B.Tech. BIOTECHNOLOGY

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FOREWORD

The discipline of Biotechnology is unique in that it is an interdisciplinary science with the flavor of technology and entrepreneurship. A few disciplines such as Lifesciences, Chemistry, Physics, Chemical Engineering, Bioinformatics, Intellectual Property Rights, Marketing and Entrepreneurship have moulded the discipline of Biotechnology as a professional engineering subject. The bio-products such as vaccines, biofuels, biomaterials, biosensors, therapeutic immunoglobulins, diagnostic monoclonal antibodies, conditioned stem cells for therapy, dendritic cell based vaccines, gene therapy such as ADA in SCID subjects, bio-similars, innumerable combinations of phyto-pharmaceuticals and cell based assays for the evaluation of safety of drugs released into the market over the past 50 years revolutionized the health and nutritional requirements of humans and livestock.

In compliance with the fast growing societal and industrial importance of bio-products, the R-22 curriculum encompassing NEP-20 compliant regulations for a four-year program in B.Tech. Biotechnology is designed to suit students in their profession such as self-employment or higher education. The pool of professional electives of odd semester and even semester are given. The student will be having the option to choose eight professional electives over the semesters starting from 2(2) semester onwards. There is also a provision for students to opt for open electives from other engineering disciplines. Further, there is one semester-long internship in 4(2) semester that provides industrial / research exposure to students. R-22 curriculum also allows students to get exposed to project based learning so as to inculcate in them the real time experience.

R22 curriculum comprises of:

Professional Core Courses	Honors Program
Professional Electives	Semester-long internship
Industry-Interface Course	Research Projects
Option to select NPTEL /SWAYAM courses for Add-on Certificate/Honors	Computer based core courses

R-22 curriculum is in compliance with NEP-20 wherein there is a provision for Exit at the end of Third Year if the student wishes to do so. Further, the R-22 Curriculum is designed to inculcate among students learning, thinking, understanding, skilling, applying and creativity.

Prof. S. Krupanidhi
Dean-Natural Sciences and
Applied Technology

Prof. T.C. Venkateswarulu
BoS Chairman and HoD, BT

VIGNAN'S
Foundation for Science, Technology & Research
(Deemed to be UNIVERSITY)
-Estd. u/s 3 of UGC Act 1956

VISION

To evolve into a Centre of Excellence in Science & Technology through creative and innovative practices in teaching - learning, towards promoting academic achievement and research excellence to produce internationally accepted, competitive and world class professionals who are psychologically strong & emotionally balanced, imbued with social consciousness & ethical values.

MISSION

To provide high quality academic programmes, training activities, research facilities and opportunities supported by continuous industry – institute interaction aimed at promoting employability, entrepreneurship, leadership and research aptitude among students and contribute to the economic and technological development of the region, state and nation.

Department of BIOTECHNOLOGY

VISION of the department

To pursue academic and research excellence and promote interdisciplinary interest among biotechnology graduates through innovative teaching practices and industry interactions besides inculcating ethical values to shape them into socially responsible individuals.

MISSION of the department

To impart current developments to young biotechnologists through value based education and explore opportunities for supporting research and technology transfer with a broad thrust on areas relating to agriculture, pharmacy, human health and environment and ultimately to serve the community and nation at large.

B.Tech in Biotechnology

Program Educational Objectives (PEOs)

PEO1: Identify and analyse biomaterials produced by biological species.

PEO2: Apply molecular tools and techniques to address challenges in genetic and tissue engineering domains.

PEO3: Communicate and draft effectively to demonstrate entrepreneurial and leadership skills.

Program Specific Outcomes (PSOs)

PSO1: Apply the process engineering principles of Biotechnology in manufacturing bioproducts, sustaining habitat ecosystem and augmenting health supporting systems.

PSO2: Adopt the modern tools of Biotechnology for improving the entrepreneurship skills.

Program Outcomes (POs)

PO1: **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem analysis:** Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5: **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project management and finance:** Demonstrate knowledge and understanding of the Engineering and management principle member and leader in a team, to manage projects and in multidisciplinary environments.

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.

R22 B.Tech.
4 YEAR
DEGREE PROGRAMME

COURSE STRUCTURE - R22

I Year I Semester

Course Code	Course Title	L	T	P	C	Course category
22MT101	Elementary Mathematics	3	2	0	4	Basic Sciences
22PY101	Applied Physics	2	0	2	3	Basic Sciences
22EE101	Basics of Electrical and Electronics Engineering	2	0	2	3	Basic Engineering
22BT103	IT Workshop and Bioproducts	1	0	4	3	Basic Engineering
22TP103	Programming in C	2	0	4	4	Basic Engineering
22EN102	English Proficiency and Communication Skills	0	0	2	1	Humanities
22SA101	Physical Fitness, Sports and Games - I	0	0	3	1	Binary grade
22TP101	Constitution of India	0	2	0	1	Binary grade
Total		**10**	**4**	**17**	**20**	
		31 Hrs				

I Year II Semester

Course Code	Course Title	L	T	P	C	Course category
22MT110	Matrices and Differential Equations	3	2	0	4	Basic Sciences
22CT104	Organic Chemistry	2	0	2	3	Basic science
22TP104	Basic Coding Competency	0	1	3	2	Basic Engineering
22ME101	Engineering Graphics	2	0	2	3	Basic Engineering
22EN104	Technical English Communication	2	0	2	3	Humanities
22BT102	Good Laboratory Practices	2	2	0	3	Professional core
22SA103	Physical Fitness, Sports & Games – II	0	0	3	1	Binary grade
22SA102	Orientation Session	0	0	6	3	Binary grade
Total		**11**	**5**	**18**	**22**	
		34 Hrs				

Department Subject is extension of Basic sciences

COURSE STRUCTURE - R22

R22 B.Tech.
4 YEAR
DEGREE PROGRAMME

II Year I Semester

Course Code	Course Title	L	T	P	C	Course category
22ST201	Biostatistics and Design of Experiments	3	2	0	4	Basic Sciences
22TP201	Data Structures	2	2	2	4	Basic Engineering
22BT101	Cell and Molecular Biology	3	0	2	4	Professional core
22BT201	Biochemistry and Enzymology	3	0	2	4	Professional core
22BT202	Chemical Engineering Principles in Biotechnology	2	0	2	3	Professional core
22BT203	Microbiology and Fermentation Technology	3	0	2	4	Professional core
22SA201	Life Skills-I	0	0	2	1	Binary grade
Total		**16**	**4**	**12**	**24**	
	NCC/ NSS/ SAC/ E-cell/ Student Mentoring/ Social activities/ Publication.	0	0	0	1	Floating credits Binary grade
Total		**16**	**4**	**12**	**25**	
		32 Hrs				

II Year II Semester

Course Code	Course Title	L	T	P	C	Course category
22TP203	Advanced Coding Competency	0	0	2	1	Basic Engineering
22TP204	Professional Communication	0	0	2	1	Humanities
22BT204	Bioanalytical Techniques	3	0	2	4	Professional core
22BT205	Industrial Biotechnology	3	0	2	4	Professional core
22CT201	Environmental Studies	1	1	0	1	Basic Sciences
22MS201	Management Science	2	2	0	3	Humanities
	Department Elective – 1	2	2	0	3	Department Elective
	Open Elective – 1	2	2	0	3	Open Elective
22SA202	Life Skills-II	0	0	2	1	Binary grade
Total		**13**	**7**	**10**	**21**	
	Minor / Honours - 1	3		2	4	
Total		**35 Hrs**				

R22 B.Tech.
4 YEAR
DEGREE PROGRAMME

COURSE STRUCTURE - R22

III Year I Semester

Course Code	Course Title	L	T	P	C	Course category
22TP301	Soft Skills Laboratory	0	0	2	1	Humanities
22BT301	Bioprocess Engineering	3	0	2	4	Professional core
22BT302	Genetic Engineering	3	0	2	4	Professional core
22BT303	Heat and Mass Transfer	2	0	2	3	Professional core
	Department Elective – 2	2	2	0	3	Department Elective
	Open Elective – 2	2	2	0	3	Open Elective
22BT305	Industry interface course (Modular course)	1	0	0	1	Binary Grades
22BT304	Inter-Disciplinary Project Phase-I	0	0	2	0	Project
Total		**13**	**4**	**10**	**19**	
	NCC/ NSS/ SAC/ E-cell/ Student Mentoring/ Social activities/ Publication.	0	0	0	1	Floating credits Binary grade
	Minor / Honours - 2	3	0	2	4	
Total			**32**		**24**	
		32 Hrs				

III Year II Semester

Course Code	Course Title	L	T	P	C	Course category
22TP302	Quantitative aptitude and Logical reasoning	1	2	0	2	Humanities
22BT306	Bioinformatics	3	0	2	4	Professional core
22BT307	Bioreaction Engineering	3	0	2	4	Professional core
	Department Elective – 3	2	2	0	3	Department Elective
	Department Elective – 4	2	2	0	3	Department Elective
	Open Elective – 3	2	2	0	3	Open Elective
22BT308	Inter-Disciplinary Project Phase-II	0	0	2	2	Project
Total		**13**	**8**	**6**	**21**	
	Minor / Honours - 3	3	0	2	4	
Total			**32**		**25**	
		32 Hrs				

COURSE STRUCTURE - R22

R22 B.Tech.
4 YEAR
DEGREE PROGRAMME

IV Year I Semester

Course Code	Course Title	L	T	P	C	Course category
22BT401	Down Stream Processing	3	0	2	4	Professional core
22BI301	Immunology and Immunoinformatics	3	0	2	4	Professional core
	Department Elective – 5	2	2	0	3	Department Elective
	Department Elective – 6	2	2	0	3	Department Elective
	Department Elective – 7	2	2	0	3	Department Elective
	Department Elective – 8	2	2	0	3	Department Elective
	Total	**14**	**8**	**4**	**20**	
	Minor / Honours – 4	3	0	2	4	
	Total		**31**		**24**	
		31 Hrs				

IV Year II Semester

Course Code	Course Title	L	T	P	C	Course category
22BT402	Internship / Project Work		2	22	12	Project
	Total				**12**	
	Minor / Honours – 5 (for project)	0	2	6	4	**Theory course may be also offered**
	Total		**32**		**16**	
		32 Hrs				

for interaction between Guide and students

R22 B.Tech. 4 YEAR DEGREE PROGRAMME

COURSE STRUCTURE - R22

Department Electives

Course Code	Course Title	L	T	P	C
22BT801	3D Bioprinting	2	2	0	3
22BT802	Biodiversity and Ecology	2	2	0	3
22BT803	Bioenergetics	2	2	0	3
22BT804	Bioethics and Intellectual Property Rights	2	2	0	3
22BT805	Biopharmaceutical Technology	2	2	0	3
22BT806	Genetics	2	2	0	3
22BT807	Genomics and Proteomics	2	0	2	3
22BT808	Instrumentation and Process Control	2	2	0	3
22BT809	Metabolic Engineering	2	0	2	3
22BT810	Phage Display	2	2	0	3
22BT811	Phytopharma	2	0	2	3
22BT812	Plant Taxonomy, Computer Applications and DNA Barcoding	2	0	2	3
22BT813	Plant Tissue Culture and Transgenics	2	0	2	3
22BT814	Solid Waste Management	2	0	2	3
22BT815	Vaccinology	2	0	2	3
22BT816	Algorithms in Bioinformatics	2	0	2	3
22BT817	Biosensors	2	2	0	3
22BT818	Cancer Biology and Therapy	2	2	0	3
22BT819	Computer Aided Drug Design	2	0	2	3
22BT820	Handling of Animals for Experiments	2	0	2	3
22BT821	Health Economics	2	2	0	3
22BT822	Health Informatics	2	2	0	3
22BT823	Methods and Practice of Animal and Human Cell Culture	2	0	2	3
22BT824	Molecular Interactions	2	0	2	3
22BT825	Molecular Phylogenetics	2	2	0	3
22BT826	Nanobiotechnology	2	2	0	3
22BT827	Python Programming for Biotechnologists	2	0	2	3
22BT828	Regulatory affairs and clinical trails	2	2	0	3
22BT829	Systems Biology	2	0	2	3
22BI802	Bioprocess Economics, Modeling and Simulations	2	2	0	3

Honours - Functional Foods and Metagenomics

Functional foods are ingredients that offer health benefits that extend beyond their nutritional value. Some types contain supplements or other additional ingredients designed to improve health. The functional foods handle the enrichment of nutrients in the food through probiotics and other bioactive ingredients. The metagenomics focused on the genome wide analysis of multiple species in food and soil samples.

Course Code	Course Title	L	T	P	C
22BT951	Probiotics and Functional Foods	3	0	2	4
22BT952	Food Biotechnology	3	2	0	4
22BT953	Metagenomics	3	0	2	4
22BT954	Next Generation Sequencing	3	0	2	4
22BT955	Project / Open source – Swayam/NPTEL	0	2	6	4
Total		**12**	**4**	**12**	**20**

I

YEAR

BIOTECHNOLOGY

B.Tech.

I SEMESTER

22MT101	-	Elementary Mathematics
22PY101	-	Applied Physics
22EE101	-	Basics of Electrical and Electronics Engineering
22BT103	-	IT Workshop and Bioproducts
22TP103	-	Programming in C
22EN102	-	English Proficiency and Communication Skills
22SA101	-	Physical Fitness, Sports and Games – I
22TP101	-	Constitution of India

II SEMESTER

22MT110	-	Matrices and Differential Equations
22CT104	-	Organic Chemistry
22TP104	-	Basic Coding Competency
22ME101	-	Engineering Graphics
22EN104	-	Technical English Communication
22BT102	-	Good Laboratory Practices
22SA103	-	Physical Fitness, Sports and Games – II
22SA102	-	Orientation Session

COURSE CONTENTS

I SEM & II SEM

22MT101 ELEMENTARY MATHEMATICS

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Basics of Geometry and Algebra.

COURSE DESCRIPTION AND OBJECTIVES:

The objective of the course is to make student acquainted with preliminary concepts of mathematics that are useful for their engineering study. Students will learn concepts of progression, partial fractions, straight line, trigonometry, calculus which will help them to apply in various aspects of engineering fields.

MODULE-1

UNIT-1 **12L+8T+0P=20 Hours**

MATHEMATICAL PRELIMINARIES

Partial fractions, Arithmetic progressions, Geometric progressions.

UNIT-2 **12L+8T+0P=20 Hours**

STRAIGHT LINES AND TRIGONOMETRIC RATIOS

Straight lines: Point in coordinate plane, distance formula, straight line, slope, equation of straight in different forms.

Trigonometric ratios: Trigonometric ratios, values in different quadrants, compound angels, multiple angles.

PRACTICES

- Splitting a given improper fraction
- Finding the general term and sum of infinite terms of a progression.
- Finding equation of a straight line in various form
- Find the tangent and normal.
- Evaluation of trigonometric function.

MODULE-2

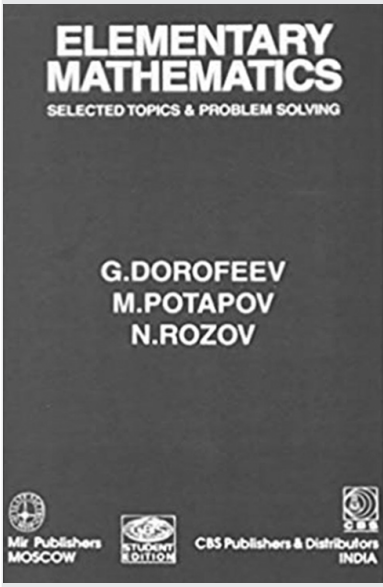
UNIT-1 **12L+8T+0P=20Hours**

CALCULUS

Differential Calculus: Introduction to differentiation, Derivatives of simple functions, Product rule, Quotient rule and Chain rule of differentiation.

Integral calculus: Integration as anti-derivative process, Standard forms, Methods of integration: by substitution, by parts, and by partial fractions.

Definite integration.



Source : https://www.amazon.in/Elementary-Mathematics-G-Dorofeev/dp/8123908423/r_1_3?crid=1N1QBXQPFWH7Q&keywords=elementary+mathematics&qid=1661240301&s=books&sprefix=elementary+mathematics%2Cstripbooks%2C210&sr=1-3

SKILLS:

- ✓ *Focusing on Trigonometric Ideas.*
- ✓ *Know the various trigonometric functions.*
- ✓ *Understanding the Applications of Trigonometry and straight lines.*
- ✓ *Understand basic applications of calculus.*

UNIT-2 **12L+8T+0P=20Hours**

APPLICATIONS OF CALCULUS

Tangent, normal, velocity and acceleration. Evaluation of length and area by integration

PRACTICES:

- To calculate the profit and loss in business using graphs.
- To check the temperature variation.
- To determine the speed or distance covered.
- Derivatives and integration are used to derive many equations in Physics.
- In the study of Seismology like to find the range of magnitudes of the earthquake.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the concepts of straight line in real life problems.	Apply	1	1, 2, 9, 10, 12
2	Apply the concepts of calculus in real life problem.	Apply	2	1, 2, 9, 10, 12
3	Distinguish between finite and infinite AP and determine the general term.	Analyse	1	1, 2, 9, 10, 12
4	Categorize right angle triangles to evaluate the trigonometric ratios.	Analyse	2	1, 2, 9, 10, 12

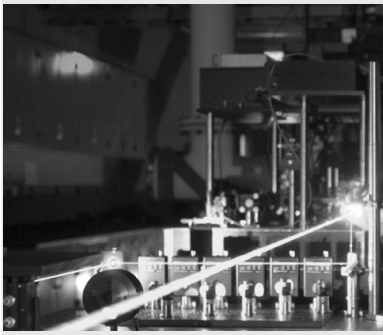
TEXT BOOKS:

1. John Bird, “Higher Engineering Mathematics”, 5th edition, Routledge (Taylor & Francis Group), London, New York, 2018.
2. Veerarajan, T., “Engineering Mathematics”, 1st edition, Tata McGraw Hill Publishing Co., New Delhi, 2019.

REFERENCE BOOKS:

1. P. Kandasamy, K. Thilagavathy, K.Gunavathy, “Engineering Mathematics”, 3rd edition, S.Chand& Co., New Delhi, 2017.
2. P. Seshagiri Rao, “A Text Book of Remedial Mathematics”, 3rd edition, PharmaMed Press / BSP Books, 2018.
3. Nabjyoti Dutta, Bulendra Limboo, Bismeeta Buragohain, Pranjal Talukdar, “A Basic Course in Mathematics for Polytechnic Vol.1, Vol.2”,Second Edition, Mahaveer Publications, 2017.

22PY101 APPLIED PHYSICS



https://www.google.com

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Basics of atomic structure and electronic transitions, Bonding in solids, and concept of waves.

COURSE DESCRIPTION AND OBJECTIVES:

The purpose of this course is to present the principles and concepts of Light and Sound waves. It enunciates the concurrent understanding of Lasers and Optical Fibers. It emphasizes on the principles and applications of Nano materials as relevant to an Engineer.

MODULE-1

UNIT-1 **8L+0T+8P = 16 Hours**

PHYSICAL OPTICS

Interference: Introduction-Superposition principle -Types of superposition of waves – Division of wave front, Division of amplitude, Newton rings- Experiment – Diameter of Newton rings (bright & dark), Determination of wavelength – Determination of Refractive Index.

Diffraction: Introduction- Interference versus Diffraction – Types of diffraction, Fraunhofer diffraction at single and double slit (qualitative), Plane transmission diffraction grating (Qualitative) – Determination of wavelength.

Polarization: Polarized and unpolarized light, Production of polarized light, Nicol prism, Quarter and half wave plates, Optical activity - Laurent's half shade polarimeter.

UNIT-2 **8L+0T+8P = 16 Hours**

LASERS AND FIBRE OPTICS

LASERS: Characteristics of laser light – spontaneous and stimulated emission, Population Inversion – Pumping Processes –He-Ne laser, Semiconductor laser and applications of lasers, Holography – construction – reconstruction and applications.

Fiber Optics: Principle of optical fibre – acceptance angle, numerical aperture, Types of fibres– Step Index fiber – Gradded Index fiber - Fibre optic sensor-Biosensors.

PRACTICES:

- Newtons rings: Determination of wavelength of a given light source.
- Diffraction grating: Determination of wavelength – Normal Incidence method.
- Polarimeter: Determination of Optical rotation of an optically active solution.
- Laser: Determination of wavelength of a given LASER source using plane diffraction grating.

MODULE-2

UNIT-1 **8L+0T+8P = 16 Hours**

CRYSTAL PHYSICS

Crystal Physics: Introduction-Fundamental terms of crystal physics, Lattice parameters and Crystal systems, packing factor for SC, BCC and FCC –Miller indices – Rules to find Miller Indices – Important features of Miller Indices – Distance of separation between successive (h k l) planes (Qualitative), XRD and Bragg's law.

SKILLS:

- ✓ *Apply the dynamics of Light to realize the various potential applications in Engineering.*
- ✓ *Evaluate the concepts of Lasers and Optical Fibers to realize versatile applications in Science, Engineering and Technology.*
- ✓ *Analyze the Crystal Structures and orientation of planes.*
- ✓ *Appraise the importance of Ultrasonics in medicine.*
- ✓ *Demonstrate the synthesis and characterization of Nano materials in view of their applications.*

UNIT-2 **8L+0T+8P = 16 Hours**

ELEMENTS OF NANOMATERIALS

Elements of Nano Materials: Introduction- Principles of Nano materials, Synthesis of Nanomaterials: top- down and bottom- up approaches – Ballmilling – Sol-gel, Applications of nanomaterials, Characterization of nanomaterials by electron microscopy (SEM-Construction – Working – Applications), TEM- (Construction – Working – Applications), AFM – Construction – Working – Applications.

PRACTICES:

- Band gap: Determination of Energy bandgap of a semiconductor.
- Optical fibre: Determination of a Numerical Aperture of an Optical Fibre.
- LED: Study of V-I characteristics of LED.
- Ultrasonic interferometer: Determination of Ultrasonic wave velocity in liquid medium.

COURSE OUTCOMES:

Upon successful completion of the course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the concepts of Physical Optics in the perspective of Engineering applications.	Apply	1	1, 3, 5, 6, 7
2	Analyse the wavelengths of Laser for applications in medicine and to foster the knowledge on Optical Fibers to realize Fiber Optic Sensors.	Analyze	1	1, 3, 5, 6, 7
3	Recognise the importance of Crystal Physics relevant to Bio-Physical systems.	Apply	2	1, 2, 4, 5, 6, 7, 9
4	Evaluate Ultrasonic waves to apply them in medical diagnostics.	Evaluate	2	1, 2, 4, 5, 6, 7, 9
5	Connect the dimensions of Nano particles to consolidate the Physical and Chemical aspects of Nano materials.	Analyze	2	1, 3, 5, 6, 9, 11, 12

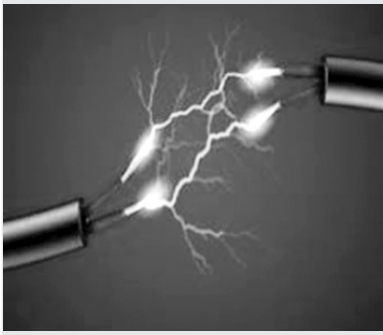
TEXT BOOKS:

1. S.O.Pillai, “Solid State Physics”, New age International publishers, 8th edition, 2018.
2. M.R. Srinivasan, “Engineering Physics”, New Age International Publishers, 1st edition 2008.

REFERENCE BOOKS:

1. M.N. Avadhanulu, P.G. Kshirsagar and T.V.S. Aruen Murthy, “A Text Book of Engineering Physics”, 11th edition, S. Chand & Company Ltd., 2019.
2. Shatendra Sharma and Jyotsna Sharma, “Engineering Physics”, 1st edition, Pearson India Education Services Pvt. Ltd., 2018.
3. D. Halliday, R. Resnick and J. Walker “Fundamentals of Physics”, 6th edition, John Wiley and Sons, 2020.
4. T. Pradeep, “A Text Book of Nanoscience and Nanotechnology”, 1st edition, Tata Mc-Graw Hill, 2018.

22EE101 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING



Source : https://vita.vision.org.in/emerging-technologies-in-electrical-engineering/

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Electrostatics and electromagnetism.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides an insight into the functioning of basic electrical components like resistor, inductor and capacitor. It deals with the constructional and operational details of AC machines. It also deals with the basic electronic components like P-N junction diode, Zener diode, Transistor and their characteristics.

MODULE–1

UNIT-1

8L+0T+8P=16 Hours

FUNDAMENTALS OF ELECTRIC CIRCUITS

DC Circuits: Concept of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, R, L and C as linear elements, Ohm's Law, Kirchhoff's Laws, Application to simple series, Parallel circuits, Mesh and nodal analysis of resistive circuits with DC source.

AC circuits: Generation of AC voltage, Frequency, Average value, R.M.S. value, Form factor, Peak factor for sinusoidal only;

UNIT-2 **8L+0T+8P=16Hours**

SEMICONDUCTOR DEVICES

Classification of semiconductors, P-N junction diode -operation and its characteristics, Half wave rectifier - operation, efficiency; Full wave rectifiers -types, operation, efficiency; Zener diode and its characteristics, Zener diode as Voltage regulator.

Bi polar junction transistor- operation, types (NPN & PNP).

PRACTICES:

- Verification of Ohm's law.
- Verification of Kirchhoff's current law.
- Verification of Kirchhoff's voltage law.
- Determination of R.M.S. Values of sinusoidal waveform.
- Verification of PN junction diode characteristics under both forward and reverse bias.
- Verification of Zener diode characteristics under reverse bias.

MODULE–2

UNIT-1 **8L+0T+8P=16Hours**

ANALYSIS OF AC CIRCUITS

Analysis of single- phase ac circuits consisting of R, L, C, RL, RC (series and parallel) (simple numerical problems). Introduction to three phase system, Relation between phase and line quantities of voltages and currents in star and delta connected systems (Elementary treatment only).

SKILLS:

- ✓ *Distinguish between linear and nonlinear elements by looking at VI characteristics.*
- ✓ *Develop a simple loop generator.*
- ✓ *Design a voltage regulator using Zener diode.*
- ✓ *Design a half wave rectifier using PN junction diode.*
- ✓ *Design a full wave rectifier using PN junction diodes.*

UNIT-2 **8L+0T+8P=16Hours**

AC MACHINES

Electromagnetism: Concepts of Magneto motive force, Reluctance, Flux and flux density, Concept of self-inductance and mutual inductance, Coefficient of coupling.

Static AC Machine: Principle of operation of single phase transformer, Constructional features, EMF equation (simple numerical problems).

Rotating AC Machine Principle of operation of three phase induction motor, Slip ring and squirrel cage motors, Torque equation; Constructional details of synchronous machine.

PRACTICES:

- Transformation ratio of a single phase transformer at different loads.
- Measurement of Energy in single phase resistive load circuit.
- Measurement of Power in single phase resistive load circuit.
- Determination of impedance in complex AC circuits.
- Verification of line and phase quantities in a balanced three phase system.

COURSE OUTCOMES:

Upon successful completion of the course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the resistive circuits with independent sources and find its solution.	Analyze	1,2	1,2,6,9
2	Solve the AC (single and three phase) and DC circuits using different methods.	Apply	1,2	1,2,9,12
3	Apply the concepts of electromagnetism for its applications.	Apply	2	1,2,3,9,12
4	Examine the different electrical equipment.	Evaluate	2	1,2,9,12
5	Acquire the knowledge of semiconductor devices to create circuits.	Create	1	1,2,3,9,12

TEXT BOOKS:

1. V. K. Mehta, “Principles of Electrical Engineering and Electronics”, 1st edition, S.Chand& Co., Publications, New Delhi, 2019.
2. D.P. Kothari, “Basic Electrical and Electronics Engineering”, 2nd edition, TMH, New Delhi, 2017.

REFERENCE BOOKS:

1. Millman and Halkias, “Electronic Devices and Circuits”, Mc Graw Hill, 2006.
2. A.K. Thereja and B.L.Thereja, “Electrical Technology”, Vol.–II, S. Chand & Co., Publications, 2020.
3. U. Bakshi and A. Bakshi, “Basic Electrical Engineering”, 1st edition, Technical Publications, Pune, Nov 2020.

22BT103 IT WORKSHOP AND BIOPRODUCTS

Source : https://www.gramedia.com/pendidikan/jurusan-bioentrepreneurship/

Hours Per Week :

L	T	P	C
1	0	4	3

PREREQUISITE KNOWLEDGE: Basic idea of computer, Basics of biology.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with different IT tools and commercial bioproducts. The objective of this course is giving hands on practice on assembling and disassembling, productivity tools like Latex, word, spreadsheets and presentations and also knowledge on various bioproducts.

MODULE-1

UNIT-1 **3L+0T+12P=15 Hours**

Computer Hardware: Peripherals of a computer, components in a CPU and its functions, block diagram of the CPU.

Tools for Report writing and Presentation: Overview and Installation of Microsoft Word, Excel and PowerPoint Presentation.

UNIT-2 **5L+0T+20P=25 Hours**

Computer Hardware: Disassemble and Assemble the PC back to working condition.

Tools for Report writing and Presentation: Creating project, creating a Newsletter using Microsoft Word;Creating a Scheduler, Calculating GPA, Performance Analysis, Conditional Formatting, Charts and Pivot Tables using MS Excel; Power Point utilities and tools, Master Layouts, Design Templates, Background and textures using Power Point Presentation.

PRACTICES:

- Troubleshooting of a computer hardware.
- Assembly and disassembly of a computer.
- Creation of projects and newsletter using MS Word.
- Spreadsheet basics, modifying worksheets, formatting cells, formulas and functions, sorting and filtering, charts using MS Excel.
- Power point screen, working with slides, add content, work with text, working with tables, graphics, slide animation, reordering slides, adding sound to a presentation using MS PPT.

MODULE-2

UNIT-1 **2L+0T+8P=10 Hours**

TYPES OF BIO-PRODUCTS

Definition of bio-products, categories of bio-products, importance of bio-products, bio-products used for decoration, biofertilizers and clonal propagation of plants, Socio-economic and environmental impact of bioproducts.

SKILLS:

- ✓ *Use of computer tools in academic and project works*
- ✓ *Development of process for various bioproducts*
- ✓ *Analyse bioproducts market trend.*

UNIT-2 **6L+0T+24P=30 Hours**

BIO-MATERIALS AND BIO-FUELS

Liquid fuels-ethanol and biodiesel, solid biomass for combustion to generate heat and power, Gaseous fuel such as biogas, Bio-plastics from plantoils, Bio-rubber from latex, Bio-composites from agriculture (Ex. Hemp, flax and kenaf), Bio-fibers from flax, Biopolymers from renewable sources.

PRACTICES:

- Survey of bio-products and their market value in the last five years.
- A report on the functioning of GPS Biogas unit from food waste installed in VFSTR continuously for 15 days.
- Industrial applications of bio-plastics, bio-rubber,bio-composites and biofibers.
- Alternate energy from solid biomass: Preparation of flow chart depicting the process.

COURSE OUTCOMES:

Upon successful completion of the course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the knowledge of computer hardware in troubleshooting.	Apply	1	1,3,6,7
2	Create projects and Newsletter using MS Word and LaTeX.	Create	1	3,4,7
3	Analyze various methods for the production of novel bio-products.	Analyze	2	2,4,6,7
4	Develop sustainable biomaterials from renewable sources for commercial and health benefits.	Develop	2	3,67
5	Evaluate the importance of green entrepreneurship.	Evaluate	2	3,4,7

TEXT BOOKS:

1. Peter Norton, “Introduction to Computers”, Tata Mc Graw Hill Publishers, 7th Edition, 2017.
2. N TDunford, “Food and Industrial Bioproducts and Bioprocessing”, 1st edition, Wiley-Blackwell, 2012.
3. Christoph W, James C. Liao, Sang Y. Lee, Jens N and Gregory S, “Industrial Biotechnology: ProductsandProcess”, 1st edition, Wiley, 2017.

REFERENCE BOOKS:

1. James W. Lee, “Advance Biofuels and Bioproducts”, 1stedition, Springer, 2013.
2. G. Chen, Randall J. Weselake and Stacy D. Singer, “Plant Bioproducts”, 1st edition, Springer, 2018.
3. GrahamPBunn, “Good manufacturing Practices for Pharmaceuticals”, 7th edition, Taylor & Francis, 2021.
4. Sandy Weinberg, “Good laboratory Practice regulations”, 4th edition, Taylor & Francis, 2007.

22TP103 PROGRAMMING IN C

Source : https://www.gramedia.com/pendidikan/jurusan-bioentrepreneurship/

Hours Per Week :

L	T	P	C
2	0	4	4

PREREQUISITE KNOWLEDGE: Fundamentals of Problem Solving.

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed to impart knowledge on basic concepts of C programming language and problem solving through programming. It covers basic structure of C program, data types, operators, decision making statements, loops, functions, strings, pointers, and also file manipulations. At the end of this course, students will be able to design, implement, test and debug complex problems using features of C.

MODULE- 1

UNIT-1 **8L+0T+16P=24 Hours**

INTRODUCTION TO ALGORITHMS AND PROGRAMMING LANGUAGES

Introduction to Algorithms: Basics of algorithms, Flow charts, Generations of programming languages, Introduction to C: Structure of a C program - pre-processor statement, inline comments, variable declaration statements, executable statements, C Tokens - C character set, identifiers and keywords, type qualifiers, type modifiers, variables, constants, punctuations and operators.

Data Types and Operators: Basic data types, Storage classes, Scope of a variable, Formatted I/O, Reading and writing characters, Operators - assignment, arithmetic, relational, logical, bitwise, ternary, address, indirection, sizeof, dot, arrow, parentheses operators, Expressions - operator precedence, associative rules.

Control Statements: Introduction to category of control statements, Conditional branching statements - if, if– else, nested-if, if – else ladder, switch case, Iterative statements - for, while, do - while, nested loops, Jump statements - break, jump, goto and continue.

UNIT-2 **8L+0T+16P=24 Hours**

ARRAYS & STRINGS

Arrays: Introduction, Types of arrays; Single dimensional array - declaration, initialization, usage, reading, writing, accessing, memory representation, operations, Multidimensional arrays.

Strings: Character array, Reading string from the standard input device, Displaying strings on the standard output device, Importance of terminating a string, Standard string library functions.

Practice Questions on Data Handling – Level 1:

1. Write a program to accept a character as input from the user and print it.
2. Write a program to accept a number as input from the user and print it.
3. Write a program to accept a float value from the user and print it.
4. Write a program to accept a message as input from the user and print it.
5. Write a program to accept a message from the user as input and print it in 3 different lines.
6. Write a program to accept 2 numbers from the user as input and print their sum.
7. Write a program to accept 2 numbers from the user as input and print their product.
8. Write a program to accept a number as input from the user which denotes the temperature in Celsius, convert it to Fahrenheit reading and print it.

SKILLS:

- ✓ *Analysis of the problem to be solved.*
- ✓ *Select static or dynamic data structures for a given problem and manipulation of data items.*
- ✓ *Application of various file operations effectively in solving real world problems.*
- ✓ *Develop C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt.*

9. Write a program to accept a number as input from the user which denotes the radius and print the area of the circle.
10. Write a program to accept a character as input from the user and print it's corresponding ASCII value.

Questions on Control Statements - Looping – Level 1:

1. Write a C program to print all the characters from a to z once.
2. Write a C program to print all the characters from Z to A once.
3. Write a C program to print all the characters from A to Z 3 times.
4. Write a C program to print the first N natural numbers, where N is given as input by the user.
5. Write a C program to print the first N natural numbers and their sum, where N is given as input by the user.
6. Write a C program to print all the odd numbers between 1 and N where N is given as input by the user.
7. Write a C program to print all the even numbers between I and N where N is given as input by the user.
8. Write a C program to print the squares of the first N natural numbers between 1 and N, where N is given as input by the user.
9. Write a C program to print the cubes of the first N natural numbers between 1 and N, where N is given as input by the user.
10. Write a C program to print the squares of every 5th number starting from 1 to N, where N is given as input by the user.

Questions on Control Statements – Decision Making – Level 1:

1. Write a program to accept two numbers as input check if they are equal.
2. Write a program to accept two characters as input and check if they are equal.
3. Write a program to accept two numbers as input and print the greater of the 2 numbers.
4. Write a program to accept two numbers as input and print the lesser of the 2 numbers.
5. Write a program to accept 3 numbers as input and print the maximum of the 3.
6. Write a program to accept 3 numbers as input and print the minimum of the 3.
7. Write a program to accept a number as input and print EVEN if it is an even number and ODD if it is an odd number.
8. Write a program to accept a number as input and check if it is divisible by 3. If it is divisible by 3 print YES else print NO.
9. Write a program to accept a number as input and check if it is divisible by both 3 & 5. If it is divisible print YES else print NO.
10. Write a program to accept a number as input and check if it is positive, negative or zero.

Questions on Patterns – Level 1:

1. Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

   *****

   *****

   *****

   *****

   *****

2. Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

   *****

   * *

   * *

   * *

   *****

3. Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

   *
   **
   ***
   ****
   *****

4. Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

   *
   **
   ***
   ****
   *****

5. Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

   1
   12
   123
   1234
   12345

6. Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

   1
   22
   333
   4444
   55555

7. Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

   54321
   4321
   321
   21
   1

8. Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

   12345
   2345
   345
   45
   5

9. Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

   A
   AB
   ABC
   ABCD
   ABCDE

10. Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

    A

    BC

    DEF

    GHIJ

    KLMNO

Questions on Number Crunching – Level 1:

1. Write a program to accept a number as input and print the number of digits in the number.
2. Write a program to accept a number as input print the sum of its digits.
3. Write a program to accept a number as input, reverse the number and print it.
4. Write a program to accept a number and digit as input and find the number of occurrences of the digit in the number.
5. Write a program to accept a number as input and check if it is an Armstrong number.
6. Write a program to accept a number as input and check if it is an Adam number.
7. Write a program to accept a number as input and check if is a prime number.
8. Write a program to accept 2 numbers as input and check if they are amicable or not.
9. Write a program to accept a number as input and check if it is a power of 2.
10. Write a program to accept 2 numbers as input and find their LCM.

Questions on Arrays – Level 1:

1. Print the contents of an array from the left to the right.
2. Print the contents of an array from the right to the left.
3. Find the sum of the elements of an array.
4. Find the maximum element in an unsorted array.
5. Find the minimum element in an unsorted array.
6. Find the average of the elements in an unsorted array.
7. Count the number of 0s and 1s in an array having 0s and 1s in random order.
8. Count the number of elements in an array whose elements are lesser than a key element in an unsorted array.
9. Print all the elements in an array whose values are lesser than a key element in an unsorted array.
10. Find the repeated elements in a sorted array.

Questions Number crunching – Level 2:

1. Write a program to accept a number as input and print the product of its digits.
2. Write a program to accept a number as input and check if it is a palindrome.
3. Write a program to accept a number as input and print the frequency of occurrence of each digit.
4. Write a program to accept a number as input and print its factors.
5. Write a program to accept a number as input and print its prime factors.
6. Write a program to accept a number as input and check if it is a perfect square of not.
7. Write a program to accept 2 numbers as input and check if they are betrothed numbers or not.
8. Write a program to accept 2 numbers as input and print their HCF.
9. Write a program to accept a number as input and check if is a strong number.
10. Write a program to generate prime numbers between two intervals given as input.

Questions on Arrays – Level 2:

1. Find the sum of the maximum and minimum numbers of an unsorted array.
2. Replace every element in an array with the sum of its every other element.
3. Replace every element in an array with the sum of its right side elements.
4. Replace every element in an array with the sum of its left side elements.
5. Reverse the elements of an array (in place replacement).
6. Reverse the first half of an array.
7. Reverse the second half of an array.
8. Write a program to find the second largest element in an unsorted array.
9. Write a program to find the second smallest element in an unsorted array.
10. Write a program to print the number of odd and even numbers in an unsorted array.

