkins, P. & de Paula, J. – *Physical Chemistry for the Life Sciences*, Oxford University Press

D. Reference books:

5. Nicholls, D. G., & Ferguson, S. J. – *Bioenergetics 4*, Academic Press
6. Schnell, S. – *Thermodynamics in Biology*, CRC Press
7. Haynie, D. T. – *Biological Thermodynamics*, Cambridge University Press

8. Peters, M. S., &Timmerhaus, K. D. – *Plant Design and Economics for Chemical Engineers* (for process applications)

E. Course Outcomes:

CO1: Explain fundamental thermodynamic principles including energy transfer, entropy, and the laws of thermodynamics.
CO2: Apply thermodynamic concepts to estimate properties in biological and chemical systems using real and ideal models.
CO3: Analyze thermodynamic behavior of biological processes such as microbial growth and metabolism.
CO4: Evaluate metabolic efficiency and energy dissipation using models and Gibbs free energy.
CO5: Assess metabolic pathways and process yields thermodynamically for biotechnological optimization.
CO6: Utilize tools like biocalorimetry to enhance biological process efficiency.

SUBJECT CODE:-
INDUSTRIAL BIOTECHNOLOGY

SUBJECT CODE:-

SUBJECT NAME: MINOR PROJECT

Subject Code: BT-2206
Subject Name: Immunotechnology Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

G. Course Objectives:

4. To provide practical knowledge of basic and advanced immunological techniques.
5. To understand antigen-antibody interactions in various assay formats.
6. To apply immunological methods for disease diagnosis and research.

H. Course content:

8. Preparation of Buffers and Reagents used in Immunological Techniques
9. Assays based on agglutination reactions - Blood typing
10. Separation of Serum from Blood
11. Ouchterlony Double Immunodiffusion Assay
12. Enzyme-Linked Immunosorbent Assay (ELISA) – Direct and Sandwich Format
13. Demonstration of Lateral Flow Assay
14. Western blotting-demonstration

I. Text books

3. Kuby Immunology- Jenni Punt, Sharon Stranford, Patricia Jones, Judy Owen, 4th/7th edition.

4. Manual of Clinical Laboratory Immunology by Noel R. Rose (Author), Herman Friedman (Author), John L. Fahey (Editor).

J. Reference books

3. Practical Immunology by Frank C. Hay (Author), Olwyn M. R. Westwood (Author)
4. Handbook for Practicals in Immunology, Editor: H. Mahmutefendić. The University of Rijeka, Faculty of Medicine, 2014. (e-edition), 2015 (printed edition).

K. Course Outcomes:

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

CO1: perform and interpret results of common immunological assays.
CO2: understand the principles behind antibody-based diagnostics.
CO3: analyse the importance of immunological techniques in disease detection and therapeutic development.

Subject Code: BT-2207
Subject Name: Recombinant DNA Technology Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course objectives:

1. To acquire skills in isolating genomic DNA and visualizing in agarose gel electrophoresis
2. To demonstrate competent cells preparation, a critical step in recombinant DNA technology
3. To understand the principle and hands-on training on thermal cycler
4. To understand and execute the fundamental steps and cycles of DNA cloning
5. To interpret positive and negative clones from LB agar antibiotic plates

B. Course content:

1. Genomic DNA isolation and visualization using Agarose Gel Electrophoresis
2. Polymerase Chain Reaction of DNA using Thermal Cycler
3. Preparation of competent cells from bacteria
4. Plasmid isolation from bacterial cells
5. Restriction digestion of DNA using restriction enzymes
6. Ligation of recombinant gene into plasmid
7. Transformation of bacteria
8. Screening of colonies in LB agar plates

C. Text books:

1. Principles of Gene Manipulation and Genomics" by Primrose and Twyman
2. Molecular Biology by David P. Clarke, 1st edition; Elsevier Academic Press; 2005.
3. DNA Technology: The Awesome Skill by I. Edward Alcamo, 2nd edition; Hardcourt Academic Press; 2001.

D. Reference books:

1. Molecular Biology of the Gene by James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine & Richard Losick , 6th Edition; CSHL Press; 2007.
2. Gene Cloning and DNA Analysis: An Introduction" by T.A. Brown.
3. Molecular Cloning: A laboratory manual by Joseph Sambrook & David Russell, 3rd edition; CSHL press; 2001.

L. Course outcomes:

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

CO1 isolate genomic DNA from bacterial cells and independently run agarose gel electrophores visualize the DNA
CO2 apply the concept of PCR and operate thermal cycler for amplification of DNA
CO3 demonstrate the preparation of competent cells from bacteria. They will also understand importance of gentle handle and operation of pipette to make viable competent cells.
CO4 explain and demonstrate the steps and cycle involved in gene cloning such as plasmid isola restriction digestion, ligation and transformation.
CO5 analyze and evaluate results from bacterial colonies and identify positive and negative clones

Subject Code: BT-2208,

Subject Name: Plant Tissue Culture Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course objectives:

5. To provide hands-on training in fundamental techniques of plant tissue culture
6. To understand aseptic techniques and media preparation for in vitro pla propagation
7. To explore the applications of plant tissue culture in micropropagation, genetic modification, and secondary metabolite production
8. To train students in the maintenance and handling of plant culture syste under controlled conditions

B. Course content:

Laboratory Setup and Aseptic Techniques: Introduction to plant tissue culture lab infrastructure, Sterilization techniques (autoclaving, filtration, alcohol), Preparation and sterilization of culture media (MS medium)

Culture Initiation and Callus Induction: Surface sterilization of explants (leaf, stem, node), Inoculation and incubation, Observation of callus formation

Micropropagation and Shoot Multiplication: Subculturing of callus for shoot induction, Use of plant growth regulators (auxins and cytokinins), Clonal propagation techniques

Somatic Embryogenesis and Organogenesis: Somatic embryo induction, Shoot and root formation, Regeneration from non-meristematic tissues

Protoplast Isolation and Fusion: Enzymatic digestion for protoplast extraction, Viability testing using fluorescent dyes, Protoplast fusion demonstration

Hardening and Acclimatization: Transfer of plantlets to soil, Acclimatization in greenhouse or controlled environments, Monitoring survival and growth

C. Text books:

4. Bhojwani, S. S., &Razdan, M. K. – *Plant Tissue Culture: Theory and Pract*
5. Smith, R. H. – *Plant Tissue Culture: Techniques and Experiments*
6. Reinert, J., & Yeoman, M. – *Plant Cell and Tissue Culture: A Laboratory Manual*

D. Reference books:

5. George, E. F., Hall, M. A., & De Klerk, G.-J. – *Plant Propagation by Tissue Culture*
6. Thorpe, T. A. – *In Vitro Culture of Higher Plants*
7. Trigiano, R. N., &Gray, D. J. – *Plant Tissue Culture, Development, and Biotechnology*
8. Kartha, K. K. – *Cryopreservation of Plant Cells and Organs*

B. Course Outcomes:

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

CO1 demonstrate proficiency in aseptic techniques and media preparation for pl tissue culture.
CO2 initiate and maintain callus and organogenic cultures from different explant
CO3 carry out micropropagation and understand its commercial relevance.
CO4 perform protoplast isolation and evaluate its viability.
CO5 understand the acclimatization process and transfer of in vitro grown plantl to natural conditions.
CO6 appreciate the use of plant tissue culture for research and industrial applications such as genetic transformation and secondary metabolite production.

SUBJECT CODE:-

SUJECT NAME: SKILL DEVELOPMENT COURSE -02

Credit Point:-

Vth Semester							
Sl No	**Course Code**	**Subject Category**	**Course Title**	**L**	**T**	**P**	**C**
1	BT-3101	MA23-DSC12	Biochemical Engineering	3	0	0	3
2	BT-3102	MA24-DSC13	Computational Biology and Bioinformatics	3	0	0	3
3	BT-3103	ELE2-DSE2	Analytical Biotechnology	3	0	0	3
	CS-210A	ELE2-DSE2	Computer organization and architecture				
4	BT-310X	**OE**	**OE1***(Microbes in Human Health)	3	0	0	3
5	MH3101	SM16-ESA12	Entrepreneur essential and early stage start up	3	0	0	3
6	BT-3104	AP2-01-AECC-1	Internship-I	0	0	2	1
7	BT-3105	MA25-LAB7	Biochemical Engineering Laboratory	0	0	2	1
8	BT-3106	MA26-LAB8	Computational Biology and Bioinformatics laboratory	0	0	2	1
9	BT-3107	ELE3-LAB9	Analytical Biotechnology Laboratory	0	0	2	1
	CS-2103	ELE3-LAB9	Computer organization and architecture laboratory				
10	BT-3108	AP2-02 SECC5	Skilled development course (Internship)-03	0	0	2	1
11	BT-3109	HONS1	Secondary metabolite in plants				3*
			Contact Hours	15	0	10	
			Total Credits				20
			Total Credits with Honours				23 *

Subject Code: BT-3101
Subject Name: Biochemical Engineering
Credit Point: 3 (L=3, T=0, P=0)

C. Course Objectives:

1. To understand the fundamental principles of biochemical processes and their engineering aspects.
2. To study bioreactor design and scaling principles for microbial and enzymatic systems.
3. To explore the kinetics of cell growth, substrate utilization, and product formation.
4. To introduce downstream processing techniques.