Questions on Strings – Level 1:

1. Write a program to accept a string as input and print it.
2. Write a program to accept a string as input and count the number of vowels in it.
3. Write a program to accept a string as input and count the number of consonants in it.
4. Write a program to accept a string as input and print its length.
5. Write a program to accept a string as input and print the reversed string.
6. Write a program to accept 2 strings as input and check if they are the same.
7. Write a program to accept a string as input and copy the contents into a second string and print the second string.
8. Write a program to accept 2 strings as input and concatenate them into a third string and print the third string.
9. Write a program to accept a string as input and check if it is a palindrome.
10. Write a program to accept two strings as input and check if the second string is a substring of the first.

Questions on Strings – Level 2:

1. Implement the string length function.
2. Implement the string copy function.
3. Implement the string concatenate function.
4. Implement the string compare function.
5. Implement the vowel count function.
6. Implement the consonant count function.
7. Implement the count words function.
8. Implement the string reverse function.
9. Implement the strstr function.
10. Complete the code snippet to implement the is Palindrome function that checks if a given string is a palindrome. You will need to use the 3 functions string Copy, str Reverse and string Compare functions provided to accomplish this.

MODULE-2

UNIT-1 **8L+0T+16P=24 Hours**

FUNCTIONS& POINTERS

User-defined functions: Function declaration - definition, header of a function, body of a function, function invocation, Call by value, Call by address, Passing arrays to functions, Command line arguments, Recursion, Library Functions.

Pointers: Declaration, Initialization, Multiple indirection, Pointer arithmetic, Relationship between arrays and pointers, Scaling up - array of arrays, array of pointers, pointer to a pointer and pointer to an array; Dynamic memory allocation functions.

UNIT-2 **8L+0T+16P=24 Hours**

STRUCTURES, UNIONS & FILES

Structures: Defining a structure, Declaring structure variable, Operations on structures, Pointers to structure - declaring pointer to a structure, accessing structure members using pointer, Array of structures, Nested structures, Passing structures to functions - passing each member of a structure as a separate argument, passing structure variable by value, passing structure variable by reference/ address, Typedef and structures.

Unions: Defining a union - declaring union variable, operations on union, Pointers to union - declaring pointer to a union, accessing union members using pointer, Array of union, Nested union, Typedef and union, Enumerations, Bit-fields.

Files: Introduction to files, Streams, I/O using streams – opening a stream, closing stream, Character input, Character output, File position indicator, End of file and errors, Line input and line output, Formatted I/O, Block input and output, File type, Files and command line arguments.

PRACTICES:

Questions on Strings – Level 3:

1. Write a program to swap two given strings and print the swapped strings.
2. Write a program to swap two given words of the given sentence and print the altered string.
3. Return the maximum occurring character in the string.
4. Write a program to print the character in the string with the count where count is the occurrence of the character.
5. Write a program to print the duplicate characters in the given string.
6. Write a program to remove the duplicate characters in the given string.
7. Write a program to remove the vowels from a given string.
8. Write a program to rotate a given string N number of times.
9. Write a program to check if 2 strings are rotations of each other.
10. Write a program to remove the characters from the first string that are present in the second string.

Questions on 2D Arrays – Level 1:

1. Print the contents of a 2D array row-wise.
2. Print the contents of a 2D array column-wise.
3. Print the contents of a 2D array in a zig-zag order.
4. Print the contents of a 2D array diagonal-wise.
5. Print the contents of a 2D array right-diagonal order.
6. Print the contents of a 2D array left-diagonal order.
7. Print the contents of a 2D array in the upper triangular order – left top to right bottom.
8. Print the contents of a 2D array in the lower triangular order.
9. Find and print the maximum element along with its position in a matrix.
10. Find and print the minimum element along with its position in a matrix.

Questions on 2D Arrays – Level 2:

1. Find and print the maximum element of each row of a matrix.
2. Find and print the minimum elements of each row of a matrix.
3. Find and print the maximum element of each column of a matrix.
4. Find and print the minimum element of each column of a matrix.

5. Find the lowest value in the upper triangle area and the largest value in the lower triangular area of a matrix and print their product.
6. Find the sum of the elements of each row and each column of a matrix and print the minimum row sum and maximum sum column.
7. Write a program to find the row with the maximum number of 1's in a matrix consisting of only 0's and 1's.
8. Write a program to print the quotient and remainder on dividing sum of left-top to right-bottom diagonal by sum of right-top to left-bottom diagonal.
9. Write a program to print the absolute difference of the sum of major diagonal elements and the sum of minor diagonals of the given matrix.
10. Write a program to search a given element in a row-wise and column-wise sorted 2D array.

Questions on 2D Arrays – Level 3:

1. Write a program to find the Kth smallest element in the given matrix.
2. Write a program to find the Kth largest element in the given matrix.
3. Write a program to check whether the given two two-dimensional array of same dimensions are equal or not.
4. Write a program to add the given two two-dimensional array of same dimensions.
5. Write a program to subtract the given two two-dimensional array of same dimensions.
6. Write a program to multiply the given two two-dimensional array of same dimensions.
7. Write a program to sort each row of a matrix.
8. Write a program to find the sum of the elements in 'Z' sequence of the given 2D array.
9. Write a program to print the unique rows of the given two-dimensional array consisting of only 0's and 1's.
10. Write a program to print the unique columns of the given two-dimensional array consisting of only 0's and 1's.

Questions on Files, Structures & Unions:

1. Write a C program to create a struct, named Student, representing the student's details as follows: first_name, last_name, Age and standard.

   Example
   Read student data
   john
   carmack
   15
   10
   Display the data in the following format
   First Name: john
   Last Name: carmack
   Age: 15
   Standard: 10
2. Declare a structure POINT. Input the coordinates of point variable and write a C program to determine the quadrant in which it lies. The following table can be used to determine the quadrant.

Quadrant	X	Y
1	Positive	Positive
2	Negative	Positive
3	Negative	Negative
4	Positive	Negative

Example

Input the values for X and Y coordinate: 7 9

The coordinate point (7,9) lies in the First quadrant.

3. Bob and Alice both are friends. Bob asked Alice how to store the information of the books using Structures. Then Alice written a c program to store the information of books using book structure by taking different attributes like book_name, author, book_id, price. Write a C program to read and display the attributes of the books using structures.

   Sample Input:

   Enter number of books: 1

   Enter the book name: c Programming

   Enter the author name: balaguruswamy

   Enter the book ID: 23413

   Enter the book price: 500

   Sample Output:

   The details of the book are:

   The book name is: c Programming

   The author name is: balaguruswamy

   The book ID is: 23413

   The book price is: 500.00

4. Ramesh wants to do addition on complex numbers. He did it with regular practice but Charan asked him to do with the help of structures by following below Criteria.

   Write a C program that defines a structure named 'Complex' consisting of two floating point members called "real and imaginary". Let c1 and c2 are two Complex variables; compute the sum of two variables.

   Example:

   c1= 2 8

   c2= 6 4

   Sum= 8.000000+12.000000i

5. Customer Payment Details is a structure with members as customers_name, address, account_number, payment_status(paid(1)/ not_paid(0)), due_date, and amount. In this example, payment_date is another structure with month, day and year as integer members. So, every customer record can be considered as an array of structures.

   Write a C program that displays the amount to be paid by each customer along with their names. If payment_status is 1, display NIL for such customers.

   Input Format:

   First line of input contains 'n' number of customers, followed by 8 lines of input for each customer. Each line represents (customers_name, address, account_number, amount payment_status(paid(1)/ not_paid(0)), and due_date).

   Output Format: First line of output is Amount to be paid by each customer as on date: followed by n lines of output. Each line contains name of the customer followed by tab space, and amount to be paid.

   Hint: Use nested structure to represent date.

   Write a 'C' program to accept customer details such as: Account_no, Name, Balance using structure. Assume 3 customers in the bank. Write a function to print the account no. and name of each customer whose balance < 100 Rs.

6. Write a C program to accept details of 'n' employee(eno, ename, salary) and display the details of employee having highest salary. Use array of structure.

7. Write a C program to print the bill details of 'N' number of customers with the following data: meter number, customer name, no of units consumed, bill date, last date to deposit and city. The bill is to be calculated according to the following conditions:

No. of units	Charges
For first 100 units	Rs.0.75 per unit
For the next 200 units	Rs.1.80 per unit
For the next 200 units	Rs.2.75 per unit

Sample Input

Enter no. of customers
1
Enter Meter Number AP01213
Enter Customer Name: Karthik
Enter No. of units consumed: 200
Enter Bill date:22/01/2021
Enter Last date: 12/2/2021
Enter City: Guntur
Sample Output
Meter Number AP01213
Customer Name: Karthik
No. of units consumed: 200
Bill date:22/01/2021
Last date: 12/2/2021
City: Guntur
Total Amount: 255.000000

8. Write a C program that creates a student file containing {Roll No, Student Name, Address, Stream}, where the data will be inserted and display the list of students who are in CSE (Stream=CSE).

   Input: A file name

   Output: The attributes such as Roll_No, Student_Name, Stream, Address.

   Sample Input

201fa4200	Raja	CSE	Guntur
201fa4201	Bala	IT	Tenali

   Sample Output

201fa4200	Raja	CSE	Guntur

9. Write a C program that reads content from an existing text file and write the same in a new file by changing all lowercase alphabetic character to upper case. (Existing file may contain digit and special characters).

   Example:

   Input: Enter the file name.

   Output: New file with updated content.

10. Write a C program to count the occurrences of the given string in a file.

    Example:

    Input: Enter the File name to read the string to be counted.

    Output: Display the count of occurrences of the string.

11. Write a C Program to transfer the data from one location to another location without changing the order of the content.

    Example:

    Read the file name from the user. If the source file exists, Transfer the data and display the message as “Data is transferred successfully” otherwise display the message “No such file is existing in the directory.”

12. Write a C program that reads numbers and write them into a text-file. Also find odd and even numbers in that file and store it in 2 separate files named odd.txt and even.txt. All the values should be in ascending order.

Input: Enter the values.
Output: Creates a separate file for Even and Odd numbers.
Sample Input:
4 43 2 53 45
Sample Output:
Even.txt: 2 4
Odd.txt: 43 45 53

13. Write a C program to replace the content in the given text file.
Input: Enter the file name, line number to be replaced and the new content
Output: New file with replaced lines.
Example:
Sample Input: Enter the file name: abc.txt
Enter the line no to replace: 3
Enter the content: Files stores data presently.
Sample Output:
Line no 3 is replaced with the given content.
The content of the file abc.txt contains:
test line 1
test line 2
Files stores data presently
test line 4

COURSE OUTCOMES:

Upon successful completion of the course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify suitable data type for operands and design of expressions having right precedence.	Apply	1,2	1
2	Apply decision making and iterative features of C Programming language effectively.	Apply	1,2	1
3	Select problem specific data structures and suitable accessing methods.	Analyze	1,2	1,2
4	Design and develop non- recursive and recursive functions and their usage to build large modular programs and also able to design string manipulation functions.	Create	1,2	3
5	Develop C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt.	Evaluate	1,2	3,4

TEXT BOOKS:

1. Behrouz A. Forouzan, Richard F.Gilberg, “Programming for Problem Solving”, 1st edition, Cengage publications, 2019.
2. Ajay Mittal, “Programming in C - A Practical Approach”, 1st edition, Pearson Education, India, 2010.

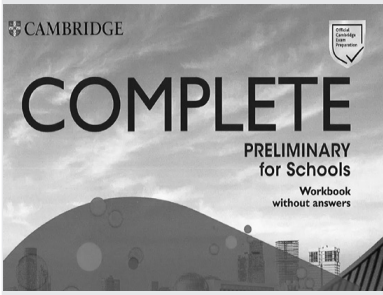
REFERENCE BOOKS:

1. Reema Thareja, “Computer Fundamentals and Programming in C”, 1st edition, Oxford University Press, India, 2013.
2. Herbert Schildt, “C: The Complete Reference”, 4th edition, Tata McGraw-Hill, 2017.
3. Byron S Gottfried, “Programming with C”, 4th edition, Tata McGraw-Hill, 2018.

22EN102 ENGLISH PROFICIENCY AND COMMUNICATION SKILLS

Hours Per Week :

L	T	P	C
0	0	2	1



Source : https://www.gramedia.com/pendidikan/jurusan-bioentrepreneurship/

PREREQUISITE KNOWLEDGE: Basics of grammar, Read and understand for global context, Cultural sensitivity and Basic writing skills.

COURSE DESCRIPTION AND OBJECTIVES:

English Proficiency and Communication Skills seeks to develop the students' abilities in grammar, speaking, reading, writing and overall comprehension skills. The course will provide students an exposure on a wide range of language use in everyday situations. It will make the students to equip with functional English and make them use it confidently in their professional and social contexts. Finally, students will strengthen their reading, writing, listening and speaking skills in English.

MODULE-1

UNIT-1 **0L+0T+8P=8 Hours**

MY LIFE AND HOME - MAKING CHOICES - HAVING FUN

Reading: Understanding main message, factual information global meaning, specific information and paraphrasing.

Writing: Developing hints based mail, Writing short messages/paragraphs.

Listening: Understanding short monologues or dialogues and choose the correct visual.

Speaking: Express simple opinions /cultural matters in a limited way.

Vocabulary: Discerning use of right word suiting the context, B1 Preliminary word list.

Grammar: Frequency Adverbs, State Verbs, AFV and Prepositions.

UNIT-2 **0L+0T+8P=8 Hours**

ON HOLIDAY - DIFFERENT FEELINGS - THAT'S ENTERTAINMENT!

Reading: Longer text for detailed comprehension, gist and inference.

Writing: Developing notes and responding to penfriends or 'e-pals'.

Listening: Understand straightforward instructions or public announcements.

Speaking: Describing people, things and places in a photograph.

Vocabulary/Grammar: Comparatives and Superlatives, Gradable and non-gradable adjectives, Cloze tests.

PRACTICES:

- Developing hints based mail.
- Writing short message.
- Writing paragraphs.
- Expressing opinions and cultural matters.
- Understanding short monologues.
- Understanding straight forward instructions and public announcements.
- Describing people, things and places in a photograph.

SKILLS:

- ✓ *Use of appropriate grammar and vocabulary with syntactic patterns in short texts.*
- ✓ *Read and extract the main message, global meaning, specific information, detailed comprehension, understanding of attitude, opinion and writer purpose and inference.*
- ✓ *Listen to understand key information, specific information, gist and detailed meaning and to interpret meaning.*
- ✓ *Understand questions and make appropriate responses and talk freely on everyday topics.*

MODULE-2

UNIT-1 **0L+0T+8P=8 Hours**

GETTING AROUND – INFLUENCES - STAY FIT AND HEALTHY

Reading: Reading for understanding coherence of the text and drawing inferences.
Writing: Reading an announcement from a magazine or website for preparing an article.
Listening: Discussion activities and listening to understand the gist of each short dialogue.
Speaking: Snap Talks, Make and respond to suggestions, discuss alternatives and negotiate agreement.
Vocabulary / Grammar: Punctuation, Prepositions, Phrasal Verbs, B1 Preliminary word list.

UNIT-2 **0L+0T+8P=8 Hours**

LOOKS AMAZING! - THE NATURAL WORLD - EXPRESS YOURSELF!

Reading: Content, Communicative Achievement, Organisation and Language.
Writing: Developing a story with clear links to the given opening sentence.
Listening: An interview for a detailed understanding of meaning and to identify attitudes and opinions.
Speaking: Discuss likes, dislikes, experiences, opinions, habits, etc.
Vocabulary / Grammar: Modals, Conditionals, Verb forms (Time and Tense).

PRACTICES:

- Listening to understand the gist of each short dialogue.
- Listening to an interview for a detailed understanding of meaning and to identify attitudes and opinions.
- Preparing an article.
- Discuss for alternatives andnegotiate agreement.
- Discussion on likes, dislikes, experiences, opinions, habits, etc.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply to read and grasp content on a range of topics/ texts related to their everyday life like notifications, advertisements, travel brochures, news reports, articles.	Apply	1	7, 8, 9, 10, 12
2	Apply suitable strategies to achieve comprehension, like listening for main points and checking comprehension using contextual clues etc.	Apply	1	7, 8, 9, 10, 12
3	Use functional English to communicate and interact effectively in everyday situations.	Apply	1, 2	7, 8, 9, 10, 12
4	Demonstrate vocabulary beyond that of the familiar subjects.	Analyze	1, 2	7, 8, 9, 10, 12
5	Show sufficient control of English grammar and sentence variety to coherently organise information at sentence and discourse levels.	Evaluate	2	7, 8, 9, 10, 12

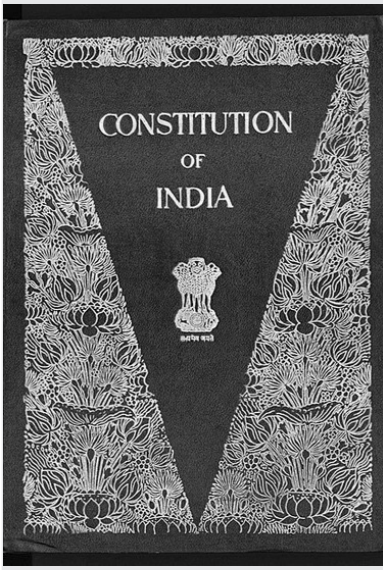
TEXT BOOK:

1. Emma Heyderman and Peter May, “Complete Preliminary”, Student’s Book. Answers, 2nd edition, Cambridge University Press, 2019.

REFERENCE BOOKS:

1. Annette Capel and Rosemary Nixon, “Introduction to PET”, 1st edition, Oxford University Press, 2009.
2. Adrian Doff and Craig Thaine, Empower Pre intermediate, 2nd edition, Cambridge University Press, 2015.
3. Louise Hashemi and Barbara Thomas, Objective PET, 1st edition, Cambridge University Press, 2010.

22TP101 CONSTITUTION OF INDIA



Source : https://commons.wikimedia.org/wiki/File:Constitution_india.jpg

Hours Per Week :

L	T	P	C
0	2	0	1

PREREQUISITE KNOWLEDGE:

High School-level Civics and Social Studies.

COURSE DESCRIPTION AND OBJECTIVES:

To provide students with a basic understanding of Indian Polity and Constitution and make students understand the functioning of government at the center and state level besides local self-government. This course also equips students with knowledge pertaining to fundamental rights and fundamental duties of a citizen in a democracy such as India.

MODULE-1

UNIT-1 **0L+8T+0P=8 H**

HISTORICAL BACKGROUND TO THE INDIAN CONSTITUTION

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

UNIT-2 **0L+8T+0P=8 H**

FUNDAMENTAL RIGHTS, DUTIES, DIRECTIVE PRINCIPLES, AND AMENDMENT

Scheme of the fundamental rights - scheme of the Fundamental Right to Equality, scheme of the Fundamental Right to certain Freedom under Article 19, scope of the Right to Life and Personal Liberty under Article 21, Scheme of the Fundamental Duties and its legal status, Directive Principles of State Policy – its importance and implementation, Amendment of the Constitution - Powers and Procedure.

PRACTICES:

- Enactment of Constituent Assembly debates to further understand the rationale for the provisions of the constitution.
- Fundamental Rights in our popular culture - discussion in the movie Jai Bhim.

MODULE-2

UNIT-1 **0L+8T+0P=8 H**

STRUCTURE AND FORM OF GOVERNMENT

Federal structure and distribution of legislative and financial powers between the Union and the States; Parliamentary Form of Government in India – The constitution powers and status of the President of India; Emergency Provisions: National Emergency, President Rule, Financial Emergency.

SKILLS:

- ✓ *Understanding the basics of the Indian constitution.*
- ✓ *Know the fundamental rights, fundamental duties, and Directive Principles of State Policy.*
- ✓ *Fair knowledge about the functioning of various institutions in a democracy.*

UNIT-2 **0L+8T+0P=8 H**

LOCAL SELF GOVERNMENT

Local Self Government – Constitutional Scheme in India – 73rd and 74th Amendments.

PRACTICES:

- Debate on federalism in India.
- Collect news published in the local papers about panchayats in the nearby areas.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyse major articles and provisions of the Indian constitution.	Analyze	1	6
2	Appreciation for the constitution and safeguarding individual rights.	Apply	1	6
3	Evaluating functions of various organs of the State in a democracy.	Evaluate	2	6

TEXTBOOKS:

1. PM Bhakshi, “Constitution of India”, 15th edition, Universal Law Publishing, 2018.

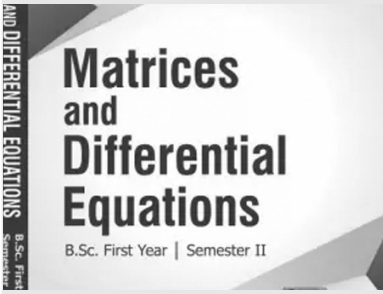
REFERENCE BOOKS:

1. B. R. Ambedkar, “The Constitution of India” 2020 edition, Educreation Publishing, India, 2020.
2. Subhash Kashyap, “Our Constitution” 2nd edition, National Book Trust, India, 2011.
3. Arun K. Thiruvengadam, “The Constitution of India: A Contextual Analysis”, Hart Publishing India, 2017.

22MT110 MATRICES AND DIFFERENTIAL EQUATIONS

Hours Per Week :

L	T	P	C
3	2	0	4



Source:https://www.flipkart.com/matrices-differential-equations-nep-b-sc-sem-ii/p/itmefb5ea2219421

PREREQUISITE KNOWLEDGE:

School level Mathematics, Differentiation and Integration

COURSE DESCRIPTION AND OBJECTIVES:

This course will help the students to learn the concepts of matrices and differential equations. Also they can apply these concepts in any engineering and science domains.

MODULE-1

UNIT -1 **12L+8T+0P=20 Hours**

MATRICES

Definition of matrix; Types of matrices, Algebra of matrices, adjoint of a matrix, inverse of a matrix by elementary operations, Rank of a matrix, Echelon form, Normal form.

UNIT-2 **12L+8T+0P=20 Hours**

APPLICATIONS OF MATRICES

Consistency of system of linear equations, Solution of system of linear equations by Gauss elimination method and Gauss Jordan method.

Eigen values and Eigen vectors (up to 3 x 3 matrices only) and properties (without proofs).

PRACTICES:

- Identify the matrix and do various operations on it.
- Finding rank of matrix.
- Solving a system of equation using matrix method
- Find Eigen values and Eigen vectors.

MODULE-2

UNIT-1 **12L+8T+0P=20 Hours**

ORDINARY DIFFERENTIAL EQUATIONS

First Order Differential Equations: Introduction to ODE, variable separable method, homogenous and non-homogenous differential equations, linear differential equations, Bernoulli's equations.

Second Order Differential Equations: Linear Homogeneous and non-homogeneous differential equations with constant coefficients (RHS is eax, xn, sin(ax) or cos(ax)).

UNIT-2 **12L+8T+0P=20 Hours**

APPLICATIONS OF ODE

Applications of ODE: Newton's law of cooling, Law of natural growth and decay, LC circuit.

PRACTICES:

- Finding Solutions of Differential Equations.
- Apply the concepts of Differential equations.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply elementary transformations to find the rank and inverse.	Apply	1	1, 2, 9, 10, 12
2	Solve the Ordinary differential equations.	Apply	2	1, 2, 9, 10, 12
3	Apply the differential equation in various problems.	Apply	2	1, 2, 9, 10, 12
4	Examine the consistency of the system of linear equations.	Analyse	1	1, 2, 9, 10, 12

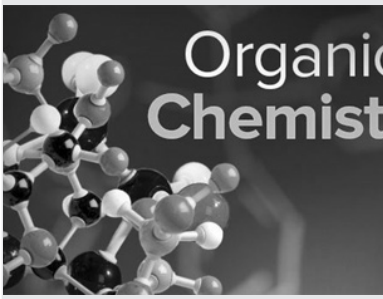
TEXT BOOKS:

1. N. P. Bali, K. L. Sai Prasad, "A Textbook of Engineering Mathematics I, II, III", 2nd Edition, Universal Science Press, New Delhi, 2018.
2. B. S. Grewal, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, 2018.

REFERENCE BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons, Inc., 2015
2. H. K. Dass and Er. Rajanish Verma, "Higher Engineering Mathematics", 3rd Edition, S. Chand & Co., 2015.
3. B. V. Ramana, "Advanced Engineering Mathematics", TMH Publishers, 2020.

22CT104 ORGANIC CHEMISTRY



source: https://grasptutorials.com/subjects/jee.html

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Intermediate level knowledge of chemistry

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed at offering fundamental concepts of organic chemistry which will help to design and synthesize organic compounds and understand their properties. This course will make the student familiar with basic concepts of bonding, reaction intermediates and stereochemical aspects applicable in synthetic organic chemistry and organic materials. As a first-level course for B. Tech. students with biology background, it will be a strong basis to understand advanced level mechanistic aspects of biochemical reactions and also synthesis of organic molecules with medicinal value.

MODULE-1

UNIT-1 **9L+0T+6P=15 Hours**

CHEMICAL BONDING AND REACTION INTERMEDIATES

Chemical Bonding: Introduction to VBT and VSEPR theory, Molecular Orbital (MO) energy diagram of Ethylene, 1,3-Butadiene.

Reaction Intermediates: Bond fissions and arrow-pushing, formation, and reactivity of carbanions, carbocations, free radicals, carbenes.

UNIT-2 **15L+0T+10P=25 Hours**

STEREOCHEMISTRY

Representations of 3 Dimensional structures, Structural isomers and Stereoisomers, Chirality, optical isomerism - Enantiomers and Diastereomers (Lactic acid and Tartaric acid), Absolute configurations (R/S), Conformational analysis – Ethane.

PRACTICES:

- Comparison MO diagrams of 1,3,5 hexatriene and Benzene.
- Determination of melting point and boiling point of organic compounds.
- Separation of organic compounds by thin layer chromatography(TLC).
- Drawing of chemical structures (Vitamin A, B1, C, D/Amino acids/Sugars/Carbohydrates/ Flavonoids/Terpenoids).
- Analysis of functional groups.
- Carboxylic acids.
- Carbonyl compounds.
- Amines.
- Construction of organic molecules (Tartaric acid (meso, RR and SS) using ball stick models.
- Relevance of stereochemistry in biology eg. Thalidomide.
- Stability of carbocation by rearrangement.

SKILLS:

- ✓ *Design a scheme for an organic reaction.*
- ✓ *Identify the stereochemical feature of a molecules based on the structure.*
- ✓ *Apply the R&D scale to Gram scale reaction.*
- ✓ *Choose the desired green solvent required for a reaction.*
- ✓ *Analyse the desired product, side product and impurities formed during the course of the reaction pathway.*

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

ORGANIC REACTIONS AND GREEN CHEMISTRY

Organic reactions: Introduction to reactions involving substitution (SN1 vs SN2), addition (Electrophilic and Nucleophilic), Elimination (E1 and E2), Oxidation (Jones reagent) and reduction (LiAlH4).

Green chemistry 12 Principles of Green chemistry and introduction to catalysis with example.

UNIT-2 **15L+0T+10P=25 Hours**

STRUCTURAL ELUCIDATION OF ORGANIC COMPOUNDS

IR Spectroscopy: Introduction, principle, identification of functional groups.

NMR spectroscopy: Introduction, principle, chemical shift, 1H-NMR (Ethyl alcohol and other simple molecules), cis-trans isomers (J values).

Mass spectroscopy: Introduction, principle, fragmentation (nitrogen rule), Radioisotopes in biology.

PRACTICES:

- Preparation and characterization of Aspirin.
- Paper Chromatography for Identification of Amino acids from the mixture.
- Reduction of Nitro group to amino group using metal catalysis and characterization by IR and NMR
- Characterisation (IR) of functional groups.
  Carboxylic acids.
  Carbonyl compounds.
  Amines.
- Oxidation and of an Organic compound using Potassium Permanganate (KMnO4).
- Reduction and of Aldehydes using Sodium Borohydride (NaBH4).
- Preparation and characterization of Paracetamol using IR.
- Synthesis of BINOL using solvent free methods.
- Qualitative analysis of Phytochemicals.
  Alkaloid.
  Flavonoids.
- Synthesis and characterisation of Friedel-Craft acylation and alkylation product using β-naphthol.
- Demonstration of C-C bond formation reaction using L-Proline catalyst.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the theories of bonding to predict the formation and reactivity of different reaction intermediates in organic reactions.	Apply	1	1, 2, 9, 10, 11, 12
2	Identify the stereochemical features of organic molecules and their the importance of chirality with relevance to biological activity.	Analyse	1,	1, 2, 6, 9, 10, 11, 12
3	Analyse various synthetic reactions for preparation of drug molecules by implementing the concept of Green Chemistry.	Analyse	1, 2	1, 2, 6, 7, 9, 10, 11, 12
4	Verify the structure of organic compound using the principles of instrumental techniques for structure determination.	Evaluate	2	1, 2, 4, 5, 9, 10, 11,12

TEXT BOOKS:

1. A. Bahl and B.S. Bahl, “Text Book to Organic Chemistry”, S.Chand & Co, 8th Edition, 2009.
2. R.T. Morrison, R.M. Boyd and S.K. Bhattacharjee, “Organic Chemistry”, Pearson Publications, 7th Edition, 2018.

REFERENCE BOOKS:

1. I. L. Finar, “Organic Chemistry”, Vol. 1, Longman Scientific Publications, 6th Edition,2006.
2. P. Bruice, “Organic Chemistry”, Pearson Scientific Publications, 8th Edition, 2020.
3. R. M. Silverstein, G. Bassler, M. Clayton, C.Terence, “Spectroscopic Identification of Organic Compounds”, Wiley-VCH, 8th Edition, 2014.
4. J. Mendham, R. C. Denney, J.D. Bares, M. Thomas, B. Siva Sankar, “Vogel’s Text Book of Qualitative Chemical Analysis”, Pearson Publications - Volume I, 2009.
5. D.L. Pavia, G.M. Lampman, G.S. Kriz, R.G. Engel, “A microscale approach to Organic Laboratory Techniques”, Cengage Learning Brooks/Cole Cengage, 5th Edition, 2012.

Source: https://www.geeksforgeeks.org/best-way-to-start-with-competitive-programming-geeksforgeeks-cp-live-course/

22TP104 BASIC CODING COMPETENCY

Hours Per Week :

L	T	P	C
0	1	3	2

PREREQUISITE KNOWLEDGE: Programming in C.

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed to impart knowledge on advanced concepts of C programming language and problem solving. At the end of this course, students will be able to design, implement, test and debug complex problems using features of C.

MODULE-1

UNIT-1 **0L+4T+12P=16 Hours**

NUMBER CRUNCHING

PRACTICES:

Problems On Number Crunching

- Write a program to check if a given number is perfect or not.
- Write a program to check if a given number is deficient or not.
- Write a program to check if 2 given numbers are amicable or not.
- Write a program to check if 2 given numbers are betrothed or not.
- Write a program to check whether a given number is an Armstrong number or not.
- Write a program to print the series of prime numbers in the given range.
- Write a program to print all the perfect numbers in a given range.
- Write a program to generate all deficient numbers in a given range.
- Write a program to generate all the amicable numbers in a given range.
- Write a program to generate all the betrothed numbers in a given range.
- Write a program to find the largest prime factor of a given number.
- Write a program to check whether the given number is a palindrome or not.
- Write a program to calculate sum of the individual digits for the given number.
- Write a program to find the first number that has more than ‘n’ factors, excluding 1 and that number.
- Write a program to accept a number as input and print its factorial.
- Write a program to accept a number n, print first N Fibonacci numbers.
- Write a program to check if an input number is Armstrong number or not.
- Write a program that takes input a,b. Print a power b.
- Write a program that takes input a number n, check if it a perfect square or not.
- Print array in spiral format.
- Print sum of each row in a matrix.
- Print sum of each column in matrix.
- Print left->right and right->left diagonals in a matrix.
- Initially you are at (0,0) find the shortest path count to reach the (n, n) block in matrix.
- Remove all the elements present in row and column of unsafe elements. An element is called unsafe if it is equal to smallest or largest value. Count number of remaining elements.
- Write a program to check if the string contains all the letters of alphabet.
- Check if a string is matching password requirements.

- Check if String A contains String B (String searching).
- Check if a number is harshad number or not.
- Write a program to get 3 numbers as input. The first is the number num1 and second is the digit that needs to be replaced. The third is the digit that is to replace the 2nd digit. Print the number after performing this operation.
- Write a program to accept a number and swap its alternate digits. Print the number generated.
- Write a program to accept a number and choice as input. If the choice is 0 rearrange the number such that the odd digits are ordered first followed by the even digits. If the choice is 1 rearrange the number such that the even digits are ordered first followed by the odd digits. Print the rearranged number. The order of occurrence of the digits is to be preserved.
- Write a program to determine that whether the given quadrilateral is cyclic or not. You are given the sizes of angles of a simple quadrilateral (in degrees) A, B, C and D, in some order along its perimeter.

  Note: A quadrilateral is cyclic if and only if the sum of opposite angles is 180∘.
- Chef is a very lazy person. Whatever work is supposed to be finished in x units of time, he finishes it in m∗x units of time. But there is always a limit to laziness, so he delays the work by at max d units of time. Given x,m,d, find the maximum time taken by Chef to complete the work.
- Suppose Chef is stuck on an island and currently he has x units of food supply and y units of water supply in total that he could collect from the island. He needs xr units of food supply and yr units of water supply per day at the minimal to have sufficient energy to build a boat from the woods and also to live for another day. Assuming it takes exactly D days to build the boat and reach the shore, tell whether Chef has the sufficient amount of supplies to be able to reach the shore by building the boat? Read five integers x,y,xr,yr,D from the user and display “YES” if Chef can reach the shore by building the boat and “NO” if not (without quotes).
- There are 3 problems in a contest namely A,B,C respectively. Alice bets Bob that problem C is the hardest while Bob says that problem B will be the hardest.

  You are given three integers SA,SB,SC which denotes the number of successful submissions of the problems A,B,C respectively. It is guaranteed that each problem has a different number of submissions. Determine who wins the bet.

1) If Alice wins the bet (i.e. problem C is the hardest), then output Alice.
2) If Bob wins the bet (i.e. problem B is the hardest), then output Bob.
3) If no one wins the bet (i.e. problem A is the hardest), then output Draw.

   Note: The hardest problem is the problem with the least number of successful submissions.

   Input Format

- The first line of input contains a single integer T denoting the number of test cases. The description of T test cases follows.
- The first and only line of each test case contains three space-separated integers SA,SB,SC, denoting the number of successful submissions of problems A,B,C respectively.

  Output Format

  For each test case, output the winner of the bet or print Draw in case no one wins the bet.

  Sample Input 1

  3

  1 4 2

  16 8 10

  14 15 9

  Sample Output 1

  Draw

  Bob

  Alice

SKILLS:

- ✓ *Analysis of the problem to be solved.*
- ✓ *Application of various file operations effectively in solving real world problems.*
- ✓ *Develop C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt.*

- In a season, each player has three statistics: runs, wickets, and catches. Given the season stats of two players A and B, denoted by R, W, and C respectively, the person who is better than the other in the most statistics is regarded as the better overall player. Tell who is better amongst A and B. It is known that in each statistic, the players have different values.

  Input

  The first line contains an integer T, the number of test cases. Then the test cases follow.

  Each test case contains two lines of input.

  The first line contains three integers R1, W1, C1, the stats for player A.

  The second line contains three integers R2, W2, C2, the stats for player B.

  Output

  For each test case, output in a single line "A" (without quotes) if player A is better than player B and "B" (without quotes) otherwise.

- Write a program to find the direction.

  Chef is currently facing the north direction. Each second he rotates exactly 90 degrees in clockwise direction. Find the direction in which Chef is facing after exactly X seconds.

  Note: There are only 4 directions: North, East, South, West (in clockwise order). Initially chef is at 0th second i.e., facing North direction.

  Input Format

- First line will contain T, number of testcases. Then the testcases follow.
- Each testcase contains of a single integer X.

  Output Format

  For each testcase, output the direction in which Chef is facing after exactly X seconds.

  Sample Input 1

  3

  1

  3

  6

  Sample Output 1

  East

  West

  South

- Chef is playing in a T20 cricket match. In a match, Team A plays for 20 overs. In a single over, the team gets to play 6 times, and in each of these 6 tries, they can score a maximum of 6 runs. After Team A's 20 overs are finished, Team B similarly plays for 20 overs and tries to get a higher total score than the first team. The team with the higher total score at the end wins the match.
- Chef is in Team B. Team A has already played their 20 overs, and have gotten a score of R. Chef's Team B has started playing, and have already scored C runs in the first O overs. In the remaining 20−O overs, find whether it is possible for Chef's Team B to get a score high enough to win the game. That is, can their final score be strictly larger than R?

  Input: There is a single line of input, with three integers, R, O, C.

  Output: Output in a single line, the answer, which should be "YES" if it's possible for Chef's Team B to win the match and "NO" if not.

- Make Array Zeros using pointers

  You are given an array A of length N (size should be created using Dynamic memory allocation) and can perform the following operation on the array:

  Select a subarray from array A having the same value of elements and decrease the value of all the elements in that subarray by any positive integer x.

  Find the least possible number of operations required to make all the elements of array A equal to zero.

The first line contains an integer N denoting the number of elements in the array.

The next line contains space-separated integers denoting the elements of array A.

Print the least possible number of operations required to make all the elements of array A equal to zero.

Sample Test case

Input:

5

2 2 1 3 1

Output:

4

UNIT-2 **0L+4T+12P=16 Hours**

PATTERNS

PRACTICES:

- Problems on Number Patterns
- Write a program to generate Floyd triangle. Sample input N= 4.

  1

  2 3

  4 5 6

  7 8 9 10
- Write a program to generate the following pattern. Sample input N=5.

  13579

  3579

  579

  79

  9
- Write a program to generate the following pattern. Sample input N=4.

  1111111

  222222

  33333

  4444

  333

  22

  1
- Write a program to generate the following pattern. Sample input N=5.

  5432*

  543*1

  54*21

  5*321

  *4321
- Write a program to generate the following pattern. Sample input N=5.

  12 21

  123 321

  1234 4321

  123454321

- Write a program to generate the following pattern. Sample input N=5.

```
1
2*2
3*3*3
4*4*4*4
4*4*4*4
3*3*3
2*2
1
```

- Write a program to generate the following pattern. Sample input N=4.

```
1
212
32123
4321234
```

- Write a program to generate the following pattern. Sample input N=5.

```
*
* *
* * * *
* *
*
```

- Write a program to print Pascal triangle for the given number of rows. Sample input N=5.

```
          1
        1   1
      1   2   1
    1   3   3   1
  1   4   6   4   1
```

- Write a program to generate the following pattern. Sample input N=4.

```
1234
2341
3421
4321
```

- Print Hollow Diamond pattern.
- Print pascals triangle.
- Print Floyds triangle.
- Print Butterfly Pattern.
- Print palindromic pattern.
- Print full inverted number triangle.
- Check if a number is prime or not (Efficient Approach).
- Find sum of all the digits of the number.
- Print transpose of given matrix.
- Rotate a two dimensional matrix by 90, 180, 270 degrees.

MODULE-2

UNIT-1 **0L+4T+12P=16 Hours**

ARRAYS

PRACTICES: Problems On Arrays

Given an unsorted array of size N, and the array elements are in the range of 1 to N. There are no

duplicates, and the array is not sorted. One of the integers is missing. Write a program to find the missing number.

Given an array consisting of only 0s and 1s in random order rearrange the array such that all the 0s are to the left of the array and 1s to the right.

Give an array consisting of odd and even numbers in random order, rearrange the array such that all the odd numbers are to the left of the array and even numbers are to the right of the array.

- Write a program to find all the unique elements in an array.
- Write a program to merge two arrays of the same size sorted in descending order.
- Write a program to count the frequency of each element in an array of integers.
- Write a program to find the second largest element in an array.
- Write a program to find the second smallest element in an array.
- Write a program to find that one element in array that occurs odd number of times, where every other element appears even number of times.
- Create a jagged array (adjacency list representation of a graph) with no of rows and no of columns in each row as specified by the user.