B. Course contents:

Introduction to Biochemical Engineering- Overview of biochemical engineering and its role in industry. Historical development of fermentation technology. Microbial culture requirements, media composition (molasses, CSL, whey, synthetic media), and sterilization methods. Isolation and maintenance of industrial microorganisms.

Microbial Growth and Kinetics-Kinetics of microbial growth, product formation (primary/secondary metabolites). Substrate utilization kinetics, death kinetics, and growth models (Monod model, etc.). Inoculum development and aseptic operations. Introduction to metabolic flux and pathway analysis.

Bioreactor Engineering- Design and construction of bioreactors and ancillary systems. Bioreactor types: batch, fed-batch, continuous, CSTR, PFR, air-lift, fluidized bed, and photo-bioreactors. Fermentation parameters: pH, temperature, DO, foam control, agitation and aeration. Control strategies and instrumentation in bioprocessing.

Transport Phenomena and Scale-Up- Heat and mass transfer in bioreactors (oxygen transfer, mixing, rheology). Scale-up principles: geometric, kLa, power, and mixing-time based. Residence Time Distribution (RTD), concentration and temperature gradients. Bioreactors with microbial flocs and biofilms.

Industrial Bioprocesses and Downstream Processing- Production processes: ethanol, citric acid, penicillin, enzymes (amylase, protease), vitamins (e.g., B12), vaccines, and steroids.

D. Text Books:

1. Microbes & Fermentation, A. Lel and Kotlers Richard J. Mickey, Oriffin Publication
2. Industrial Fermentations- Leland, N. Y. Chemical Publishers
3. Biochemical Engineering Fundamentals by James E. Bailey and David F. Ollis second edition.
4. H. W. Blanch and D. S. Clark, Biochemical Engineering, Marcel Dekker, 1996.

D. Reference Books:

1. Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA. Okafor N. (2007).

2. Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001).

3. Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company Glaze A.N. and Nikaido H. (1995).

E. Course Outcomes:

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

CO1 understand biochemical processes, microbial kinetics, and their industrial relevance.
CO2 analyze bioreactor configurations and scale-up criteria used in industrial bioprocesses.
CO3 evaluate the kinetics of cell growth, substrate consumption, and product formation.
CO4 apply engineering principles to fermentation process design and operation.
CO5 examine downstream processing methods.

Subject Code: BT-3102
Subject Name: Computational Biology and Bioinformatics
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

5. To introduce the theoretical foundations of bioinformatics and computational biology.
6. To understand the basic computational tools and programs with relevance to bioinformatics
7. To know various algorithms and their use in sequence analysis, databases search and phylogenetic tree construction
8. To utilize public biological databases and tools for data retrieval, sequence alignment and homology modelling

B. Course Content:

Introduction to Bioinformatics and Computational Biology: Definition, scope, and interdisciplinary nature. Historical development and milestones. Applications in genomics, proteomics, drug design, and systems biology.

Computational Tools and Programming: Introduction to Python and R. BioPython and BioConductor. Sequence parsing and file handling. Basic data visualization and statistics. Overview of machine learning in bioinformatics.

Biocomputing and sequence analysis: Introduction to String Matching Algorithms, Graph matching algorithms, Database Search Techniques, types of databases. Tools for sequence retrieval: Entrez, BLAST interface. Sequence formats: FASTA, GenBank, and PDB. Sequence Comparison and Alignment Technique: Global vs. local alignment. Dynamic programming algorithms: Needleman-Wunsch, Smith-Waterman. Heuristic methods: BLAST, FASTA. Multiple sequence alignment: ClustalW, MUSCLE. Scoring matrices: PAM, BLOSUM. Phylogenetic tree basics: UPGMA, Neighbor-Joining. Applications in Automated genome comparison, gene prediction.

Homology modelling and Molecular dynamics: Levels of protein structure. Homology modelling and structure refinement: SWISS-MODEL, MODELLER. Structure visualization: PyMOL, Chimera. Molecular docking basics. Brief introduction to molecular dynamics (GROMACS overview). Applications of homology modelling and molecular dynamics.

C. Text books:

4. Bioinformatics: Sequence and Genome Analysis – David W. Mount
5. Introduction to Bioinformatics – Arthur Lesk
6. Fundamentals of Bioinformatics and Computational Biology – Gautam B. Singh

D. Reference Books:

4. Biological Sequence Analysis – Richard Durbin et al.
5. An Introduction to Computational Systems Biology – Karthik Raman
6. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins – Andreas D. Baxevanis & B. F. Francis Ouellette

E. Course Outcomes:

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

CO1 understand the role and scope of computational biology and bioinformatics in modern biotechnology.
CO2 apply their programming knowledge to develop bioinformatics tools.
CO3 have clear concept behind sequence alignment, database search and phylogenetic tree construction and they will be able to apply their concept on improving the existing algorithms.
CO4 understand the concept of genome and gene sequences prediction and they will enjoy the use of bioinformatics tools in biological research.
CO5 apply their bioinformatics skills to solve real-world problems in diagnostics, drug design, and synthetic biology.

Subject Code: BT-310A
Subject Name: Analytical Biotechnology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To introduce fundamental principles and applications of analytical techniques in biotechnology.
2. To provide hands-on experience with modern analytical instruments used in biological research.
3. To develop skills in data interpretation and troubleshooting of analytical methods.
4. To understand the role of analytical techniques in diagnostics, therapeutics, and bioprocessing.

B. Course content:

Fundamentals of Analytical Techniques: Understanding accuracy, precision, sensitivity, specificity, limit of detection (LOD), and limit of quantification (LOQ). Emphasis on calibration methods, standard curve preparation, and method validation in accordance with regulatory standards.

Spectroscopic Methods: UV-Visible spectroscopy, fluorescence spectroscopy, infrared (IR) spectroscopy, and circular dichroism (CD) for analyzing biomolecules.

Chromatographic Techniques: Study of paper chromatography, thin-layer chromatography (TLC), ion-exchange chromatography, gel filtration chromatography, affinity chromatography, high-performance liquid chromatography (HPLC), and gas chromatography (GC) for separation and analysis of biomolecules.

Electrophoresis and Centrifugation: Principles and applications of agarose gel electrophoresis, SDS-PAGE, isoelectric focusing, and two-dimensional electrophoresis for nucleic acid and protein analysis. Overview of centrifugation techniques, including differential and density gradient centrifugation, for subcellular fractionation.

Advanced Analytical Techniques: Introduction to mass spectrometry (e.g., MALDI-TOF, ESI) and nuclear magnetic resonance (NMR) spectroscopy for biomolecular characterization. Basics of X-ray crystallography for structural analysis. Discussion on biosensors, enzyme-linked immunosorbent assay (ELISA), flow cytometry, and real-time PCR in biotechnology applications. Atomic absorption spectroscopy (AAS).

C. Text books:

3. Wilson, K., & Walker, J. *Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge University Press.

4. Skoog, D. A., West, D. M., & Holler, F. J. *Fundamentals of Analytical Chemistry*. Cengage Learning.

D. Reference books:

4. Meyer, V. R. *Practical High-Performance Liquid Chromatography*. Wiley.
5. Robyt, J. F., & White, B. J. *Biochemical Techniques: Theory and Practice*. Waveland Press.
6. Gupta, P. K. *Elements of Biotechnology*. Rastogi Publications.

E. Course outcomes:

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

CO1 comprehend the fundamental principles of various analytical techniques used in biotechnology.
CO2 apply spectroscopic and chromatographic methods for the qualitative and quantitative analysis of biomolecules.
CO3 utilize electrophoretic and centrifugation techniques for the separation and analysis of biological samples.
CO4 interpret data obtained from advanced analytical instruments such as mass spectrometers and NMR spectrometers.
CO5 Integrate analytical techniques in the development and optimization of biotechnological processes and products.