  Hint: Use Dynamic memory allocation (malloc() or calloc())

  Input:

  Enter no of rows: 3

  Enter no of columns Row in 1: 3

  Enter no of columns Row in 2: 5

  Enter no of columns Row in 3: 2

  Enter the elements row wise:

  8 6 5

  8 4 6 9 7

  9 2

  Output:

  8 6 5

  8 4 6 9 7

  9 2
- Write a program to find second largest number in the array.
- Write a program to find first repeating element in the array.
- Write a program to left rotate the array.
- Write a program to right rotate the array.
- Write a program to find the largest continuous sum.
- Write a program to print the sum of 2nd largest and 2nd smallest elements.
- Write a program to find the maximum product of two numbers multiplies in array (same index should not be used twice).
- Rearrange an array consisting of 1s and 0s such that they are alternatively arranged. Print minimum number of moves required.
- In a given array, find two numbers whose sum equal k.
- Find the difference between positive and negative elements in the array.
- Implement sorting algorithms (Insertion, selection, bubble).

UNIT-2 **0L+4T+12P=16 Hours**

STRINGS

PRACTICES: Problems on Strings:

- Write a program to reverse a given string word by word.
- Write a program to find the first occurrence of non-repeating character in the given string.

- Write a program to compress the string as provided in the example.
- Write a program to expand a string as provided in the example.
- Write a program to reverse those words of a string whose length is odd.
- Write a program to check if a given matrix is symmetric or not.
- Write a program to convert all the cases of letter (Lower case -> Upper Case, Upper Case-> Lower Case).
- Write a program to reverse all the words (Not the entire sentence but individual words).
- Find the longest palindrome in a given string.
- Check if two strings are anagrams or not.
- Find minimum number of changes to be done to make a string palindrome.
- Convert Excel sheet name to number (A-1, B-2, Z-26, AA-27).
- Find number of possible palindromes present in a string.
- Write a C program to read a string s, and determine the number of words in s.
  Example : s=oneTwoThree

  There are 3 words in the string: 'one', 'Two', 'Three'.
- Write a C program that reads a string S and remove all duplicates characters from the given string S.
  NOTE: 1) Order of characters in output string should be same as given in input string.

  2) String S contains only lowercase characters ['a'-'z'].

  Example: S = Vignanuniversity

  The program should generate the output as: Vignauersty
- Today Ron is reading the book. Due to some reason, he started hating the word 'are' (without quotes). So he decided to replace the substring 'are' with 'R'. Write a C program that reads a line of message 's' and replace the substring 'are' with 'R'. Example: s= Howareyou.
- The program should generate the output as: HowRyou
- Write a program to concatenate the characters of the two given strings alternatively.
- Given a string S consisting of uppercase and lowercase letters, change the case of each alphabet in this string. That is, all the uppercase letters should be converted to lowercase and all the lowercase letters should be converted to uppercase.
  Input: Vignan University

  Output: vIGNAN uNIVERSITY
- Write a program to insert a given character at the beginning and end of the given string.
- Given two Strings A and B. They are said to be friends if ASCII sum of the each individual string is divisible by 4 else they are not friends. You need to find whether given two strings are friends or not.
  Sample Test case:

  Input:

  man nam

  vignan university

  Output:

  YES

  NO
- Write a program to find the frequency of each digit in the given string.
  Input Format

  The first line contains a string, which is the given number.

Output Format

Print ten space-separated integers in a single line denoting the frequency of each digit, indicate that the integers are from 0 to 9.

Sample Input 0

a11472o5t6

Sample Output 0

0 2 1 0 1 1 1 1 0 0

Explanation 0

In the given string:

- 1 occurs two times.
- 2,4,5,6 and 7 occur one time each.
- The remaining digits and don't occur at all.
- Sherlock considers a string to be valid if all characters in the given string appear the same number of times. It is also valid if he can remove just 1 character at 1 index in the string, and the remaining characters will occur the same number of times.

  Write a C program that reads a string s and determine whether it is valid or not. If valid, return YES, otherwise return NO.

  Example: S=abc

  This is a valid string because frequencies are {a:1,b:1,c:1}

  S=abcc

  This is a valid string because we can remove one c and have 1 of each character in the remaining string.

  S=abccc

  This string is not valid as we can only remove 1 occurrence of c. That leaves character frequencies of {a:1,b:1,c:2}
- Read a string containing characters A and B only. Your task is to change it into a string such that there are no matching adjacent characters. To do this, you are allowed to delete zero or more characters in the string.

  Write a C program that finds the minimum number of deletions required.

  Example: S=AABAAB

  Remove A at positions 0 and 3 to make S=ABABA in 2 deletions.

  Input Format

  The first line contains an integer (the number of queries).

  The next q lines each contain a string s to analyze.

  Sample Input:

  5

  AAAA

  BBBBB

  ABABABAB

  BABABA

  AAABBB

Sample Output:

3

4

0

0

4

- Write a C program that reads a string ‘s’ and it is said to be complete if it contains all the characters from a to z.

  Input Format

  First line of the input contains the number of strings N. It is followed by N lines each contains a single string.

  Output Format

  For each test case print “YES” if the string is complete, else print “NO”

  Constraints 1 <= N <= 10

  The length of the string is at max 100 & the string contains only the characters a to z.

- Write a C program that reads two strings and determine whether they share a common substring or not. A substring may be as small as one character.

  Example;

  S1=and

  S2=art

  The common substring in these two strings: a.

  Sample Input

  2

  hello

  world

  hi

  world

  Sample Output

  YES

  NO

COURSE OUTCOMES:

Upon successful completion of the course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Write simple, but complete, C programs.	Apply	1,2	1
2	Identify suitable data type for operands and design of expressions having right precedence.	Apply	1,2	1
3	Apply decision making and iterative features of C Programming language effectively.	Apply	1,2	1
4	Select problem specific data structures and suitable accessing methods.	Analyse	1,2	1,2
5	Design and develop non- recursive and recursive functions and their usage to build large modular programs and also able to design string manipulation functions.	Create	1,2	3
6	Develop C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt.	Create	1,2	3,4

TEXT BOOKS:

1. Behrouz A. Forouzan, Richard F.Gilberg, “Programming for Problem Solving”, 1st edition, Cengage publications, 2019.
2. Ajay Mittal, “Programming in C - A Practical Approach”, 1st edition, Pearson Education, India, 2010.

REFERENCE BOOKS:

1. Reema Thareja, “Computer Fundamentals and Programming in C”, 1st edition, Oxford University Press, India, 2013.
2. Herbert Schildt, “C: The Complete Reference”, 4th edition, Tata McGraw-Hill, 2017.
3. Byron S Gottfried, “Programming with C”, 4th edition, Tata McGraw-Hill, 2018.

source:https://depositphotos.com/5087383/stock-photo-the-engineering-drawing.html
Image file name: Engineering Graphics

22ME101 ENGINEERING GRAPHICS

Hours Per Week :

L	T	P	C
2	0	2	2

PREREQUISITE KNOWLEDGE: Basics of Geometry.

COURSE DESCRIPTION AND OBJECTIVES:

Engineering graphics is the language of engineers and is the most effective way of communicating and sharing technical ideas in the form of pictures/drawings. The objective of this course is to familiarize the students with the conventional concepts of engineering drawing and computer aided drawing.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

ENGINEERING CURVES

Types of lines; Lettering, Dimensioning, Geometric constructions - lines, polygons (Angle, ARC, General and Inscribe in circle method), Conical curves (General method), Ellipse by Oblong method.

UNIT-2 **10L+0T+10P=20 Hours**

ORTHOGRAPHIC PROJECTIONS OF POINTS, LINES & PLANES

Principles of projection, Projections of points, Projection of straight lines - Inclined to one plane, inclined to both planes, Projection of planes - Inclined to one plane.

PRACTICES:

- Construction of polygons using different methods (i.e. ARC, Angle, General).
- Inscribe a regular hexagon & pentagon in a circle of the given diameter.
- Tracing of conical curves (Ellipse, Parabola, Hyperbola) by using General Method.
- Draw the projections of the points situated in all the 4 quadrants.
- Draw the projections of a line when it is inclined to one plane (HP or VP).
- Draw the projections of a line when it is inclined to both the planes (HP &VP).
- Draw the projections of a plane when it is inclined to one plane (HP or VP).

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

PROJECTIONS OF SOLIDS: Projection of solids axis inclined to one reference plane - Prisms, pyramids, Cylinder and cone.

DEVELOPMENT OF SURFACES: Development of lateral surfaces of simple solids - Prisms, Pyramids, Cylinder and cone.

UNIT-2 **10L+0T+10P=20 Hours**

ORTHOGRAPHIC VIEWS: Conversion of pictorial views into orthographic views.

DRAFTING USING COMPUTER PACKAGE: Introduction to 2D modelling software - AutoCAD, Conversion of Isometric view into Orthographic views of simple castings, Conversion of Orthographic views into Isometric view of simple solids - Prisms, Pyramids, Cylinders and cones

PRACTICES:

- Draw the projections of Prisms, when they are inclined to one reference plane (HP or VP)
- Draw the projections of Pyramids, when they are inclined to one reference plane (HP or VP)
- Draw the projections of cylinder & cone, when they are inclined to one reference plane (HP or VP)
- Draw the complete surface development of prisms&pyramids with the given dimensions
- Draw the complete surface development of cylinder & cone with the given dimensions
- Draw the orthographic view's (i. e. front view, top view, and side view) of the given pictorial view of the sketches by using AutoCAD
- Draw the Isometric view of simple solids (Prisms & Pyramids) by using AutoCAD
- Draw the Isometric view of simple solids (Cylinder & Cone) by using AutoCAD.

SKILLS:

- ✓ *Convert isometric views of objects into orthographic views and vice versa*
- ✓ *Visualize the shape of the 3D components*
- ✓ *Create pictorial views by using AutoCAD*
- ✓ *Understand projections by visualization.*

COURSE OUTCOMES:

Upon successful completion of the course, students will have the ability to:

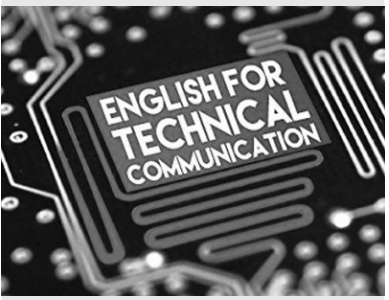
CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Communicate the technical ideas in the form of drawings.	Apply	1	1,2,3,5
2	Apply the drawing skills in representing various geometrical features.	Apply	1	1,2,3,5
3	Develop orthographic projections and isometric views of various objects.	Apply	1	1,2,3,5
4	Estimate the lateral surface area of regular geometrical solids.	Analyze	2	1,2,3,5
5	Sketch simple objects and their pictorial views using AutoCAD.	Analyze	2	1,2,3,5

TEXT BOOKS:

1. J Hole, "Engineering Drawing", 2nd edition, Tata McGraw-Hill, 2019.
2. N D Bhatt, "Engineering Drawing", 53rd edition, Charotar Publication, 2014

REFERENCE BOOKS:

1. Basant Agrawal and C.M. Agrawal "Engineering Drawing", 2nd edition, Tata Mc Graw- Hill, 2018.
2. K L Narayana, "Engineering drawing", 3rd edition, SciTech Publications, 2011.
3. Colin H. Simmons, Dennis E. Maguire, Manual of Engineering Drawing, 2nd edition, 2003.



source: https://www.abebooks.com/9781316640081/English-Technical-Communication-Students-Book-1316640086/plp

22EN104 TECHNICAL ENGLISH COMMUNICATION

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Basic sentence formation, understanding contextual meanings, basic writing skills and moderate fluency in English.

COURSE DESCRIPTION AND OBJECTIVES:

In this course students will read, analyze, and interpret material from technical and general fields, and practice reading, writing, listening and speaking skills to gain exposure and functional English on a variety of contemporary topics. The overall course objective is to provide English for Specific Purposes(ESP) instruction to enhance students' reading, writing, listening and speaking skills through a practice in the language. It will aim to build students' confidence and motivation through exposure to academic skills like Note making/taking, Paraphrasing, Summarizing, Report Writing, Making Presentations etc., so as to generate interest in the language from an ESP perspective. Finally, students are expected through the course to gain key strategies and expression for communicating with professionals and non-specialists.

MODULE-1

UNIT-1 **8L+0T+8P=16 Hours**

GENETICS

Reading: Reading for Note MakingSub skills, Reading for global understanding (skimming), specific information (scanning), understanding main ideas and supporting ideas, guessing contextual meanings from the text. -Vocabulary building: commonly used roots, prefixes, and suffixes.

Writing: Note making, organising main points and sub points, numbering and sequencing, suggesting titles, paraphrasing and summarising.

Functional grammar: Common Errors in Articles and Prepositions (Handout).

Listening: Listening for Note Taking, top down and bottom up approach, listening for main ideas and supporting points.

Speaking : Presentation in teams - ideas on the topic summarised, making a PPT, effective introductions and conclusions, logical organisation of content, using appropriate structure and cohesive devices.

UNIT-2 **8L+0T+8P=16 Hours**

ALIENS

Reading : Reading: predicting, skimming, scanning, reading for inference, extrapolative reading.

Vocabulary building: Academic vocabulary from the text: synonyms, antonyms, Words often confused.

Writing : Paragraph writing; writing a topic sentence, supporting sentences, effective introductions and conclusions, use of cohesive devices. Types of Paragraphs: Descriptive, narrative, argumentative and expository.

Functional grammar: Common Errors inVerb forms and Conditional sentences (Handout).

Listening: Listening for identifying parts from a description, listening to and sorting information, listening for specific information.

Speaking: Narrating/Retelling an incident,using suitable cohesive devices/discourse markers Speaking of past and present habits/ activities/events - Speaking of future plans.

PRACTICES:

- Note making.
- Summarizing.
- Paragraph Writing.
- Error correction and Restructuring.
- Vocabulary building.
- Listening comprehension.
- Note taking.

SKILLS:

- ✓ *Apply different subskills like skimming, scanning, reading for information, reading for inference etc. to understand different kinds of text.*
- ✓ *Apply different sub skills like top down, bottom up approaches to listening.*
- ✓ *Use functional vocabulary relevant to engineering and technology to express ideas lucidly.*
- ✓ *Use appropriate sentence structure, cohesive devices to construct simple text in regular correspondence like e-mails and letters.*

MODULE-2

UNIT-1 **L+0T+8P=16 Hours**

SOCIAL MEDIA – HEALTH AND NUTRITION

Reading: Reading for factual information researching for supporting evidence - skimming, scanning, Vocabulary building: One-word substitutes.

Writing: Letter Writing- E-mail writing – New age communication – Format, protocol, and style- WhatsApp, Facebook and Twitter Functional grammar:Common Errors in Sub-Verb Agreement and Modals.

Listening: Listening to a Business Presentation: Listening for deducing information, for abstract details and specific details, listening for taking a message.

Speaking: Making a presentation with a PPT on a topic assigned- organising the presentation using appropriate discourse markers - presenting a point of view - Extempore.

UNIT-2 **8L+0T+8P=16 Hours**

FASHION

Reading: Reading for data interpretation and information transfer from graphical aids to text reports (pictograms. tables, graphs, pie charts, flow charts), deducing specific information and general information

Vocabulary building: business vocabulary, collocations, idioms and phrasal verbs.

Writing: Writing a Report:Drafting general and factual reports - writing an overview - an effective introduction - organising information into paragraphs (Stages of writing: planning /organising /writing / editing /rewriting)

Functional grammar:transformations and miscellaneous common errors.

Listening : Listening to a Ted talk and sorting information – taking notes from a discussion.

Speaking: Group Discussion – prerequisites -generating content - initiating a discussion - expressing one's opinion ~ leading a discussion - agreeing/ disagreeing to someone's view - cutting into a speech - body language and voice modulation.

PRACTICES:

- E-mail writing.
- Letter writing.
- Report writing.
- Messaging in Social media.
- Extempore.
- Making PPTs.

COURSE OUTCOMES:

Upon successful completion of the course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply a variety of strategies to interpret and comprehend spoken texts/ discourse using contextual clues.	Apply	1	6, 7, 8, 9, 10, 12
2	Apply appropriatereading strategies to interpret content / material related to engineering and technology domain.	Apply	1	6, 7, 8, 9, 10, 12
3	Participate in discussions and make short presentations on general and technical topics.	Apply	1, 2	6, 7, 8, 9, 10, 12
4	Possess an ability to write clearly on topics related to technology and workplace communication.	Analyze	2	6, 7, 8, 9, 10, 12
5	Choose functional language, grammar structures, cohesive devices and skills of organisation to express clearly in speaking.	Evaluate	2	6, 7, 8, 9, 10, 12

LANGUAGE LAB ACTIVITIES:

- Session-1: Dictionary Skills.
- Session-2: Introduction to Phonetics and Identifying Phonemes.
- Session-3: Pronunciation Practice (Commonly mispronounced words).
- Session-4: Rosetta Stone (Exercises on LSRW).
- Session-5: Listening Comprehension (Summarising exercise on a Ted Talk).
- Session - 6: Technical Presentations (Individual).
- Session - 7: Technical Presentations (Team).
- Session - 8: TOEFL Mastery.

TEXT BOOKS:

1. N P Sudharshana&C Savitha,“English For Technical Communication”, 2nd edition, Cambridge University Press, 2016.

REFERENCE BOOKS:

1. Balasubramanian T,“A Text book of Phonetics for Indian Students”, 1st edition, Orient Longman, New Delhi, 1989.
2. Krishnaswamy, N and Sriraman, T,“Current English for Colleges”, 1st edition, Trinity publications, 2016.
3. Mohan Krishna and Meera Banerjee,“Developing Communication Skills”, 1st edition, Macmillan India Ltd. New Delhi, 1990.
4. Ashraf Rizvi M, “Effective Technical Communication”, 2nd Edition, McGraw Hill Education, 2017.
5. Narayana Swamy V R,“Strengthen your Writing”, 3rd Edition Orient Black Swan, New Delhi, 2005.

22BT102 GOOD LABORATORY PRACTICES

Source : https://journalsofindia.com/good-laboratory-practice-glp-working-group-of-oecd/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Microbiology and Fermentation Technology, Genetic Engineering, Industrial Biotechnology

COURSE DESCRIPTION AND OBJECTIVES:

The course provides insights about regulations and standards associated with GLP and GMP followed in industries. Further, create awareness on safety standards and the fundamental requirements of GLP and consequences of noncompliance for regulated laboratories.

MODULE-1

UNIT-1 **8L+8T+0P=16 Hours**

GOOD LABORATORY PRACTICE

Good laboratory Practices-Fundamentals, WHO guidelines on GLP and GMP, History of Good Laboratory Practices, Quality assurances in GLP.

UNIT-2 **8L+8T+0P=16 Hours**

QUALITY STANDARD AND ASSURANCES

Quality standards- advantages and disadvantages, concept of quality control, Quality assurance- their functions and advantages, Quality assurance and quality management in industry, Customer requirement of quality, Government and trade standards of quality federal food and drug law, FDA action, BSTI: action, activities and other food laws (Legalization).

PRACTICES:

- Indian policies related to GMP and GLP.
- Laws related to FDA.
- Quality standards for manufactured products.
- Report on WHO guidelines pertaining to GLP and GMP.

MODULE-2

UNIT-1 **8L+8T+0P=16 Hours**

QUALITY CONTROL

Introduction to quality control and total quality control in the food industry, Various quality attributes of food such as size, shape, texture, color, viscosity and flavor; Instrumental, chemical and microbial quality control, Sensory evaluation of food and statistical analysis, Food regulation and compliance, Food inspection and food law.

UNIT-2 **8L+8T+0P=16 Hours**

BACKGROUND, BIOSAFETY IN LABORATORY/ INSTITUTION

Laboratory associated infections and other hazards, Assessment of biological hazards and levels of biosafety, Prudent biosafety practices in the laboratory/institution, Introduction to biological safety cabinets, Primary containment of biohazards, Biomedical waste management, biosafety levels, Recommended biosafety levels for infectious agents and infected animals' bio safety guidelines; Government of India guidelines, definition of genetically modified organisms (GMOs).

SKILLS:

- ✓ *Following good laboratory practices*
- ✓ *Assessing the quality of products.*
- ✓ *Handling hazardous chemicals.*

PRACTICES:

- Quality control management in industry considering two industry examples.
- A report on Food inspection laws.
- Examination and preparation of a report on the functioning of biosafety cabinets in the biotechnology lab including the components.
- A report on Biomedical waste management in India.
- Disposal of biological and radio isotope wastes.
- Biosafety levels and related infectious agents handling.

COURSE OUTCOMES:

Upon successful completion of the course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze GLP environment.	Analyze	1	6,7,8,9,10
2	Apply the principles of GLP.	Apply	1	4,7,8,5,9,10
3	Evaluate the risks and environmental release of GMO's.	Evaluate	2	6,7,8,9,10
4	Create awareness on biosafety guidelines.	Creating	2	3,6,7,8,9,10

TEXTBOOK:

1. Syed Imtiaz Haider, "Pharmaceutical Master Validation Plan the Ultimate Guide to FDA, GMP, and GLP Compliance", St. Lucie, 2002.
2. Hubbard MR, "Statistical quality control for the food industry", Springer Science & Business Media, 3rd edition, 2012.

REFERENCEBOOK:

1. Richmond JY, McKinney RW, "Biosafety in microbiological and biomedical laboratories", US Government Printing Office, 2009.
2. Nally JD, "Good manufacturing practices for pharmaceuticals", 1st edition, CRC Press, 2016.
3. Sharp J, "Good pharmaceutical manufacturing practice: rationale and compliance", 1st edition, CRC Press, 2004.

II

YEAR

B.Tech.

BIOTECHNOLOGY

COURSE CONTENTS

I SEM & II SEM

I SEMESTER

22ST201	-	Biostatistics and Design of Experiments
22TP201	-	Data Structures
22BT101	-	Cell and Molecular Biology
22BT201	-	Biochemistry and Enzymology
22BT202	-	Chemical Engineering Principles in Biotechnology
22BT203	-	Microbiology and Fermentation Technology
22SA201	-	Life Skills-I

II SEMESTER

22TP203	-	Advanced Coding Competency
22TP204	-	Professional Communication
22BT204	-	Bioanalytical Techniques
22BT205	-	Industrial Biotechnology
22CT201	-	Environmental Studies
22MS201	-	Management Science
	-	Department Elective – 1
	-	Open Elective – 1
22SA202	-	Life Skills-II

22ST201 BIOSTATISTICS AND DESIGN OF EXPERIMENTS

Source: https://www.clinfo.eu/biostatistics/

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Basic engineering mathematics.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides students the foundation in elementary topics of statistics and probability such as descriptive statistics, regression analysis and probability. It also enhances the knowledge of students towards successfully analyse the practical situations with the concepts of testing of hypothesis with design of experiments.

MODULE-1

UNIT-1 **09L+6T+0P=15 Hours**

DESCRIPTIVE STATISTICS

Basic Definitions, Frequencies, Graphical Representation, Histogram, Ogive curves, Measures of Central tendency, Arithmetic mean, Median, Mode, Mean deviation, Standard deviation, Symmetry and Skewness, Karl Pearson's Coefficient of skewness, Covariance, Correlation, Types, Pearson's Coefficient of correlation, Rank correlation, Spearman's rank correlation.

UNIT-2 **15L+10T+0P=25 Hours**

REGRESSION ANALYSIS AND PROBABILITY

Regression, Linear regression lines and Properties, Introduction (Classical and Axiomatic approach), Addition theorem, Conditional probability, Multiplication theorem and Bayes theorem.

PRACTICES:

- Graphical representation (histogram, Pie Diagram and Ogive curve) of the covid-19 affected subjects in the year 2020-21. (collect the data from Google).
- Calculate arithmetic mean of the height of boy students and girl students in your class.
- Find the standard deviation for the height difference between 10 boy and girl students.
- Measure the height and weight of your class mates. Calculate the correlation coefficient between the observed height and weight.
- Draw linear regression equation between the two quantifiable hypothetical variables.

Months in the year 2021	Vaccinated Subjects	Subjects suffering from Covid-19 in my location.
May	100	2000
June	150	1850
July	250	1500
August	500	1000
September	750	500
October	850	200
November	950	100
December	1000	10

- Study the skewness of the data.
- Apply probability concepts in real time situations.

SKILLS:

- ✓ *Analyse the data using measures of central tendency*
- ✓ *Fit an appropriate curve for a given set of data*
- ✓ *Test the statistical models using ANOVA*

MODULE-2

UNIT-1 **9L+6T+0P=15 Hours**

TESTING OF HYPOTHESIS

Testing large samples-one mean, two means, one proportion and two proportions. Testing small samples-one mean, two means (independent and paired samples).

UNIT-2 **15L+10T+0P=25 Hours**

ANALYSIS OF VARIANCE

ANOVA one-way, two-way classifications, Design of experiments: completely randomized design, Randomized complete block design. Chi square tests-goodness of fit and independence of attributes.

PRACTICES:

Download a published paper on dye decolourization using design of experiments (or RSM) strategy for identifying the optimum operating conditions.

(a) Develop one parameter, multi parameter linear and nonlinear regression models with those experimental data.

(b) Develop other linear and nonlinear designs for the same set of parameters and mention their advantages and disadvantages.

Download a published paper on L-Lysine Production using design of experiments (or RSM) strategy for identifying the optimum operating conditions.

(a) Develop one parameter, multi parameter linear and nonlinear regression models with those experimental data.

(b) Develop other linear and nonlinear designs for the same set of parameters and mention their advantages and disadvantages.

Download a published paper on Production of Amylase using design of experiments (or RSM) strategy for identifying the optimum operating conditions.

(a) Develop one parameter, multi parameter linear and nonlinear regression models with those experimental data.

(b) Develop other linear and nonlinear designs for the same set of parameters and mention their advantages and disadvantages.

Download a published paper on L-asparagine production using design of experiments (or RSM) strategy for identifying the optimum operating conditions.

(a) Develop one parameter, multi parameter linear and nonlinear regression models with those experimental data.

(b) Develop other linear and nonlinear designs for the same set of parameters and mention their advantages and disadvantages.

Download a published paper on enzymatic biodiesel synthesis using design of experiments (or RSM) strategy for identifying the optimum operating conditions.

(a) Develop one parameter, multi parameter linear and nonlinear regression models with those experimental data.

(b) Develop other linear and nonlinear designs for the same set of parameters and mention their advantages and disadvantages.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

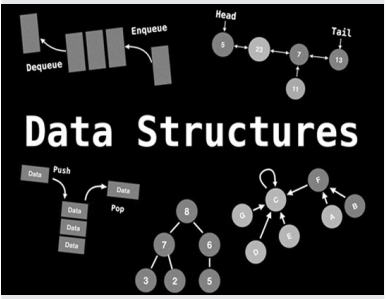
CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Applytheknowledge of statics to determine values of various descriptive measures	Apply	1	1,3,6,7
2	Analyse the fitness of the models using regression analysis.	Analyse	1	2,4,6,7
3	Design of experiments for various bioprocesses	Create	2	3,67
4	Evaluate the design models using statistical tools	Evaluate	2	3,4,7

TEXT BOOKS:

1. Khan and Khanum, 'Fundamentals of Biostatistics", 1st Edition, Ukaaz Publications, 2004.
2. S. C. Gupta and V. K. Kapoor, "Fundamentals of Mathematical Statistics", 2nd Edition, Sultan Chand & Sons, 2012.

REFERENCE BOOKS:

1. P. R. Vittal, "Mathematical Statistics", 2nd Edition, Margham Publications, Chennai, 2018.
2. Kishore S. Trivedi, "Probability and Statistics with Realiability, Queueing and Computer Science Applications", 2nd edition, Wiley Student edition, 2008.
3. A. Singaravelu, "Probability and Statistics", 22nd edition, Meenakshi Agency, 2015.



Source: https://www.youtube.com/watch?v=Qmt0QwzEmh0

22TP201 DATA STRUCTURES

Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Programming in C.

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed at offering fundamentals concepts of data structures and explains how to implement them. It begins with the basic concepts of data, data structures and then introduces the primitive and non-primitive data structures in detail. It forms the basis for understanding various ways of representing data and its usage in different computing applications.

MODULE-1

UNIT-1 **5L+6T+6P = 17 Hours**

DATA STRUCTURES BASICS

Basic Terminology – data, information, datatype, Data Structures – Introduction, storage structures-sequential and linked storage representations, classification of data structures, Applications of data structures.

Sorting: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort and Merge Sort.

Searching: Linear Search and Binary Search.

UNIT-2 **11L+10T+10P = 31 Hours**

LINKED LISTS AND STACKS, QUEUES

Linked List: Introduction, Types of linked list – Singly linked list, doubly linked list and circular linked list, representation of linked list, Operations of linked list, Traverse forward/ reverse order, searching, insertion and deletion, Applications of linked lists.

Stack - Introduction, array and linked representations, implementation and their applications, Queue - Introduction, array and linked representations, implementation, Types - Linear, circular and doubly ended queues - operations, Applications of Queues.

PRACTICES:

PROBLEMS ON RECURSION - LEVEL 1

- Find the product of 2 numbers using recursion.
- Find the sum of natural numbers using recursion.
- Find the factorial of a number using recursion.
- Find the Nth term of Fibonacci series using recursion.
- Calculate the power using recursion.
- Write a recursive program for checking if a given number is a prime number.
- Given two integers write a function to sum the numbers without using any arithmetic operators.
- Convert a decimal to binary using recursion.
- Print all factors using recursion.
- Find the maximum product of digits among numbers less than or equal to N.

PROBLEMS RECURSION – LEVEL 2

1. Implement insertion sort recursively.
2. Write a program to find the numbers less than N that are product of exactly 2 distinct prime numbers - using recursion.
3. Implement selection sort recursively.
4. Find the middle of a singly linked list using recursion.
5. Find the sum of even numbers of an array using recursion.
6. Check if a given array is in sorted order using recursion.
7. Print alternate nodes of a linked list using recursion.
8. Reverse a doubly linked list using recursion.
9. Write a recursive function that returns all permutations of a given list.
10. Implement bubble sort recursively.

PROBLEMS ON SORTING AND SEARCHING – LEVEL 1

1. Implement the insertion sort function.
2. Implement the bubble sort function.
3. Implement the quick sort function.
4. Implement the merge sort function.
5. Implement the selection sort function.
6. Implement linear search function.
7. Implement binary search function.

PROBLEMS ON SLL – LEVEL 1

1. Implement the insert function to insert nodes into a singly linked list (ascending order).
2. Implement the insert function to insert nodes into a singly linked list (descending order).
3. Implement the search node function.
4. Implement the delete node function.
5. Display forwards function.
6. Display backwards function.
7. Count the number of nodes in a singly linked list.
8. Swap alternate nodes of a singly linked list.
9. Move last node to the front of the linked list.
10. Move first node to the last of the linked list.

PROBLEMS ON STACKS – LEVEL 1

1. Implement two stacks using a single array.
2. Given an array replace every element with nearest greater element on the right.
3. Given a stack reverse the elements using only push and pop functions.
4. Postfix evaluation using stack.
5. Balance symbols.
6. Find middle element in a stack.
7. Remove middle element from a stack.
8. Implement push and pop using linked list.
9. Given an array of characters with the middle marked by X, check if the string is a palindrome.
10. Maximum sum in sliding window.

PROBLEMS ON QUEUES – LEVEL 1

1. Write a program to accept two numbers as input check if they are equal.
2. Write a program to accept two characters as input and check if they are equal.
3. Write a program to accept two numbers as input and print the greater of the 2 numbers.
4. Write a program to accept two numbers as input and print the lesser of the 2 numbers.
5. Write a program to accept 3 numbers as input and print the maximum of the 3.

SKILLS:

- ✓ *Experienced to Store data and various types of data to handle.*
- ✓ *Ordering and sorting of data.*
- ✓ *Indexing and Searching of required data from large data sequences.*
- ✓ *Exposed to various characteristics such as Linear or non-linear, Homogeneous or heterogeneous and Static and Dynamic.*

6. Write a program to accept 3 numbers as input and print the minimum of the 3.
7. Write a program to accept a number as input and print EVEN if it is an even number and ODD if it is an odd number.
8. Write a program to accept a number as input and check if it is divisible by 3. If it is divisible by 3 print YES else print NO.
9. Write a program to accept a number as input and check if it is divisible by both 3 & 5. If it is divisible print YES else print NO.
10. Write a program to accept a number as input and check if it is positive, negative or zero.

PROBLEMS ON DLL – LEVEL 1

1. Implement insert function.
2. Implement display forward function.
3. Implement display backward function.
4. Implement search function.
5. Implement delete function.
6. Reverse a doubly linked list from M to N.
7. Find the sum of the odd and even nodes.
8. Count odd keys of the linked list.
9. Merge two sorted lists.
10. Delete adjacent duplicate nodes.

PROBLEMS ON CLL – LEVEL 1

1. Insert function (circular doubly linked list).
2. Search function.
3. Display forward.
4. Display backward.
5. Delete node (circular doubly linked list).
6. Print the middle N nodes of a circular singly linked list.
7. Move the last node of a circular singly linked list to the beginning.
8. Delete adjacent duplicate nodes of a circular singly linked list.
9. Delete nodes greater than a value from a circular doubly linked list.
10. Find the sum of the nodes of a circular linked list.

PROBLEMS ON LINKED LIST – LEVEL 2

1. Given 2 sorted linked lists, print the common elements.
2. Reverse a list (using Stack).
3. Given a pointer to a node (not the last node), delete the node.
4. Reverse a list (Recursive).
5. Reverse a list (Iterative).
6. Reverse a singly linked list in pairs (recursive).
7. Reverse a singly linked list in pairs (iterative).
8. Check if a singly linked list is a palindrome or not.
9. Remove the loop if exists.
10. Given 2 linked lists with data in the ascending order, merge them into a single list.

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

TREES

Trees: Basic Terminology, Types of Trees, Binary Tree – Introduction, properties, array and linked representations, Tree traversals and their implementation, Expression trees, BST – definition and operations, AVL trees – definition and construction, Applications of binary trees.

UNIT-2 **8L+8T+8P=24 Hours**

GRAPHS & HASHING

Graphs: Basic Terminology, Types of Graphs, Graphs representations – adjacency matric, adjacency list; Traversals - breath first search and depth first search, Applications of graphs.

Hashing: Introduction, Different hash functions, collision - avoidance and handling methods.

PRACTICES:

PROBLEMS ON BST – LEVEL 1

1. Insert function.
2. Insert function (recursive).
3. Search function.
4. Pre order traversal.
5. Post order traversal.
6. In order traversal.
7. Level order traversal.
8. Delete child node.
9. Delete parent node.
10. Delete nodes greater than a value from a circular doubly linked list.

PROBLEMS ON PRIORITY QUEUES – LEVEL 1

1. Meeting rooms problem.
2. Ugly number.
3. Find median from data stream.
4. Find the top K frequent elements.
5. Find K Pairs with smallest sums.
6. Find the Kth smallest element in a sorted matrix.
7. Trapping Rain Water.
8. Rearrange String k distance apart.
9. Sort characters by frequency.
10. Solve the maze problem.

PROBLEMS ON GRAPHS – LEVEL 1

1. Implement Graph data structure.
2. Implement BFS - iterative solution.
3. Implement BFS - recursive solution.
4. Implement DFS - iterative solution.
5. Implement DFS - recursive solution.
6. Check if given graph is strongly connected or not.
7. Check if given graph is strongly connected or not - using DFS.
8. Given a graph find the arrival and departure time of its vertices in DFS. Arrival time is the time when the vertex was explored for the first time, and departure time is the time at which all the neighbours are explored and are ready to backtrack.
9. Given a directed acyclic graph and a source vertex, find the cost of the shortest path from source vertex to all other vertices present in the graph. If a vertex cannot be reached from given source vertex that distance may be printed as infinite.
10. Given an undirected graph, check if the graph is 2 edge connected or not.

PROBLEMS ON HASHING – LEVEL 1

1. Print a binary tree in vertical order.
2. Find whether an array is subset of another array.
3. Given an array A [] and a number x, check for pair in A [] with sum as x.

4. Minimum operation to make all elements equal in array.
5. Maximum distance between two occurrences of same element in array.
6. Check if a given array contains duplicate elements within k distance from each other.
7. Find duplicates in a given array when elements are not limited to a range.
8. Most frequent element in an array.
9. Smallest subarray with all occurrences of a most frequent element.
10. First element occurring k times in an array.

PROBLEMS ON GRAPHS – LEVEL 2

1. Find the shortest graph distances between every pair vertex in a given path. Assume that the graph does not have any negative edges.
2. Find the shortest graph distances between every pair of vertices in a given path. The graph can have negative edges.
3. Detect cycle in DFS.
4. Count the number of connected components of a graph represented in the adjacent matrix.
5. Count the number of connected components of a graph represented in the adjacent matrix - using DFS.
6. Find a spanning tree - not necessarily a minimum spanning tree.
7. Detect cycle in an undirected graph.
8. Given an undirected graph, find its depth.
9. Determine if a directed graph has a unique topological ordering.
10. Given a directed acyclic graph and two vertices v and w, find the lowest common ancestor.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Explore the organization of several ADTs and the manipulation (searching, insertion, deletion, traversing) of data stored in various data structures.	Apply	1,2	1
2	Apply different data structures to solve a given problem.	Apply	1,2	1
3	Analyze the efficiency of using different data structures and choose the efficient data structure for solving a given problem.	Analyze	1,2	2
4	Develop new algorithms to solve various problems.	Create	1,2	3,4

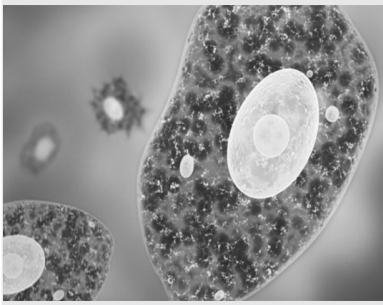
TEXT BOOKS:

1. ReemaThareja, “Data Structures Using C”, 2ndEdition, Oxford University Press, 2014.
2. Seymour Lipschutz, “Data Structures with C”, 1st edition, McGraw Hill Education, 2017.

REFERENCEBOOKS:

1. Ellis Horowitz and SartajSahni, “Fundamentals of Data Structures”, illustrated edition, Computer Science Press, 2006.
2. Richard F. Gilberg and Behrouz A. Forouzan, “Data Structures: A Pseudocode Approach with C”, 2nd edition, CENAGE Learning, 2005.
3. R G Dromey and Pearson, “How to solve it by Computer”, 2nd edition, Impression edition, 1998.

22BT101 CELL AND MOLECULAR BIOLOGY



source: https://www.illumina.com/areas-of-interest/cellular-molecular-biology-research.html

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Basics of Biology and Biochemistry.

COURSE DESCRIPTION AND OBJECTIVES:

This course helps to know different cell components and their functions like transport of material, signalling etc. And also, it imparts knowledge on cell division & cancer, structure, synthesis and processing of nucleic acids and protein synthesis in prokaryotes and eukaryotes. Further, familiarize students about the classification and types of mutations and how they affect the gene and its expression.

MODULE-1

UNIT-1 **9L+0T+6P= 15 Hours**

CELL STRUCTURE AND FUNCTION

Plasma membrane organization, cellorganelles- nucleus (chromatin and chromosome organization, karyotyping, cell division), mitochondria, chloroplast, endoplasmic reticulum,golgi bodies, lysosomes, cytoskeletal elements - microtubules, microfilaments and intermediate filaments.

UNIT-2 **15L+0T+10P= 25 Hours**

CELLULAR COMMUNICATION

Types of extra cellular signal molecules and their binding mechanisms, secondary messengers, types of signaling pathways-G-protein linked cell surface receptor mediated system, enzyme-linked cell surface receptors, cell cycle- mitosis and meiosis, molecular regulation of cell cycle (check points), mechanisms of cellular death, regulation of programmed cell death.

PRACTICES:

- Karyotyping of human chromosomes along with normal, Down and Turner syndromes.
- Cell Counting by Haemocytometer.
- Meiosis.
- Mitosis.
- MTT assay.