Subject Code: CS-2103
Subject Name: Computer Organization & Architecture
Credit Point: 3 **(**L=3, T=0, P=0)

F. ***Course Objectives:***

1. To understand the structure, function and characteristics of computer systems.
2. To understand the design of the various functional units and components of computers.
3. To identify the elements of modern instructions sets and their impact on processor design.
4. To explain the function of each element of a memory hierarchy,
5. To identify and compare different methods for computer I/O.

G. ***Course Content:***

Fundamentals of Computers: Digital computers, layers in computer system, types of computers, history of computers

Data representation and computer arithmetic: Data types, complement, fixed point representation, floating point representation, multiplication and division of sign and unsigned integers.

Micro operation and design of arithmetic logic unit: Register transfer micro operation, bus transfer, memory transfer, arithmetic micro operation, logic micro operation, logic unit, shift unit, design of arithmetic and logic unit.

Instruction set: Instruction code, register, computer instruction, timing and control, instruction cycle, instruction formats, CPU organization, instruction length, addressing standard, addressing mode, instruction set, RISC, CISC.
Design of control unit: hardware control design, micro programmed control.

Memory organization: memory hierarchy, main memory, cache memory, virtual memory.

OEI (MICROBES IN HU**Subject Code:** MH-2201

Subject Name: Entrepreneur Essential and Early-stage Start-up

Credit Point: 3 (L=3, T=0, P=0)

F. ***Course Objectives:***

The course is designed to meet the objectives of:

1. To involve themselves in the business activities

2. Starting innovative practices in their entrepreneurial activities.

3. Developing theirs kills on the traits that they want to carry forward.

G. *Course Content:*

Introduction to Entrepreneurship Meaning, Role of Entrepreneur, Entrepreneur Process: different approaches, Qualities of successful Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur, Issues & Problems Entrepreneurial Practices, Motivation for becoming an Entrepreneur. SME Concept, its role, status, prospects and policies for promotion of SMEs. Importance of Entrepreneurship: innovations, Qualities of successful Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneurs, Issues &Problems Entrepreneurial Practices. Identifying and Assessing the Idea, Identifying Target Segment & Market Sizing, Analysing Environment & Competitive Advantage, Choosing the right legal structure, Permits, Registrations & Compliances, Components of a Business Plan, Creating an Effective B-Plan Part, Valuation, Investor pitch. Importance of Entrepreneurship: Entrepreneurship and Innovations, Converting Innovation to Economic Value which includes, Growth Strategies, value position, Market Segments, Value Chain Structure, Revenue Model, Contribution of Entrepreneurs: Towards R&D, creates Wealth of Nation & Self prospect with Challenge. Characteristics of Entrepreneurship idea generation techniques, Business plan, Strategic Plan etc.

H. *Text Books:*

1. Donald F. Kuratko, Entrepreneurship: Theory, Process, Practice Cengage Learning 2017
2. Desai, Vasant, Small Scale Industries and Entrepreneurship. Himalaya Publishing House, Delhi.2008
3. Kaulgud, Aruna Entrepreneurship Management. Vikas Publishing House, Delhi.2003
4. Cynthia, L. Greene. Entrepreneurship Ideas in Action. Thomson Asia Pvt. Ltd., Singapore. 2004

I. *Reference Books:*

1. Barringer Entrepreneurship: Successfully Launching New Ventures, Pearson Education Publishing 2015
2. Timmons, Jerry A., and Spinelli, Stephen, New Venture Creation: Entrepreneurship for the 21st Century, 8th Edition, Boston, MA: Irwin McGraw-Hill 2009.
3. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001

J. *Programme Outcomes:*

1. Start the venture more scientifically.
2. Start the venture by linking with the financial institutions.

3. Seeking for a start-up idea
4. To be an entrepreneurs

Subject name:-Internship-1

Subject Code: BT-3205
Subject Name: Biochemical Engineering Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

4. To provide hands-on training on techniques used in microbial cultivation and bioprocess operations.
5. To conduct experimental determination of microbial growth kinetics and analysis of fermentation parameters.
6. To provide training on product purification using chromatography.

B. List of Laboratory Experiments:

7. Optimization of Microbial Culture Media
8. Growth Kinetics Study – Determination of specific growth rate (μ), generation time, and growth curve plotting.
9. Effect of pH and Temperature on Microbial Growth – Optimizing environmental parameters for maximal biomass.
10. Centrifugation and cell disruption methods.
11. Cell immobilization technique
12. Demonstration of fermenter

C. Text Books

4. J. E. Bailey and D. F. Ollis. Biochemical Engineering Fundamentals, 2nd Edition, New York, McGraw Hill, 1986.
5. H. W. Blanch and D. S. Clark, Biochemical Engineering, Marcel Dekker, 1996.
6. Najafpour, Ghasem. Biochemical engineering and biotechnology. Elsevier, 2015.

D. Reference Books

3. Levenspiel O, Chemical Reaction Engineering, Wiley India Pvt Ltd, 3rd ed., 2007
4. Endo WB, Enfors SO, Fiechter A, Hoare M, Mattiasson B, Sahm H, Schiigerl K, Stephanopoulos G, yon Stockar U. Advances in biochemical engineering/biotechnology. Springer; 2009.

E. Course Outcomes (COs):

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

CO1 perform microbial cultivation, sterilization, and aseptic operations effectively.
CO2 analyze microbial growth and substrate utilization kinetics through experimental data.
CO3 acquire knowledge on purification of bioproducts.
CO4 examine preparation of different fermented products.

CO5 interpret bioprocess data and correlate experimental outcomes with theoretical models.

Subject Code: BT-3108
Subject Name: Computational Biology and Bioinformatics laboratory
Credit Point: 1 (L=0, T=0, P=2)

I. Course objectives:

J. To critically explore biological databases for use in learning and research
K. To understand how to retrieve gene sequence from chromatogram files and convert to acceptable formats
L. To apply sequence alignment and phylogenetic tools
M. To analyse and interpret gene and domain function using various tools
N. To understand how to predict protein structure and visualise using bioinformatic tools
O. To utilize tools used for docking studies
P. To practice basic scripting for bioinformatics such as Python/Perl.

B. Course content:

8. **Exploration of Biological Databases**
   Access and retrieve data from primary and secondary databases such as GenBank, UniProt, and Pfam.
9. **Gene Sequence Processing and Annotation**
   Open chromatogram files, extract FASTA sequences, annotate ORFs, and convert sequence formats.
10. **Sequence Alignment and Phylogenetic Analysis**
    Perform pairwise and multiple sequence alignments using BLAST, EMBOSS Needle, and Clustal Omega; construct phylogenetic trees using MEGA or Phylogeny.fr.
11. **Gene Function and Domain Analysis**
    Identify ORFs, translate in six frames, and detect conserved domains using NCBI CDD and InterProScan.
12. **Protein Structure Prediction and Visualization**
    Model protein structures using SWISS-MODEL and analyze them using PyMOL and validation tools.
13. **Molecular Docking and Drug Interaction Study**
    Carry out basic docking using AutoDock or SwissDock and interpret ligand binding.
14. **Basic Scripting in Bioinformatics**
    Write and execute simple Python/Perl scripts for sequence parsing, format conversion, and data filtering.

C. Text books:

1. Bioinformatics: Sequence and Genome Analysis – David W. Mount
2. Introduction to Bioinformatics – Arthur Lesk

3. Fundamentals of Bioinformatics and Computational Biology – Gautam B. Singh

D. Reference Books:

1. Biological Sequence Analysis – Richard Durbin et al.
2. An Introduction to Computational Systems Biology – Karthik Raman
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins – Andreas D. Baxevanis & B. F. Francis Ouellette

E. Course Outcomes

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

CO1: Explain key concepts and applications of computational biology and bioinformatics.

CO2: Retrieve, process, and analyze biological data using public databases and standard tools.

CO3: Perform sequence alignment, phylogenetic analysis, and functional annotation.

CO4: Predict and visualize biomolecular structures and perform basic molecular docking.

CO5: Develop and apply simple scripts for biological data analysis using Python or Perl.

Subject Code: BT-3107
Subject Name: Analytical Biotechnology Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

4. To provide hands-on training in techniques for qualitative and quantitative analysis of biomolecules.
5. To enable students to use advanced instruments in biotechnology for analytical purposes.
6. To develop data interpretation skills relevant to analytical tools used in biotechnology and bioengineering.

B. Course content:

6. Estimation of DNA concentration and purity using UV-Vis spectrophotometry
7. Separation of biomolecules by agarose gel electrophoresis and SDS-PAGE
8. Chromatographic separation of amino acids or plant pigments by thin-layer chromatography (TLC)
9. Analysis of a mixture of compounds using paper or column chromatography
10. Demonstration of high end equipments used in biotechnology

C. Text books:

1. Principles & Techniques of Biochemistry & Molecular Biology by Keith Wilson & John Walker.
2. Laemmli UK (1970), Cleavage of structural proteins during the assembly of the head of bacteriophage T4, Nature 227, 680–685.

D. Reference books:

1. S. B. Primrose & R. Twyman – *Principles of Gene Manipulation and Genomics*

C. Course Outcomes:
Upon successful completion of the lab course, students will be able to:
- CO1: Accurately quantify nucleic acids and proteins using spectroscopic methods.
- CO2: Separate and analyse biomolecules using electrophoresis and chromatography.
- CO3: Operate basic analytical instruments and understand their principles.
- CO4: Interpret data and troubleshoot common issues in analytical biotechnology workflows.

Input-output organization: peripheral device, I/O interface and I/O driver, synchronous and asynchronous data transfer, modes of data transfer, priority interrupt, DMA, input- output processor.
Parallel processing: performance measurement of computer, parallel computer structure, general classification of computer architecture, pipelining, vector processing, multiprocessor system, flow computers.
Introduction to Microprocessor: Microcomputer structure and operation, 8086 microprocessor family, Overview, Architecture of processor 8085 and 8086.

H. ***Text Books:***

1. W. Stallings, Computer Organization and Architecture: Designing for Performance,

   Pearson Education India, 2019.
2. A. Patterson and J. L. Hennessy, Computer Organization and Design, Morgan Kaufmann, 2013.
3. S. Tanenbaum, Structured Computer Organization, 5th Ed., Prentice Hall of India, 2013.

I. ***Reference Books:***

1. C. Hamacher, Z. Vranesic, Computer Organisation‖, Tata Mcgraw

Hill, 2011.
2. M. Jain, S.Jain, V. Pillai, Computer Organization and System Software, BPB Publications, 2003.
3. P. Pal Chaudhuri, Computer Organisation & Design, PHI Learning Private Ltd., 2009.

J. *Course Outcomes:*

1. Identify various components of computer and their interconnection
2. Identify basic components and design of the CPU: the ALU and control unit.
3. Compare and select various Memory devices as per requirement.
4. Compare various types of IO mapping techniques
5. Critique the performance issues of cache memory and virtual memory

SUBJECT NAME:- Computer Organization and architecture laboratory

VIth Semester							
Sl No	**Course Code**	**Subject Category**	**Course Title**	**L**	**T**	**P**	**C**
1	BT-3201	MA27-DSC14	Animal Biotechnology	3	0	0	3
2	BT-3202	MA28-DSC15	Indigenous Technical Knowledge of North East India	3	0	0	3
	CS-2203						
3	BT-3203	ELE4-DSE4	Nanotechnology	3	0	0	3
	CS-320A	ELE4-DSE4	Database Management System				
4	BT-320A	ELE5-DSE5	Enzyme Technology				3
	CS-2203	ELE5-DSE5	Design Analysis of Algorithm				
5	BT-320X	OPEN ELE1	**OE2*** (Biosensors and Biotronics)	3	0	0	3
6	BT-3204	AP2-03VAC5	Minor Project	0	0	4	2
7	BT-3205	MA29-LAB10	Indigenous Technical Knowledge of North East India	0	0	2	1
8	BT-3206	ELE6-LAB11	Nano-Biotechnology Laboratory	0	0	2	1
	CS-3207	ELE6-LAB11	Database Management System				
9	BT-3207	ELE7-LAB12	Enzyme Technology Laboratory	0	0	2	1
	CS-2203	ELE7-LAB12	Design Analysis of Algorithm Laboratory				
10	BT-3208	AP2-04-SECC 6	Skilled development course (internship)-04	0	0	2	1
11		HONS2	Gene Therapy				3*
			Contact Hours	15	1	12	
			Total Credits				21
			Total Credits with Honours				24 *

Subject Code:BT-3203
Subject Name: Animal Biotechnology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives

5. To impart foundational knowledge of animal cell culture techniques and their applications.
6. To explore the development and use of transgenic animals in research and industry.
7. To understand the production and application of biopharmaceuticals derived from animal systems.
8. To discuss ethical, regulatory, and biosafety considerations in animal biotechnology.

C. Course Content

Introduction to Animal Biotechnology: Historical background and scope of animal biotechnology. Overview of animal cell culture: types of culture media (natural and synthetic), serum-based and serum-free media, and growth supplements. Laboratory design, aseptic techniques, and biosafety measures.

Animal Cell Culture Techniques: Primary and secondary cell cultures, establishment and maintenance of continuous cell lines. Anchorage-dependent and suspension cultures. Cell growth kinetics, scaling up of cultures using bioreactors, and cryopreservation methods.

Genetic Manipulation and Transgenic Animals: Methods of gene transfer: microinjection, electroporation, viral vectors, and somatic cell nuclear transfer. Creation and applications of transgenic animals in agriculture and medicine. Knockout and knock-in technologies. Ethical and regulatory aspects of transgenic animal research.

Biopharmaceuticals and Therapeutic Proteins: Production of recombinant proteins, monoclonal antibodies, and vaccines using animal cell systems. Hybridoma technology for monoclonal antibody production. Downstream processing and purification techniques. Quality control and regulatory compliance in biopharmaceutical production.

Applications of animal biotechnology: Stem cell technology and regenerative medicine. Tissue engineering and organ culture. In vitro fertilization and embryo transfer techniques. Applications of animal biotechnology in disease modeling, xenotransplantation, and conservation biology.

C. Textbooks

6. Freshney, R.I. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell.
7. Spier, R.E., & Griffiths, J.B. Animal Cell Biotechnology. Academic Press

D. Reference Books

8. Portner, R. Animal Cell Biotechnology: Methods and Protocols. Humana Press.
9. Mather, J.P., & Roberts, P.E. Introduction to Cell and Tissue Culture: Theory and Technique. Springer.
10. Glick, B.R., & Pasternak, J.J. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.

E. Course Outcomes:

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

CO1	understand the principles and practices of animal cell culture and their applications.
CO2	demonstrate proficiency in techniques for genetic manipulation and the development of transgenic animals.
CO3	analyze the processes involved in the production and purification of biopharmaceuticals using animal cell systems.
CO4	evaluate the ethical, regulatory, and biosafety considerations in animal biotechnology research and applications.
CO5	explore advanced applications of animal biotechnology in medicine, agriculture, and conservation.

SUBJECT NAME:-
Indigenoues Technical Knowledge of North East India.

Subject Code: BT-320B
Subject Name: Nano-Biotechnology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To introduce the fundamental concepts of nanoscience, including the unique physical and chemical properties of nanomaterials compared to bulk materials.

2. To familiarize students with various nanoparticle synthesis techniques and their relevance in producing quantum dots, nanocrystalline phases, and surface-functionalized materials.

3. To explain the principles of nanoparticle characterization using modern analytical techniques such as UV-Visible spectroscopy, Fluorescence, XRD, DLS, SEM, AFM, TEM, and EDAX.

4. To explore the interaction of nanoparticles with biological molecules and their integration with natural biomaterials, biopolymers, ceramics, and implantable medical devices.

5. To emphasize the role of nanomaterials in tissue engineering, biosensing, and medical diagnostics, emphasizing their ability to cross biological barriers and function in complex physiological environments.

B. Course content

Fundamentals of Nanoscience and Nanomaterials: Dimensions of nanoscience, Size of bulk versus nanomaterials, Nanoparticle synthesis techniques, Speciality of nanomaterials, Quantum dots and size effect, Classification and properties of nanomaterials, Nanocrystalline phase, Electronic structure of nanoparticles, Physics of small systems & theoretical principles, Effects of surface functionalisation and optical properties, Role of surfaces in nanotechnology devices, Micelles, Colloids Surface active agents, Critical micellar concentration (CMC).

Characterization Techniques for Nanomaterials: Physical characterization of nanoparticles using UV-Visible, Fluorescence Spectrophotometers X-ray diffraction,

DLS, Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Transmission Electron Microscope (TEM), EDAX analysis.

Biomaterials and Nanobiotechnology Interfaces: Applications of nanoparticles, Interaction between biomolecules and nanoparticle surface. Natural Biomaterials, Biopolymers & Ceramics, Some nanocomposite biomaterials, teeth and bone substitution, Natural nanocomposite systems as spider silk, bones, shells; Metallic, Ceramic and Polymeric implant materials, Biomaterials in Tissue Engineering, Nanoparticles to cross biology barriers, Biomaterials and device retrieval and analysis, Biomaterials and central nervous system, Biosensors, semi-conductor nanoparticle, CNT.