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

NUCLEIC ACIDS AND DNA REPLICATION

DNA discovery and structure, DNA models (A, B, Z models), DNA denaturation and melting curves, semi conservative DNA replication of prokaryotes and eukaryotes, rolling circle replication, replication in bacteriophages, inhibitors of DNA replication, DNA damage and repair mechanisms, site directed mutagenesis and reverse genetics.

UNIT-2 **15L+0T+10P= 25 Hours**

TRANSCRIPTION AND TRANSLATION

Transcription machinery, RNA polymerases, mechanism of transcription in prokaryotes and eukaryotes, post transcriptional modifications, inhibitors of transcription, genetic code and wobble hypothesis, mechanism of translation in prokaryotes and eukaryotes, post-translational modifications.

SKILLS:

- ✓ *Regulation of cell cycle.*
- ✓ *Processing of transcripts.*
- ✓ *Modification by site-directed mutagenesis.*
- ✓ *Identify various stages of cell division and differentiation.*
- ✓ *Handling reagents, enzymes and biochemicals related to molecular biology.*

PRACTICES:

- Isolation of genomic DNA from bacteria, plants and animals.
- Tm value for the genomic DNAs of bacteria, Plants and animals.
- Quantification of extracted genomic DNA from bacteria, plants and animals.
- Restriction enzyme digestion.
- Plasmid DNA isolation.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the concepts of gene expression and regulation.	Analyze	2	1,2,4,5,6,8,9,10
2	Analyze different mechanisms of cell signalling and role of secondary messenger pathways.	Analyze	1	2,4,5,9,10
3	Evaluate the leads of cancers through metastasis.	Evaluate	2	3,5,6,9,10
4	Design experiments incorporating the principles of microscopy and identification of different cell types.	Create	1	3,4,5,9,10

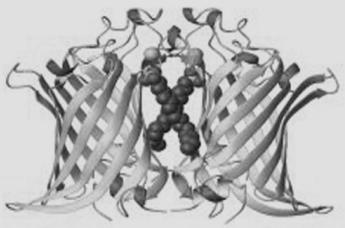
TEXT BOOKS:

1. G M Cooper, “The Cell: A Molecular Approach”, 8th edition, Oxford University Press, 2019.
2. Channarayappa, “Molecular Biotechnology: Principles and Practices”, 1st edition, CRC Press, 2007.

REFERENCE BOOKS:

1. B Alberts, A Johnson, J Lewis, M Raff, K Roberts and P Walter, “Molecular Biology ofthe Cell”, 6th edition, Garl and Science, 2014.
2. H Lodish, A Berk, S L Zipursky, P Matsudaira, D Baltimore and J Darnell, “Molecular Cell Biology”, 6th edition, Palme, 2018.
3. Jocelyn E. Krebs, Elloit S. Goldstein and Stephen T. Kilpatrick, “Lewin’s Genes XI”, 11th edition, Jones & Bartlett Learning, 2014.

22BT201 BIO CHEMISTRY AND ENZYMOLOGY



source: https://biochemistry.conferenceseries.com/events-list/enzymology-biochemistry

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Biology and Organic chemistry.

COURSE DESCRIPTION AND OBJECTIVES:

This course is intended to imbibe concepts of biological macromolecules and their role in the metabolism. It also focuses on classification, isolation and kinetics of enzymes.Techniques employed in estimation and characterization of biomolecules are also emphasized.

MODULE-1

UNIT-1 **9L+0T+6P=15 Hours**

BIOMOLECULES AND THEIR METABOLISM

Mono, di, oligo and polysaccharides, Stereo isomerism and optical isomerism of sugars, Nitrogen cycle, Amino acids, physio chemical properties of amino acids, Organizational structure of proteins, Lipids - Importance & Classification, Fatty acids Structures and properties, Storage Lipids & membrane lipids, Structure and properties of purines and pyrimidines, nucleic acids.

UNIT-2 **15L+0T+10P=25 Hours**

METABOLISM OF NITROGEN COMPOUNDS

Metabolism of carbohydrates - Glycolysis, Krebs cycle, Electron Transport chain, Gluconeogenesis, Entener - Doudoroff pathway, Pentose Phosphate pathway and its importance in nucleic acid synthesis, Metabolism of amino acids - Glutamate pathway, Serine pathway, Shikimate pathway, Metabolism of lipids-Biosynthesis of fatty acids, Beta oxidation, Metabolism of purines and pyrimidines - biosynthesis and degradation.

PRACTICES:

- Qualitative assessments of Carbohydrates and proteins.
- Comparison of the estimation of reducing sugars by Benedicts & Dinitro-salicylicacid (DNSA) method in relation to their sensitivity and specificity.
- Comparison of protein quantification by Biuret & Lowry methods in relation to their sensitivity, specificity and interference.
- Estimation of DNA by diphenylamine method.
- Estimation of RNA by Orcinol method.
- Estimation of Cholesterol by Zak Method.

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

CONCEPTS OF ENZYMES

Classification of enzymes, Principles of catalysis - collision theory, transition state theory, Role of entropy in catalysis, Concept of active site and energetics of enzyme substrate complex formation, Specificity of enzyme reaction, Methods of immobilization of enzymes-physical & chemical techniques, Limitation & applications of immobilized enzymes.

SKILLS:

- ✓ *Detection of macromolecules by biochemical and calorimetric assays.*
- ✓ *Quantification of biomolecules using spectrophotometer.*
- ✓ *Purification and quantification of enzymes from various sources.*
- ✓ *Analyzing the effect of parameters such as concentration of substrate, pH and temperature on enzyme production.*

UNIT-2 **15L+0T+10P=25 Hours**

ENZYME KINETICS

Kinetics of single substrate reactions: Michaelis–Mentenmodel, Multi-substrate reaction mechanisms and kinetics, Types of Inhibition -kinetic models, Substrate and product inhibition, Allosteric regulation of enzymes, Kinetics of immobilized enzyme, Effect of external mass transfer & intra-particle diffusion, Bioreactors using immobilized enzyme.

PRACTICES:

- Extraction of at least three commercially important enzymes and their characterization.
- Purification of enzymes – Ammonium sulfate precipitation & dialysis.
- Determination of enzyme activity & specific activity.
- Estimation of Michaelis - Menten parameters.
- Effect of pH on enzyme activity.
- Effect of temperature on enzyme activity.
- Techniques of enzyme immobilization: matrix entrapment, ionic and cross linking.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Employ suitable technique for characterization of biological macromolecules.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Appraise the significance of biomolecules in maintaining the homeostasis.	Analyse	1	1,2,4,5,9, 10
3	Categorize the nature of enzymes and able to appreciate their role in cellular functioning.	Analyse	2	1,2,4, 5, 9, 10
4	Evaluate the influence of physico-chemical properties of enzymes during their industrial application.	Evaluate	2	1,2,4, 5, 9, 10

TEXT BOOKS:

1 J L Jain, Sunjay Jain and Nitin Jain, “Fundamentals of Biochemistry”, 7th edition, S Chand, 2016.
2. T Palmer and P L Bonner, “Enzymes: Biochemistry, Biotechnology, Clinical Chemistry”, 2nd edition, Affiliated East-West press, 2017.

REFERENCE BOOKS:

1. David L. Nelson and Michael M. Cox Lehninger, “Principles of Biochemistry”, 8th edition, W. H. Freeman & Co, 2021.
2. J M Berg, John L Tymoczko and L Stryer, “Biochemistry”, 9th edition, W.H. Freeman, 2019.
3. Donald Voet, Judith G. Voet, “Biochemistry”, 4th edition, Wiley, 2010.

22BT202 CHEMICAL ENGINEERING PRINCIPLES IN BIOTECHNOLOGY

source: https://cheme.stanford.edu

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Engineering Physics and Chemistry.

COURSE DESCRIPTION AND OBJECTIVES:

The main objective of the course is to familiarize students about process calculations, fluid dynamics and fluid flow calculations. The course enlightens about basics and fundamentals of process calculations, nature of fluids and fluid flow characterization. It also enables students to acquaint with fluid flow measurements and friction factor calculations in pipes, packed and fluidized beds.

MODULE-1

UNIT-1 **6L+0T+6P= 12 Hours**

FUNDAMENTALS OF FLUID FLOW

Units and dimensions, conversion of units, chemical reaction stoichiometry, material and energy balances, nature of fluids, Newton's law of viscosity, concept of Newtonian and Non - Newtonian fluids, boundary layer formation and separation, Reynolds number.

UNIT-2 **10L+0T+10P= 20 Hours**

PROCESS AND FLUID FLOW CALCULATIONS

Material balances for fluid flow, Bernoulli's equation and its applications, calculation of power required for pumping fluids, flow through pipes, average velocity, pressure drop due to skin friction and foam friction, Hagen-Poiseuille equation.

PRACTICES:

- Identification of various flow patterns (laminar and turbulent) using Reynolds apparatus.
- Verification of Bernoulli's equation for variable cross-sectional pipe.
- Friction factor in flowt hrough pipes.
- Frictional losses due to sudden contraction, expansion and fittings.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

FLOW MEASUREMENT OF PAST IMMERSED BODIES

Definition of drag and drag co-efficient, packed bed sand fluidized beds, Flow measuring devices: orificemeter, venturimeter and rota meter.

UNIT-2 **10L+0T+10P=20 Hours**

FRICTION AND VELOCITY CALCULATIONS

Derivation of friction factor equations and pressure drop expressions and applications, minimum fluidization velocity.

SKILLS:

- ✓ *Solving material and energy balance problems.*
- ✓ *Calculation of fluid flow rates and fluid velocity and pressure drop in pipe flow.*
- ✓ *Estimation of power requirement for pumping of fluids.*
- ✓ *Determination of frictional losses due to flow immersed bodies.*

PRACTICES:

- Determination of co efficient of discharge for venturi meter.
- Estimation of co efficient of discharge for or ifice meter.
- Assessment of pressure drop for packed bed reactor.
- Determination of pressure drop for fluidized bed reactor.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Solve mass and energy balance problems using reaction stoichiometry.	Apply	1	1,2,4,5,9,10
2	Characterize the fluid flow behaviour by applying principles of fluid dynamics.	Apply	1	1,2,5,9,10
3	Determine velocity, pressure drop and frictional losses for fluid flow in closed channels.	Evaluate	1	1,2,3,4,5,9,10
4	Design and evaluate flow measuring devises.	Design	2	1,3,4,5,9,10
5	Calculate the pressure drop and friction factor in packed and fluidized beds.	Analyze	2	1,2,3,4,5,9,10

TEXT BOOKS:

1. Warren L.McCabe, Julian C. Smithand Peter Harriot,“Unit Operations of Chemical Engineering”, 7th edition, Mc Graw Hill, 2021.
2. Paulin M. Doran, “Bio-Process Engineering Principles”, 2nd edition, Elsevier, 2012.

REFERENCE BOOKS:

1. Salil K. Ghosal, Shyamal K. Sanyal and Siddhartha Dutta, “Introduction to Chemical Engineering”, 1st edition, McGraw Hill, 2021.
2. S Pushpavanam, “Introduction to Chemical Engineering”, 1st edition, PHI Learning, 2012.
3. D G Rao, “Introduction to Biochemical Engineering”, 2nd edition, McGraw Hill, 2009.

22BT203 MICRO BIOLOGY AND FERMENTATION TECHNOLOGY

source: https://www.scientificbio.com/biomass-monitoring/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Basics of Biology.

COURSE DESCRIPTION AND OBJECTIVES:

The main objective of the course is to familiarize the students to understand the classification, diversity and physiology of microorganisms. It emphasizes on the methods of microbe cultivation, sterilization techniques, microbial diseases, host pathogen interactions and their control. Further, it enables the students about design of fermentation process, media and prediction of nutritional and other process variables on the production of bioproducts.

MODULE-1

UNIT-1 **9L+0T+6P=15 Hours**

FUNDAMENTALS OF MICROBIOLOGY

Spontaneous generation theory, germ theory of diseases, microscopy-types, staining techniques, characteristics used in microbial taxonomy, sterilization processes - physical agents and chemical agents, evaluation of effectiveness of anti microbial agents, biosafety levels.

UNIT-2 **15L+0T+10P=25 Hours**

MICROBIAL DIVERSITY

Characteristic features and biological importance of viruses, bacteria, fungi, yeast and algae. Molecular basis of pathogenicity, human diseases caused by viruses, bacteria and fungi, Emerging infectious diseases.

PRACTICES:

- Sterilization techniques in microbiology.
- Microscopic examination of microorganisms.
- Gram staining of bacteria.
- Evaluation of effectiveness of anti microbial agents.
- Biochemical tests for identification of bacteria.
- Culturing and identification of fungal organisms.

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

FERMENTATION PROCESES

Design and construction of fermenter and ancillaries, main parameters to be monitored and controlled in fermentation processes, nutrient requirement for fermentation process, culture media and types, medium optimization techniques with special emphasis on statistical techniques, pure culture techniques, microbial growth and measurement, improvement of industrially important micro organisms, preservation of pure cultures.

SKILLS:

- ✓ *Handle different microscopes.*
- ✓ *Isolation and identification of microbes from various sources.*
- ✓ *Microbial species differentiation.*
- ✓ *Aseptic maintenance of lab and hood.*
- ✓ *Maintenance of stock cultures.*
- ✓ *Handling of microbial fermentation process in fermenter.*

UNIT-2 **15L+0T+10P=25 Hours**

TYPES OF FERMENTATION

Batch culture, continuous culture, fed-batch culture- applications and examples, solid state fermentation, development of inoculum for microbial, yeast, fungal and animal cell cultivations, supply of air/nitrogen for aerobic and anaerobic process, aeration andagitation.

PRACTICES:

- Fermentation media for cultivation of microorganisms.
- Isolation of pure cultures by streak plate and pour plate technique.
- Preservation of purecultures.
- Microbial growth measurement - Viable cell count method.
- Microbial growth measurement - Turbidity estimation.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Categorize different characteristic features of micro organisms under microbial taxonomy.	Analyze	1	1,2,5,4,7,9,10
2	Apply the control agents against disease causing pathogens.	Apply	1	1,5,6,9,10
3	Evaluate the role of microorganisms in various fields.	Evaluate	1	1,3,4,5,6,9,10
4	Design fermentation media for enhanced growth and product formation.	Create	2	1,2,3,4,5,6,9,10
5	Analyze fermentation processes for industrial production of bioproducts.	Analyze	2	1,3,4,5,6,9,10

TEXT BOOKS:

1. Joanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton, “Prescott’s Microbiology”, 10th edition, Mc Graw Hill, 2017.
2. Peter F. Stanbury, Allan Whitaker, Stephen J. Hall,“Principles of Fermentation Technology”, 3rd edition, Elsevier, 2016.

REFERENCE BOOKS:

1. Douglas S. Clark and Harvey W. Blanch,“Biochemical Engineering”, 2nd edition, CRC Press, 1997.
2. Michael L Shuler, Fikret Kargi and Matthew P DeLisa,“Bio process Engineering: Basic Concepts, 3rd edition, Pearson. 2017.
3. S. Krupanidhi, A. Venkata Narayana, D. JohnBabu, “Handbook of Fermentation Technology-Instant Class Notes” (eBook), 1st edition, Pothi, 2015.
4. K. R. Aneja, “Experiments in Microbiology Plant Pathology and Biotechnology”, 4th edition, New Age International limited, 2007.

22TP203 ADVANCED CODING COMPETENCY

source: https://www.geeksforgeeks.org/best-way-to-start-with-competitive-programming-geeksforgeeks-cp-live-course/

Hours Per Week :

L	T	P	C
0	0	2	1

PREREQUISITE KNOWLEDGE: Programming in C, Data Structures.

COURSE DESCRIPTION AND OBJECTIVES:

This course helps to understand the impact of the choice of data structures and design strategies to solve the problem in an efficient manner. This course also provides the understanding of advanced graph applications and also throw light in tractable intractable problems.

MODULE-1

UNIT-1 **0L+0T+8P =8 Hours**

STACKS, QUEUES AND SINGLE LINKED LISTS

PRACTICES:

Problems On Stacks & Queues

- Check if given stack of integers are consecutive or not (could be ascending or descending).
- Find the maximum sum in a sliding window using queues.
- Given a queue of integers, rearrange the elements by interleaving the first half with the second half.
- Given an integerk and a queue of integers, reverse the order of the first k elements of the queue.
- Given a maze in the form of a rectangular matrix filled with O, X or M where O represents an open cell, X represents a blocked cell and M represents landmines, find the shortest distance of every open cell in the maze from its nearest mine.
- For a given parenthesis expression, check whether it is balanced parenthesis or not.
- Reverse a number using stack.
- You are given a string s consisting of lowercase English letters. A duplicate removal consists of choosing two adjacent and equal letters and removing them. We repeatedly make duplicate removals on s until we no longer can.
- Find first Unique character in a string (Queue).
- Implement Tower of Hanoi problem.

Problems On Linked Lists

- Given a random pointer to a random node in a singly linked list, clone the list.
- Given a list rotate the list to the right by k places.
- Remove duplicates from a sorted list.
- Find fractional node in a singly linked list.
- Sort a linked list using constant space complexity.
- Delete a node in start, middle, end of Singly linked list.
- Add a node in start, middle, end of Singly linked list.
- Find whether given single linked list is circular or not.
- Arrange a singly linked list in Descending order.
- Addition of two numbers using Singly Linked List.

SKILLS:

- ✓ *Experienced to Store data and various types of data to handle.*
- ✓ *Ordering and sorting of data.*
- ✓ *Indexing and Searching of required data from large data sequences.*
- ✓ *Exposed to various characteristics such as Linear or non-linear, Homogeneous or heterogeneous and Static and Dynamic.*

UNIT-2 **0L+0T+8P =8 Hours**

DOUBLY LINKED LISTS, CIRCULAR LINKED LISTS

PRACTICES:

Problems on Double Linked Lists and Circular Linked Lists.

- Implement a clockwise rotation of a doubly linked list by N places.
- Count triplets in a sorted doubly linked list whose product is equal to a given value x.
- Find the product of all prime nodes in a doubly linked list.
- Find the count of common nodes in two doubly linked lists.
- Find pairs with given product in a sorted doubly linked list.
- Delete all the even nodes of a circular singly linked list.
- Count nodes in a circular linked list.
- Delete all prime nodes from a circular singly linked list.
- Exchange first and last nodes in a circular linked list.
- Reverse a doubly circular linked list.
- Linear search using a stack of incomplete sub problems.
- 1 2 3 4 5 6 in stack S is push X is pop, SSSSXXSSSXXX.
- Recursively remove all adjacent duplicates.
- Check if a given singly linked list is a palindrome using stack.
- Convert a multilevel singly linked list to a singly linked list.
- Remove duplicates from an unsorted doubly linked list.
- Sort a doubly linked list using insertion sort.
- Check if a doubly linked list of characters is palindrome or not.
- Swap Kth node from beginning with Kth node from end in a Double Linked List.
- Convert a Binary Tree into Double Linked List.

MODULE-2

UNIT-1 **0L+0T+8P =8 Hours**

TREES

PRACTICES:

Problems on Trees

- Given a sorted doubly linked list, convert it into a balanced BST.
- Given a singly linked list with data in the ascending order, convert it into a height balanced BST.
- Print the leaf to root path for every leaf node in a binary tree.
- Write a function to implement the reversed level order traversal of a binary tree.
- Truncate a given binary tree to remove nodes that lie on a path having sum less than K.
- Find the vertical sum in a given binary tree.
- Delete minimum & Maximum element from a BST.
- Implement Inorder, preorder and postorder tree traversal techniques.
- Print Kth largest element in a BST.
- Implement Zig-Zag tree traversal.

UNIT-2 **0L+0T+8P =8 Hours**

GRAPHS

PRACTICES:

Problems on Graphs.

- Given a directed acyclic graph, determine whether there is a path that visits every vertex exactly once.
- Reverse a directed graph such that each edge from v to w is replaced by an edge from w to v.
- Find the shortest path in a graph that visits each vertex at least once, starting and ending at the same vertex.
- Find the minimum number of throws required to win a snake and ladder game.
- Implement DFS of a Graph.
- Implement BFS of a Graph.
- Detect whether a cycle is present in an undirected graph.
- Detect cycle in a Directed Graph.
- Find Shortest Distance to goal node from root node in a graph.
- Find no.of nodes in Kth level of a Graph.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

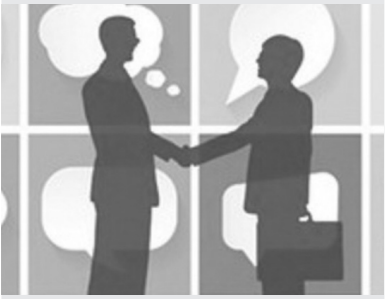
CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply various data structures to solve a different algorithm.	Apply	1,2	1
2	Investigate the various data structures to solve a given problem in an efficient manner.	Analyse	1,2	2
3	Design and implement an appropriate hashing function for an application.	Create	1,2	4

TEXT BOOKS:

1. ReemaThareja, “Data Structures Using C”, 2nd Edition, Oxford University Press, 2014.
2. Seymour Lipschutz, “Data Structures with C”, 1st Edition, McGraw Hill Education, 2017.

REFERENCEBOOKS:

1. Ellis Horowitz and Sartaj Sahni, “Fundamentals of Data Structures”, illustrated edition, Computer Science Press, 2006.
2. Richard F. Gilberg and Behrouz A. Forouzan, “Data Structures: A Pseudocode Approach with C”, 2nd Edition, CENAGE Learning, 2005.
3. R G Dromey and Pearson, “How to solve it by Computer”, 2nd edition, Impression edition, 1998.



Source : https://www.coursera.org/specializations/improve-english

22TP204 PROFESSIONAL COMMUNICATION

Hours Per Week :

L	T	P	C
0	0	2	1

PREREQUISITE KNOWLEDGE: High School-level English.

COURSE DESCRIPTION & OBJECTIVES: To improve the overall professional communication skills (LSRW) of students and prepare them for their profession as engineers and managers. To provide them exposure to conventions of corporate communication and training them on how to function in the business world.

MODULE-1

UNIT-1 **0L+0T+8P=8 Hours**

BASICS OF BUSINESS WRITING SKILLS, PRACTICING BUSINESS CORRESPONDENCE AND REPORT WRITING

Business English Vocabulary: Glossary of most commonly used words (formal and informal usage).

Elements of Technical Writing: Sentence structure, reducing verbosity, arranging ideas logically, building coherence, cohesive devices and transitional words.

Mechanics of Writing: elementary rules of grammar, choice of diction, elementary principles of composition, matters of form, punctuation, conventions of business communication, language and professional tone, code of conduct (not sending illegal, offensive, disparaging personal remarks or comments) in written business communication.

Business Correspondence: E-mail: nature and scope, e-mail etiquette, clear call for action, common errors in composing e-mails, office communication such as meeting agenda and notice, circular and memo.

Letter-Writing: Formal and informal letters, structure of formal letters, expressions of salutations, different types of letters [such as sales letter, complaint letter, response to the complaint letter (dispute resolution), letter of permission, letter of enquiring, claim letter – letter of apology etc], introductory and concluding paragraphs and clear call for action.

Professional Proposal/Report: Differentiating proposals and reports, Drafting formal business proposals, types of reports such as factual reports, feasibility reports and survey reports, parts of a report (such as title page, declaration, acknowledgements, table of contents, abstract, introduction, findings, conclusion and recommendations).

New Age Corporate Communication Media: Importance of social media communication and Etiquettes, form and structure, sharing texts through Twitter, Whatsapp, instgram etc.

UNIT-2 **0L+0T+8P=8 Hours**

PRACTICING COMMUNICATIVE LANGUAGE IN VARIOUS PROFESSIONAL CONTEXTS

Speaking: Speaking in business context, assertiveness, politeness, making requests, queries and questions, negotiations, asking for information, offering suggestions, conflict resolution, contacting clients, initiating, addressing delegates (in public), delivering the presentation effectively, telephone etiquettes, delivering seminar/proposal/report effectively, team meeting etiquettes (face to face and conference call), making effective one minute presentations(JAM) and participating in Group Discussions.

PRACTICES:

- Basic grammar practice, framing paragraphs on topics allocated, paraphrasing an article or a video in your own words, finding topic sentences in newspaper articles, finding out new words from a professional viewpoint and understanding the meaning and its usage.
- Perusing samples of well-prepared business emails, memo, letter writing and short proposals

and reports, students will draft business correspondence writing tasks and different proposals/ reports on topics assigned.

- Watching videos/listening to audios of business presentations, classroom activities of team and individual presentations, using PPTs, mock exercises for BEC speaking, agreeing, disagreeing politely, developing content, extended speaking in Group Discussion(s).

MODULE-2

UNIT-1 **0L+0T+8P=8 Hours**

READING AND COMPREHENDING BUSINESS DOCUMENTS

Reading: Reading and comprehending business documents, learning business register, regularizing the habit of reading business news, suitable vocabulary, skimming and scanning a text for effective and speedy reading and dealing with ideas from different sectors of corporate world in different business contexts.

UNIT-2 **0L+0T+8P=8 Hours**

IMPARTING AND PRACTICING LISTENING SKILLS

Listening: Specific information in business context, listening to telephonic conversations / messages and understanding the correct intended meaning, understanding the questions asked in interviews or in professional settings, summarizing speaker's opinion or suggestion, enable active listening.

PRACTICES:

- Hand-outs - matching the statements with texts, finding missing appropriate sentence in the text from multiple choices, using right vocabulary as per the given context and editing a paragraph.
- Working out BEC/TOEFL/IELTS listening exercises with hand-outs; matching the statements with texts, finding missing appropriate sentence in the text from multiple choice- multiple choices, using right vocabulary in context-editing a paragraph, listening to a long conversation such as an interview and answer MCQ s based upon listening.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Possess comprehensive skills in listening and reading business texts in formal context.	Apply	2	7
2	Communicate effectively both in their academic as well as professional environment.	Apply	2 and 1	10
3	Clear grasp on the register of business language.	Analyze	1	8
4	Possess the ability to write business reports and proposals clearly and precisely to succeed in their future.	Create	1	12
5	Make effective presentations and participate in formal context.	Create	2	10

TEXT BOOKS:

1. S. Schnurr,"Exploring Professional Communication: Language in Action", London: Routledge, 2013.

REFERENCE BOOKS:

1. Brook Hart Guy,"Cambridge English Business Bench Mark: Upper Intermediate", 2ndEdition: CUP, 2014.
2. Cambridge University Publication, "Cambridge: BEC VANTAGE Practice Papers", CUP, 2002.
3. J. Seely, "The Oxford Guide to Effective Writing and Speaking", OxfordUniversity Press, 2005.

SKILLS:

- ✓ *To enhance listening and spoken abilities of students needed for professional and social success in interpersonal situations, group interactions, and personal and professional presentations.*
- ✓ *Understand and practice specific functions and vocabulary in a business context.*
- ✓ *Produce short business reports, proposals and correspondence.*
- ✓ *Write various business documents through reading techniques.*

Source : https://mpl.loesungsfabrik.de/en/english-blog/method-validation/analytical-vs-bioanalytical-method-validation

22BT204 BIOANALYTICAL TECHNIQUES

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Biochemistry and Organic Chemistry.

COURSE DESCRIPTION & OBJECTIVES:

The course provides an in-depth understanding of various scientific instruments used for analysis. The objective of this course is to understand the scope of application, advantages and limitations of the various modern analytical and separation techniques.

MODULE-1

UNIT-1 **9L+0T+6P=15 Hours**

TRADITIONAL AND MODERN ANALYTICAL METHODS

Microscopy – types of bright field, types of dark field and electron microscopy, Electromagnetic radiation– Breaking of bonds, Vibration and rotation in chemical bonds, Absorption spectroscopy, Beer-Lambert's law and apparent deviations, Mass determination.

UNIT-2 **15L+0T+10P= 25 Hours**

MICROSCOPY AND SPECTROSCOPY

Fluorescent microscopy, Confocal microscopy, Phase contrast microscopy, Scanning electron microscopy and Transmission electron microscope, Flow cytometry, UV-Visible spectrophotometer, Infra-Red spectroscopy, Proton and 2D-NMR, X-ray spectroscopy, Mass spectroscopy.

PRACTICES:

- Application of array of fluorochromes to identify cells and sub-microscopic cellular components.
- Determination of lambda max using UV visible spectrophotometer.
- Estimation of Molar Extinction Co-efficient using Beer Lamberts law.
- Characterization of proteins using Fourier Transform Infrared Spectroscopy.
- Fortitude crystalline nature of biological materials using X-ray diffraction analysis (XRD).
- Measuring of materials under Scanning electron microscopy.

MODULE-2

UNIT-1 **9L+0T+6P= 15 Hours**

BASICS IN SEPARATIONS

Centrifugation–basic & principles, RPM-RCF, Electrophoresis - principles and types, Chromatography-general principles and its applications, Liquid and gas chromatography.

UNIT-2 **15L+0T+10P= 25 Hours**

ADVANCED TECHNIQUES IN SEPARATION

Ultra centrifugation and density gradient centrifugation, Disc electrophoresis, slab iso - electric focusing and iso tachophoresis, Ion - exchange chromatography, gel -filtration chromatography, affinity chromatography and HPLC.

PRACTICES:

- Separation of biomolecules using a density gradient centrifuge.
- Agarose gel electrophoresis for separation of DNA fragments.
- SDS-PAGE electrophoresis for determination of molecular weight of proteins.
- Purification of biological macromolecules using Ion Exchange chromatography.
- Fractionation of bioactive compounds using gel filtration chromatography.
- Characterization of bioactive compounds through HPLC.

SKILLS:

- ✓ *Handling of microscope and UV Visible spectrophotometer.*
- ✓ *Skilled handling of chromatography techniques.*
- ✓ *Experience in analyze the results of XRD and FTIR.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the morphology of cells using Microscopy.	Analyze	1	1,2,4,5,9,10
2	Apply the analytical techniques for characterization of proteins.	Apply	1	1,2,3,5,9,10
3	Apply the electrophoresis techniques for separation of proteins.	Apply	2	1,2,3,5,9,10
4	Analyze the purity level of molecules using chromatographic techniques.	Analyze	2	2,3,4,5,9,10

TEXT BOOKS:

1. Keith Wilson and John Walker, “Principles and Techniques of Biochemistry and Molecular Biology”, 7th edition, Cambridge University Press, 2013.
2. J. Jayaraman, “Laboratory Manual in Biochemistry”, 2nd edition, New Age International, 2011.

REFERENCE BOOKS:

1. K. Wilson, K.H. Goulding, “A Biologist Guide to Principles and Techniques of Practical Bio chemistry”, 7th edition, Cambridge University Press, 2006.
2. Douglas A. Skoog, Donald M. West, F. James Holler and Stanley R. Crouch “Fundamentals of Analytical Chemistry”, 9th edition, Cengage learning, 2013.
3. Frank A. Settle, “Hand Book of Instrumental Techniques for Analytical Chemistry”, Prentice Hall,1997.

Source : https://www.biooekonomie-bw.de/en/articles/dossiers/industrial-biotechnology-biological-resources-for-industrial-processes

22BT205 INDUSTRIAL BIOTECHNOLOGY

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Microbiology and Fermentation Technology, Biochemistry and Enzymology.

COURSE DESCRIPTION & OBJECTIVES:

The course aims to provide fundamental insights to exploit enzymes and microbes for the manufacturing of products which have a huge industrial significance. It uniquely blends the science and engineering with various biochemical processes to obtain products of diverse fields such as chemicals, food and bioenergy.

MODULE-1

UNIT-1 **9L+0T+6P= 15 Hours**

MARKETING MANAGEMENT

Fermentations by Bacteria, Fungi and yeast, Modern Biotechnology processes and products, Upstream and Down stream processes, Process Flow Diagram - industrial production of wine.

UNIT-2 **15L+0T+10P= 25 Hours**

PRODUCTION OF PRIMARY AND SECONDARY METABOLITES

Industrial Production of commercially importantorganic acids, amino acids and solvents, Production of Antibiotics, Vitamins and steroids.

PRACTICES:

- Bacterial fermentation for production of Amino acids.
- Preparation of wine.
- Lactic acid production by fermentation.
- Citric acid production by fermentation.

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

INDUSTRIAL BIOPRODUCTS

Importance of Industrial Enzymes, Biopesticides, Biofertilizers, Bio-preservatives, Biopolymers, Biodiesel, Single cell Proteins.

UNIT-2 **15L+0T+10P=25 Hours**

PRODUCTION OF THERAPEUTIC MOLECULES

Recombinant proteins for therapeutic and diagnostic applications, Production of vaccines and recombinant proteins, Product development based on Plant Cell and Animal Cell culturing technologies. Bioreactors for production of modern biotechnology products, Production of Monoclonal Antibodies.

PRACTICES:

- Production of bio-preservatives.
- Shake flask fermentation for production of *Spirulina.*
- Fermentation for production Amylase.
- PBH production by fermentation.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the principles and methods of fermentation processes for bioproducts production.	Apply	1	1,4,5,6,9,10
2	Select suitable microbial strains for production of primary and secondary metabolites.	Analyze	1	2,4,6,7,9,10
3	Develop the process flows steps for efficient production of products.	Create	2	3,4,6,9,10
4	Design of novel process trains for enhanced yield of bioproducts.	Create	2	3,4,6,9,10

TEXT BOOKS:

1. Lee SY, Nielsen J and Stephanopoulos G, “Industrial biotechnology: microorganisms”, 2nd edition, John Wiley & Sons, 2016.
2. Liese A, Seelbach K and Wandrey C, “Industrial biotransformations”, 1st edition, John Wiley & Sons, 2006.

REFERENCE BOOKS:

1. Glazer AN and Nikaido H, “Microbial biotechnology: fundamentals of applied microbiology”, 1st edition, Cambridge University Press, 2007.
2. Faye L and Gomord V, “Recombinant Proteins From Plants”, 1st edition, Humana Press, 2009.
3. Lee SY, Nielsen J and Stephanopoulos G, “Cell culture engineering: recombinant protein production”, 3rd edition, 2nd edition, John Wiley & Sons, 2020.
4. Okafor N and Okeke BC, “Modern industrial microbiology and biotechnology”, CRC Press, 2017.
5. Rai BK, “Basic Practical Manual on Industrial Microbiology”, 2nd edition, Lulu. Com, 2016.

SKILLS:

- ✓ *Lab scale culturing of bacteria and yeast for production of bioproducts.*
- ✓ *Developing the process flow sheet for production of products.*
- ✓ *Selecting the suitable mode of fermentation reactions for production of products.*

Source :
Biogas plant at VFSTR

22CT201 ENVIRONMENTAL STUDIES

Hours Per Week :

L	T	P	C
1	1	0	1

PREREQUISITE KNOWLEDGE: General awareness regarding environmental problems and importance of environmental protection.

COURSE DESCRIPTION AND OBJECTIVES:

It is a multidisciplinary subject where different aspects of society and environment are dealt using a holistic approach. It is evolving to be the education for sustainable and ethical development both at a local and global level. It helps to prepare the next generation for planning appropriate strategies to address environmental issues. It identifies and creates solutions that conserve to manage ecosystem and biodiversity and helps to eliminate pollutants, toxicants, preserve air, water and soil quality. Environmental education recognizes impacts of global issues, enhances the public awareness and helps to take decisions towards environmentally responsible actions.

MODULE-1

UNIT-1 **4L+4T+0P=8 Hours**

NATURAL RESOURCES, ECOSYSTEMS AND BIODIVERSITY

Environment and sustainable development, Natural resources- forest, water, energy and land resources; Ecosystem-basic structural components, function and interactions in ecosystem, ecological succession.

UNIT-2 **4L+4T+0P=8 Hours**

BIODIVERSITY AND CONSERVATION

Introduction to biodiversity, types of biodiversity - species, genetic and ecosystem diversity, Threats to biodiversity - natural and anthropogenic, species extinctions, man wildlife conflicts, Biodiversity conservation - principles and strategies, in-situ and ex-situ conservation.

PRACTICES:

- Visit to a Biogas plant, Solar Power plant.
- Visit to a local area: river/pond/lake/forest / grassland / hill /mountain and study of different.
- types of ecosystems, biodiversity study and documentation (herbarium sheet preparation).
- Set up an aquarium.
- Case study: Renewable energy use.

MODULE-2

UNIT-1 **4L+4T+0P=8 Hours**

ENVIRONMENTAL POLLUTION AND CLIMATE CHANGE

Air, water, soil, radioactive and noise pollution, Study of different pollutants (SOx, NOx, PAN, PAH etc.); Toxicity study, Climate change - greenhouse effect, acid rain, ozone layer depletion.

UNIT-2 **4L+4T+0P=8 Hours**

POLLUTION CONTROL DEVICES AND WASTEWATER TREATMENT TECHNOLOGIES

Air pollution control devices - Gravitational settling chambers, cyclonic separators, electrostatic precipitators, fabric filters and bio filters, Wastewater management.

PRACTICES:

- Visit to a sewage treatment plant and wastewater analysis.
- Case study: Recycling Technologies.
- Case study: Effects of contaminants on microorganisms.
- Report writing: 12 principles of green chemistry for environmental sustainability.
- Report writing: Environmental Impact Analysis, Local Disaster Management Plan.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the basic concepts of sustainable development, natural resource utilization and ecology for the purpose of environmental protection.	Apply	1	1,6,7, 9, 10, 11, 12
2	Design remediation technologies for their abatement.	Apply	2	1, 3,6,7, 9, 10, 11, 12
3	Analyze the biodiversity of different ecosystems and formulate various conservation approaches	Analyze	1	1, 7, 8, 9, 10, 11, 12
4	Analyze the presence of various environmental pollutants.	Analyze	2	1, 6,7,9, 10, 11, 12
5	Recommend various waste management approaches and their implementation strategies.	Evaluate	2	1,2, 7,8,9,10,11, 12

TEXT BOOKS:

1. A. Kaushik and C. P. Kaushik, “Perspectives in Environmental Studies”, New Age International Publishers, 5th Edition, 2016.
2. Y. Anjaneyulu, “Introduction to Environmental Science”, 1st edition, B. S. Publications, 2015.

REFERENCE BOOKS:

1. B. Joseph, “Environmental Studies”, Mc Graw Hill Education, 2nd Edition, 2015.
2. S. Subash Chandra, “Environmental Science”, 1st eidition New Central Book Agency, 2011.
3. M.Basuand S.Xavier, “Fundamentals of Environmental Studies”, 2nd edition Cambridge University Press, 2016.

SKILLS:

- ✓ *Create a bio-diversity map of any habitat/ ecosystem.*
- ✓ *Strategize different ways of using renewable energy resources.*
- ✓ *Design novel strategies and approaches for pollution control and waste management.*

Source : https://xueqi326.wordpress.com/semester-3/management-science/

22MS201 MANAGEMENT SCIENCE

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basic knowledge on management.

COURSE DESCRIPTION & OBJECTIVES:

The goal of this course is to analyse the importance of management, significance of operation management and carry out production operations through work-study. Students will be able to analyse the markets, customers, competitors, and then plan HR function effectively.

MODULE- 2

UNIT- 1 **6L+6T+0P=12 Hours**

INTRODUCTION TO MANAGEMENT

Concepts of Management and organization- nature, importance and Functions of Management, Systems approach to Management - Taylor's Scientific Management Theory, Fayol's Principles of Management, Mayo's Hawthorne Experiments, Maslow's Theory of Human Needs, Douglas McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory of Motivation, Leadership Styles, Social responsibilities of Management.

UNIT- 2 **10L+10T+0P =20 Hours**

OPERATIONS MANAGEMENT

Principles and Types of Plant Layout-Methods of production (Job, batch and Mass Production), Work Study -Basic procedure involved in Method Study and Work Measurement,Objectives, Need for Inventory control, EOQ, ABC Analysis, Purchase Procedure, Stores Management and Stores Records. Statistical Quality Control: control charts for variables and attributes (simple Problems), Acceptance Sampling

PRACTICES:

- Collect some examples with videos for types of production.
- Carry out production operations through work-study.
- Practice problems with Inventory control methods and Quality Control charts.