Nanotechnology in Diagnostics and Therapeutics: Current status of nanobiotechnology, Nanotechnology in Diagnostics applications, Materials used in Diagnostics and Therapeutic application, Anti-bacterial activity, Developing of Nanomedicines, Drug Carriers & Delivery System, Cancer treatment, Probes for bioimaging, Cardiovascular medical devices. Toxicological health effects caused by nanoparticles.

C. Text Books

1. Lindsay, S.M., Introduction to Nanoscience, Oxford University Press (2010).

2. Niemeyer C.M. and Mirkin, C.A., Nanobiotechnology: Concepts, Applications and Perspectives, Wiley-VCH (2004).

3. Balaji, S., Nanobiotechnology, MJP Publishers (2010).

4. Wang, Z.L., Characterization of Nanophase Materials, Wiley-VCH (2000).

D. Reference Books

1. Rao, C.N.R., Muller, A. and Cheetham, A.K., The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. 1&2, Wiley-VCH (2004).

2. Kumar, C.S.S.R., Hormes, J. and Carola, L., Nanofabrication towards biomedical applications, Wiley-VCH (2005).

3. Christof M. Niemeyer, Chad A. Mirkin Nanobiotechnology: Concepts, Applications and Perspectives, Wiley 2004.

E. Course Outcomes:

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

CO1 differentiate between bulk materials and nanomaterials based on size, properties, and behavior at the nanoscale, and understand the underlying principles such as the quantum size effect and surface phenomena.

CO2 understand various nanoparticle synthesis techniques and functionalization methods, and the classification, unique properties of nanomaterials.

CO3 analyze the structural, morphological, and optical properties of nanomaterials using advanced physical characterization tools such as UV-Vis, DLS, XRD, SEM, TEM, AFM, Fluorescence Spectroscopy, and EDAX.

CO4 identify the use of biopolymers, ceramics, and nanocomposites in medical and tissue engineering applications.

CO5 understand current applications of nanotechnology in diagnostics, therapeutics, drug delivery, bioimaging, and medical devices.

Subject Code: CS-320A
Subject Name: Database Management Systems
Credit Point: 3 (L=3, T=0, P=0)

F. Course Objectives:

1. Introduction & Conceptual Modeling
2. Relational Model: Concepts, Constraints, Languages, Design and Programming
3. Database Design Theory and Methodology
4. Data Storage, Indexing, Query Processing and Physical Design
5. Transaction Processing Concepts
6. Database Security and Authorization

G. Course Content:

Introduction & Conceptual Modelling: Database and Database Users, Database System Concepts and Architecture, Data Modelling using ER Model, Enhanced ER Modelling.

Relational Model: Concepts, Constraints, Languages, Design and Programming: Relational Data Model and Relational Database Constraints, Relational Algebra and Relational Calculus, Relational Database Design by ER to & EER to Relational Mapping, SQL: Schema Definition, Basic Constraints, Queries, Assertions, Views and Programming Techniques.

Database Design Theory and Methodology: Functional Dependencies, Normalization, Relational Database Design Algorithms and Other Dependencies, Practical Database Design Methodology.

Data Storage, Indexing, Query Processing and Physical Design: Disk Storage, File Structures, Hashing, Indexing Structures for Files, Algorithms for Query Processing and Optimization, Practical Database Design and Tuning.
Transaction Processing Concepts: Transaction Processing Concepts and Theory, Concurrency Control Techniques, Database Recovery Techniques.

Database Security and Authorization: Database Security Issues, Discretionary Access Control, Mandatory and Role base Access Control, Statistical Database Security.

H. Text Books:

4. Avi Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, McGraw-Hill, 2020.
5. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of DatabaseSystems, Pearson, 2020.
6. Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-Hill, 2019.

I. Reference Books:

4. C.J.Date, An Introduction to Database Systems, Addison-Wesley ongman, 2014.
5. JeffreyD. Ullman, Principles of Database Systems, Galgotia Publication, 1994.
6. Wilfried Lemahieu, Seppe Vanden Broucke, Bart Baesens, Principles of Database Management, Cambridge University Press, 2020.

J. Course Outcomes:

5. Ability to understand user requirements and develop ER model
6. Ability to map ER model into Relational model
7. Ability to normalize Relational model
8. Ability to implement Relational model using DBMS software
9. Ability to understand Transactions, Recovery and Security of DBMS

Subject Code: BT-321A
Subject Name: Enzyme Technology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives

5. To provide an in-depth understanding of enzyme structure, function, and kinetics.
6. To explore various enzyme immobilization techniques and their industrial applications.
7. To study the production, purification, and characterization of enzymes.
8. To examine the role of enzymes in industrial processes and clinical diagnostics

B. Course Content

Introduction to Enzymes: Introduction to Enzymes Overview of enzyme nomenclature, classification, and structure. Discussion on enzyme specificity, coenzymes, and cofactors. Understanding the mechanisms of enzyme action, including the lock and key model and induced fit hypothesis. Applications of enzymes in industries, clinical diagnosis and therapeutics.

Enzyme Kinetics and Inhibition Mechanisms: Enzyme Kinetics and Inhibition Study of enzyme kinetics, including Michaelis-Menten equation, Km and Vmax. Analysis of factors affecting enzyme activity such as pH, temperature, and substrate concentration. Exploration of enzyme inhibition types: competitive, non-competitive, uncompetitive, and irreversible inhibition.

Enzyme Immobilization and Industrial Utility: Enzyme Immobilization Techniques of enzyme immobilization: adsorption, covalent binding, entrapment, and encapsulation. Evaluation of the effects of immobilization on enzyme activity and stability. Applications of immobilized enzymes in industrial processes.

Enzyme Production and Purification Techniques: Methods for microbial production of enzymes, including fermentation techniques. Strategies for enzyme purification: precipitation, dialysis, chromatography, and electrophoresis. Determination of molecular weight, isoelectric point, and activity assays.

C. Textbooks

3. Trevan, M.D., Boffey, S., Goulding, K.H., & Stanbury, P.F. Biotechnology: Principles and Applications. Tata McGraw-Hill.
4. Palmer, T. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry. Horwood Publishing.

D. Reference Books

4. Price, N.C., & Stevens, L. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins. Oxford University Press.
5. Whitaker, J.R., Voragen, A.G.J., & Wong, D.W.S. Handbook of Food Enzymology. Marcel Dekker.
6. Chaplin, M.F., & Bucke, C. Enzyme Technology. Cambridge University Press.

E. Course Outcomes:

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

CO1 understand the fundamental concepts of enzyme structure and function.

CO2 analyse enzyme kinetics and the effects of various inhibitors.

CO3 apply enzyme immobilization techniques for industrial applications.

CO4 demonstrate proficiency in enzyme production, purification, and characterization methods.

CO5 evaluate the applications of enzymes in industrial processes and clinical diagnostics.

SUBJECT NAME:-Design Analysis of Algorithm

SUBJECT NAME:- OE2(Biosensors and Biotronics)

SUBJECT NAME:-Minor Project

SUBJECT NAME:-Indigenous Technical Knowledge of North East India

Subject Code: BT-3207
Subject Name: Enzyme Technology Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives (Practical)

4. To develop basic laboratory skills for enzyme assay and kinetic analysis.
5. To introduce immobilization techniques and evaluate enzyme performance.
6. To understand enzyme behavior under various physicochemical conditions.

B. List of Experiments

7. Assay of enzyme activity
8. Effect of pH on enzyme activity and determination of optimum pH.

9. Effect of temperature on enzyme activity and thermal stability.
10. Estimation of kinetic parameters (Km and Vmax) using Lineweaver-Burk plot.
11. Enzyme de-activation kinetics
12. Enzyme immobilization

G. Course Outcomes (Practical)

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

CO1	perform basic enzyme activity assays and evaluate data.
CO2	assess the influence of pH and temperature on enzyme performance.
CO3	analyze kinetic behavior of enzymes using experimental data.
CO4	compare activity and stability of free versus immobilized enzymes.

Subject Code: CS-3206
Subject Name: Database Management Systems Laboratory
Credit Point: 1 (L=0, T=0, P=2)

F. Course Objectives:

1. Create and use a database.
2. SQL: DDL, DML & DCL commands.
3. Advanced SQL queries.
4. Development of DBMS applications.