MODULE- 2

UNIT- 1 **8L+8T+ 0P =16 Hours**

HUMAN RESOURCES MANAGEMENT

Concepts of Human Resource Management, Basic functions of HR Manager - Manpower planning, Recruitment, Selection, Training and Development, Placement, Wage and Salary Administration, Promotion, Transfer, Separation, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating.

UNIT- 2 **8L+8T+0P =16 Hours**

MARKETING MANAGEMENT

Evolution of Marketing, Functions of Marketing Selling Vs Marketing, 4 P's of Marketing – Product Mix - Product Life Cycle – Place Mix – Channels of Distribution – Price Mix – Pricing Methods – Promotion Mix – Tools of Promotions.

PRACTICES:

- Select any Designation in an organization and try to describe its job description and job specifications.
- How do you deal with grievances at your work.
- Analyze marketing mix in various situations.

SKILLS:

- ✓ *Expert in managerial skills.*
- ✓ *Maintain social relations.*
- ✓ *Evaluate pricing strategies.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the nature and importance of management.	Analyze	1	1,2,4,6
2	Significance of Operations Management.	Analyze	1, 2	1,2,5
3	Carry out production operations through work-study.	Apply	1, 2	1, 2, 3, 5
4	Analyze the markets, customers, and competition.	Analyze	2	1,2,4,5,6
5	Plan and control the HR function effectively.	Evaluate	1, 2	1,2,3,4,5,6

TEXT BOOKS:

1. Stoner, Freeman, Gilbert, “Management”, 6th edition, Pearson Education, New Delhi, 2004.
2. Aryasri, “Management Science”,1st edition, TMH, 2004.

REFERENCE BOOKS :

1. Kotler Philip & Keller Kevin Lane, “Marketing Mangement”, 12th edition, PHI, 2005.
2. Koontz & Weihrich, “Essentials of Management”, 6th edition, TMH, 2005.
3. Thomas N. Duening & John M. Ivancevich, “Management- Principles and Guidelines”, 1st edition, Biztantra, 2003.

III

YEAR

B.Tech.

BIOTECHNOLOGY

COURSE CONTENTS

I SEM & II SEM

I SEMESTER

22TP301	-	Soft Skills Laboratory
22BT301	-	Bioprocess Engineering
22BT302	-	Genetic Engineering
22BT303	-	Heat and Mass Transfer
	-	Department Elective – 2
	-	Open Elective – 2
22BT305	-	Industry Interface Course (Modular course)
22BT304	-	Inter-Disciplinary Project – Phase-I

II SEMESTER

22TP302	-	Quantitative Aptitude and Logical Reasoning
22BT306	-	Bioinformatics
22BT307	-	Bioreaction Engineering
	-	Department Elective – 3
	-	Department Elective – 4
	-	Open Elective – 3
22BT308	-	Inter-Disciplinary Project Phase-II
	-	Minor / Honours – 3

22TP301 SOFT SKILLS LABORATORY

Source: https://www.kgi.edu/news/what-is-bioprocess-engineering/

Hours Per Week :

L	T	P	C
0	0	2	1

PREREQUISITE KNOWLEDGE: Grasp on their own academic achievements.

COURSE DESCRIPTION AND OBJECTIVES:

To impart employability skills like resume preparation and facing interviews. To enable trainees to develop interpersonal and leadership skills and to train them on work place skills like making presentations, participating in group discussions etc.

MODULE-1

UNIT-1 **0L+0T+8P=8 Hours**

PERSONALITY DEVELOPMENT

Soft Skills: Need for soft skills, professionalism, employability skills, Communication - Need for effective communication - the process of communication, levels of communication, flow of communication, choice of diction and style with reference to setting (formal, semi-formal or informal), communication networks, barriers to communication, miscommunication, noise and ways to overcome the barriers; Career Planning: Job vs. career, SWOT analysis.

UNIT-2 **0L+0T+8P=8 Hours**

LANGUAGE AND VOCABULARY

Vocabulary Building: Word etymology, roots, prefixes & suffixes, synonyms & antonyms, collocations, one-word substitutes, analogies, idioms and phrases, contextual guessing of unfamiliar words, task-oriented learning, Reflection of language on Personality, Gender sensitive language in MNCs, Mind your language, Seven essential skills for a team player; attentive listening, intelligent questioning, gently persuading, respecting other's views, assisting others, sharing, participating actively.

PRACTICES:

- Self-Introduction.
- Personal and Academic SWOC.
- Johari Window.
- Giving and taking opinions of Self Vs others and assessing oneself.
- Goal setting.
- Short, Mid and Long Term goals planning the semester.
- Time management: four quadrant system.
- Stephen Covey Time Management Matrix planning a semester.
- Stress-management.
- Questionnaire to assess level of stress.
- 50 words towards resume preparation and interviews.
- Newly coined words.
- Gender sensitive words and Words acceptable in Indian context and objectionable international context.

SKILLS:

- ✓ *Balance social and emotional intelligence quotients though SWOC, JOHARI etc. activities.*
- ✓ *Prepare tailor made resume and face various job interviews with enriched personality traits.*
- ✓ *Career planning with clear personal and professional goals.*
- ✓ *Solve personal and professional life hiccups with confidence and maturity.*

MODULE-2

UNIT-1 **0L+0T+8P=8 Hours**

LANGUAGE IN ACTION

Functional English: Situational dialogues, Role plays (including small talk); Group Discussion: Articulation and flow of oral presentation, dynamics of group discussion, intervention, summarizing and conclusion, voice modulation, content generation, Key Word Approach (KWA), Social, Political, Economic, Legal and Technical Approach (SPELT), View Point of Affected Part (VAP), language relevance, fluency and coherence - 11th and 12th weeks, Resume preparation - Structure and presentation, defining career objective, projecting one's strengths and skill-sets, summarizing, formats and styles and covering letter-Statement of Purpose.

UNIT-2 **0L+0T+8P=8 Hours**

PREPARING FOR PRESENTATIONS AND INTERVIEWS

Facing Interviews: Interview process, understanding employer expectations, pre-interview planning, opening strategies, impressive self-introduction, answering strategies, other critical aspects such as body language, grooming, other types of interviews such as stress-based interviews, tele- interviews, video interviews, frequently asked questions (FAQs) including behavioral and HR questions and the aspect looked at by corporate during interviews; Presentation Skills - Selection of a topic, preparing an abstract, gathering information, organizing the information, drafting the paper, citing reference sources – writing striking introductions, discussing the methodology used, developing the argument, presentation style, language, presenting the paper and spontaneously answering audience questions.

PRACTICES:

- Opening and closing a telephonic conversation.
- Making an appointment.
- Making a query.
- Offering/Passing on information.
- Communicating with superiors.
- Expressing agreement/objection.
- Opening bank account (combination of prepared and impromptu situations given to each student).
- Group Discussions on various topics.
- Preparing SoP and Resume.
- Mock interviews on the FAQs including feedback.
- Oral presentation with the help of technology (Preparing PPT and presenting).

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Have the ability to introspect on individual strengths and weaknesses, and emerge as a balanced personality with improved self-awareness and self-worth .	Apply	1	12
2	Observe gender sensitive language and workplace etiquette in his professional life.	Analyze	1	9
3	Be able to prepare a resume and gain the confidence to face an interview.	Create	1 and 2	10
4	Possess the interpersonal skills to conduct himself/herself effectively in everyday professional and social contexts.	Apply	2	8
5	Bring professionalism into his/her daily activities.	Create	2	8

TEXTS BOOKS:

1. Adrian Furnham, “Personality and intelligence at work”, Psychology Press, 2008.
2. S. P. Dhanvel, “English and Soft skills”, Orient Blackswan, 2011.

REFERENCE BOOKS:

1. Edward Holffman, “Ace the corporate personality”, McGraw Hill, 2001.
2. John Adair Kegan Page, “Leadership for innovation”, Kogan, 2007.
3. Krishna Mohan & NP Singh, “Speaking English effectively”, Macmillan, 2008.
4. Rajiv K. Mishra, “PersonalityDevelopment”, Rupa & Co. 2004.

Source : https://www.kgi.edu/news/what-is-bioprocess-engineering/

22BT301 BIOPROCESS ENGINEERING

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Chemical engineering principles in biotechnology, Microbiology and Fermentation Technology.

COURSE DESCRIPTION AND OBJECTIVES:

This course objective is to acquaint students on various aspects of cell growth kinetics and bioreactors, also provide an insight about the media and other requirements for successful run of bioprocess operations.

MODULE-1

UNIT-1 **9L+0T+6P= 15 Hours**

INTEGRATED BIOPROCESS

Outline of an integrated bioprocess, Design of fermentation media, Kinetics of microbial growth, Monod model, Growth of filamentous organisms, Growth associated (primary) and non - growth associated (secondary), Substrate and product in hibition on cell growth, Environmental requirements for animal cell cultivations, Plant and animal cellcultures compared to microbial cultures.

UNIT-2 **15L+0T+10P= 25 Hours**

BIOREACTORS FOR CULTIVATION OF ANIMAL CELLS

Bioreactor considerations for animal cell culture, Bioreactors for suspension cultures, Immobilized cellcultures, Methods used for cultivation of animal cells (suspension and anchored cell culture).

PRACTICES:

- Fermentation media and preparation of inoculum.
- Media design by Plackett - Burman.
- Batch growth kinetics - Monod kinetic parameters.
- Immobilization of cells.
- Effect of pH and temperature on growth.

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

MIXING IN REACTORS

Mixing equipments, radial and axial flow impellers, Mechanism of mixing, Flow patterns in agitated tanks, time calculation for mixing, improvement of mixing infermenters; Assessing mixing effectiveness, Power requirement for gassed and ungassed systems, measuring dissolved oxygen concentration, Oxygen up take in cellcultures, Measurement of $K_L a$, Factors affecting $K_L a$ and scale-up.

UNIT-2 **10L+0T+15P=25 Hours**

DIFFERENT TYPES OF INDUSTRIAL STERILIZATION

Thermal death kinetics of micro organisms, Batch and continuous heat sterilization of liquid media, Filter sterilization of liquid media, Air sterilization and design of depth filters, Design of sterilization equipment - batch and continuous.

PRACTICES:

- Fermenter operation for batch and fed-batch cultivation.
- Mixing time in reactors.
- Estimation of $K_L a$ by $Na_2 SO_3$ oxidation method.
- Determination of gas hold up in sparged reactor.
- Batch heat sterilization and thermal death kinetics.

SKILLS:

- ✓ *Cultivation of microorganisms in a fermenter.*
- ✓ *Apply the sterilization techniques.*
- ✓ *Design of fermentation media for production of bioproducts*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

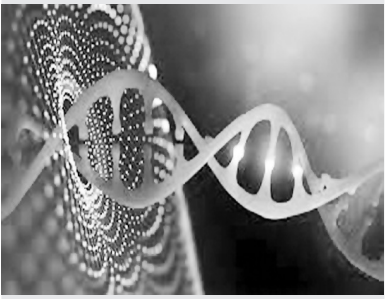
CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Design the low-cost media for lab scale fermentation process.	Design	1	1,3,5,7,9,10
2	Evaluate the kinetic parameters of microbial cell growth.	Evaluate	1	2,4,9,10
3	Identify the methods for cultivation and immobilization of cells.	Analyze	1	1,4,5,9,10
4	Determine mixing time and flow behaviour of fluids in the agitated tanks.	Evaluate	2	1,2,4,9,10
5	Analyze sterilization methods for complete elimination of all forms of microbial life and solve death rate kinetic parameters.	Analyze	2	2,3,4,9,10

TEXT BOOKS:

1. MichaelL Shuler, Fikret Kargi and Matthew P De Lisa,"Bioprocess Engineering Basic Concepts, 3rd edition, Pearson. 2017.
2. Paulin M. Doran, "Bio-Process Engineering Principles", 2nd edition, Elsevier, 2012.

REFERENCE BOOKS:

1. Douglas S.Clark and Harvey W. Blanch, "Biochemical Engineering", 2nd edition, CRC Press, 1997.
2. James E.Baileyand David F.Ollis,"Biochemical engineering fundamentals", 2nd edition, McGraw Hill, 2017.
3. D G Rao, "Introduction to Biochemical Engineering", 2nd edition, McGraw Hill, 2009.



source: https://leaps.org/our-genetically-engineered-future-is-closer-than-you-think/

22BT302 GENETIC ENGINEERING

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Cell and Molecular biology.

COURSE DESCRIPTION AND OBJECTIVES:

The aim of this core-course is to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology. This course provides theoretical bases for the application of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants. Students will also be introduced to prominent nucleic acid labelling techniques, construction of genomic and cDNA library and whole genome sequencing.

MODULE-1

UNIT-1 **9L+0T+6P= 15 Hours**

PROKARYOTES

Lactose, tryptophan and arabinoseoperons, Repressors and activators, Eukaryotes – gene regulation, promoters and enhancer elements, Plasmids- definition, types, identification, classification, transfer of plasmids, Enzymes involved in genetic engineering, Different types of cloningv ectors - plasmid (pUC19), lambdaphage, cosmid, M13, BAC, YAC and YEP.

UNIT-2 **15L+0T+10P= 25Hours**

APPLICATIONS OF GENETIC ENGINEERING

Sigma switch in *Bacillus subtilis*, Gene rearrangement, Gene amplification, Epigeneticregulations–methylation, glycation and acetylation, Hostrestrictionin transfer, Transposable elements definition, types of bacterial transposons, mechanisms of transposition and excision, detection of transposition in bacteria, retroviruses, applications of transposons, retrotransposons, Cloning strategies, construction of prototype vector (pBR322), Genomic and cDNA library construction and application, Detection of clone sandits expression.

PRACTICES:

- Isolation of plasmid DNA by alkaline lysis method from *E.coli.*
- Restriction analysis of plasmid DNA and analysis by agarosegel electrophoresis.
- Cloning experiments using the chosen gene and a bacterial plasmid in a prokaryotic host.
- Setting up a dephosphorylation reaction using alkaline phosphatase enzyme.

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

MOLECULAR TECHNIQUES

Purification of genomic DNA from living cells, manipulation of purified DNA; Introduction of DNA intoliving cells-methods of genetransfer, DNA hybridization, blot analysis - southern, northern & western blot, Dot and slotblot, PCR-Principles, designing of primers, methodology, identification of PCR product.

UNIT-2 **5L+0T+10P=25 Hours**

APPLICATIONS OF RDNA TECHNOLOGY

DNA sequencing, DNA fingerprinting; Types of PCR, RT - PCR, multiplex PCR, application of PCR technology; Molecular markers: RFLP, RAPD, AFLP;16s r-DNA typing, gene chip and microarray applications in disease profile and phylogeny; Gene cloning in medicine (Insulin, Blood clotting factor VIII); Gene therapy (Ex vivo & In vivo), case study of ADA as an example, advantages and limitations of gene therapy and novel technologies.

PRACTICES:

- Primer design to amplifygenes.
- Optimization of PCR reaction mixture to Amplify gene by polymerase chain reaction (PCR).
- Preparation of competent cells by calciumchloride treatment for plasmid transformation.
- Setting up of ligation reaction using T4 DNA ligase and Dot Blot Techniques for quantification.
- Transformation of chemically competent *E.coli* with the ligation mixture, plating and analysis of transformants.

SKILLS:

- ✓ *Analysis of digested DNA samples.*
- ✓ *Competent cell preparation.*
- ✓ *Selection of recombinant clones.*
- ✓ *Design of primers.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

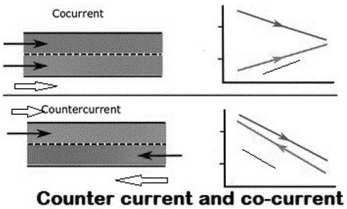
CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze gene expression and regulation mechanisms.	Analyze	1	2, 4, 5,9,10
2	Apply gene manipulation techniques to produce GMO's.	Apply	1	2, 5, 6, 8,9,10
3	Evaluate structure and organization of differentvectors used in gene transfer.	Evaluate	1	1,3,4,5,9,10
4	Design primers for amplification of genes.	Design	2	3,5,6,7,9,10

TEXT BOOKS:

1. T.A. Brown,"GeneCloning and DNA Analysis: An Introduction", 8th edition, Wiley, 2020.
2. Bernard R Glick and Cheryl L. Patten,"Molecular Biotechnology: Principles and applications of recombinant DNA", 5th edition, ASM Press, 2017.

REFERENCE BOOKS:

1. R. M. Twyman and S.B. Primrose, "Principles of gene manipulation and genomics", 7thedition, Black Well, 2006.
2. G M Malacinski, "Freifelder's Essentials of Molecular Biology", 4th edition, Jones & Bartlett, 2015.
3. JeffHardin,Gregory Paul Bertoni and Lewis J. Kleinsmith, "Becker's World of the Cell", 8th edition, Pearson Education, 2013.



Counter current and co-current mass transfer

source: https://www.chemicalslearning.com/2022/06/counter-current-and-cocurrent-mass.html

22BT303 HEAT AND MASS TRANSFER

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Chemical engineering principles in biotechnology.

COURSE DESCRIPTION AND OBJECTIVES:

The objective of the course is to train students with the knowledge and skills required to solve problems for the design, analysis and assessment of heat and mass transfer processes. It also helps to optimize the cost of heat and mass transfer operations.

MODULE-1

UNIT-1 **6L+0T+6P= 12 Hours**

HEAT TRANSFER MODES AND MECHANISMS

Conduction, convection and radiation, Fourier's law, Newtons law of cooling / heating, Stefan's Boltzmann law, thermal conductivity, steady state heat transfer in constant and variable area objects, energy balances, LMTD, overall and individual heatt ransfer co-efficients, thermal boundary layer.

UNIT-2 **10L+0T+10P= 20Hours**

HEAT EXCHANGE EQUIPMENT DESIGN

Empirical correlations for forced convectionheat transfer in laminar and turbulent flow, natural convection to air from verticaland horizontal planes, industrial problems of natural and forced convection, general design of shell and tube heat exchangers, condensers, boilers, calandrias and evaporators.

PRACTICES:

- Estimation of rate of heat transfer through metal rod.
- Calculation of heat transfer coefficient through natural convection.
- Calculation of heat transfer coefficient through forced convection.
- Assessment of LMTD and rate of heat transfer for double pipe heat exchange rinco-current and countercurrent pattern.
- Determination of LMTD, rate of heat transfer and efficiency of shell and tube heat exchanger.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

MASS TRANSFER OPERATIONS

Classification of mass transfer operations, Fick's law of diffusion, mass transfer coefficients, interphase masstransfer, basics of absorption and distillation.

UNIT-2 **10L+0T+10P=20 Hours**

DESIGN OF MASS TRANSFER OPERATIONS

Determination of minimum flow rate of solvent and operating lines for counter and co-current absorption and stripping of single component transfer, Steam distillation, estimation of number of trays through graphical McCabe - Thielemethod for binary distillation, flash vaporization and differential distillation.

PRACTICES:

- Separation of miscible liquid mixture using simple distillation.
- Determination of degree of separation for miscible liquids using liquid-liquid extraction.
- Determination of no.of trays required for desired degree of separation using graphical McCabe-Thiele method.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply principles of heat and mass transfer to industrial problems.	Apply	1,2	1,2,4,9,10
2	Analyze problems on natural and forced convection.	Analyze	1	2,5,7,9,10
3	Develop equations for design of heat and mass transfer equipment.	Create	1,2	2,3,9,10
4	Evaluate no. of stages required for given degree of separation in mass transfer operations.	Evaluate	2	3,4,5,9,10
5	Evaluate minimum amount of solvent required for given degree of absorption mass transfer process.	Evaluate	2	2,4,5,7,9,10

TEXT BOOKS:

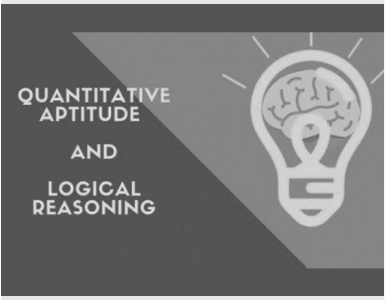
1. Warren L. McCabe, Jullian C. Smith and Peter Harriott, “Unit Operations of Chemical Engineering”, 7th edition, McGrawHill, 2017.
2. R.E.Treybal,“MassTransfer Operations”, 3rd edition, McGraw Hill, 2017.

REFERENCE BOOKS:

1. K. A. Gavhane, “Heat Transfer Operations”, 19th edition, Nirali Prakashan, 2019.
2. C. J. Geankoplis, “Transport Processes and Unit Operations”, 3rd edition, Prentice Hall,1993.
3. Ann Marie Flynn, Toshihiro Akashige and Louis Theodore, “Kern’s Process Heat Transfer”, 2nd edition, Wiley, 2019.

SKILLS:

- ✓ *Design and operation of heat exchangers.*
- ✓ *Determination of LMTD and effectiveness of heat exchangers.*
- ✓ *Estimation of heat and mass transfer coefficients.*
- ✓ *Calculation of number of stages for given degree of separation in mass transfer operations.*



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22TP302 QUANTITATIVE APTITUDE AND LOGICAL REASONING

Hours Per Week :

L	T	P	C
1	2	0	2

PREREQUISITE KNOWLEDGE: Basic Logical Thinking and Problem Solving Ability.

COURSE DESCRIPTION AND OBJECTIVES:

The Students will be introduced to various Arithmetic and Reasoning Problems. The students will have acquaintance with various problems like Time & Work, Time & distance, Percentages, Profit & Loss etc. besides solving puzzles and Critical Reasoning.

MODULE-1

UNIT-1 **4L+8T+0P=12 Hours**

Number system, LCM & HCF of numbers, Percentage, Ratio and proportion, Profit, loss and discount, Average & Mixtures, Simple Interest & Compound interest.

UNIT-2 **4L+8T+0P=12 Hours**

Time and work, Time & distance, Problems on trains, Problems on ages, Permutation & Combinations, Probability.

PRACTICES:

- Each concept would be taught in detail in the class followed by 10 problems solved in the class.
- Students would have to solve 10 additional problemsas a home work assignment in each concept.

MODULE-2

UNIT-1 **4L+8T+0P=12 Hours**

Number series, Letter series, Analogy, Odd man out, Coding and decoding, Syllogisms-Statement & Conclusions, Puzzle test.

UNIT-2 **4L+8T+0P=12 Hours**

Blood relations, Direction sense test, Order & Ranking, Seating Arrangements, Calendar & Clocks.

PRACTICES:

- Each concept would be taught in detail in the class followed by 10 problems solved in the class.
- Students would have to solve 10 additional problems as home work assignments in each concept

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Meet the demands of current job market besides equipping them higher studies like CAT, GMAT etc.	Apply	1	2, 5
2	Solve Arithmetic and Reasoning Problems within shortest possible time without paperwork.	Apply	1	2, 5
3	Exhibit better analytical skills and aptitude skills.	Analyse	2	2, 4
4	Develop interpretational skills.	Evaluate	2	2, 4

TEXT BOOKS:

1. R. S. Aggarwal,"Quantitative Aptitude for Competitive Examinations", S. CHAND Publications- Revised Edition, 2017.
2. ARIHANT, "A New Approach to Verbal & Non-Verbal Reasoning", Arihant Publication- Revised Edition, 2021.

REFERENCE BOOKS:

1. Trishna Knowledge Systems, "Quantitative Aptitude for Competitive Examinations", Pearson Publication, 2013.
2. R. S. Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", Revised Edition, S. CHAND Publications, 2018.

SKILLS:

- ✓ *Helps in developing and improving problem-solving skills.*
- ✓ *Flexing and honing logical abilities.*
- ✓ *Allow students to develop critical thinking skills.*

source: https://academic.oup.com/bioinformatics

22BT306 BIOINFORMATICS

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Biochemistry and Enzymology, Cell and Molecular Biology.

COURSE DESCRIPTION AND OBJECTIVES:

The main objective of this course is to equip students with computational skills and to help them use computational methods to study, organize, analyze and interpret biological informationat molecular and genomics levels.

MODULE-1

UNIT-1 **9L+0T+6P=15 Hours**

OVERVIEW OF BIOINFORMATICS

Scope & emerging are as of bioinformatics, Applications of bioinformatics in life sciences, Internet protocols - HTTP, HTML, FTP and TELNET.

UNIT-2 **15L+0T+10P= 25Hours**

BIOLOGICAL DATABASES

Primary databases - NCBI, EMBL and DDBJ, Secondary data bases – Swissprot, PIR, Structural database - PDB, Biochemical databases – KEGG and BRENDA, Literature database – Pub Med, Protein classification databases - CATH, SCOP.

PRACTICES:

- Analyzing nucleotide sequence from biological database like NCBI.
- Analyzing protein sequence from biological databases like Swissport.
- Mining of protein structured at a from PDB database.
- Retrieving pathways from KEGG & BRENDA.
- Retrieve open reading frame of given query nucleotide sequence by gene prediction methods.

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

SEQUENCEALIGNMENTMETHODS

Pair wise sequence alignment, Global vs local alignment, Dot plots, Heuristic alignment algorithms, Amino acid substitution matrices.

UNIT-2 **15L+0T+10P=25 Hours**

PHYLOGENETIC TREE AND CDNA LIBRARIES

Multiple sequence alignment - algorithms and tools, Phylogenetic tree construction methods - distance based - character based, DNA Sequencing methods, Large scale sequencing, Genomicc - DNA library construction, Gene identification methods, whole genome sequence analysis, Ramachandran Plot, Drug design.

PRACTICES:

- Sequence similarity searching of nucleotide & protein sequences (BLASTN & BLASTP).
- Homology modeling studies using SWISS modeler & I-TASSER.
- Multiple sequence alignment of sequences using ClustalW.
- Protein Secondary structure prediction by SOPMA.
- Docking studies using Auto Dock Vina.
- Phylogenetic tree construction using MEGA.

SKILLS:

- ✓ *Screening and design of molecule using Insilico tools.*
- ✓ *Statistical analysis of biologicaldata pertainingto genomics and proteomics.*
- ✓ *Determination of relationships among biological species using molecular phylogeny.*
- ✓ *Analysis of differentstructures of protein.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply different bioinformatics softwares for prediction of protein structures.	Apply	1	1,2,5,9,10
2	Analyze secondary and tertiary structure of proteins using bioinformatics tools.	Analyze	1	2,3,4,9,10
3	Use of algorithms for pair wise alignments, multiple sequence.	Apply	2	2,3,4,5,9,10
4	Evaluate the stability of drug molecules using docking tools.	Evaluate	2	3,4,5,9,10

TEXT BOOKS:

1. David W. Mount, “Bioinformatics: Sequence and Genome Analysis”, 2nd edition, CSHL Press, 2004.
2. A.D. Baxevanis and B.F.F. Ouellette, “Bioinformatics: A Practical Guide to the analysis of Genes and Proteins”, 3rd edition,Wiley-Inter Science, 2004.

REFERENCE BOOKS:

1. Arthur Lesk,“Introduction to Bioinformatics”, 5th edition, OxfordUniversity Press, 2019.
2. Richard Durbin, Sean R. Eddy, Anders Krogh and Graeme Mitchison, “Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids”, 1st edition, Cambridge University Press, 2008.
3. H. P. Bal, “Bioinformatics- Principles and Applications”, 1st edition, Tata McGraw-Hill, 2006.
4. T. K. Attwood and D. J. Smith, “Introduction to Bioinformatics”, 1st edition, Pearson Education, 2005.

source: https://en.wikipedia.org/wiki/Biochemical_engineering

22BT307 BIOREACTION ENGINEERING

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Chemical engineering principles in biotechnology, Bioprocess Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

The objective of the course is to familiarize reaction kinetics, diagnosis the ills of bioreactors and develop design equations for various bioreactors. Its major goal is successful design and operation of bioreactors to maximize yield and productivities of different metabolites.

MODULE-1

UNIT-1 **9L+0T+6P= 15 Hours**

REACTIONENGINEERINGFUNDAMENTALS

Over view of reaction engineering, concepts of order and molecularity, elementary and non-elementary reactions, models for intermediates, significance of rate constant, temperature dependency of Arrhenius equation, differential method of analysis and integral method of analysis. Ideal reactor design using energy and material balances.

UNIT-2 **15L+0T+10P= 25Hours**

DESIGN OF IDEAL REACTORS

Determination / Search of reaction mechanism for biological reactions, Estimation of rate constant for first and second order irreversible reactions, development of performance equations for batch reactor, plug flow reactor, mixed flow reactor.

PRACTICES:

- Estimation of rate constant for any chosen reaction in continuous stirred tank reactor.
- Determination of rate constant for any selected reaction in plug flow reactor.
- Calculation of rate constant for any chosen reaction in combined reactor.
- Determination of rate constant for any selected reaction of equimolar feed in batch reactor.
- Determination of rate constant for any selected reaction of non-equimolar feed in batch reactor.

MODULE-2

UNIT-1 **9L+0T+6P= 15 Hours**

NON-IDEAL REACTORS

Differential mass balance equation, various modes of bioreactor operation, concepts of RTD, reasons for non-ideality, E, C and Fcurves, scale-up of bioreactors, bioreactor applications for processing plant and animal cells.

UNIT-2 **15L+0T+10P=25 Hours**

BIOREACTOR DESIGN

Development of performance equation for batch, fed-batch and continuous fermenters (chemostat & turbidostat), recycle flow in chemostat and multi stage chemostat. Design of various bioreactors, measurement of RTD and diagnosis of ills of non - ideal reactors. Industrial problems of bio reactors and RTD.

PRACTICES:

- Estimation of RTD for continuous stirred tank reactor.
- Estimation of RTD for continuous stirred tank reactors in series.
- Calculation of RTD for plug flow reactor.
- Determination of RTD for combined reactor.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply principles of reaction engineering to design ideal reactors.	Apply	1	1,3,4,5,9,10
2	Analyze concepts of RTD and non-ideal reactors.	Analyze	2	2,5,9,10
3	Develop design equations for various bio reactors.	Create	2	3,4,9,10
4	Determine the productivities of various bio reactors.	Evaluate	1,2	5,6,9,10
5	Evaluate ills of bioreactors.	Evaluate	2	4,5,7,9,10

TEXT BOOKS:

1. O. Levenspiel, “Chemical Reaction Engineering”, 3rd edition, Wiley, 2006.
2. Paulin M. Doran, “Bio-Process Engineering Principles”, 2nd edition, Elsevier, 2012.

REFERENCE BOOKS:

1. James E. Bailey and David F.Ollis, “Biochemical engineering fundamentals”, 2nd edition, McGraw Hill, 2017.
2. MichaelLShuler, Fikret Kargi and Matthew P DeLisa,“Bioprocess Engineering: Basic Concepts, 3rd edition, Pearson. 2017.
3. H.S. Fogler, “Elements of Chemical Reaction Engineering”, 4th edition, Prentice Hall of India, 2008.

SKILLS:

- ✓ *Calculation of rate of biochemical reactions.*
- ✓ *Designing the bioreactor.*
- ✓ *Estimation of RTD.*
- ✓ *Development of performance equations for various bioreactors.*

IV

YEAR

BIOTECHNOLOGY

B.Tech.

I SEMESTER

22BT401	-	Down Stream Processing
22BI301	-	Immunology and Immunoinformatics
	-	Department Elective – 5
	-	Department Elective – 6
	-	Department Elective – 7
	-	Department Elective – 8

II SEMESTER

22BT402	-	Internship / Project Work

COURSE CONTENTS

I SEM & II SEM

22BT401 DOWNSTREAM PROCESSING

source: https://bioprocessintl.com/downstream-processing/downstream-single-use-technologies/downstream-processing-single-use-solutions/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Chemical engineering principles in biotechnology, Microbiology and fermentation technology.

COURSE DESCRIPTION AND OBJECTIVES:

The course presents the state of the art in downstream processing of biotechnological products. It provides knowledge on different techniques for solid-liquid separation, product release, concentration and purification of valuable bio-products with a focus on the integrated process.

MODULE-1

UNIT-1 **9L+0T+6P= 15 Hours**

DOWNSTREAM PROCESSING METHODS

Need & Importance of downstream processing in biotechnology, range and characteristics of bioproducts, characteristics of fermentation broths, cell disruption - physical, chemical & mechanical methods, filtration, centrifugation, extraction, A few case studies highlighting the down stream processing steps involved in the production of ethanol, citricacid.

UNIT-2 **15L+0T+10P= 25Hours**

CELL DISRUPTION TECHNIQUES

Equipment's for cell disruption– bead mill, homogenizer, ultrasonicator, Industrial filters - plate and frame filter, pressure leaf filter, continuous rotary filters, Industrial-scale centrifuges - disc bowl, tubular and decanter centrifuges, Equipment for extraction and industrial scale contactors.

PRACTICES:

- Cell disruption techniques - Ultra sonication.
- Cell disruption techniques - Enzymatic vs Chemical methods.
- Solid - liquidseparation - Centrifugation.
- Aqueous two - phase extraction of biologicals.
- Production of ethanol.

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

MEMBRANESEPARATIONTECHNOLOGY

Membrane separations - advantages, classification, factors affecting the separation process, Principles of dialysis & electro-dialysis, Sophisticated chromatographic techniques, Crystallization - theoretical considerations, drying, freeze drying, lyophilized products, polishing and product formulation.

UNIT-2 **15L+0T+10P=25 Hours**

PURIFICATION AND FINISHING OPERATIONS

Design of membrane module configurations, design of equipment for microfiltration, ultrafiltration, reverse osmosis, HPLC, ion- exchange, Gel filtration, affinity, GC, Crystallization - Equipment for Batch crystallization, Industrial drying equipment design - rotary drum drier, Equipment for Freeze drying - Lyophilizer.

SKILLS:

- ✓ *Performing experiments for product recovery.*
- ✓ *Solving problems related to various unit operations.*
- ✓ *Evaluating the product yield post purification.*

PRACTICES:

- Performance evaluation of a reverse osmosis unit.
- Concentration of proteins by dialysis.
- Compound / product analysis by HPLC.
- Product polishing by Freeze drying / Lyophilization.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the principles of downstream processing in biotechnology industry.	Apply	1,2	1,2,6,9,10
2	Develop downstream processing flowsheets for product recovery and isolation.	Develop	1	2,3,6,9,10
3	Analyze economics of “low volume and high value” and “high volume and low value” products.	Analyze	1	2,4,9,10
4	Design of sequence of unit operations for bio-separations.	Create	1,2	3,4,6,9,10

TEXT BOOKS:

1. Belter, P.A., E.L.Cusslerand Wei-Houhu, “Bio separations–Down stream Processing for Biotechnology”, 1st edition, John Wiley, 1988.
2. B. Sivasankar, “Bio separations Principles and Techniques”, 1st edition, PHI Publications, 2009.

REFERENCE BOOKS:

1. S.N. Mukhopadhyay, “Process Biotechnology Fundamentals”, 2nd edition, Viva, 2005.
2. P. F. Stanbury and A. Whitaker, “Principles of Fermentation Technology”, 2nd edition, Elsevier, 2008.
3. R.O. Jenkins, “Product recovery in bioprocess technology”, Butterworth Heinemann Limited, Oxford, 1992.

22BI301 IMMUNOLOGY AND IMMUNO INFORMATICS

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Cell and Molecular Biology, Biochemistry and Enzymology.

COURSE DESCRIPTION AND OBJECTIVES:

The course on Immunology and immunoinformatics is designed in such a way that the topics related to concepts in immunology, cellular components of immune system, innate and adaptive immune responses and their components are introduced in the first module. This is being followed by the practical exercises. In the second module, the immunoinformatics tools are focused so as to enable students to design vaccine using the online tools.

MODULE-1

UNIT-1 **9L+0T+6P=15 Hours**

FUNDAMENTALS OF IMMUNOLOGY

Types of Immunity: innate and adaptive, humoral and cell mediated, Immune cells and lymphoid organs, Antigens, epitopes, factors influencing antigenicity, Software tools for predicting antigenicity, Antigen processing and presentation, HLA - Role and Types, Cytokines - types and immune response, T cell and B cell activation and differentiation, Applications of Immunoinformatics tools.

UNIT-2 **15L+0T+10P= 25Hours**

CLINICAL IMMUNOLOGY

Inflammation, Hypersensitive reactions, Immune check point inhibitors for cancer therapy, Autoimmunity, Monoclonal antibodies - production and applications, Humanized & Bi-specific antibodies, Structure and types of Immunoglobulins.

PRACTICES:

- Isolation of lymphocytes from the mouse spleen and thymus.
- Identification and enumeration of mouse and human leukocytes.
- Hemagglutination test for blood grouping and evaluation of antigen and antibody behavior in vitro.
- Navigate HLA database to trace HLA haplo types of Indian population. Focus on the population of Andhra Pradesh.
- Prepare a chart showing the Hybridoma Technology.

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

ANTIGEN ANTIBODY INTERACTIONS

Antibody affinity and activity, Ouchterlony double immunodiffusion and precipitation, Antibody titer, Agglutination, RIA, ELISA, Western Blotting, Immuno fluorescence, MLR, FACS, Vaccines: various platforms of vaccines, vaccine composition, Disease burden due to the vaccine preventable diseases.

UNIT-2 **15L+0T+10P=25 Hours**

IMMUNOINFORMATICS

Design of multi-subunit and polytope vaccines, Population coverage based on HLA haplotypes, HLA Haplotypes of the population of state of Andhra Pradesh, Prediction of epitopes in vaccine design, Web based tools for vaccine design, IMGT-HLA - KIR databases.

IMMUNE CELL DEVELOPEMENT

source: https://www.slideshare.net/MekhlaDiwan/immunoinformatics-microarray-and-machine-learning-all-about-immunology-immunological-database

SKILLS:

- ✓ *Immunize lab animals for the production of antibodies.*
- ✓ *Work on immunodiffusion techniques.*
- ✓ *Perform ELISA.*
- ✓ *Purify IgG.*

PRACTICES:

- Antibody titer.
- Immuno diffusion and precipitation.
- ELISA Test for the estimation of antigen / antibody / protein.
- Mapping of the burden due to vaccine preventable diseases. (e.g. Covid-19, Malaria)
- Prediction of Epitope, Conformational and sequential epitopes.
- Design of multi - subunit polytope vaccine.
- Preparation of antigen and adjuvant emulsion (mineral oil, alum, Freund's adjuvants,etc.).
- Immunization of mouse through intra muscular and intra peritoneal routes.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply cellular machinery of immune system to recognize pathogen and its antigens.	Apply	1,2	1,3,7,9,10
2	Analyze the immune factors involved in the defence mechanisms against viruses, bacteria, fungi and nematode parasites.	Analyze	1	1,2,3,9,10
3	Evaluate immune techniques as life saving devices.	Evaluate	1	3,5,7,8,9,10
4	Design experimental protocols using antigen and antibody immune complexes.	Create	1,2	3,6,7,9,10
5	Design a vaccine using immunoinformatics online tools.	Create	2	1,3,5,9,10

TEXT BOOKS:

1. Thomas J Kindt, Barbara A Osborne, Richard A Golds by and J Kuby, "Immunology", 9th edition, WHFreeman, 2016.
2. Gregory R. BockandJamie A. Goode, "Immunoinformatics: Bioinformatic strategies for better understanding of immune function",1st edition,Wiley, 2003.

REFERENCE BOOKS:

1. Rajat K De and Namrata Tomar, "Immunoinformatics", 2nd edition, Humana, 2014.
2. Kenneth Murphy,"Janeway's Immunobiology", 9th edition, Garland Science, 2016.
3. R.L. Myers, "Immunology: Alaboratory manual", 2nd edition, William C Brown, 2007.
4. Lydyard, P.M., Whelan, A., & Fanger, M.W. "Kingdomtittle of instant notes inimmunology", 3rd edition, Taylor and Francis, 2011.

DEPT. ELECTIVES

B.Tech.

COURSE CONTENTS

I SEM & II SEM

BIOTECHNOLOGY

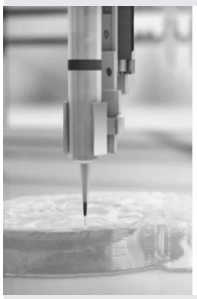
ODD SEMESTER

- 22BT801 - 3D Bioprinting
- 22BT802 - Biodiversity and Ecology
- 22BT803 - Bioenergetics
- 22BT804 - Bioethics and Intellectual Property Rights
- 22BT805 - Biopharmaceutical Technology
- 22BT806 - Genetics
- 22BT807 - Genomics and Proteomics
- 22BT808 - Instrumentation and Process Control
- 22BT809 - Metabolic Engineering
- 22BT810 - Phage Display
- 22BT811 - Phytopharma
- 22BT812 - Plant Taxonomy, Computer Applications and DNA Barcoding
- 22BT813 - Plant Tissue Culture and Transgenics
- 22BT814 - Solid Waste Management
- 22BT815 - Vaccinology

EVEN SEMESTER

- 22BT816 - Algorithms in Bioinformatics
- 22BT817 - Biosensors
- 22BT818 - Cancer Biology and Therapy
- 22BT819 - Computer Aided Drug Design
- 22BT820 - Handling of Animals for Experiments
- 22BT821 - Health Economics
- 22BT822 - Health Informatics
- 22BT823 - Methods and Practice of Animal and Human Cell Culture
- 22BT824 - Molecular Interactions
- 22BT825 - Molecular Phylogenetics
- 22BT826 - Nanobiotechnology
- 22BT827 - Python Programming for Biotechnologists
- 22BT828 - Regulatory affairs and clinical trails
- 22BT829 - Systems Biology
- 22BI802 - Bioprocess Economics, Modeling and Simulations

22BT801 3D BIOPRINTING



Source: https://interestingengineering.com/the-science-fiction-world-of-3d-printed-organs

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Cell and Molecular biology, Applied Physics.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers insights about stereo lithography and fused deposition modelling. It also emphasizes the principles; design software's and file formats for 3D objects. It provides knowledge on different applications of additive manufacturing of biomaterials.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

TISSUE ENGINEERING

Need for the in vitro development of organs and parts of organs for in situ placements, Tissue engineering, Scaffolds in Tissue engineering, classification of rapid prototyping systems, Types of 3D Bioprinting - Extrusion based Bioprinting, Droplet based Bioprinting, laser based Bioprinting, Applications of 3D Bioprinting used in biosensor constructions.

UNIT-2 **10L+10T+0P=20 Hours**

BIOCOMPATIBLE MATERIALS

Chemical and physical properties of biocompatible materials, synthetic sources and natural sources-marine source, plant sources, hydrogels, ceramics and glasses, cell sources, cell culture media, seeding of cells, cell viability and challenges, processing of cells for bioprinting, bioink-collagen, alginate, cellulose, fibronectin, RGD and carrageenan.

PRACTICES:

- A review on the preparation of cell type, bioink and scaffolds in 3D bioprinting.
- A report on the scaffolds used in tissue engineering.
- Compilation of different Bioink material used in 3D bioprinting.
- A report on the functioning of Extrusion based bioprinting.
- A review on the merits and demerits of Ink jet based bioprinting.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

TISSUE SCAFFOLDS

Scaffolds for tissue engineering, scaffold design and fabrication, Additive manufacturing techniques of Scaffolds, Applications of additive manufacturing scaffolds, challenges and clinical considerations with scaffold-based tissue engineering, Scaffold-based and scaffold-free 3D Bioprinting, cross - linkers - Ionic, enzymatic, physical, light and temperature based - advantages and limitations.

UNIT-2 **10L+10T+0P=20 Hours**

DESIGN FOR ADDITIVE MANUFACTURING

Design for assembly, manufacturing and additive manufacturing, STL for slicing and layering, Design for support - Overhangs, built orientation, Design for finishing, Design for aesthetics, DICOM & STF file format G-Code, Applications of CAD, Fusion 360 software and BIOVIA material studio.

SKILLS:

- ✓ *Bio-ink preparations using natural biomaterials and cells.*
- ✓ *Assembling of extrusion-based 3D Bioprinting.*
- ✓ *Selection of biocompatible agents for scaffoldings.*
- ✓ *Maintenance of sterile environment during 3D bioprinting.*

PRACTICES:

- Design a 3D model for the skin tissue bioengineering.
- Report on the software and their formats: STL file, G-code file and DICOM file formats.
- Review on Fusion 360 software.
- Review on Biovia material studio applied in 3D bioprinting.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the processes of 3D bio-printing methods.	Analyze	1	1,2,9,10
2	Formulate bioink for manufacturing of tissue engineering materials.	Apply	1	2,3,5,9,10
3	Evaluate and analyze biocompatible agents to be used in scaffolds.	Evaluate	2	2,3,4,9,10
4	Apply software tools for design of 3D objects.	Apply	2	1,4,5,9,10

TEXTBOOKS:

1. Chee Kai Chua and Wai Yee Yeong, “Bioprinting: Principles and Applications, 1st edition, World Scientific, 2015.
2. Ibrahim Tarik Ozbolat, “3D Bioprinting: Fundamentals, Principles and Applications”, 1st edition, Elsevier, 2017.

REFERENCEBOOKS:

1. Barnatt C, “3D printing”, 3rd edition, Create Space Independent Publishing Platform, 2016.
2. Kumar LJ, Pandey PM, Wimpenny DI, “3D printing and additive manufacturing technologies”, 1st edition, Springer, 2019.
3. Khademhosseini A, Camci-Unal G, “3D bioprinting in regenerative engineering: principles and applications”, CRC Press, 2018.

22BT802 BIODIVERSITY AND ECOLOGY

Source: https://www.eden.gov.uk/your-environment/zero-carbon-eden/ecology-and-biodiversity/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Environmental Science.

COURSE DESCRIPTION AND OBJECTIVES:

The course is designed to provide basic knowledge on conservation, values and threats to biodiversity & environmental protection. It enables the students to understand the functions of ecosystem, habitat loss and afforestation. The student will acquire insights about the national conservation laws and policies related to Biodiversity.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

COMPONENTS OF BIODIVERSITY

Importance and threats to biodiversity, flora and fauna, factors causing loss of biodiversity, in situ and ex situ techniques for conservation of biodiversity, biodiversity at global, national and local values, India as a mega-biodiversity nation, Hotspots of biodiversity, habitat loss, endangered and endemic species of India.

UNIT-2 **10L+10T+0P=20 Hours**

ECOLOGY AND ECOSYSTEM

Ecology and environment, Functions of an ecosystem, Habitats of biological species, Ecological succession, Food-chains and food-webs, the bio-geo-chemical cycles of elements and minerals, Functioning of ecosystem–energy flow and nutrient cycles, impact of ozone effect on biodiversity.

PRACTICES:

- Report on hotspots of biodiversity in India and world.
- Compilation of endangered and endemic species in India.
- A review on Red Data Book.
- A report on the effect of global warming on biodiversity.
- Identify the major ecosystems and sanctuaries in India.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

CONSERVATION BODIES

Earth Summits, Kyoto and Montreal protocol, international conservation bodies-IUCNUNDP, FAO and WWF.

UNIT-2 **10L+10T+0P=20 Hours**

BIODIVERSITY CONSERVATION AND POLICIES

National conservation strategy and policy statement on environment and development, policy statement on afforestation and deforestation, felling license, reforestation, national parks, sanctuaries and gardens, RIO declaration, Doha declaration, IPPC, WCED, IBA, PPV and PVP.

SKILLS:

- ✓ *Analyze the threats that cause the loss of biodiversity.*
- ✓ *Identify the endemic and endangered species in local areas.*
- ✓ *Techniques of silviculture*

PRACTICES:

- Enlist the international conferences on environment protection.
- Report on earth summits and sustainable development.
- Compile and summarize on environmental protection policies.
- List the strategies adopted for the conservation of biodiversity.
- Identification of flora and fauna of India. .

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the factors causing loss of biodiversity.	Analyze	1	2,6,7,9,10
2	Identify the factors affecting social, ethical, aesthetic values of biodiversity.	Analyze	1	2,6,9,10
3	Evaluate the national conservation strategy and its policies.	Evaluate	2	3,4,6,7,9,10
4	Design the new steps involved in environmental protection laws, policy statements.	Create	2	3,6,7,9,10

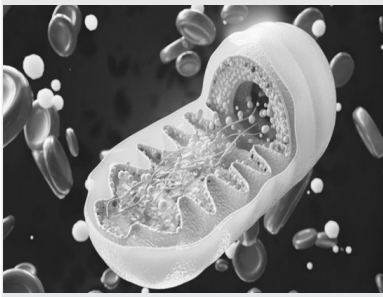
TEXT BOOKS:

1. SC Santra, “Environmental Science”, 2nd edition, New Central, 2011.
2. Krishnamurthy KV. Textbook of biodiversity. 1st edition, Science Publishers; 2003.

REFERENCE BOOKS:

1. Cunningham, WP Cooper and TH Gorhani, “Environmental Encyclopedia”, 1st edition, Jaico,2001.
2. N Ramakrishnan, “Biodiversity in Indian Scenarios”, 1st edition, Daya, 2006.
3. Singh MP, Singh JK, Mohanka R, “Forest environment and biodiversity”, .2nd edition, Daya Books, 2007.

22BT803 BIOENERGETICS



Source: https://creatingbalancedhealth.com/what-is-bioenergetics-an-essential-guide-to-everything-you-need-to-know/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Biochemistry and Enzymology.

COURSE DESCRIPTION AND OBJECTIVES:

The course enables in depth study on the relationship between energy and living systems. The aim of the course is to provide knowledge about biosynthesis and principles of classical thermodynamics of cellular systems.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

CHEMIOSMOTIC ENERGY TRANSDUCTION

Morphology of energy - transducing membranes, chemiosmotic concepts; Ion transport across energy-conserving membranes, bilayer-mediate transport, protein-catalyzed transport, swelling and the coordinate movement of ions across membranes.

UNIT-2 **10L+10T+0P=20 Hours**

QUANTITATIVE BIOENERGETICS

Gibbs energy and equilibrium, ΔG for the ATP hydrolysis and synthesis reactions, redox potentials, electron and hydrogen carriers, thermodynamics of electron transfer and membrane transport, diffusion potentials, donnan potentials, and surface potentials.

PRACTICES:

- A compilation on the efficiency of oxidative phosphorylation.
- Calculation of Gibbs free energy of cellular reactions.
- A review on permeability of ions.
- A report on diffusion potentials of physiologically important ions.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

ARCHITECTURE, CHEMICAL ACTIVITY OF MITOCHONDRIA

Sequence of electron carriers and sites of oxidative phosphorylation, ATP generation, heme and non-heme iron proteins, Thermodynamic considerations, oxidation-reduction electrodes, standard electrode potential, redox couples, phosphate group transfer potential, Respiratory controls, Theories of oxidative phosphorylation, uncouplers and inhibitors of energy transfer, ATP synthetase complex, ATP generation in bacterial system.

PRACTICES:

- Report on thermodynamics of oxidative phosphorylation.
- Review on mammalian and bacterial respiratory chains.

SKILLS:

- ✓ *Relating ATP and proton motive forces.*
- ✓ *Evaluating energy conversions in different organelles.*
- ✓ *Differentiating respiratory chains between plants and animals.*

UNIT-2 **10L+10T+0P=20 Hours**

CELLULAR BIOENERGETICS

Respiration in photosynthetic bacteria, electron transfer pathways in green plants, algae and cyanobacteria, bacteriorhodopsin, halorhodopsin and proteorhodopsin, ATP synthases and bacterial flagella rotary motors, Cellular bioenergetics-the cytoplasmic environment, mitochondrial monovalent ion transport, quantifying the mitochondrial proton current in intact cells, mitochondrial proton motive force in intact cells.

PRACTICES:

- Thermodynamics of photo systems.
- Compare impacts of electron leaks and proton leaks.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Evaluate bio-energetics of cellular reactions.	Evaluate	1	1,2,5,9,10
2	Calculate free energy changes of biological reactions.	Apply	1	2,3,5,9,10
3	Develop energy balance equation in ETC.	Create	2	2,3,4,5,6,9,10
4	Analyze metabolic pathways involved in bioenergetics.	Analyze	2	2,4,5,7,9,10

TEXT BOOKS:

1. L Ernster, “Bioenergetics”, 1st edition, Elsevier, 2011.
2. David G Nicholls and S J Ferguson, “Bioenergetics”, 4th edition, Academic, 2013.

REFERENCE BOOKS:

1. James Hemp, Robert B. Gennis, Gunter Schafer, Harvey S. Penefsky, “Bioenergetics: Energy Conservation and Conversion”, 1st edition, Springer-Verlag Berlin Heidelberg, 2008.
2. David Nicholls, Stuart Ferguson, “Bioenergetics”, 3rd edition, Elsevier, 2002.
3. Vladimir P. Skulachev, Alexander V. Bogachev, Felix O. Kasparinsky, “Principles of Bioenergetics”, 1st edition, Springer-Verlag Berlin Heidelberg, 2013.

22BT804 BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS

Source: https://www.mdpi.com/2075-471X/10/2/24

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Microbiology and Fermentation Technology, Cell and Molecular Biology, Genetic Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

This course describes ethical perspective and moral obligations related to biotechnology. It also imparts knowledge on intellectual property and its legalities. The objective of this course is to create awareness on legal rights, responsivities, regulatory affairs and ethical stand point of intellectual assets in the field of biological research.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

BIOETHICS

Engineering ethics, Social and ethical issues in biotechnology, Biosafety for human health and environment, Regulation, national and international guidelines of biosafety, rDNA guidelines, regulatory requirements for drugs and biologicals, GLP and GMP.

UNIT-2 **10L+10T+0P=20 Hours**

ENVIRONMENTAL ETHICS

Computer ethics, Weapons development and bioterrorism, Engineers as managers, Consulting engineers, Moral leadership, Sample code of ethics, Conflicts of interest, Occupational crime and hazards, Special procedures for rDNA-based products, transgenic plants and animals, Roles of institutional biosafety committees - RCGM, GEAC etc., Assessment of safety and risk, Risk benefit analysis.

PRACTICES:

- Report on three-mile island.
- Commentary on Chernobyl nuclear accident.
- Survey on IKEA and environmental ethics.
- Review on Biosafety of rDNA based products.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

INTELLECTUAL PROPERTY RIGHTS

TRIP and GATT, Concept of intellectual property, Kinds of intellectual property - patents, copyrights, designs, trademarks, geographical indication, WTO guidelines.

UNIT-2 **10L+10T+0P=20 Hours**

PATENTS

Requirement of patentable novelty, inventive step, classifying products as patentable and non-patentable procedure for applying patent, biological patentability, Infringement of IPR, its protection and remedies, Farmers rights and plant breeder's rights.

SKILLS:

- ✓ *Appreciating scientific article/ patent.*
- ✓ *Knowing the procedure for a patent application.*
- ✓ *Learn engineering discoveries towards the betterment of the society.*
- ✓ *Familiar with farmers' and plant breeders' rights*

PRACTICES:

- Survey on patent in fringement cases in India.
- Review on significant copy right in fringement cases.
- Commentary on Coca-Cola vs. Pepsi Cola.
- Report on McDonald's loses trade mark battle to Malaysia's 'McCurry'.
- Awareness and preparation of the report on traditional knowledge and paten tissues - concerning turmeric, neem and basmati rice.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Create awareness on good laboratory and manufacturing procedures.	Create	1	1, 6,7,9,10
2	Apply bioethics in manufacturing and marketing of bioproducts.	Apply	1	1,9,10,12
3	Analyze the key issues of biosafety, bioethics and IPR.	Analyze	2	2, 8,9,10
4	Apply appropriate intellectual property rights for protecting the individual rights in the society.	Apply	2	1,6,8,9,10

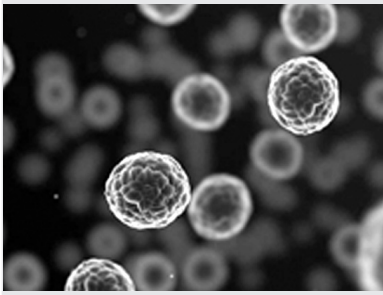
TEXT BOOKS:

1. M Martinand and R Schinzinger,"Ethics in Engineering", 1st edition, McGraw Hill, 2000.
2. M Govindarajan, S Natarajan and V S S Kumar, "Engineering Ethics",1st edition, Prentice Hall, 2004.

REFERENCEBOOKS:

1. Sasson,"Biotechnologies and Development", 1st edition, UNESCO,1988.
2. Sasson,"Biotechnologies in developing countries present and future", 1st edition, UNESCO,1993.
3. E G Seebauer and R L Barry, "Fundamentals of Ethics for Scientists and Engineers", 1st edition, Oxford, 2001.

22BT805 BIOPHARMACEUTICAL TECHNOLOGY



Source: https://www.prweb.com/releases/advancements_series_to_explore_breakthroughs_in_biopharmaceutical_technology/prweb18382243.htm

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Microbiology and Fermentation Technology, Bioinformatics.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers information on sources of drugs, pharmacodynamics and pharmacokinetics. It provides the knowledge on production and applications of biopharmaceuticals, drug delivery systems and drug manufacturing. Further it emphasizes on recombinant therapeutic products and its applications.

MODULE-1

UNIT-1 **6L+6T+0P=12Hours**

SOURCES OF DRUGS

Plant, animals, microbes and minerals, Routes of drug administration, Different dosage forms, Manufacturing facilities, Recent advances in the manufacture of drugs using r-DNA technology, Structure based denovo ligand design, Drug discovery.

UNIT-2 **10L+10T+0P=20 Hours**

MECHANISM OF DRUG ACTION

Physicochemical principles, Pharmacodynamics - mechanism of drug action, drug receptors-structural and functional families, Pharmacokinetics-drug absorption, factors that affect the absorption of drugs, distribution of drugs, biotransformation of drugs, bioavailability of drugs.

PRACTICES:

- Report on FDA approved drugs from Plants, animals and microbes.
- Analysis on reported efficacy of pharmaceutical drugs for blood pressure, cancer and diabetes.
- Identify commercially used recombinant strains for biopharmaceuticals.
- Report on active pharmaceutical ingredients/key intermediates.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

THERAPEUTIC PROTEINS

Production of therapeutic proteins, hormones, cytokines-interferons, interleukins, TNF, Haemopoietic growth factors, Blood products and nucleic acid therapeutics.

UNIT-2 **10L+10T+0P=20 Hours**

BIOMATERIALS & SUSTAINED DRUG DELIVERY

Controlled and sustained delivery of drugs, Biomaterial for the sustained drug delivery; Liposome mediated drug delivery, hydrogel biomaterials, gene/nucleic acid delivery; cells as drugs and drug delivery systems.

SKILLS:

- ✓ *Formulation of dosage of bio-pharmaceuticals.*
- ✓ *Implementation of good manufacturing practices in industries.*
- ✓ *Development of production process for therapeutic proteins.*

PRACTICES:

- Preparation of a pie chart on the available therapeutic drugs.
- Development of flow chart for the industrial production of recombinants.
- Report on biomaterials in sustained drug delivery.
- Review on cells and nucleic acids as delivery systems.

.COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the sources of drugs, different dosage forms and routes of drug administration.	Analyze	1,2,4	2,3,4,6,9,10
2	Assess the pharmacodynamic and pharmacokinetic mechanisms for biopharmaceuticals using in-silico tools.	Analyze	3,5	2,4,6,9,10
3	Adopt Good Manufacturing Practices (GMP) for production, analysis and formulation of biopharmaceuticals.	Apply	3,4	3,4,6,7,9,10
4	Develop process flowsheets for production of therapeutic proteins.	Create	2,3,4	3,6,7,9,10
5	Evaluate and analyze the biomaterials used for different drug delivery systems.	Evaluate	3,4	3,6,7,9,10

TEXT BOOKS:

1. L Lachman, H A Lieberman and J L Kanig, “Theory and Practice of Industrial Pharmacy”, 3rd edition, Varghese, 2001.
2. G Walsh, “Biopharmaceuticals: Biochemistry and Biotechnology”, 2nd edition, Wiley, 2005.

REFERENCEBOOKS:

1. M Gibaldi, “Biopharmaceutics and Clinical Pharmacokinetics”, 1st edition, Pharma Book Syndicate, 2006.
2. J P Remington, “Remington-The science and practice of pharmacy”, 2nd edition, publisher, 2006.
3. K D Tripathi, “Essentials of Medical Pharmacology”,6th edition, Jaypee, 2006.

22BT806 GENETICS

Source: https://www.accessscience.com/content/genetics/285300

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Cell and Molecular Biology.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with concepts of genetics. It also emphasizes the following topics: structure and function of genes and chromosomes. Various genetic tools are provided to study protein function, gene regulation and inherited illness.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

PHYSICAL BASIS OF HERIDITY

Mendelian laws/basic laws of inheritance-monohybrid, dihybrid and trihybrid cross, Modification of Mendel's ratios due to gene interactions, Multiple alleles and lethality, Multiple factors of inheritance, Probability in Mendelian inheritance, Genotyping by molecular markers and the concept of linkage, crossing over and gene mapping.

UNIT-2 **10L+10T+0P=20 Hours**

BIOCOMPATIBLE MATERIALS

Identification of the genetic material, Classical experiments - Hershey-Chase, Avery–MacLeod–McCarty and Meselson-Stahl, Packing and organization of genetic material in prokaryotes and eukaryotes, Chromosome morphology.

PRACTICES:

- Monohybrid cross, Dihybrid cross and Trihybrid cross.
- Incomplete dominance.
- Codominance.
- Linkage and XY linked inheritance.
- Autosomal inheritance.
- Insertion, duplication, deletion, transversion, transmission mutations.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

POPULATION GENETICS

HARDY - WEINBERG law and its applications, random mating and population equilibrium, conditions for HARDY - WEINBERG equilibrium, GENE pool allele frequency.

UNIT-2 **10L+10T+0P=20 Hours**

GENESTRUCTUREANDMUTATIONS

Spontaneous and induced mutations and types of mutations, Chromosomal aberrations, fine structure of genes in prokaryotes and eukaryotes, epigenetics.

SKILLS:

- ✓ *Solve genetic problems related to Mendelian laws of inheritance.*
- ✓ *Mapping of chromosomes.*
- ✓ *Karyotyping of human chromosomes.*

PRACTICES:

- Problems related to sickle cell anemia and malaria in African population.
- Allele frequency of ABO blood groups.
- Hemophilia: allele frequency and genotype frequency in the population.
- Color blindness: allele frequency and genotype frequency in the population.
- A review on Hardy – Weinberg Equilibrium.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Predict the genetic basis of heredity by linkage mapping.	Apply	1	1,2,3,9,10
2	Explore the organization and packing of chromosome and its functions.	Analyze	1	1,2,3,9,10
3	Analyze the structure of DNA and mutations.	Analyze	2	2,4,6,7,9,10
4	Evaluate population genetics and epigenetics.	Evaluate	2	3,4,9,10

TEXT BOOKS:

1. K Gupta,“Genetics”,3rd edition, Rastogi, 2005.
2. E J Gardner, M J Simmons and D P Snustad, “Principles of Genetics”, 8th edition, Wiley, 2007.

REFERENCE BOOKS:

1. M W Strickberger, “Genetics”, 3rd edition, Prentice Hall, 2006.
2. Daniel L. Hartl, Elizabeth W. Jones, “Genetics: principles and analysis”, 4th edition, Jones and Bartlett Publishers, 1998.
3. Marion Leboyer, Frank Bellivier, “Methods in Molecular Biology Psychiatric Genetics. Methods and Reviews”, 1st edition, Humana Press, 2002.

22BT807 GENOMICS AND PROTEOMICS

Source: https://www.townscript.com/e/genomics-proteomics-molecular-biology-training

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Cell and Molecular Biology, Genetic Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

To acquaint the students with the knowledge of various tools available for analyzing genomes and proteomes. And also, to throw light on genomic and proteomic approaches utilized for various applications.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

INTRODUCTION TO GENOME

Classification of genomics, organization and structure of genomes-genome size, Sequence complexity, Introns and exons, Chromosome micro dissection and its applications.

UNIT-2 **10L+0T+10P=20 Hours**

GENOME ANNOTATION METHODS

Genome annotation, traditional routes of gene identification, detecting open reading frames (ORFs), tools for finding genes, approaches for expression profiling, Determining gene function by sequence comparison and through conserved protein structure.

PRACTICES:

- Insilicodetermination of introns and exons in a given sequence.
- Determining ORF in a given nucleotide sequence.
- Analyzing the function of gene by insilicomeans.
- Sequence analysis by BLAST and identification of cSNPs.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

MICROARRAYS

Microarrays: Importance, types, designing microarray experiment and applications, Next generation sequencing- comparison of various next generation sequencing approaches and its applications, Insights from genome sequencing of various species.

UNIT-2 **10L+0T+10P=20 Hours**

PROTEOMICS

Mining proteomes, detecting proteins in polyacrylamide gels, Two-dimensional polyacrylamide gel electrophoresis- procedure, image analysis, mass spectrometry, MALDI-ToF, Applications of proteomics.

PRACTICES:

- Amplification of a gene and sub-cloning into vectors.
- Prokaryotic expression of genes.
- Analyzing the solubility of proteins.
- Determining the biological activity of a given protein.

SKILLS:

- ✓ *Identification of exons and introns in genes of different species.*
- ✓ *Identification of cSNPs between any two genes pertaining to two different breeds of species.*
- ✓ *Analysis of gene expression profiles and protein sequences*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Adopt various tools for annotation of genomes and proteomes.	Apply	1	1, 2, 4,5,9,10
2	Analyze gene expression patterns using NGS and biochip technology.	Analyze	1	2,4,5,9,10
3	Apply analytical techniques for protein-separation and identification.	Apply	2	2,3,6,9,10
4	Integrate the concepts of genomics and proteomics in various biotechnological applications towards sustainable development.	Design	2	2,3,7,9,10

TEXT BOOKS:

1. S B Primrose and R M Twyman, “Principles of Genome Analysis and Genomics”, 7th edition, Blackwell, 2014.
2. S Sahai, “Genomics and Proteomics, Functional and Computational Aspects”, 2nd edition, Springer, 2013.

REFERENCE BOOKS:

1. Andrezej K Konopka and James C Crabbe, “Compact Hand Book-Computational Biology”, 3rd edition, CRC Press, 2004.
2. Pennington and Dunn, “Proteomics from Protein Sequence to function”, 1st edition, Garland Science, 2002.
3. Lesk AM, “Introduction to genomics”, Oxford University Press, 3rd edition, 2017.

22BT808 INSTRUMENTATION AND PROCESS CONTROL

Source: https://nttinc.com/blog/process-instruments-and-controls/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Chemical Engineering principles in Biotechnology, Bioreaction Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

The course objective is to choose suitable control strategy for a process and analyze the stability of a dynamic systems. It also provides insights about major types of instruments and their working principles.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

PROCESS DYNAMICS

Fundamentals of process dynamics and control, response of first order Systems, Physical examples of first order systems, response of first order systems in series, block diagram of chemical reactor control.

UNIT-2 **10L+10T+0P=20 Hours**

PROCESS CONTROLLERS

Servo & regulator operations, flow, level, temperature and pressure control, Basic control actions, characteristics of two position, two position control of single Capacitance process, single speed floating control. P, PD, PI and PID control modes.

PRACTICES:

- Servo and regulator operations with real time examples.
- Control of flow, level and pressure variables in biotechnological processes.
- Application of P, PD, PI and PID control modes in process control.
- Real time applications of P, PD, PI and PID control modes.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

MULTILOOP CONTROL SYSTEM

Feed forward control-Feedback control, Ratio control–Cascade control–Split range control-Multivariable control and examples from distillation column and Boiler system.

UNIT-2 **10L+10T+0P=20 Hours**

PROCESS INSTRUMENTATION

pH probes, DO probes, biosensors - online glucose sensors and biomass sensors, Pumps, pneumatic, hydraulic and electronic controllers, Pneumatic, electric and hydraulic actuators, Control valves-characteristics of control valves, Globe, butterfly and diaphragm valves.

PRACTICES:

- Calibration and working of pH and DO probes.
- Online glucose and biomass sensors in fermentation processes.
- Industrial significance of various valves.
- Centrifugal and reciprocating pumps.

SKILLS:

- ✓ *Development of block diagram for a reactor.*
- ✓ *Controllers design for flow rate, pressure and temperature.*
- ✓ *Designing of sensors for monitoring biomass and glucose.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply principles of control systems to industrial problems.	Apply	1	1,2,5,9,10
2	Analyze the stability of dynamic systems.	Analyze	1	2,4,5,9,10
3	Design block diagram for process identification.	Create	2	3,4,9,10
4	Develop suitable controller for controlling process variables.	Create	2	3,5,9,10

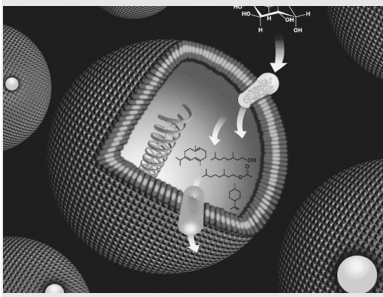
TEXT BOOKS:

1. D R Coughanowr, “Process Systems Analysis and Control”, 2nd edition, McGraw-Hill,1991.
2. Harriott P, “Process control”, 1st edition, McGraw Hill, 1972.

REFERENCE BOOKS:

1. Stephanopolous G, “Chemical Process Control”, 1st edition, PHI,1998.
2. Eckman D P, “Automatic Process Control”, 2nd edition, Wiley, 1967.
3. Garcia CE, Prett D, Ramaker B, “Fundamental process control. In The Second Shell Process Control Workshop: Solutions to the Shell Standard Control Problem”, 2nd Edition, Butterworth-Heinemann 1990.

22BT809 METABOLIC ENGINEERING



Source: https://newscenter.lbl.gov/2010/12/02/metabolic-engineering/

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Biochemistry and enzymology.

COURSE DESCRIPTION AND OBJECTIVES:

Metabolic engineering is an emerging field of biotechnology / bioprocess engineering which aims towards purposeful modification of cellular (metabolic, gene regulatory, and signalling) processes/networks to achieve desirable goals such as enhanced production of metabolites including pharmaceuticals, biofuels and biochemicals and other biotechnology products. The objective of this course is systematic analysis of metabolic and other pathways with molecular biological techniques to improve cellular properties for the product improvement by designing and implementing rational genetic modifications.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

CELLULAR METABOLISM

Overview of cellular metabolism, Fueling Metabolism, Supply of biomass precursors, Anabolism and anaplerosis, Methods employed to study metabolism and pathway analysis, Importance of metabolic engineering, material balances and data consistency.

UNIT-2 **10L+0T+10P=20 Hours**

METABOLIC NETWORKS

Coordination of metabolic reactions, Metabolic regulation network at enzyme level and whole cell level, Metabolic strategies and regulation, Integration of metabolic pathways, Comprehensive models for cellular reactions, Metabolic pathway synthesis.

PRACTICES

- Create a comprehensive model using stoichiometry.
- Create a comprehensive model using reaction rates.
- Create a comprehensive model using dynamic mass balance.
- Develop a simple black box model.
- Synthesize a metabolic pathway based on a validated template.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

METABOLIC FLUX ANALYSIS

Theory, Determination of flux by isotope labelling - Metabolic control analysis-control coefficients and summation theorems, Bottom up and Top-down approaches.

UNIT-2 **10L+0T+10P=20 Hours**

FLUX ANALYSIS AND NETWORKS

FCC determination, Grouping of reactions- gFCC and identification of independent pathways, Bottom up and Top-down approaches-case study, Optimization of flux amplification-consistency tests and experiment validation.

SKILLS:

- ✓ *Exploiting black box model to evaluate data consistency.*
- ✓ *Ascertain the viability of a synthesized metabolic pathway.*
- ✓ *Grouping of reactions via metabolic control analysis.*

PRACTICES:

- Create a group of reactions from known pathways.
- Identify an independent pathway.
- Establish the control distribution in a metabolic network through bottom-up approach.
- Establish the control distribution in a metabolic network through top-down approach.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Establish data consistency using black box model.	Analyze	1	1, 4, 5,9,10
2	Develop a comprehensive model for a balanced cellular reaction.	Create	1	2, 3, 5,9,10
3	Synthesize metabolic pathways.	Analyze	1	3, 4,9,10
4	Determine metabolic flux using isotope labelling.	Apply	2	1, 4, 5,9,10
5	Assess flux control coefficients by direct and indirect methods.	Evaluate	2	4, 5,9,10
6	Rationalize the use of top-down and bottom-up approaches of metabolic network discovery.	Create	2	1, 5,9,10

TEXT BOOKS:

1. Stephanopoulos G, Aristidou AA, Nielsen J, “Metabolic Engineering: Principles and Methodologies”, 1st edition, Academic Press, 1998.
2. Cortassa SD, Aon MA, Aon JC, Iglesias AA, Lloyd D, “Introduction to Metabolic and Cellular Engineering”, 1st edition, World Scientific, 2011.

REFERENCE BOOKS:

1. Cheng Q, editor, “Microbial Metabolic Engineering: Methods and Protocols”, Humana Press, 2012.
2. Challacombe JF, “Metabolic Pathway Engineering: Analysis and Applications in the Life Sciences” 1st edition, CRC Press, 2021.
3. S. Y. Lee, E.T. Papoutsakis, “Metabolic Engineering”, 1st edition, CRC Press, New York, 1999.

22BT810 PHAGE DISPLAY

Source: https://www.news-medical.net/life-sciences/Phage-Display-Explained.aspx

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Microbiology and Fermentation Technology, Cell and Molecular Biology, Genetic Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides knowledge on principles of phage display, properties of phage display vectors, role of phage display in antibody engineering, medicine and therapy. It enables the students to learn about the Fab fragment, sCFV and phage displayed peptide libraries.

MODULE-1

UNIT-1 **6L+6T+0P=12Hours**

BACTERIOPHAGES

A historical perspective, Biology of bacteriophages, Structural characterization and lifecycles of M13, T4 and T7 bacteriophages, Phage typing and their expression.

UNIT-2 **10L+10T+0P=20 Hours**

PHAGE DISPLAY

Phage display vectors, antibody libraries, phagemid-displayed peptide libraries, functional domains and scaffolds, Phage display for epitope mapping of antigens, applications of phage display.

PRACTICES:

- Sequential steps in the isolation of bacteriophages from sewage water.
- Report on culturing of bacteriophages-T4, T7and M13.
- Develop models on replication of bacteriophages.
- Report on Phage lysate and Bacteriophage titer assay.
- Model preparation on the Phage display of sCFV.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

SCFV

Identification and analysis of selected antibodies, production and purification of fab fragment and sCFV, Amplification of antibody genes - PCR amplification and assembly of light and heavy chain coding regions, Cell surface selection markers and analysis of monoclonal antibodies from phage libraries.

UNIT-2 **10L+10T+0P=20 Hours**

ANALYSIS OF PHAGE BORNE PEPTIDES

Construction and use of phage displayed peptide libraries, construction and selection from cDNA phage display expression libraries, applications of phages in medicine and therapy; Phage therapy, phage lysins and phages as vaccine delivery vehicles.

SKILLS:

- ✓ *Employ standard microbiological techniques to isolate and purify phages from environmental samples.*
- ✓ *Observation of plaques on bacterial plates.*
- ✓ *Estimation of plaque forming units (PFU) in a sample.*
- ✓ *Phage typing and imprinting.*

PRACTICES:

- Sequential steps in Production and purification of Fab fragment and sCFV.
- Report on the Phage libraries.
- Application of phages in medicine and phage therapy.
- Report on purification of potential bacteriophages (M13) for E.coli.
- Report on Phages as vaccine delivery vehicles.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the importance of bacteriophages in development of molecular biology.	Analyze	1	2,4,9,10
2	Apply the structure and biology of certain filamentous/non-filamentous bacteriophages to display proteins/peptides.	Apply	1	1,2,9,10
3	Evaluate the application of phage display technique in recombinant antibody engineering.	Evaluate	2	3,4,9,10
4	Investigate the role of phage display in medicine and health.	Analyze	2	3,4,6,9,10
5	Design experimental outline for in silico expression of peptide/protein on M13 bacteriophage.	Create	1	4,5,9,10

TEXT BOOKS:

1. C R Geyer and S S Sidhu,"Phage display in biotechnology and drug discovery", 2nd edition, CRC Press, 2015.
2. Brian K, Kay, Jill Winter, John McCafferty, "Phage Display of Peptides and Proteins: A Laboratory Manual", 1st edition, Elsevier, 1996.

REFERENCEBOOKS:

1. J.Nicastro, S.Wong, Z. Khazaei, P.Lam, J.Blay and R.A Slavcev,"Bacteriophage Applications-Historical Perspective and Future Potential", 2nd edition, Springer, 2016.
2. P.M.O Brien and R. Aitken, "Antibody Phage Display: Methods and Protocols", 1st edition, Springer, 2004.
3. Carlos F Barbas, Dennis R Burton, Gregg J Silverman, "Phage Display: A Laboratory Manual", 2nd edition, CHSL Press, 2004.

22BT811 PHYTOPHARMA

Source: https://www.ingredientsnetwork.com/frutarom-to-focus-on-phytopharma-news044746.html

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Bioanalytical Techniques, Bioinformatics.

COURSE DESCRIPTION AND OBJECTIVES:

This course designed to illustrate the importance of secondary metabolites of plants. Screening of phytochemicals from indigenous medicinal plants and its efficacy evaluation. This course provides knowledge on phyto drugs with typical examples as a prelude to design new formulation.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

INDIAN SYSTEM OF MEDICINE

Basic principles of plant taxonomy, agronomic features, medicinally important plant species, Database on medicinal plants.

UNIT-2 **10L+0T+10P=20 Hours**

ANALYSIS OF PHYTOCHEMICALS

Preparation of crude extracts and essential oils, Qualitative and quantitative identification and characterization methods for crude drugs and active phyto compounds, HPTLC, FTIR, GCMS, LCMS, and QSAR and molecular docking.

PRACTICES:

- Preparation of plant crude extract.
- Extraction of phyto compounds from different medicinal plants.
- Screening of phyto chemicals using HPTLC.
- Screening of phyto chemicals using GC-MS.
- Molecular Docking studies.

MODULE -2

UNIT-1 **6L+0T+6P=12 Hours**

THERAPPEUTIC PHYTOCOMPOUNDS

Antimicrobial, anti-inflammatory, antiulcer, antidiabetic, anti-cancer, hepatoprotective and immuno modulatory phytochemicals, Bio-fungicides and biopesticides, Nutraceuticals.

UNIT-2 **10L+0T+10P=20 Hours**

PHYTO DRUGS

Patents, IPR, Breeder's right and biopiracy, Phyto drugs and their mode of action - andrographolide, vinblastine, vincristine, curcumin, cinnamaldehyde, anthocyanins, kaempferol, morindin, berberine, quercetin.

SKILLS:

- ✓ *Preparation of crude extracts and essential oils.*
- ✓ *Identification and separation of phytochemicals.*
- ✓ *Molecular Docking of phytochemicals*

PRACTICES:

- A report on filing a patent.
- Indian legal framework on IPR.
- Case study on Plant breeder's rights.
- Report on ADMET properties of Andrographolide, Vinblastine, Vincristine, Curcumin, Cinnamaldehyde, Anthocyanins, Kaempferol, Morindin, Berberine, Quercetin.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply analytical methodsfor structural elucidation of phytochemicals.	Apply	1	1,2,4,5,9,10
2	Design the combinatorial drugs for specific applications.	Create	1	1,3,4,5,9,10
3	Isolate and evaluate the active compounds from medicinal and aromatic plants.	Evaluate	2	2,4,9,10
4	Develop novel nutraceuticals and cosmetic products.	Create	2	3, 4,9,10

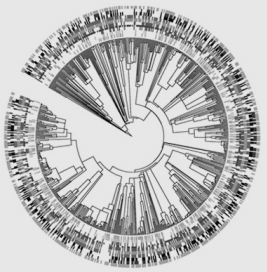
TEXT BOOKS:

1. Trease& Evans, "Pharmacognosy–William Charles Evans", 14th edition, Harcourt Brace, 1989
2. Raymond G Hill, Duncan Richards, "Drug Discovery and Development Technology in Transition", 3rd Edition, Elsevier 2021.