G. Course Content:

1. Data Definition Language (DDL) commands in RDBMS.
2. Data Manipulation Language (DML) and Data Control Language (DCL) commands in RDBMS.
3. High-level language extension with Cursors.
4. High level language extension with Triggers
5. Procedures and Functions.
6. Embedded SQL.
7. Database design using E-R model and Normalization.
8. Design and implementation of Payroll Processing System.
9. Design and implementation of Banking System.
10. Design and implementation of Library Information System.

H. Text Books:

3. Bob Bryla & Kevin Loney, Oracle Database 12C The Complete Reference, Oracle Press, 2020.
4. Steven Feuerstein &Bill Pribyl, ORACLE PL/SQL Programming, Shroff/O'Reilly, 2020.

I. Reference Books:

1. Oracle Database A Complete Guide, Oracle Press, 2021.

J. Course Outcomes:

1. Design database schema for a given application and apply normalization

2. Acquire skills in using SQL commands for data definition and data manipulation.
3. Develop solutions for database applications using procedures, cursors and triggers

SUBJECT NAME:- Design Analysis of Algorithm laboratory

Skill Development course -4

VIIth Semester							
Sl No	**Course Code**	**Subject Category**	**Course Title**	**L**	**T**	**P**	**C**
1	BT-4101	MA30-DSC 16	Pharmaceutical Biotechnology	3	0	0	3
2	BT-4102	MA31-DSC17	Biostatistics	3	0	0	3
3	BT-410A	ELE8-DSE6	Product design and development	3	0	0	3
	BT-410B	ELE8-DSE6	Introduction to Biomedical Engineering & Bio-tronics				
4	BT-411A	ELE9-DSE7	Systems Biology	3	0	0	3
	ME-2103	ELE9-DSE7	Fluid mechanics				
5	BT-412A	ELE10-DSE8	Bio-mass and Biofuels	3	0	0	3
	ME-412B	ELE10-DSE8	Tissue Engineering and Biomaterials				
6	BT-413A	ELE11-DSE9	Cancer Biology and Therapeutics	3	0	0	3
	BT-413B	ELE11-DSE9	Engineering ethics and IPR in Bioengineering				
7	BT-4103	AP2-05-AECC -2	Internship-II	0	0	2	1
8	BT-4104	AP2-06-VAC6	Major Project-I	0	0	6	3
	BT-4105	HONS3	Bioseparation Technology				3*
			Contact Hours	21	0	10	
			Total Credits				22
			Total Credits with Honours				25 *

Subject Name: Pharmaceutical Biotechnology
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

5. To understand the fundamental principles and applications of biotechnology in the pharmaceutical industry
6. To explore the production of biopharmaceuticals, vaccines, and therapeutic proteins using microbial and mammalian systems
7. To comprehend recombinant DNA technology, cell culture techniques, and downstream processing related to drug development
8. To understand regulatory, quality control, and ethical issues in pharmaceutical biotechnology

B. Course content:

Introduction to Pharmaceutical Biotechnology: Definition, scope, and significance, Overview of biologics: therapeutic proteins, monoclonal antibodies, vaccines, biosimilars, Comparison of biopharmaceuticals vs conventional drugs

Microbial and Mammalian Cell Culture Systems: Cell lines used in pharmaceutical production, Growth kinetics

Recombinant DNA Technology in Drug Development: Production of recombinant proteins: insulin, growth hormone, interferons, Molecular biology tools (PCR, blotting, ELISA)

Vaccine Technology and Gene Therapy: Types of vaccines: live attenuated, subunit, DNA/RNA vaccines, Vaccine production and delivery systems, Gene therapy: vectors, delivery methods, clinical trials and challenges

Downstream Processing and Formulation: Protein purification: precipitation, chromatography, filtration, Formulation of biopharmaceuticals: stability, storage, delivery routes, Characterization and quality control of biotech drugs

Regulatory and Ethical Aspects:FDA, EMA, and CDSCO guidelines for biopharmaceutical approval, Good Manufacturing Practices (GMP) and biosafety, Intellectual Property Rights and ethical considerations

C. Text books:

5. Gary Walsh – Pharmaceutical Biotechnology: Concepts and Applications
6. Subramanian, S. – Biotechnology: Pharmaceutical Aspects
7. B. R. Glick & J. J. Pasternak – Molecular Biotechnology: Principles and Applications
8. Sambamurthy, K. – Pharmaceutical Biotechnology

D. Reference books:

5. Crommelin, D. J. A., Sindelar, R. D., &Meibohm, B. – Pharmaceutical Biotechnology: Fundamentals and Applications
6. Shanmugam, S. – Biopharmaceuticals: Biochemistry and Biotechnology
7. Thieman, W. J., &Palladino, M. A. – Introduction to Biotechnology
8. R. K. Jain – Textbook of Pharmaceutical Biotechnology

E. Course Outcomes:

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

CO1	comprehend the principles and applications of biotechnology in pharmaceutical sciences.
CO2	utilize microbial and mammalian systems for the production of biopharmaceuticals.
CO3	implement recombinant DNA technology and cell culture methods in therapeutic product development.

CO4 understand production, formulation, and characterization of vaccines and biotech drugs.
CO5 assess regulatory pathways, quality assurance, and ethical implications in drug development.
CO6 demonstrate basic laboratory skills relevant to pharmaceutical biotechnology.

Subject Code: BT-3103
Subject Name: Biostatistics
Credit Point: 3 (L=3, T=0, P=0)

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1. **Course Objectives:**
4. To introduce students to statistical concepts used in biological science
5. To develop understanding of data visualization, probability, and inference
6. To apply hypothesis testing and data modelling to biological problems

B. Course content:

Biological Data Types and Descriptive Statistics: Types of biological data: categorical, continuous, time-series, spatial, omics data. Data scales: nominal, ordinal, interval, ratio. Descriptive statistics: mean, median, mode, range, quartiles, standard deviation, standard error. Data visualization: bar chart, pie chart, histogram, scatter plot, line graph. Error bars and variability; identifying outliers. Introduction to data normalization and transformation.

Probability and Probability Distributions: Basics of probability: events, sample space, rules of probability. Conditional probability and independence. Bayes' theorem and its applications in biological contexts. Discrete distributions: binomial, multinomial, Poisson. Continuous distributions: exponential, Gaussian (normal).

Statistical Inference and Hypothesis Testing: Concepts of statistical inference and p-value. Hypothesis testing: null and alternative hypotheses. Parametric tests: one-sample and two-sample t-test, Z-test. Chi-squared test. One-way and two-way ANOVA. Interpretation of statistical results in biological contexts.

Correlation, Regression, and Estimation: Pearson and Spearman correlation, Linear regression: simple and multiple regression, Non-linear regression, Assumptions of regression models and model diagnostics, Introduction to model fitting: least squares, residuals. Likelihood, concept of likelihood function, Maximum Likelihood Estimation (MLE): concept and examples

C. **Text Books:**

1. S. Ross, A First Course in Probability, 9th Edition, Pearson Education India, 2014.
2. R. C. Elston and W. D. Johnson, Basic Biostatistics for Geneticists and Epidemiologists: A Practical Approach, 1st Edition, Wiley, 2008.

D. Reference Books:

1. M. C. Whitlock, and D. Schluter, The Analysis of Biological Data, 2nd Edition, W. H. Freeman & Company, 2014.
2. G. P. Quinn, and M. J. Keough, Experimental Design and Data Analysis for Biologists, 1st Edition, Cambridge University Press, 2002.
3. M. D. Ugarte, A. F. Militino, and A. T. Arnholt, Probability and Statistics with R, 2nd Edition, CRC Press, 2016.

E. Course Outcomes:

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

CO1 classify and interpret different types of biological data and apply descriptive statistical measures for summarizing biological datasets.
CO2 understand how to apply fundamental concepts of probability and probability distributions to biological problems.
CO3 perform hypothesis testing using appropriate statistical methods (e.g., t-tests, ANOVA, chi-squared test) and interpret the biological significance of the results.
CO4 analyze relationships between biological variables using correlation and regression techniques.

Subject name:-Product design and development

Subject Code: BT-410A
Subject Name: Introduction to Biomedical Engineering & Bio-tronics
Credit Point: 3 (L=3, T=0, P=0)

D. Course Objectives:

6. To introduce the foundational principles of biomedical engineering and biotronic systems.
7. To explain how biological systems interface with electronic devices for diagnostic and therapeutic applications.
8. To help students understand different bio signal acquisition methods and the role of bioinstrumentation.
9. To show how nanotechnology and materials science enhance biomedical devices and sensors.
10. To provide insight into device design, miniaturization, and development of wearable/implantable health technologies.