REFERENCEBOOKS:

1. Gunnar Samuelss, "Drugs of Natural Origin, A Textbook of Pharmacognosy", English edition, Swedish Phramaceutical, 1992.
2. W C Evans, "Trease and Evans' Pharmacognosy" ,15th edition, Saunders, 2002.
3. Chaudhary MI, "Frontiers in Drug Design & Discovery", 10th edition, Bentham Science Publishers, 2016.

22BT812 PLANT TAXONOMY, COMPUTER APPLICATIONS AND DNA BARCODING



Source: https://onlinelibrary.wiley.com/doi/full/10.1111/jse.12254

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Cell and Molecular Biology, Bioinformatics.

COURSE DESCRIPTION AND OBJECTIVES:

The course is designed to provide knowledge on DNA Barcoding, Medicinal plant databases and modern trends in Plant taxonomy, phylogenetic analysis techniques, KBD, IPNI, BOLD, CBOL and digitalization of herbaria.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

MEDICAL PLANT TAXONOMY

Modern trends in plant taxonomy - biosystematics, numerical taxonomy, Phenetics and cladistics, Cladistic methodology, Molecular taxonomy, Phylogenetic systematics-basic principles.

UNIT-2 **10L+0T+10P=20 Hours**

CONSTRUCTION OF PHYLOGENETIC TREES

UPGMA, Neighbor joining, Parsimony, Maximum likelihood approaches and MEGA, Reliability of phylogenetic tree-based analysis, Concepts of homoplasy, Commonly encountered problems with tree construction and interpretation.

PRACTICES:

- Explore National Centre for Biotechnology information.
- Retrieve and prepare a report for medicinal plants using USDA Plant Databases.
- Bio-informatics tools like BLAST, FASTA, Rooted and unrooted tree for data analysis.
- Pair wise alignment and multiple sequence alignment to build relations among species.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

PLANT TAXONOMY

Keys for identification of plants, International code of nomenclature of plants (ICN), Articles governing effective and valid publication, Priority of names, Typification-lectotypification, neotypification, epitypification, Rejection and retention of names, Conservation of names, Alternative names, Basic rules of species names, Common technical terms in nomenclatural citations-basionyms, synonyms, autonyms, tautonyms, homonyms.

UNIT-2 **10L+0T+10P=20 Hours**

COMPUTER APPLICATION IN TAXONOMY

DNA Barcoding, techniques, tools & databases, Data analysis, benefits, applications and limitations, Gene markers used for Barcoding, Databases, KBD, IPNI, digitizing herbaria, DNA barcoding in conservation of plants, Barcode of Life Data System (BOLD), Consortium for the Bar code of Life (CBOL).

SKILLS:

- ✓ *Creation of Medicinal plant databases.*
- ✓ *Digitizing of Herbaria.*
- ✓ *Appling DNA Barcoding technique.*
- ✓ *Construction of UPGMA & MEGA based Phylogenetic trees.*

PRACTICES:

- DNA barcoding of medicinal plant species.
- DNA barcoding of algal species.
- Review on plant bar coding database or repository.
- Enlist keys for identification of plants.
- Report on international code of nomenclature of plants..

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply 18s RNA technique for plant species identification.	Apply	1	1,2,5,9,10
2	Determine the genetic similarity among plant species using molecular phylogenetic analysis.	Evaluate	1	1,3,5,9,10
3	Adopt computational tools for construction of phylogenetic trees.	Apply	2	2,4,5,9,10
4	Analyze taxonomic similarity of plant species by DNA barcoding.	Analyze	2	2,4,5,9,10

TEXT BOOKS:

1. Lopez, Ida, Erickson and David L, “DNA Barcodes-Methods and Protocols”, 1st edition, Springer, 2012.
2. Sucher NJ, Hennell JR, Carles MC, “Plant DNA fingerprinting and barcoding: methods and protocols”, 1st edition, Humana Press; 2012.

REFERENCE BOOKS:

1. Schindel, David E AU Miller and E. Scott, “DNA barcoding a useful tool for taxonomists Nature”, 1st edition, Nature, 2005.
2. Singh G, “Plant systematics: an integrated approach”, 3rd edition, CRC Press; 2010.
3. Michael Simpson, “Plant Systematics”, 3rd Edition, Elsevier, 2019.

22BT813 PLANT TISSUE CULTURE AND TRANSGENICS

Source: https://microscopiaiwm.com/tag/transgenic-plants/

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Basics of Biology, Genetic Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

The course describes importance of plant tissue culture for production of haploids, hybrids, artificial seeds and development of transgenic crops tolerant to various abiotic stresses. It also aids in the production of commercial compounds alongside with understanding the regulatory issues.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

PLANT TISSUE CULTURE

Introduction to plant tissue culture, basic steps involved in tissue culture, Initiation and maintenance of callus, Plant acclimatization, Production of haploids, somoclonal variations-causes, advantages and disadvantages, Synthesis of artificial seeds.

UNIT-2 **10L+0T+10P=20 Hours**

TRANSFORMATION TECHNOLOGY

Gene transfer methods-direct and indirect, Agrobacterium mediated gene transfer, vector less or direct DNA, Development of biotic (bacterial resistance, fungal resistance, viral resistance) and abiotic (salt tolerance, Drought tolerance, Heat tolerance, Cold tolerance) stress tolerance crops.

PRACTICES:

- Micropropagation of elite species.
- Genetic transformation of plant tissue using Agrobacterium tumefaciens.
- Preparation of recombinant plant expression vector with gene of interest.
- Confirmation of transgenes by PCR.
- Confirmation of transgenes by Southern blot.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

MOLECULAR FARMING

Genetic engineering for quality improvement - seed storage proteins, essential amino acids, vitamins and minerals, industrial enzymes; Bioplastics, Bioreactor systems and models for mass cultivation of plant cells.

UNIT-2 **10L+0T+10P=20 Hours**

BIOSAFETY GUIDELINES OF GMO'S

Environmental issues associated with transgenic crops, Biosafety guidelines - Government of India; Roles of IBSC, RCGM, GEAC etc. for GMO applications in food and agriculture, Food safety and Environmental release of GMO's-risk analysis, assessment, management and communication.

SKILLS:

- ✓ *Optimization of media components for clonal propagation.*
- ✓ *Genetic improvement of crop plants.*
- ✓ *Biosafety of GMOs.*

PRACTICES:

- Compilation of acreage and yield production of transgenic plants.
- Case studies on effect of GMOs in the ecosystem.
- Induction of hairy root cultures using Agrobacteriumrhizogenes for the production of secondary metabolites.
- Induction of somatic embryos preparation of synthetic seeds.
- Elicitation for secondary metabolites using elicitors.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the knowledge of molecular markers for transformation.	Apply	1	1, 6,8,9,10
2	Analyze different plant tissue culture techniques for development of seedlings and transgenic plants.	Analyze	1	2,3,4,5,9,10
3	Investigate the role of elicitors for enhanced production of secondary metabolites.	Analyze	2	3,4,5,9,10
4	Select suitable bioreactors for production of commercial products.	Analyze	2	3,5,6,9,10

TEXT BOOKS:

1. B B Buchanan, W Gruissem, K Vickers and R L Jones, “Biochemistry and Molecular Biology of Plants”, 2nd edition, Wiley, 2015.
2. H S Chawla, “A Text Book of Plant Biotechnology”, 2nd edition, Oxford, 2002.

REFERENCE BOOKS:

1. Bhojwani, Sant Saran, Dantu and Prem Kumar, “Plant Tissue Culture: An Introductory Text”, Springer, 2013.
2. Adrian Slator, Nigel W. Scott and Mark R. Fowler, “Plant Biotechnology: the genetic manipulation of plants”, 2nd edition, Oxford, 2008.
3. R C Dubey, “A Text Book of Plant Biotechnology”, 4th edition, S. Chand, 2006.

22BT814 SOLID WASTE MANAGEMENT

Source: https://blog.kingmakersias.academy/editorial/solid-waste-management

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Environmental Studies, Microbiology and Fermentation Technology.

COURSE DESCRIPTION AND OBJECTIVES:

The course emphasizes on types of solid waste, legal issues and requirements for solid waste management. And also impart knowledge on planning of municipal solid waste management systems for sustainable environment and health.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

SOLID WASTE MANAGEMENT

Need for solid waste management, evolution of SWM, functional elements of SWM, Sources, types and characteristics of solid waste - municipal, industrial and hazardous wastes.

UNIT-2 **10L+0T+10P=20 Hours**

ANALYSIS OF SOLID WASTE

Sampling of solid waste, characteristics of solid waste - physical, chemical and biological, Waste quantification, 3R policy.

PRACTICES:

- Separation of solid wastes into biodegradable and non-biodegradable waste.
- Determine the moisture content of the sample.
- Analysis of cellulose content of solid waste.
- Determination of lignin content of solid waste.
- Assessment of degradability of solid waste by measuring the volatile solids content.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

WASTE HANDLING

Collection, separation and storage of solid waste, Processing at source - component separation and compaction, incineration, composting, anaerobic digestion, Transfer and transport of waste.

UNIT-2 **10L+0T+10P=20 Hours**

SOLID WASTE MANAGEMENT

Recycling of dry waste, waste as fuel, Incineration/combustion, Composting - types, factors affecting composting, vermicompost, and biogas, Disposal of Solid Waste - types of landfills, management of bio-medical, e-waste and inert waste, SWM rules, Finance in SWM projects.

PRACTICES:

- Case study 1: Polyethylene waste plastic cement.
- Case study 2: Recycling of non-ferrous metal waste.

SKILLS:

- ✓ *Handling of the solid waste.*
- ✓ *Characterization and quantification of solid waste.*
- ✓ *Conversion of biological waste into value-added products.*

PRACTICES:

- Investigation of effective pre-treatment methods.
- Optimizing enzymatic hydrolysis process.
- Optimizing fermentation process.
- Biogas production from food waste.
- Design an experiment using Minitab.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply suitable strategies for storage, collection and transfer of solid waste management.	Apply	1	1,6,7,9,10
2	Analyze physical, chemical and biological composition of wastes.	Analyze	1	2,6,7,9,10
3	Apply 3R approach for processing and recovery of solid waste management.	Apply	2	1,6,7,9,10
4	Design appropriate disposal facilities/technologies for solid waste management.	Create	2	3,4,7,9,10

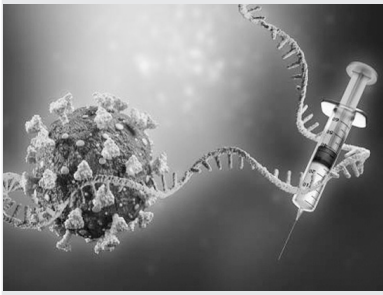
TEXT BOOKS:

1. Christensen H T, “Solid Waste Technology & Management”, 2nd edition, Wiley, 2010.
2. Haug T R, “The Practical Hand book of Compost Engineering”, 1st edition, Lewis, 1993.

REFERENCE BOOKS:

1. Tchobanoglous G and Kreith F, “Hand Book of Solid Waste Management”, 2nd edition, McGraw Hill, 2002.
2. Tchobanoglous G, Theisen and Vigil, “Integrated Solid Waste Management: Engineering Principles and Management Issues”, 2nd edition, McGraw Hill, 1993.
3. Reinhart R D and Townsend G T, “Land fill Bioreactor Design & Operation”,1st edition, CRC Press, 1997.

22BT815 VACCINOLOGY



Source: https://www.bioprocessonline.com/doc/what-s-all-the-hype-about-mrna-vaccinology-0001

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Cell and Molecular Biology, Microbiology and Fermentation Technology.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with fundamentals of vaccination and types of vaccine platforms. The topics relating to the vaccine design and vaccine manufacturing are also indicated. Hence, the students who undergo this course will acquire knowledge on the herd immunity, adult vaccination schedule and sustenance of community health.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

VACCINATION

History of vaccination, Importance of vaccination, Disease burden due to vaccine preventable diseases, Immunization - live, killed, attenuated, subunit vaccines, Vaccination routes, Properties of adjuvants, Pneumococcal conjugate vaccines, Toxoids and anti-toxins.

UNIT-2 **10L+0T+10P=20 Hours**

APPLICATIONS

Vaccines for tropical diseases-malaria, diarrhea, influenza, tuberculosis. Pediatric, Adolescent and Elderly vaccines, Anti-ovarian cancer vaccines, Anti- pregnancy vaccines, Hybrid monoclonal antibodies, Single chain (SCFV) antibodies.

PRACTICES:

- Antigen selection from the viral pathogens of the choice of student. Browsing NCBI for the sequence of the chosen antigen.
- Prediction of sequential and conformational epitopes for the chosen antigen.
- Epitope prediction using RANKPEP.
- Allergy prediction using AlerTop.
- Construct a disease burden grid using the online data for any two communicable diseases.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

VACCINE MANUFACTURING

Procedure for Vaccine manufacture, Vaccine, safety, Clinical evaluation, Role of regulatory agencies in vaccine testing and licensing, Domestic and international vaccine policy, Ethical considerations and regulatory issues.

UNIT-2 **10L+0T+10P=20 Hours**

PROTEIN BASED VACCINES

Epitope mapping and phage display, Recombinant DNA and protein-based vaccines, Reverse vaccinology, Peptide vaccines, Vaccine design using online tools, Viral-like particles (VLPs), Dendritic cell-based vaccines.

SKILLS:

- ✓ *Epitope prediction.*
- ✓ *Design of protein-based vaccines.*
- ✓ *Prediction of toxicity due to vaccine.*

PRACTICES:

- Design vaccine with the chosen antigen using online tools.
- Population coverage using IEDB tool.
- Building a model of SCFV antibody.
- Building a model of Reverse Vaccinology.
- Building a model for the promotion of vaccination in the population.
- Prepare a protein-based vaccine and immunize a mouse.
- Evaluate antibody titer.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Evaluate the role of vaccines in the prevention of communicable and therapeutic diseases.	Evaluate	1	2,3,6,7,9,10
2	Apply knowledge of immunology to manufacture vaccines.	Apply	1	1,3,4,6,7,8,9,10
3	Evaluate the methods of vaccine development in different biopharmaceutical companies.	Evaluate	2	3,4,5,6,7,9,10
4	Design experimental frame work for preparation of different classes of vaccines.	Create	2	3,4,5,6,9,10

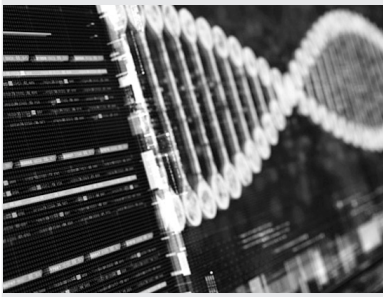
TEXT BOOKS:

1. Thomas J Kindt, Barbara A Osborne and Richard AGoldsby, “Kuby Immunology”, 9th edition, WH Freeman, 2016.
2. Kenneth Murphy, “Janeway’sImmunobiology”, 9th edition, Garland Science, 2016.

REFERENCEBOOKS:

1. Myers RL, “Immunology: A laboratory manual”, 1st edition, Brown William C, 2007.
2. Prugnaud JL, Trouvin JH, “Biosimilars: A new generation of Biologics”, 1st edition, Springer, 2012.
3. Glick BR, Patten CL, “Molecular Biotechnology: Principles and Applications of Recombinant DNA”, 6th edition, John Wiley & Sons, 2022.

22BT816 ALGORITHMS IN BIOINFORMATICS



Source : https://www.istockphoto.com/photo/holographic-display-of-advance-dna-sequence-analysis-gm1221783874-358273848

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Bioinformatics.

COURSE DESCRIPTION AND OBJECTIVES:

This course is to familiarize with the computational problems in biology useful for aligning sequences, phylogeny and sequencing technologies. The overall objective of the course is to train the students to improvise the understanding of algorithms used in Bioinformatics.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

ALGORITHMS

Algorithms and complexity, biological algorithms versus computer algorithms, iterative versus recursive algorithms, big-O notations and algorithm design techniques.

UNIT-2 **10L+0T+10P=20 Hours**

TYPES OF ALGORITHMS

Exhaustive search, mapping algorithms, greedy algorithms, approximation algorithms.

PRACTICES:

- Retrieving nucleotide sequence from gen bank database.
- Retrieving protein sequence from Swissprot database.
- Retrieving pathways from KEGG & BRENDA.
- Global alignment using NeddlemanWunsch algorithm.
- Local alignment using Smith watermann algorithm.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

DNA SEQUENCE ALIGNMENT

DNA sequence comparison, Scoring alignment, Global sequence alignment, Local sequence alignment, Alignment with gap penalties, Multiple sequence alignment.

UNIT-2 **10L+0T+10P=20 Hours**

EVOLUTIONARY TREES

DNA sequencing, fragment assembly in DNA sequencing, protein sequencing and identification, gene expression analysis, evolutionary trees Construction-Distance based methods and Character based methods.

PRACTICES:

- Multiple sequence alignment of sequences using Clustal W.
- Protein Secondary structure prediction by SOPMA.
- Phylogenetic tree construction using MEGA.
- Finding ORF's using gene prediction methods.

SKILLS:

- ✓ *Enhancing logical thinking for analyzing biological problems.*
- ✓ *Integration of computational programme to fetch answers for bio-systems.*
- ✓ *Develop robust programming by implementing dynamic programming skills.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze biological data using algorithms of bioinformatics.	Analyze	1	1,2,4,5,9,10
2	Select suitable algorithms to solve a given biological problem.	Analyze	1	2,3,5,9,10
3	Design bioinformatics prediction algorithms.	Create	2	3,4,5,9,10
4	Apply dynamic programming, sequence clustering and weight matrices for alignment.	Apply	2	1,4,5,9,10

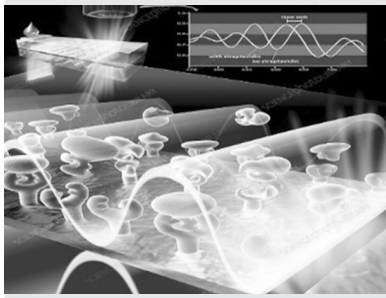
TEXT BOOKS:

1. Gollery Martin, “Bioinformatics: Sequence and Genome Analysis ‘, 2nd edition, publisher, 2005.
2. Neil C Jones and Pavel A Pevzner,“An Introduction to Bioinformatics Algorithms”, 1st edition, MITPress, 2004.

REFERENCE BOOKS:

1. Wing-Kin Sung, “Algorithms in Bioinformatics: A Practical Introduction”, 1st edition, CRC Press, 2009.
2. Arthur Lesk, “Introduction to Bioinformatics”, 1st edition, Oxford, 2002
3. T. K Attwood and D J Smith, “Introduction to Bioinformatics”, 1st edition, Pearson Education, 2005.

22BT817 BIOSENSORS



Source: https://www.behance.net/gallery/13712465/Molecular-Systems-Biology?tracking_source=search_projects%7Csystems%20biology

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Applied Physics, Nano Biotechnology, Biochemistry and Enzymology.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers an insight into the usage of bio-molecules as recognition elements for detection of a particular analyte and biological elements such as proteins in place of silicon chips. It enlightens the types of biosensors, their working principles and applications in various fields. Further it emphasizes on biomolecular computers and its applications.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

BIOSENSORS

Biosensors-advantages and limitations, various components of biosensors, Bio-catalysis based biosensors, Bio-affinity based biosensors, microorganisms- based biosensors, Biologically active material and analyte, Types of membranes used in biosensor constructions.

UNIT-2 **10L+10T+0P=20 Hours**

TRANSDUCERS

Various types of transducers, Principles and applications - calorimetric, optical, potentiometric/ amperometric, conductometric/resistometric, piezoelectric, semiconductor, impedimetric and chemiluminescence.

PRACTICES:

- Review on analyte detection using bio-catalysis based biosensors in environmental samples.
- Report on design of bio-affinity based biosensors.
- Quiz/debate on commercial diagnostic kits based on biosensors.
- Report on biosensors in industrial process control.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

APPLICATIONS OF BIOSENSORS

Biosensorsin clinical chemistry, medicineand healthcare, veterinary, agriculture, food and environmental monitoring, Low-cost biosensor for industrial processes for online monitoring, Design of enzyme electrodes and their applicationas biosensors in industry, CO_2, O_2, NOx and Air particulate sensors.

UNIT-2 **10L+10T+0P=20 Hours**

BIO-MOLECULAR COMPUTERS

Potential advantages and developments towards a biomolecular computer and molecular arrays as memory stores, Molecular wires and switches, Mechanisms of unit assembly, Assembly of photonic biomolecular memory store, Information processing, Commercial prospects for biomolecular computing systems.

SKILLS:

- ✓ *Immobilization of enzymes and biomolecules on solid platforms.*
- ✓ *Selection of suitable sensing method for detection of specific biomolecules and pathogens.*
- ✓ *Paper based sensors development for detection of analyte.*

PRACTICES:

- Report on applications of biosensors for detection of toxins in food industry.
- Review on the different designs of enzyme electrode.
- Debate on pesticide detection methods in environment using biosensors.
- Report on biomolecular computers development worldwide.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the principles of biosensors for the development of devices.	Apply	1	1,2,9,10
2	Design biosensors for biomedical applications.	Create	1	2,3,4,5,6,9,10
3	Develop biosensors for detection of pollutants in environmental samples.	Create	2	2,3,4,5,9,10
4	Evaluate different types of transducers for development of biosensors.	Evaluate	2	2,3,5,9,10

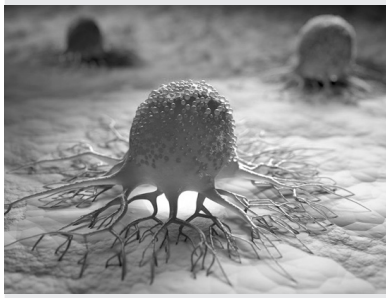
TEXT BOOKS:

1. B R Eggins, “Chemical sensors and biosensors”, 1st edition, Wiley, 2002.
2. J. Yoon, “Introduction to Biosensors”, 1st edition, Springer, 2013.

REFERENCE BOOKS:

1. V. C. Yang, “Biosensors Theory and Applications”, 1st edition, Plenum, 2000.
2. Loic J Blum and Pierre R Coulet, “Biosensors Principles and Applications”, 1st edition, Marcel Dekker, 1991.
3. Donald G. Buerk, “Biosensors Theory and Applications”, 1st edition, Technomic, 1993.
4. Graham Ramsay, “Commercial Biosensors”, 1st edition, Wiley, 1998.

22BT818 CANCER BIOLOGY AND THERAPY



Source: https://www.healio.com/~/media/slack-news/stock-images/nephrology/c/cancer-cell.jpeg

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Cell and Molecular Biology.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the understanding physiological and molecular behaviour of cancer cells. The main intention of this course is to acquaint students with the factors associated with cancer, biochemical assays, diagnostic methods, therapies and palliative care.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

CANCER BIOLOGY AND CARCINOGENESIS

Regulation of cell cycle, mutations that cause changes in signal molecules, signal switches, tumor suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer, chemical and physical carcinogenesis

UNIT-2 **10L+10T+0P=20 Hours**

SCREENING, DETECTION AND DIAGNOSIS

Cancer screening, early and advanced detection, detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer.

PRACTICES:

- Evaluation of anticancer potential of selected plant extracts.
- Investigation of immunomodulatory potential of plant extracts.
- Differentiation of live and dead cells using fluorescent diacetate.
- In vitro cytotoxicity evaluation by MTT assay.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

MOLECULAR CELL BIOLOGY OF CANCER AND METASTASIS

Signal targets and cancer, activation of kinases, Oncogenes, identification of oncogenes, retroviruses and oncogenes, Oncogenes/proto-oncogene activity, Growth factors related to transformation, Role of telomerases in cancer, Clinical significances of invasion, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumor cell invasion.

UNIT-2 **10L+10T+0P=20 Hours**

CANCER THERAPY

Different forms of therapy-chemotherapy, radiation therapy, gene therapy and immunotherapy, Use of signal targets towards therapy of cancer.

SKILLS:

- ✓ *Culturing cancer cell lines.*
- ✓ *Identification of cancer cells based on morphology.*
- ✓ *Evaluation of anticancer and immunomodulatory effects on cancer cell lines*

PRACTICES:

- Report on chemotherapy and radiation therapy.
- Review on therapeutic significance of monoclonal antibodies in cancer treatment.
- Report on future prospects of stem cells as therapeutic agents in treatment of cancer.
- Report on Immune checkpoint blockade/inhibition therapy.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Evaluate biochemical diagnostic methods in screening of cancer.	Evaluate	1	2,3,4,9,10
2	Adopt molecular tools in detection of cancer.	Apply	1	2,4,5,9,10
3	Assess different treatment therapies of cancer.	Evaluate	2	3,4,5,6,9,10
4	Design management strategies for cancer palliative care.	Create	2	3,4,9,10,11

TEXT BOOKS:

1. Margaret A. Knowles, Peter J. Selby, “Introduction to the Cellular and Molecular Biology of Cancer” 4th edition, Oxford, 2005.
2. Raymond W. Ruddon, “Cancer Biology, 4th edition, Oxford University Press, 2007.

REFERENCE BOOKS:

1. Robert T.A. Weinburg, “The Biology of Cancer”,1st edition, Garland Science, 2007.
2. Robin Hesketh, “Introduction to cancer biology: a concise journey from epidemiology through cell andmolecular biology to treatment and prospects”, 1st edition, Cambridge University Press, 2012.
3. Rita Fior, Rita Zilhão, “Learning Materials in Biosciences Molecular and Cell Biology of Cancer: When Cells Break the Rules and Hijack Their Own Planet”, 1st edition, Springer International Publishing, 2019.

22BT819 COMPUTER AIDED DRUG DESIGN

Source: https://q-more.chemeurope.com/q-more-articles/223/perspectives-of-computer-aided-drug-design.html

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Bioinformatics, Organic chemistry, Biochemistry and Enzymology.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers knowledge on current approaches and principles of drug design processes. It helps to learn the different computational drug designing techniques to develop the novel, safe and effective drugs which reduce the cost and time of drug discovery process.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

INTRODUCTION TO DRUG DISCOVERY

Drugs; principles of drug development, Chemoinformatics and Pharmacoinformatics, Structure-based drug designing approaches-target identification, hit validation, active site/binding site prediction and analysis, molecular docking and types.

UNIT-2 **10L+0T+10P=20 Hours**

TYPES OF DRUG DESIGN

Ligand-based drug designing approaches-lead designing, combinatorial chemistry, high throughput screening (HTS), QSAR, 2D-QSAR, pharmacophore mapping, database generation and chemical libraries, ADME properties.

PRACTICES:

- Perform homology modeling using I-TASSER.
- Docking studies using Auto Dock Vina.
- Active site prediction of protein using CastP.
- Protein secondary structure prediction using SOPMA.
- QSAR studies of drug.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

DRUG ACTION

Theories of enzyme inhibition and inactivation, Enzyme activation of drugs and prodrugs, Concept of drug like molecules, Pharmacophore hypotheses, Lipinski's rule of five.

UNIT-2 **10L+0T+10P=20 Hours**

DRUG DESIGN POLICIES

Quality assurance, ISO, WHO, NIH, NDA, Food and drug administration (FDA), IPR, Good manufacturing practices (GMP), Good laboratory practices (GLP).

SKILLS:

- ✓ *Performing homology modelling of proteins.*
- ✓ *Docking of ligand with corresponding target.*
- ✓ *Protein secondary structure prediction using Ramachandran Plot.*

PRACTICES:

- Retrieving pathways from KEGG & BRENDA.
- Finding out drug likeliness using Lipinski's rule of five.
- Smiles notation of drug compounds.
- Design of ligands by Chemdraw.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the current approaches of drug discovery processes.	Analyse	1	1,2,4,9,10
2	Apply the steps involved in ligand-receptor and ligand-enzyme binding for novel drug discovery.	Apply	1	1,2,3,9,10
3	Create 3D structures of macromolecules by applying homology modelling techniques.	Create	2	3,4,5,9,10
4	Evaluate the pharmacokinetics and pharmacodynamics of novel drugs using pharmaco informatics principles.	Evaluate	2	3,4,5,9,10

TEXT BOOKS:

1. K. I. Ramachandran, GopakumarDeepa and Krishnan Namboori, "Computational Chemistry and Molecular Modeling", 1st edition, Springer, 2008.
2. Hans-Dieter Holtje, Wolfgang Sippl, Didier Rognan and GerdFolkers, "Molecular Modeling: Basic Principles and Applications", 3rd edition, Wiley, 2008.

REFERENCE BOOKS:

1. Tagelsir Mohamed Gasmelseid, "Pharmacoinformatics and Drug Discovery Technologies: Theories and Applications", 1st edition, Idea Group, 2012.
2. Jan H. Jensen, "Molecular Modeling Basics", 1st edition, CRC Press, 2010.
3. M. Rami Reddy, Mark D. Erion, "Free Energy Calculations in Rational Drug Design", 1st edition, Springer, 2001.

22BT820 HANDLING OF ANIMALS FOR EXPERIMENTS

Source: https://saras-project.eu/wp-content/uploads/2020/04/small_experimental_mouse_is_on_the_laboratory_researchers_hand_slider.jpg

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Vaccinology, Immunology and Immunoinformatics.

COURSE DESCRIPTION AND OBJECTIVES:

Proof-of-concepts in biotechnological investigations are made using the model specimens. Particularly, in the areas of animal physiology, developmental biology, drug toxicity and immunology, the laboratory animal models are being used across all the laboratories. Hence, the present course embedded with practices give hands-on-training and ethical issues in handling lab animals.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

ANIMAL EXPERIMENTATION

Animals used in India in scientific and industrial research, Ethical issue in use of animals for scientific research - necessity of the animal in studies, Guidelines for care and use of animals in scientific research - basic guidelines for housing, maintenance of hygiene and health, regulatory approvals from statutory body and basic guidelines.

UNIT-2 **10L+0T+10P=20 Hours**

ANIMAL MODELS IN MEDICAL EDUCATION AND RESEARCH

Animal models in medical education, Animal models used in medical research - guinea pigs, murine /rodent and primate models, Animal models in pharmaceutical Research - studies for evaluation of toxicity and tolerance of novel drugs, Animal models in preclinical studies / trials.

PRACTICES:

- Maintenance and handling of experimental animals.
- Evaluation of drug toxicity using animal models.
- Audit report on the visit of animal house.
- Card requirement procedures for tagging in-bred and out-bred specimens.
- Immunization of experimental animals.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

BIOMEDICAL RESEARCH

Primates in biomedical research, Product efficacy evaluation, Primates use in brain function and structure evaluation research, Imaging and biochemical quantification of vital parameters, Models like chicken, guinea pig, horse in development of live-stock biologics.

UNIT-2 **10L+10T+0P=20 Hours**

ANIMALS FOR TEACHING AND RESEARCH

Animal models like rodents (rats/mouse), drosophila, daphnia, cockroach, dogs, bovines etc., in teaching and education, Alternatives to the experimental animals in biomedical research and testing - optimizing animal use- refinement and reduction.

SKILLS:

- ✓ *Maintaining sanitation and sterilization in the animal house.*
- ✓ *Handling of animal cages.*
- ✓ *Immunization of experimental animals.*

PRACTICES:

- Case study: Mice handling by a group of students and submit a report.
- Report on Immunization routes in rodents and non-rodents.
- Review on animal ethics and safety regulations.
- List out strains of laboratory rodents used for experiments.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the basic structure of the animal house, its maintenance and housing of animals.	Analyze	1	2,4,8,9,10
2	Adopt ethical practices to handle and maintain animals during experimentation.	Apply	1	6,8,9,10
3	Compile ethical standards in animal studies related to pharmaceuticals and bio products.	Evaluate	2	4,6,8,9,10
4	Analyze the regulations and ethics followed in any studies involving animals for research and development.	Analyze	2	2,3,4,8,9,10

TEXT BOOKS:

1. P.N. Tandon, K. Muralidhar and Y.K. Gupta, “Use of Animals in Scientific Research and Education”, 1st edition, Indian National Science Academy, 2012.
2. Pierce K. H. Chow, Robert T. H. Ng, Bryan E. Ogden, “Using Animal Models in Biomedical Research: A Primer for the Investigator” 1st edition, World Scientific Publishing Company, 2008.

REFERENCE BOOKS:

1. Natalie Thomas, Andrew Linzey and Priscilla Cohn, “Animal Ethics and the Autonomous Animal Self”, 1st edition, Palgrave Macmillan, 2016.
2. R. Renaville and A. Burny, “Biotechnology in Animal Husbandary”, 1st edition, Kluwer Academic, 2002.
3. P. Michael Conn, “Sourcebook of models for biomedical research” 1st edition, Humana Press, 2008.

22BT821 HEALTH ECONOMICS

Source: https://www.york.ac.uk/study/postgraduate-taught/courses/msc-health-economics/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Management Science.

COURSE DESCRIPTION AND OBJECTIVES:

This module explores in detail the key economic concepts, application of economic concepts on financing and delivering of health programs, market failure in health care and financing services, a guideline for assessment of economic evaluation and application of economic evaluation in health technology assessment and health care practice.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

DEMAND FOR HEALTH CARE

Introduction to the idea of demand, and demand for health, health care and health technology, responsiveness of demand to price/income, Cross elasticity, Normal and inferior goods, Elasticity and demand for health care, Elasticity and health.

UNIT-2 **10L+10T+0P=20 Hours**

COSTING CONCEPT AND COST ANALYSIS IN HTAS

Types of cost, Costing approaches- top down, bottom up and mixed methods, Perspective, concept of discounting and inflation, Cost of illness, Cost of risk factors, Costing of healthcare programs, Sources of cost data for economic evaluation.

PRACTICES:

- Design and conduct costing of health care services.
- Design and conduct costing of health care programs.
- Design and conduct cost of illness.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

ECONOMIC ANALYSIS IN HEALTH CARE

Why economic analysis, the government and private mix, technical and allocative efficiency, common allocation mechanisms, alternative allocation models, basic health economics, Emphasis on evidence of government failure in health care finance and delivery, Burden due to vaccine preventable diseases, filariasis, covid-19, malaria.

UNIT-2 **10L+10T+0P=20 Hours**

CLINICAL EVENTS

Patient-reported outcomes, Outcome measurement in chronic diseases, Monetary outcomes, Concept of quality-adjusted life years, Concept of disability adjusted life years, Health-related quality of life (HRQoL), Direct and indirect valuation, HRQoL instruments, Human Development Index (HDI).

SKILLS:

- ✓ *Design of health care services.*
- ✓ *Conduct health care programs.*
- ✓ *Organize cost of illness.*

PRACTICES:

- Design and measure Health-related quality of Life.
- Prepare Generic questionnaires and Disease-specific questionnaires.
- Cost-effectiveness analysis or cost-utility Analysis. The research should be conducted to incorporate cost and effectiveness data in India.
- Evaluation of burden to due to Covid-19, Lymphatic Filariasis and Malaria.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the concepts of elasticity of demand, marginal analysis and opportunity cost.	Apply	1	1,7,9,10,11
2	Apply the basic market model, market failure and the roles and limitations of markets and governments in the finance and organization of health care.	Apply	1	1,6,9,10,11
3	Evaluate different health systems that generate incentives for managers and health care professionals, and likely outcomes in terms of efficiency and equity.	Evaluate	2	3,4,5,9,10
4	Analyze issues in measurement of costs and benefits of health care.	Analyze	2	2,4,9,10,11

TEXT BOOKS:

1. Drummond M and McGuire A, “Economic evaluation in health care: merging theory with practice”, 1st edition, Oxford University Press, 2001.
2. Peter Zweifel, Friedrich Breyer, Mathias Kifmann, “Health Economics 2nd edition, Springer-Verlag Berlin Heidelberg, 2009.

REFERENCE BOOKS:

1. Anthony Scott, Alan Maynard, Robert Elliott, “Advances in Health Economics” 1st edition, J. Wiley & Sons, 2003.
2. Folland, S., Goodman, A.C., and Stano, M, “The economics of Health and health care”, 7th edition, Prentice Hall, 2013.
3. Kutzin, J, “Towards universal health care coverage: A goal-oriented framework for policy analysis”, 1st edition, World Bank, 2000.

22BT822 HEALTH INFORMATICS

Source: https://www1.villanova.edu/content/university/liberal-arts-sciences/programs/computing-sciences/graduate-programs/certificate-health-informatics/_jcr_content/pagecontent/image.img.jpg/1619470102785.jpg

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of biology.

COURSE DESCRIPTION AND OBJECTIVES:

Health (medical) informatics is the intersection of information science, computer science, and health care. This field deals with the resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

MODULE -1

UNIT-1 **6L+6T+0P=12 Hours**

INTRODUCTION

Introduction and overview of informatics in hospital management system, brief history of medical informatics, Nursing informatics, Public health informatics, health information ethics.

HEALTH CAREDATA, INFORMATION AND KNOWLEDGE: Electronic health records and automatic updating of health records, Electronic medical records, the language of biomedical informatics, Health in formation exchange.

UNIT-2 **10L+10T+0P=20 Hours**

APPLICATIONS

Vaccines for tropical diseases-malaria, diarrhea, influenza, tuberculosis, swineflu vaccines, Pediatric, Adolescent and Elderly vaccines, Anti-ovarian cancer vaccines, Anti Pregnancy vaccines, Monoclonal antibodies, Single chain (SCFV) antibodies.

PRACTICES:

- General concepts in Health Informatics.
- Collect thepatient datathrough internet.
- Analysis the data.
- General concepts in Health Informatics.
- Collect thepatient datathrough internet.
- Analysis the data.

MODULE -2

UNIT-1 **6L+6T+0P=12 Hours**

MEDICAL STANDARDS

Evolution of Medical Standards, IEEE 11073, HL7,DICOM, IRMA, LOINC,HIPPA, Electronics Patient Records, Healthcare Standard Organizations, JCAHO (Joint Commission on Accreditation of Healthcare Organization), JCIA (Joint Commission International Accreditation), Evidence Based Medicine, Bioethics.

UNIT-2 **10L+10T+0P=20 Hours**

RECENT TRENDS IN HEALTH INFORMATICS

Medical Expert Systems, Virtual Environment, Surgical simulation, Radiation therapy and planning, Telemedicine, virtual Hospitals, Smart Medical Homes, Personalizede-health services, Biometrics, GRID and Cloud Computing in Medicine.

SKILLS:

- ✓ *Calculusin medical bioinformatics.*
- ✓ *Statistical Hypothesis testing.*

INFORMATION TECHNOLOGY IN HEALTH RESEARCH: The use of Information technology inaccessing the literature, Health related electronic bibliographic databases, software for handling the health research data.

PRACTICES:

- Collect the new forms of clinical information.
- Electronic Health Record analysis.
- Find the doctor using of information sources.
- How to apply Probability in health informatics data.
- Use truth tables in medical informatics data.
- Hospital Management and Information systems.
- Statistical hypothesis testing in Medical informatics.
- Clinical data management (an overview).

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Adopt computational tools for maintenance of electronic health records.	Apply	1	2,6,7,9,10
2	Examine the expertise with information systems that collect, manage, access, assess, and interpret health care / public health data using communication and computer technologies.	Evaluate	1	2,4,9,10
3	Demonstrate how informatics approaches and resources may be used strategically to improve health care delivery and public health.	Apply	2	1,2,4,9,10
4	Articulate the importance of collaboration among medical, public health, communication and informatics specialists in the process of design, implementation, and evaluation of healthcare/ public health programs.	Apply	2	3,6,9,10

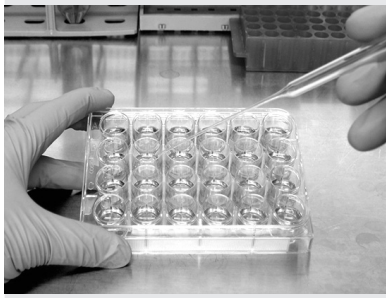
TEXT BOOKS:

1. R.D.Lele, “Computers inmedicine progress in medical informatics”, 1st edition, Tata Mc Graw Hill Publishing Ltd, 2015.
2. Mohan Bansal, “Medicalinformatics”, 1st edition, TataMcGraw Hill Publishing Ltd, 2013.