B. Course Content:

Fundamentals of Biomedical Engineering: Definition and scope of biomedical engineering; Historical background and milestones; Applications in healthcare, diagnostics.

Biocomponents & Biorecognition Systems: Biomolecules in diagnostics: Enzymes, antibodies, DNA/RNA; Immobilization strategies; Interaction principles – specificity, affinity, and selectivity; Signal generation in biological systems; Concepts of label-free and label-based detection; Examples from diagnostic kits and therapeutic devices.

Biomedical Signal Transduction: Transduction principles and classification: Optical (absorbance, fluorescence), Electrical (ECG, EEG), Electrochemical (potentiometric, amperometric, impedimetric); Mechanical (piezoelectric sensors); Signal acquisition and conditioning circuits.

Nanotechnology in Biotronics: Introduction to nanomaterials and classification: 0D to 3D nanostructures; Nanomaterial properties for biomedical use (biocompatibility, conductivity); Synthesis of biomedical nanomaterials: metallic (Au, Ag, Pt), metal oxides (ZnO, TiO_2, Fe_2O_3), carbon-based (CNTs, graphene); Hybrid nanocomposites; Use in bio-signal enhancement and drug delivery.

Bio-tronics & Biomedical Device Engineering: Introduction to bio-tronics and bioelectronic systems; Types of electrodes – Working, Reference, Counter; Biomedical interfaces; Wearable and implantable medical devices (pacemakers, insulin pumps, smart bands); Microfabrication methods: photolithography, screen printing, soft lithography; Lab-on-chip, microfluidics, and point-of-care devices.

C. Text books

3. Analytical Electrochemistry, 2nd edition. Joseph Wang
4. Biosensors an Introduction, First edition, Brian R Eggins

D. Reference books

1. Zhang X. ZuH. Wang J. (2018). Electrochemical Sensors, Biosensors and their Biomedical applications. Elsevier Science and Technology Books

2. Jason J Davis. (2009). Engineering the bioelectronic interface.

3. Egbo, Munonyedi Kelvin. "A fundamental review on composite materials and some of their applications in biomedical engineering." Journal of King Saud University-Engineering Sciences 33, no. 8 (2021): 557-568.

E. Course Outcomes:

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

CO1 describe the fundamental concepts and interdisciplinary scope of biomedical engineering and its role in modern healthcare solutions.
CO2 understand the types and functions of biorecognition elements (e.g., enzymes, antibodies, nucleic acids) and immobilization strategies.
CO3 differentiate among various types of transducers, including electrochemical, optical, and piezoelectric, and understand their underlying detection principles.
CO4 analyze the role of nanomaterials in improving the functionality, sensitivity, and miniaturization of biomedical devices.
CO5 demonstrate an understanding of bio-tronics, including wearable and implantable systems, and the fabrication technologies used in developing micro-scale biomedical devices.

Subject Code: BT-321B
Subject Name: Systems Biology

Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To introduce the fundamental principles and concepts of systems biology.
2. To develop mathematical and computational modeling skills for analyzing biological systems.
3. To understand the dynamics of biological networks and their regulatory mechanisms.
4. To apply systems biology approaches in interpreting high-throughput biological data.

B. Course content:

Introduction to Systems Biology: Definition, scope, and significance of systems biology. Key concepts: dynamic systems, networks, self-organization, emergent properties, homeostasis, and robustness in biological contexts.

Modeling of Biological Systems: Deterministic models using ordinary differential equations (ODEs); numerical methods for solving ODEs; graphical analysis including direction fields and phase planes; stability analysis of linear and nonlinear systems; bifurcation theory and its biological implications.

Molecular Networks and Network Motifs: Structure and function of molecular networks; identification and analysis of network motifs; mathematical modeling of elementary molecular processes such as ligand binding, enzymatic reactions, transcription, and translation; analysis of feedback loops, biochemical switches, and transcriptional circuits; concepts of bistability and hysteresis.

Stochastic Modeling in Biochemical Networks: Introduction to stochastic processes in biology; probability distributions relevant to biochemical systems (Binomial, Poisson, Exponential); Poisson processes and their applications; stochastic simulation algorithms including Gillespie's algorithm; impact of noise on gene expression and cellular decision-making.

Case Studies illustrating the applications of systems biology in real world scenarios.

C. Text books:

3. Alon, U. *An Introduction to Systems Biology: Design Principles of Biological Circuits*. Chapman & Hall/CRC, 2006.
4. Murray, J.D. *Mathematical Biology: I. An Introduction*. Springer, 2002.

D. Reference books:

4. Wolkenhauer, O. *Systems Biology: Dynamic Pathway Modeling*. Springer, 2010.

5. Nowak, M.A. *Evolutionary Dynamics: Exploring the Equations of Life*. Belknap Press, 2006.

6. Klipp, E., Herwig, R., Kowald, A., Wierling, C., & Lehrach, H. *Systems Biology in Practice: Concepts, Implementation and Application*. Wiley-VCH, 2005.

E. Course outcomes:

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

CO1 comprehend and articulate the fundamental concepts and significance of systems biology.
CO2 develop and analyze mathematical models representing biological systems.
CO3 interpret and simulate the behavior of molecular networks using computational tools.
CO4 apply stochastic modeling techniques to understand variability in biological processes.
CO5 integrate and analyze high-throughput biological data using systems biology approaches.

Subject Code: ME-2103
Subject Name: Fluid Mechanics
Credit Point: 3 (L=3, T=0, P=0)

F. Course Objectives:

1. Illustrate the properties of fluids and the applications of fluid mechanics.
2. Understand the fundamental of kinematics and dynamics of fluid flows and the governing non-dimensional parameters of a fluid element.
3. Apply the concepts of mass, momentum and energy conservation to flows.
4. Describe the fundamentals of incompressible viscous flow, various flow measurement devices and boundary layer concepts.
5. Solve simplified problems analytically.

G. Course Content:

Review of fundamentals: Introductory concepts, properties and classification of fluids, basic hydrostatic equation, measurement of pressure, forces on submerged plane and curved surfaces, buoyancy and stability.

Kinematics of fluids: Streamline, pathline, streakline, scalar and vector fields, flow field and description of fluid motions, deformation of fluid element.

Conservation equations: integral and differential formulations - conservation of mass, conservation of momentum and conservation of energy; Bernoulli equation, stream function, velocity potential and vorticity, Euler equation.

Principles of physical similarity and dimensional analysis: Introduction, concept and type of physical similarity, applications of dynamic similarity, dimensional analysis.

Some incompressible viscous flows: Reynolds experiment, plane Poiseuille flow, Hagen Poiseuilleflow, Couetteflow, losses

in pipes, friction factors, hydraulic diameter, pipes in series and parallel.

Flow measurement devices: Pilot tube, venturi meter, orifice meter, orifice and mouthpieces, pitot static tube.

Boundary layer concept: Introduction to laminar boundary layer for flow over a flat plate – boundary layer thickness, displacement and momentum thickness.

H. Text Books:

1. Som, S. K.,.Biswas, G and Chakraborty, S., "Introduction to Fluid Mechanics and Fluid Machines", TMH, 2017, 3rd Ed.
2. Munson, B. R., Young, D. F., Okiish, T. H., "Fundamental of Fluid Mechanics", Wiley, 2012, 7th Ed.
3. Cengel Y. A. and Cimbala J. M., Fluid Mechanics: Fundamentals and applications, McGraw, 2019, 4th Ed.

I. Reference Books:

1. White, F. M., "Fluid Mechanics", TMH, 2014, 8th Ed.
2. Fox, R. W., McDonald, A. T., Pritchard, P. J., "Introduction to Fluid Mechanics", 2003, 6th Ed.

J. Course outcomes:

1. Understand the basics of fluid statics, kinematics and dynamics.
2. Describe the fundamentals of incompressible viscous flow, various flow measurement devices and boundary layer concepts.
3. Analyse fluid flow problems with the applications of mass and momentum.
4. Apply principles of dimensional analysis and similitude to simple problems and use dimensionless parameters.

Subject Code: BT-411A
Subject Name: Bio-mass and Biofuels
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

5. To commend a foundational understanding of biomass resources and their conversion into biofuels
6. To explore various biochemical and thermochemical pathways for biofuel production
7. To understand the design and operation of biofuel production systems and related technologies
8. To evaluate the environmental, economic, and sustainability aspects of biomass energy

B. Course content:

Introduction to Biomass and Bioenergy: Definition and classification of biomass, Global and national biomass energy potential, Comparison of fossil fuels and biofuels, Biomass resources: lignocellulosic, algal, agricultural, and forest residues

Biomass Characterization and Pretreatment: Chemical composition: cellulose, hemicellulose, lignin, extractives, Physical and thermochemical characterization, Biomass densification (pellets, briquettes), Pretreatment methods: mechanical, chemical, biological

Biochemical Conversion Technologies: Anaerobic digestion: process, factors, and biogas production, Fermentation: ethanol production from sugars, starches, and lignocellulose, Biodiesel production: transesterification of oils/fats, Microbial and enzymatic routes in biofuel generation

Thermochemical Conversion Technologies: Pyrolysis types, bio-oil production, Gasification: syngas generation and applications, Combustion and co-firing, Hydrothermal liquefaction and torrefaction

Algal Biofuels and Advanced Biofuels: Algae as biomass: growth systems, harvesting, oil extraction, Drop-in biofuels: green diesel, bio-butanol, bio-jet fuels, Genetic engineering in biofuel-producing microbes, Current research and future prospects

Life cycle assessment of biofuels.

C. Text books:

5. Demirbas, A. – Biofuels: Securing the Planet's Future Energy Needs
6. S. N. Naik – Biomass to Biofuels: Strategies for Global Industries
7. Pandey, A., Larroche, C., et al. – Biofuels: Alternative Feedstocks and Conversion Processes
8. Kamm, B., Gruber, P. R., &Kamm, M. – Biorefineries – Industrial Processes and Products

D. Reference books:

5. Mital, K. M. – Biogas Systems: Principles and Applications
6. Boyle, G. – Renewable Energy: Power for a Sustainable Future
7. Kumar, A. &Yadav, G. – Biomass and Bioenergy Technologies
8. Sims, R. – The Brilliance of Bioenergy: In Business and in Practice

H. Course Outcomes:

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

CO1 understand the types and potential of biomass as a renewable energy source.
CO2 apply knowledge of biochemical and thermochemical pathways for converting biomass into usable energy.
CO3 analyze and operate basic biofuel production systems such as biodiesel, biogas, and ethanol.
CO4 evaluate biomass properties and their influence on energy conversion processes.

CO5explore advanced technologies in algal and microbial biofuels and assess the environmental, social, and policy aspects of bioenergy deployment.

Subject Code: BT-411B
Subject Name: Tissue Engineering and Biomaterials
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

5. To provide an in-depth understanding of the principles of tissue engineering and the role of biomaterials in regenerative medicine
6. To explore the types, design, and biocompatibility of biomaterials used in tissue scaffolding and implants
7. To emphasize cell–material interactions, scaffold fabrication techniques, and clinical applications
8. To train students in laboratory techniques for scaffold development, cell culture, and tissue characterization

B. Course content:

Introduction to Tissue Engineering: Concept and historical background of tissue engineering, Basic components: cells, scaffolds, signaling molecules, Tissue engineering triad and its integration

Biomaterials for Tissue Engineering: Classification of biomaterials: natural vs synthetic, Properties of biomaterials: mechanical, chemical, biological, Biodegradability and bioactivity, immunological response, Biomaterials used in orthopedics, cardiovascular, and skin regeneration

Scaffold Fabrication Techniques: Fabrication methods: solvent casting, electrospinning, freeze-drying, 3D printing, Surface modification and functionalization of scaffolds, Porosity, pore size, and interconnectivity in scaffold design

Cell Sources and Cell–Biomaterial Interaction: Types of cells used: stem cells, primary cells, iPSCs, Cell adhesion, migration, proliferation, and differentiation on scaffolds, Co-culture and organoid systems, Cell seeding strategies and dynamic culture systems (bioreactors)

Growth Factors and Bioreactors: Role of cytokines and growth factors in tissue regeneration, Controlled release systems and delivery mechanisms, Design and use of bioreactors for engineered tissues (perfusion, rotating wall, spinner flask)

Clinical Applications and Challenges: Case studies: skin, cartilage, bone, and vascular tissue engineering, FDA regulations and clinical trial procedures for engineered products, Ethical issues and commercialization in regenerative medicine

C. Text books:

5. Lanza, R. P., Langer, R., &Vacanti, J. – Principles of Tissue Engineering, Academic Press

6. Ratner, B. D. et al. – Biomaterials Science: An Introduction to Materials in Medicine, Elsevier
7. Palsson, B. O. & Bhatia, S. N. – Tissue Engineering, Pearson
8. Saltzman, W. M. – Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues

D. Reference books:

5. Hench, L. L., & Jones, J. R. – Biomaterials, Artificial Organs and Tissue Engineering
6. Temenoff, J. S., &Mikos, A. G. – Biomaterials: The Intersection of Biology and Materials Science
7. O'Brien, F. J. – Biomaterials & Scaffolds for Tissue Engineering
8. Bhat, S. V. – Biomaterials, Narosa Publishing House

G. Course Outcomes:

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

CO1 understand the foundational principles of tissue engineering and the role of biomaterials in regenerative therapies.
CO2 classify and evaluate biomaterials based on their properties and suitability for specific tissue engineering applications.
CO3 fabricate and characterize scaffolds using various techniques and assess their physicochemical and biological properties.
CO4 analyze cell–material interactions and implement strategies for effective tissue regeneration.
CO5 utilize knowledge of bioreactors, growth factors, and stem cells in tissue engineering designs.
CO6 assess clinical case studies and understand the regulatory and ethical landscape of regenerative medicine.

Subject Code: BT-412A
Subject Name: Cancer Biology and Therapeutics

Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

5. To introduce students to the cellular and molecular basis of cancer
6. To understand genetic, epigenetic, and environmental factors in cancer initiation and progression
7. To explore current and emerging cancer therapies, including chemotherapy, targeted therapy, and immunotherapy
8. To familiarize students with diagnostic tools and research approaches in oncology.

B. Course content:

Fundamentals of Cancer Biology: Definition, hallmarks of cancer, differences between normal and cancer cells, Types and stages of cancer, Cancer epidemiology and major risk factors

Molecular Mechanisms of Oncogenesis: Oncogenes, tumor suppressor genes, proto-oncogenes, Cell cycle regulation and checkpoints, Apoptosis and cancer; signal transduction in cancer

Tumor Microenvironment and Metastasis: Angiogenesis, tumorstroma, immune evasion, Invasion, metastasis, epithelial-mesenchymal transition (EMT), Role of inflammation and hypoxia in tumor progression

Diagnostic and Molecular Tools in Oncology: Tumor markers, biopsy, imaging techniques (MRI, CT, PET), Flow cytometry, immunohistochemistry, PCR, RT-PCR, next-generation sequencing, Biomarker discovery and liquid biopsy

Cancer Therapeutics – Conventional and Targeted: Chemotherapy, radiation therapy – mechanism and side effects, Targeted therapies (TKIs, PARP inhibitors), monoclonal antibodies, Hormone therapy and angiogenesis inhibitors

Cancer Immunotherapy and Emerging Approaches: Checkpoint inhibitors (PD-1, CTLA-4), CAR-T cell therapy, Cancer vaccines and oncolytic viruses, Personalized medicine and nanotechnology-based drug delivery

Case Studies and Ethical Considerations: Case discussions on breast, lung, and colorectal cancers, Ethical issues in cancer research and clinical trials, Access to treatment and palliative care

C. Text books:

5. Weinberg, R. A. – The Biology of Cancer
6. King, R. J. B. – Cancer Biology
7. Pecorino, L. – Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics
8. Abbas, A. K., &Lichtman, A. H. – Basic Immunology (for immunotherapy background)

D. Reference books:

5. DeVita, Hellman, & Rosenberg – Cancer: Principles and Practice of Oncology
6. Mukherjee, S. – The Emperor of All Maladies: A Biography of Cancer
7. Tannock, I. F. et al. – The Basic Science of Oncology
8. Darnell, J., Lodish, H., & Baltimore, D. – Molecular Cell Biology (selected chapters on cancer)

B. Course Outcomes:

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

CO1 explain the cellular and molecular basis of cancer initiation, progression, and metastasis.
CO2 identify key oncogenes, tumor suppressors, and signaling pathways involved in cancer.
CO3 distinguish between conventional and advanced cancer diagnostics and treatments.
CO4 analyze therapeutic strategies such as chemotherapy, targeted therapy, and immunotherapy.
CO5 demonstrate laboratory techniques relevant to cancer biology research.

CO6 discuss ethical, social, and clinical aspects of cancer care and drug development.

Subject name:-Engineering ethics and IPR in Bioengineering

Subject name:-Internship-II

Subject name:- Major Project-I