REFERENCE BOOKS:

1. James W. Lee, “Advance Biofuels and Bioproducts”, 1st edition, Springer, 2013.
2. G. Chen, Randall J. Weselake and Stacy D. Singer, “Plant Bioproducts”, 1st edition, Springer, 2018.
3. Graham P Bunn, “Good manufacturing Practices for Pharmaceuticals”, 7th edition, Taylor & Francis, 2021.
4. Sandy Weinberg, “Good laboratory Practice regulations”, 4th edition, Taylor & Francis, 2007.

22BT823 METHODS AND PRACTICE OF ANIMAL AND HUMAN CELL CULTURE



Source: https://www.biopharma-reporter.com/Article/2021/12/07/New-Fujifilm-site-will-cater-to-cell-culture-media-market-demands-in-China

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Cell and Molecular Biology, Immunology and Immunoinformatics.

COURSE DESCRIPTION AND OBJECTIVES:

Animal cell culture facility is an indispensable tool for all biotechnology applications and product engineering. The objective of this course is to make student understand the principles of animal cell culture techniques, their applications in design, development of prophylactic and therapeutic interventions such as vaccines, biosimilars for human and veterinary applications.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

FUNDAMENTALS OF ANIMAL CELL CULTURE

Animal/ human cell culture, laboratory layout, instrumentation, precautions and safety, Media composition and growth conditions, Anchorage and non-anchorage dependent cell culture, Primary and secondary cultures, GMP.

UNIT-2 **10L+0T+10P=20 Hours**

APPLICATIONS OF ANIMAL CELL CULTURE

Measuring parameters of growth, Proliferation, differentiation assay, cytotoxicity determination assays, MTT, scaling-up of animal cell culture, Application of animal cell culture, Production of human and animal viral vaccines, in vitro testing of therapeutics for toxicity.

PRACTICES:

- Isolation of spleen cells from mice.
- Constitution of animal cell culture medium.
- Propagation and passaging of animal cells in medium.
- Assess cell viability by MTT assay and hemocytometer.
- Microscopic analysis of normal and cancer cell lines.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

STEM CELLS

Types and sources of stem cells - embryonic, adult, hematopoietic, hepatic, fetal, placental, bone marrow, primordial germ cells, Growth factor requirements and maintenance of stem cells in culture; Self- renewal, lineage commitment, cell cycle regulation of embryonic and adult stem cells, Induced pluripotent stem cells.

UNIT-2: **10L+0T+10P=20 Hours**

APPLICATIONS OF STEM CELLS

Therapeutic applications - nervous system, treating damaged myocardium, pancreatitis, spinal cord injuries, Parkinson's and inflammatory diseases, arthritis.

SKILLS:

- ✓ *Isolation of animal cells and their propagation.*
- ✓ *Preparation of animal cell culture medium.*
- ✓ *Analyzing the cell cytotoxicity & viability.*

PRACTICES:

- Report on Isolation of stem cells.
- Sequential steps in propagation of stem cells.
- Review on stem cell applications in various diseases.
- Review on adult stem cells and their use in personalized therapeutic applications.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Design appropriate culture media for cultivation of cells.	Create	1	3,4,6,7,9,10
2	Analyze culture conditions for effective growth of cells.	Analyze	1	2,3,4,9,10
3	Adopt the stem cell technology as a therapy for medical practices.	Apply	2	3,4,8,9,10
4	Evaluate animal cell culture methodologies for the production of biotherapeutics.	Evaluate	2	3,4,7,8,9,10

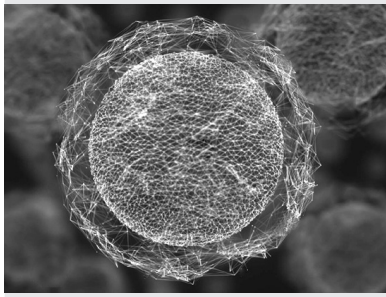
TEXT BOOKS:

1. R I Freshney, “Culture of animal cells: A manual of basic technique”, 1st edition, Wiley, 2000.
2. Victor A. Vinci, Sarad R. Parekh, “Handbook of Industrial Cell Culture: Mammalian, Microbial, and Plant Cells” 1st edition, Humana Press, 2010.

REFERENCE BOOKS:

1. M. Clynes, “Animal Cell Culture Techniques”, 1st edition, Springer, 1998.
2. Raymund E. Horch, Laurentiu M. Popescu, Elias Polykandriotis, Gustav Steinhoff, “Regenerative Medicine”1st edition Springer, 2011.
3. Joseph D. Bronzino and Donald R. Peterson, “Molecular, Cellular and Tissue Engineering”, 4th edition, Taylor & Francis, 2015.

22BT824 MOLECULAR INTERACTIONS



Source: https://www.alamy.com/molecular-science-biotechnology-or-biotech-image402380115.html?imageid=9E2FCC49-D2CF-4B0C-B585-E273C02ED707&p=339090&pn=1&searchId=962f9dfc6c42d159dc168cfdb3057765&searchtype=0

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Bioinformatics, Biochemistry and Enzymology .

COURSE DESCRIPTION AND OBJECTIVES:

The course aims to provide theoretical and practical basis of bioinformatics methods to study structure-function relationships in biological macromolecules and metabolic networks. At the end of the course, students will acquire the theoretical bases of the computational and bioinformatics methods suited to study structure-activity relationships.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

PROTEIN-PROTEIN INTERACTIONS

Database for protein - protein interactions, structural analysis, hydrogen bonds and salt bridges across PPI, prediction of binding sites in protein - protein complexes, energy - based approach for understanding the recognition mechanism of protein - protein complexes.

Protein-DNA interactions - Structural analysis of interactions, DNA stiffness and protein - DNA binding specificity, inter and intra molecular interactions, discrimination of DNA - binding domains/proteins, databases for protein-DNA interactions.

UNIT-2 **10L+0T+10P=20 Hours**

PROTEIN-RNA INTERACTIONS

Prediction of RNA- Binding sites, structural analysis, methods for detecting RNA interactions, databases for predicting protein RNA interactions.

PRACTICES:

- Analyze a few selected metabolic pathways.
- Create and analyze protein-DNA and DNA-RNA networks.
- Analyze K-core of proteins.
- Execute Protein network simulations.
- Perform whole cell simulation through E-cell/V-cell.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

PROTEIN-LIGAND INTERACTIONS

Prediction of ligand-binding sites, protein-ligand docking, estimation of protein-ligand binding free energy, scoring functions, validation of ligand and active site residues in protein structures, protein-ligand databases.

SKILLS:

- ✓ *Designing in silico enzyme variants.*
- ✓ *Prediction of protein structure.*
- ✓ *Analysis of structure-function relationships in metabolic networks.*

UNIT-2 **10L+0T+10P=20 Hours**

TOOLS AND SOFTWARES

Cytoscape for visualizing molecular interaction networks and biological pathways, SAPIN/structural analysis of protein interaction ntworks, BindML, AutoDOCK, PatchDOCK, RPISeq, NUCPLOT, CAD-score, LigPlot.

PRACTICES:

- Apply statistical tools for gene expression analysis.
- Visualize molecular interaction networks using Cytoscape.
- Analyze protein-protein interaction data sets using Cluster ONE.
- Analyze cooperative interaction of ligand with receptors using MiM1.
- Explore important nodes in biological networks using Cyto Hubba.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze computational methods to study structure-function relationships in biomolecules.	Analyze	1	2,3,4,5,9,10
2	Apply the knowledge of structure prediction tools for proteins.	Apply	1	1,2,3,5,9,10
3	Design of experiments in molecular interactions including enzyme variants.	Create	2	2,3,5,9,10
4	Apply computational methods to study metabolic networks.	Apply	2	1,2,3,5,9,10

TEXT BOOKS:

1. M. Michael Gromiha, “Protein Bioinformatics from Sequence to Function”, 1st edition, Elsevier, Academic, 2010.
2. Haian Fu, “Methods in Molecular Biology Protein-Protein Interactions - Methods and Applications”, 1st edition, Humana Press, 2004.

REFERENCE BOOKS:

1. Frederic M. Richards, David S. Eisenberg and Peter S. Kim, “Advances in Protein Chemistry: Thermodynamics of Macromolecular Interactions”, 1st edition, Academic Press,1998.
2. Gary C. Howard, William E. Brown, “Modern Protein Chemistry: Practical Aspects”, 1st edition,CRC Press, 2001.
3. David Edwards, David Hansen, Jason E. Stajich, David Edwards, Jason Stajich, David Hansen, “Bioinformatics: Tools and Applications”, 1st edition,Springer-Verlag New York, 2009.

22BT825 MOLECULAR PHYLOGENETICS

Source: http://sgugenetics.pbworks.com/w/page/38479261/The%20History%20and%20Basis%20of%20Molecular%20Phylogeny

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Bioinformatics.

COURSE DESCRIPTION AND OBJECTIVES:

The course is designed to unravel the molecular data hidden behind the organic evolution. The objective of the course is to find the utility of software packages in inferring the phylogeny.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

SYSTEMATICS AND CLASSIFICATION

Sympatric population and allopatric population, Sibling species and polytypic species, Homology, parallelism and convergence, Hardy-Weinberg principle.

UNIT-2 **10L+10T+0P=20 Hours**

MECHANISM OF SPECIATION

Species concepts - examples, Mechanism of divergence- genetic flow, genetic drift, mutation, natural selection and sexual selection, synapomorphies, homoplasy and convergent evolution.

PRACTICES:

- Calculate the percentage of heterozygous individuals in the population. (two allele frequencies need to be provided).
- Calculate the percentage of homozygous recessive in the population. (two allele frequencies need to be provided).
- Calculate the percentage of individuals homozygous for the dominant allele. (Recessive genotype of a trait is 0.09).
- Calculate the percentage of homozygous dominant and heterozygous individuals. (38% of individuals are recessive homozygous).
- In a population that is in Hardy-Weinberg equilibrium, if 160 out of 200 individuals are Rh+, calculate the frequencies of both alleles.
- In the United States, approximately one child in 10,000 is born with PKU (Phenylketonuria), a syndrome that affects individuals homozygous for the recessive allele (aa). (i) Calculate the frequency of this allele in the population. (ii) Calculate the frequency of normal allele. (iii) Calculate the percentage of carriers of the trait within the population.
- In a certain African Population, 4% of the population is born with sickle cell anemia (aa). Calculate the percentage of individuals who enjoy the selective advantage of the sickle-cell gene (increased resistance to malaria)?

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

MOLECULAR PHYLOGENIES

Immunological techniques, Nucleic acid phylogenies based on DNA-DNA hybridizations, Nucleic acid phylogenies based on restriction sites, Nucleic acid phylogenies based on nucleotide sequence comparisons and homologies.

SKILLS:

- ✓ *Differentiating the types of speciation.*
- ✓ *Identifying the factors influencing speciation.*
- ✓ *Assessing the allele and gene frequencies using Hardy-Weinberg principle.*
- ✓ *Constructing the Phylogentic tree using suitable software*

UNIT-2 **10L+10T+0P=20 Hours**

PHYLOGENETIC TREES

Rooted trees and unrooted trees, Rooting phylogenetic trees, Tree confidence bootstrapping and estimating the reliability of phylogenetic trees, Types of trees, Cladogram, Phylogram, Dendrogram, Gene tree vs. species tree.

PRACTICES:

- Build a likely phylogram using manual method for the four aligned genomic DNA sequences provided.
- Build a likely phylogram using manual method for the five aligned amino acid sequences.
- Build a most likely phylogram for the four chromosomal maps (cytogenetic ideograms) provided.
- Construct a representative cladogram considering the shared ancestry of the five primate genera: Homo, Pan, Gorilla, Pongo and Macaca.
- Using MEGA software tool construct a Dendrogram for the species of Gastropods considering the conserved genes.
- Using MEGA software tool construct a Dendrogram for the strains of Corona virus considering the Spike protein.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the molecular data in relation to organic evolution.	Analyze	1	2,4,5,9,10
2	Explore phylogenetic analysis to diagnose the outburst of viral epidemics.	Apply	1	2,3,9,10, 12
3	Apply the concepts of phylogeny in the disease outbreaks.	Apply	2	2,9,10, 12
4	Develop the conservation strategies for sustainability of species.	Create	2	3,7,9,10

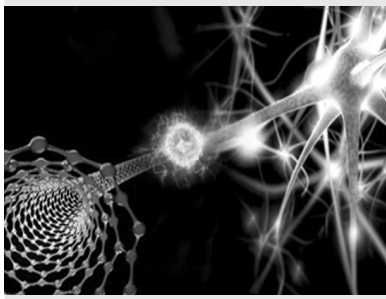
TEXT BOOKS:

1. M. W. Strickberger, “Evolution”, 1st edition, Jones and Bartlett, 1990.
2. S. Freeman and J.C.Herron, “Evolutionary analysis”, 1st edition, Prentice Hall, 2004.

REFERENCE BOOKS:

1. Masatoshi Nei, Sudhir Kumar, “Molecular Evolution and Phylogenetics”, 1st edition, Oxford University Press, USA, 2000.
2. Emmanuel Paradis, “Analysis of Phylogenetics and Evolution with R”, 2nd edition, Springer, 2011.
3. Ming-Hui Chen, Lynn Kuo, Paul O. Lewis, “Mathematical and Computational Biology Bayesian Phylogenetics: Methods, Algorithms, and Applications”, 1st edition, Chapman and Hall / CRC, 2014.

22BT826 NANOBIOTECHNOLOGY



Source: https://wallpaperaccess.com/nanotechnology#google_vignette

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Applied physics, Bioanalytical Techniques.

COURSE DESCRIPTION AND OBJECTIVES:

This course familiarizes the students about important applications of nanobiotechnology in a range of fields like medical diagnosis, drug delivery, detection of biomacromoleucles in biochemical systems.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

NANO PARTICLES

Types of nanoparticles, Length scales, Importance of nanoscale and technology, Future of nanotechnology- nanotechnology revolution, silicon-based technology, Characterization and application of nanoparticles - toxic effects of nonmaterial.

UNIT-2 **10L+10T+0P=20 Hours**

TECHNIQUES TO SYNTHESIZE NANOPARTICLES

Benefits and challenges in molecular manufacturing, Nano fabrications-MEMS/NEMS, Atomic force microscopy, Self assembled monolayers/ dip-pen nanolithography, Soft lithography, PDMS molding, Nano wires and nanotubes.

PRACTICES:

- Report on silicon-based nano particles on enhanced oil recovery.
- Case study on vapor phase synthesis of Mg-Alalloy nano particles by plasma arc evaporation technique.
- Review on dynamics of scientific knowledge bases as proxies for discerning technology emergence -The case of MEMS/NEMS technologies.
- Review on Kelvin Probe Force Microscopy Characterization of Self-Assembled Monolayers on Metals Deposited with Dip-Pen Nanolithography.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

NANOBIOSENSOR AND NANOFLUIDS

Nanocrystals in biological detection, Electrochemical DNA sensors and integrated nanoliter systems, Fabrication of novel biomaterials through molecular self-assembly-small scale systems for in vivo drug delivery, Future nanomachines, Clinical applications of nanodevices, Artificial neurons, Real-time nano sensors applications in cancer biology, Synthetic retinyl chips based on bacteriorhodopsins, High throughput DNA sequencing with nanocarbon tubules, Nano surgical devices.

UNIT-2 **10L+10T+0P=20 Hours**

ETHICAL ISSUES IN NANOTECHNOLOGY

Socio-economic challenges, Ethical issues in nanotechnology with special reference to nanomedicine applied in nonmedical contexts.

SKILLS:

- ✓ *Synthesize and characterization of nano particles.*
- ✓ *Evaluate nanoparticles for biological applications.*
- ✓ *Development of nano biosensors.*

PRACTICES:

- Report on proximal bacterial lysis and detection in nano liter wells using electrochemistry.
- Case studies for cancer and cardiovascular applications of nanobiotechnology.
- Review on artificial neural networks for analyzing impact of nanomaterials for disease control.
- Report on nano surgery of live biological tissues.
- Socio-ethical education in nano technology engineering programmes: A Case studyin Malaysia.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply principles of nanomaterial fabrication & Nanotechnology tools for synthesis of nanomaterials.	Apply	1	1,4,5,9,10
2	Synthesize nanomaterials by using physical and chemical methods.	Create	1	3,4,5,9,10
3	Evaluate the nanoparticles for drug delivery applications.	Evaluate	2	3,5,6,9,10
4	Impart the ethics in socio-economic challenges of Nanomaterials.	Apply	2	7,8,9,10

TEXT BOOKS:

1. C. M. Niemeyer and C. A. Mirkin, “Nanobiotechnology: Concepts, Applications and Perspectives”, 1st edition, Wiley, 2006.
2. J. Liu and K. Shimohara, “Biomolecular Computation by Nanobiotechnology”, 1st edition, Artech House, 2007.

REFERENCE BOOKS:

1. R. S. Greco, “Nanoscale Technology in Biological Systems”, 1st edition, CRC Press. 2005.
2. H. S. Nalwa, “Handbook of Nanostructural Biomaterials and their applications in Nanobiotechnology”, 1st edition, American Scientific, 2005.
3. Jan J. Dubowski, StoyanTanev, “Photon-based Nanoscience and Nanobiotechnology”, 1st edition, Springer 2006.

22BT827 PYTHON PROGRAMMING FOR BIOTECHNOLOGISTS

Source: https://lifelonglearning.dtu.dk/en/bioengineering/course/python/

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Programing in 'C' and Bioinformatics.

The course deals with principles of python, applications of algorithms and programming languages and bio python in life sciences. It also provides insights on core concepts of python that includes syntax, data structures, and reading/writing files to compile complex python programs in biology.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

FUNDAMENTALS OF PYTHON

Python features, installing python packages via PIP, variables, assignment, keywords, input-output, indentation, basic data types, operators and expressions, control structures.

UNIT-2 **10L+0T+10P=20 Hours**

DATA STRUCTURES

Strings - creation, accessing, operators, methods, Sets - creation, accessing, operators, methods, List comprehensions, Functions - defining functions, calling functions, passing arguments - keyword arguments, default arguments, variable-length arguments, anonymous functions (lambda), Object oriented programming in python - self-variable methods, constructor method, inheritance, overriding methods, data hiding.

PRACTICES:

- Python programming for the reverse complement and concatenation of two DNA sequences.
- Python program to print both the corresponding mRNA sequence and protein sequence including stop codons (according to the standard translation table & Yeast mitochondrial code translation table).
- Python program to write a UniProt file using the sequence of the 1AI4 PDB protein.
- Input the sequence file in FASTA and generate single-sequence FASTA files using python program.
- Use a python program to create "revcomp.fasta" file with the reverse complements of the original sequences. Hint. The SeqIO. write() function can write an entire list of SeqIO records.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

BIOPYTHON

Tetra nucleotide frequency: counting things, transcribing DNA into mRNA, Mutating Strings, reading and writing files, reverse complement of DNA, String manipulation, computing GC content, Parsing FASTA and analyzing sequences, finding the hamming distance - counting point mutations, translating mRNA into protein, find a motif in DNA, exploring sequence similarity.

SKILLS:

- ✓ *Filtering the sequences containing ambiguous or low-quality bases.*
- ✓ *Running the standalone Blast server.*
- ✓ *Performing multiple sequence alignment using modules of Biopython.*

UNIT-2 **10L+0T+10P=20 Hours**

ADVANCED BIOPYTHON

Overlap graphs: sequence assembly using shared K-mers, finding the longest shared subsequence, finding K-mers, writing functions using binary search, finding a protein motif - fetching data and using regular expressions, finding open reading frames, DNA synthesizer - creating synthetic data with markov chains.

PRACTICES:

- Download GEN BANK identifier record HE805982.1. Write a Python program using the GEN BANK record and save the corresponding protein sequencein FASTA format.
- Find and download the records relative to the four human ELAV proteins (ELAVL1: Q15717, ELAVL2: Q12926, ELAVL3: Q14576, ELAVL4: P26378) using UniProt. Write a python programthat appends all the sequencesinFASTAformat. [Hint. The os.listdir () function in the os module can save in a list all the names of the files in a directory].
- Print a new file comprising at least one occurrence of the string for a given FASTA file containing multiple proteinsequences and a string specified by the user (regularexpressionsareallowed).
- Testy our program with the FASTA sequences containing a stretch of at least three glutamines.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the principles of Python in biological problems.	Apply	1	1,4,5,9,10
2	Create a search engine using Bio python.	Create	1	2,3,5,9,10
3	Analyse the sequence input/output files.	Analyze	2	2,3,4,5,9,10
4	Perform pairwise sequence alignment, multiple sequence alignment & phylogeny.	Apply	2	2,3,5,9,10
5	Evaluate custom functions for DNA sequence analysis and protein synthesis.	Evaluate	2	2,3,4,5,9,10

TEXT BOOKS:

1. David Beazley, “Python essential reference”, 2nd edition, New Riders, 2001.
2. Mitchell L. Model, “Bioinformatics Programming Using Python: Practical Programming for Biological Data (Animal Guide)”, 1st edition, O’Reilly Media, 2009.

REFERENCE BOOKS:

1. Sebastian Bassi, “Mathematical and Computational Biology Python for Bioinformatics”, 2nd edition, Chapman and Hall / CRC, 2017.
2. Tim J. Stevens, Wayne Boucher, “Python Programming for Biology: Bioinformatics and Beyond”, 1st edition, Cambridge University Press, 2015.
3. Brad Dayley, “Python Phrasebook: Essential Code and Commands”, 1st edition, Sams, 2006.

22BT828 REGULATORY AFFAIRS AND CLINICAL TRAILS

Source: https://fusion-pharma-limited.com/combined-review-service/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Good Manufacturing Practices.

COURSE DESCRIPTION AND OBJECTIVES:

The course is designed to make the student acquaint with rules, regulations and guidelines for clinical trials and how they are applicable in different countries. Also, to understand the importance of medical ethics, IVF, audit types, audit processing in clinical trials.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

MEDICAL ETHICS, AUDITING & REGULATIONS OF CLINICAL RESEARCH

ICH-GCP guidelines, licensing authorities -roles and responsibilities of FDA, EU clinical trial directive, data protection act, declaration of Helsinki 2000 amendment and codes of practice, regulations relating to electronic signatures. Ethics in all aspects of health care, historical cases, negligence, informed consent, mental competence Up – to – date cases: cloning, human embryos and IVF, The purpose of audits, types of audits, preparing for audits - in company, on site, The audit process.

UNIT-2 **10L+10T+0P=20 Hours**

ETHICS

Shared responsibilities for decisions and the understanding of risk - INDIAN / USA / EU ethics approval system, Typical audit finding, The INDIAN / USA/ EU directives on GCP in clinical trials - purpose, how will the introduction affect clinical research, extracts from the guidance documents, possible sanctions for non- compliance - legal and regulatory, commercial and professional.

PRACTICES:

- Prepare a report on clinical trials in vaccine development.
- Compile ethical issues related to human cloning and embryos.
- Review on palliative care-promotion and implementation.
- Summarize ethics of randomization and blinding, preliminary data /medical cases and placebo.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

REGULATORY AFFAIRS

History of regulatory affairs, main concepts QSE, sources of information, regulatory affairs for studies in human subjects and required data, Current and future european, US perspectives, requirements and procedures, Drug preparation and packaging, EMEA, european directives and MRECs, ethics committees – history and structure.

UNIT-2 **10L+10T+0P=20 Hours**

PRODUCT APPROVAL

Regulatory submissions for new products, requirements for gaining approval, US perspective, regulating control over marketing and sales of medical products, regulations, codes of practice, promotional materials, Inputs of Indian guidelines & Indian perspectives.

SKILLS:

- ✓ *Design protocols for audit processing.*
- ✓ *Conduct survey on medical ethics in local hospitals.*
- ✓ *Collect data on IVF implementation strategy in nearest IVF center.*

PRACTICES:

- Review on the functionality of CDSCO.
- Overview of Indian regulatory structure for clinical trails.
- Report on regulations on vaccine approval in India.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze rules, regulations and guidelines of clinical trials.	Analyze	1	3,4,9,10
2	Compile regulations on clinical trials of different countries.	Create	1	4,6,9,10
3	Evaluate medical ethics, IVF, audit types and audit processing.	Evaluate	2	3,4,8,9,10
4	Analyze the regulatory affairs related to human subjects.	Analyze	2	2,3,4,5,9,10

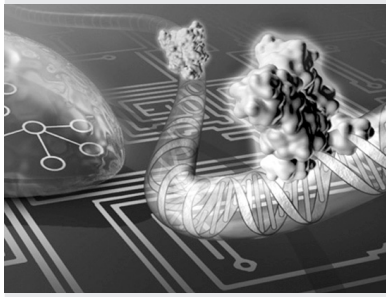
TEXT BOOKS:

1. Douglas J. Pisano, David S. Mantus, “FDA Regulatory Affairs: A Guide for Prescription Drugs, Medical Devices, and Biologics”, 2ndedition,Informa Healthcare, 2008.
2. Wendy Bohaychuk, Graham Ball, “Conducting GCP-Compliant Clinical Research” John Wiley, 1st edition, 1999.

REFERENCE BOOKS:

1. John J. Tobin, Gary Walsh, “Medical Product Regulatory Affairs: Pharmaceuticals, Diagnostics, Medical Devices”, 1st edition, Wiley-VCH, 2008.
2. Stephen Amato; Bob Ezzell, “Regulatory Affairs for Biomaterials and Medical Devices”, 1st edition, Woodhead Publishing, 2014.
3. Agarwal SP, “Good clinical practices for clinical research in India”, 1st edition, 2014.

22BT829 SYSTEMS BIOLOGY



Source: https://www.behance.net/gallery/13712465/Molecular-Systems-Biology?tracking_source=search_projects%7Csystems%20biology

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Metabolic engineering, Bioreaction engineering, Bioinformatics.

COURSE DESCRIPTION AND OBJECTIVES:

This course aims to offer an introduction to this evolving field and equip students with foundational skills and critical mind sets that are required for synthetic biology research. It will cover the biological background of gene regulation, experimental methods for circuit construction, and the mathematical basis of circuit modelling.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

NETWORK BIOLOGY AND APPLICATIONS

Types of graphs, Applications of graph theory in construction of biological network, Structural properties of biological networks, Analysis of centrality parameters in interaction networks, Network biology and human diseases, Signal transduction and gene networks, Protein–protein interaction networks, Gene regulatory networks (DNA–protein interaction networks), Gene co-expression networks (transcript–transcript association networks).

UNIT-2 **10L+0T+10P=20 Hours**

MODELLING OF BIOLOGICAL SYSTEMS

Kinetic modeling- cellular network reconstruction and static modeling - construction and verification of kinetic models- introduction to DBsolve - enzyme kinetics modeling, KEGG pathway.

PRACTICES:

- Analyzing transcriptional regulatory networks using genomic tools.
- Identification of diseased gene through GeneCards and Entrez.
- Explore protein-protein interactions from databases.

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

FLUX ANALYSIS

Flux balance analysis (FBA), Applications in biological systems, FBA in studying biochemical networks, Metabolic flux analysis.

UNIT-2 **10L+0T+10P=20 Hours**

METABOLIC MODELLING

Metabolic network simulation, Metabolic control analysis and engineering of metabolic pathways.

PRACTICES:

- Microarray dataset analysis for identifying DEGs.
- Genomic tools for analyzing transcriptional regulatory networks.
- Marker gene identification using suitable databases.

SKILLS:

- ✓ *Developing bacterial communication circuits.*
- ✓ *Identifying the noise in gene expression: Origin, propagation, consequences, and control.*
- ✓ *Applying Gene/ Genome editing tools – Recombinases, Retro-transposons, TALEN's, CRISPR/Cas9.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Construct different networks for biological systems.	Create	1	2,3,4,5,9,10
2	Analyze the different centrality parameters for biological networks.	Analyze	1	1,2,3,9,10
3	Design mathematical models for biological systems.	Create	2	2,3,5,9,10
4	Evaluate different computational techniques for working effectively with biological networks.	Evaluate	2	2,3,5,9,10

TEXT BOOKS:

1. Dokholyan, Nikolay, "Computational Modeling of Biological Systems: From Molecules to Pathways", 1st edition, Springer, 2012
2. Klipp E Wolfran L, "System Biology: A Text Book", 2nd edition, Wiley, 2016.

REFERENCE BOOKS:

1. J M Bower and H Bolouri, "Computational modeling of genetic and biochemical networks", 1st edition, MIT, 2005.
2. Choi Sangdun, "Introduction to System Biology", 1st edition, Humana, 2010.
3. Alon Uri, "Introduction to Systems Biology: Design Principles of Biology Circuits", 1st edition, CRC, 2007.

22BI802 BIOPROCESS ECONOMICS, MODELING AND SIMULATIONS

Source: Bioprocess Engineering by Kim Gail Clarke - Ebook | Scribd

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Microbiology and Fermentation Technology, Bioprocess Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

The objective of the course is to model bioprocess behaviour, predict output parameters using simulation techniques and optimize the overall cost of integrated bioprocess operation. It also helps to model growth kinetics in various modes of operation of fermenter.

MODULE -1

UNIT-1 **6L+6T+0P=12 Hours**

MATHEMATICAL MODELS

Basics of mathematical models, Principles of formulation, Fundamental laws, Continuity equations, Energy equations, Equations of motions, Transport equations, Equationstate, Equilibrium, Chemical kinetics and bio-kinetic, Model structure and complexity, Rate models.

UNIT-2 **10L+10T+0P=20 Hours**

FERMENTATION PROCESS

Modelling of fermentation processes, Structured and unstructured models, Design aspects of bioprocess economics, Modelling of bioreactors, Immobilized enzyme bioreactors, Plug flow reactor and continuous stirred tank fermenter.

PRACTICES:

- Review on parameters need to consider while modeling fermentation processes.
- A report on optimization of economics of bioprocesses.
- Design a Model on bioreactor.
- Design a model on immobilized enzyme bioreactors.

MODULE -2

UNIT-1 **6L+6T+0P=12 Hours**

BIOPROCESS CONTROL

On-line data analysis for measurement of important physico - chemical and biochemical parameters, State and parameteres timation techniques for biochemical processes.

UNIT-2 **10L+10T+0P=20 Hours**

SOFTWARE PACKAGES FOR SIMULATION

Software packages for simulation of bioprocesses - MATLA Band BERKELEY - MADONNA, Simulation of bio processes using models from literature sources.

PRACTICES:

- Model microbial fed-batchgrowthkineticsin MATLAB.
- Model microbial continuous growth kinetics in MATLAB.
- Model microbial batch growth kinetics in BERKELEY - MADONNA.
- Model microbial fed batch growth kinetics in BERKELEY - MADONNA. .

SKILLS:

- ✓ *Modeling of fermentation process.*
- ✓ *Modeling of growth kinetics in batch, fed-batch and continuous fermenter.*
- ✓ *Simulation of bioprocesses using MATLAB and BERKELEY-MADONNA softwares.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply principles of modelling to fermentation processes.	Apply	1	1,2,4,9,10
2	Analyze bioreactor models.	Analyze	1	2,5,6,9,10
3	Design simulation techniques using software-packages.	Create	2	3,5,9,10
4	Analyze economics of bioprocesses.	Analyze	1	2,4,9,10,11

TEXT BOOKS:

1. Bhanvase BA, Ugwekar RP, “Process Modeling, Simulation, and Environmental Applications in Chemical Engineering”, 1st edition, CRC Press, 2016.
2. Yang ST, “Bioprocessing for value-added products from renewable resources: new technologies and applications”, 1st edition, Elsevier, 2011.

REFERENCEBOOKS:

1. Villadsen J, Nielsen J, Lidén G, “Bioreaction engineering principles”, 1st edition, Springer Science & Business Media, 2011.
2. Bailey JE, Ollis DF, “Biochemical engineering fundamentals”, 2nd edition, McGraw-Hill, 2018.
3. Michael L. Shuler, FikretKargi, “Bioprocess Engineering: Basic Concepts”, 2nd Edition, Pearson, 2002.

HONOURS
(FUNCTIONAL FOOD AND METAGENOMICS)

B.Tech.

BIOTECHNOLOGY

22BT951	-	Probiotics and Functional Foods
22BT952	-	Food Biotechnology
22BT953	-	Metagenomics
22BT954	-	Next Generation Sequencing
22BT955	-	Project / Open source – Swayam / NPTEL

COURSE CONTENTS

I SEM & II SEM

22BT951 PROBIOTICS AND FUNTIONAL FOODS

Source: https://damdaran.ir/en/articles/probiotics-and-functional-foods

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Microbiology and Fermentation Technology.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides the knowledge on probiotics and prebiotics used in food products. It enables the students to analyze different microorganisms as starter cultures for the development of food products and also the bio-preservatives usage in control of food spoilage. In addition to these, it enlightens the novel strategies for controlling the food borne pathogens.

MODULE-1

UNIT-1 **9L+0T+6P=15 Hours**

PROBIOTICS

Probiotic microorganisms, Safety of probiotic microorganisms, Characteristics of Probiotics for selection-Tolerance to additives, Stability during storage and passage to intestinalsites, Minimum effective dose, Maintenance of probiotic microorganisms, Prebiotics and gutmicroflora, Prebiotics and health benefits.

UNIT-2 **15L+0T+10P=25 Hours**

HEALTH BENEFITS ASSOCIATED WITH PROBIOTICS

Probiotics and Prebiotics in Prevention and treatment of gastro-intestinal bacterial infection, Constipations, Hepatic encephalopathy, Chronic urinary tract infection, Antitumor, Antihypertensive and cholesterol level.

PRACTICES:

- Culturing of Probiotic organisms.
- Probiotic characterization - Acid and bile salt tolerance.
- Cell adhesion assay.
- Auto aggregation and Co-aggregation assay.
- Antibiotic susceptibility assay.

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

FUNCTIONAL FOODS

Classification of functional foods, Relation of functional foods and nutraceutical (FFN) to foods and drugs, Different foods as functional food: cereal products (oats, wheat bran, rice bran, etc.), fruits and vegetables, milk and milk products, legumes, nuts, oil seeds and sea foods, herbs, spices and medicinal plants, Coffee, tea and other beverages as functional foods/drinks.

UNIT-2 **15L+0T+10P=25 Hours**

FUNTIONAL FOODS FOR HELATH CARE

Functional foods/nutraceuticals for specific situations such as cancer, heart disease, diabetes, stress, osteoarthritis, hypertension, Role of dietary fibers in disease prevention, Soy proteins and soy isoflavones in human health, Role of nuts in cardiovascular disease prevention.

SKILLS:

- ✓ *Development of probiotics as starter cultures for food products.*
- ✓ *Development of functional foods for health care.*
- ✓ *Produce bio-preservatives from probiotic bacteria.*

PRACTICES:

- Development of aroma and spices based functional foods.
- Formulation of herbal products as functional foods.
- Preparation of health drinks/beverages as functional foods.
- Development of functional food snacks with antioxidant properties.
- Formulation of soy protein and dietary fiber-based food products.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the probiotics and prebiotics in food products.	Analyze	1	1,2,4,9,10
2	Apply the probiotics and prebiotics in health and disease control.	Apply	1	1,2,6,9,10
3	Identify the strains responsible for food spoilage.	Analyze	2	2,4,9,10
4	Formulate the functional foods using probiotics and other ingredients.	Create	2	3,4,6,7,9,10

TEXT BOOKS:

1. Lee YK, Salminen S, “Handbook of probiotics and prebiotics”, 2nd edition, John Wiley & Sons, 2009.
2. Robert E.C. Wildman, Robert Wildman, Taylor C. Wallace, “Handbook of Nutraceuticals and Functional Foods” 2nd edition, CRC Press, 2006.

REFERENCEBOOKS:

1. Ray B, Bhunia AK, “Fundamental food microbiology”, 5th edition, CRC press, 2013.
2. Matthews KR, Kniel KE, Montville TJ, “Food microbiology: An Introduction”, 4th edition, John Wiley & Sons, 2017.
3. Gibson GR, Roberfroid M, “Handbook of prebiotics”, 1st edition, CRC Press, 2008.
4. Maria Saarela, Functional foods Concept to Product” 2nd edition, Woodhead Publishing, 2011.

22BT952 FOOD BIOTECHNOLOGY

Source: The Foods of Tomorrow: How Biotechnology Is Changing What We Eat (forbes.com)

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Basics of Biology.

COURSE DESCRIPTION AND OBJECTIVES:

This course comprises of topics on current trends in food biotechnology with an emphasis on biotechnological interventions. It also enlightens about food quality, food hazards, nutraceuticals, food safety and food security.

MODULE-1

UNIT-1 **9L+6T+0P=15 Hours**

FOODS AND ITS QUALITY

Foods and nutrition, Controversial aspects of food biotechnology, Foodquality, Physical, chemical, microbial and engineered hazards and their threats, Methods for detection and documentation.

UNIT-2 **15L+10T+0P=25 Hours**

NUTRACEUTICALS

Nutraceuticals and their role in disease all eviation, Processing options for functional foods, Functionality of foods in the realtimes cenario, Production and commercial outlook, Functional Foods, Bioactive components, Antioxidantactivity, Therapeutic foods, Genetically modified foods, Consumer perception.

PRACTICES:

- Report on role of nutraceuticals in disease prevention and control.
- Review on various functional foods for commercial applications.
- Report on genetically modified foods and their importance.
- Analysis of bioactive components that have role in disease prevention.
- Report on Indian Govt. policy on GM Foods and Crops.

MODULE-2

UNIT-1 **9L+6T+0P=15 Hours**

PROBIOTICS

Gut micro flora and its sustainability, Combinations, Prebiotics, Symbiotic foods, Antibiotics produced from micro-organisms and application in foods, Classification, mode of action and applications of bacteriocins, Fermented food production processes.

UNIT-2 **15L+10T+0P=25 Hours**

GMP FOR FOOD PRODUCTION

Advanced and conventional processing methods and their effects on nutrition of foods; Food packaging and labeling, Designing safe and nutritious foods, Food safety issues, National and international norms, Traceability, HACCP, GMP, GAP, SPS, TQM, Six-sigma, EIA, ISO and GLP for food production.

SKILLS:

- ✓ *The scope of various functional foods for commercial applications.*
- ✓ *A role of biotechnology in modified foods for consumer perception.*
- ✓ *Safety issues in foods in nationally and internationally.*

PRACTICES:

- Report on conventional processing of nutritional foods in industries.
- Review on therole of biotechnology in food packaging and labeling.
- Report on various safety issuesi n food manufacturing.
- Review on HACCP, GMP and GAP in food manufacturing.
- Summarize the important guidelines of Six Sigma, EIA and ISO in foods.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze food quality parameters, food hazards and their control.	Analyze	1	2,3,4,6,9,10
2	Adopt biotechnological interventions in food security and safety.	Apply	1	2,4,6,9,10
3	Evaluate vegetarian food sources and their compositions for health benefits.	Evaluate	2	3,4,6,7,9,10
4	Develop novel food products with better quality for commercial applications.	Create	2	3,6,7,9,10

TEXT BOOKS:

1. Shetty K, Sarkar D, “Functional Foods and Biotechnology: Biotransformation and analysis of functional foods and ingredients”, 1st edition, CRC Press; 2020.
2. Johnson-Green P, “Introduction to Food Biotechnology”, 1st edition, CRC Press, 2018.

REFERENCEBOOKS:

1. Lee BH, “Fundamentals of Food Biotechnology”, 2nd edition, John Wiley & Sons, 2015.
2. Johnson-Green P, “Introduction to food biotechnology”, 1st edition, CRC Press, 2018.
3. Atkins P, Bowler I, “Food in Society: Economy, Culture, Geography”, 1st edition, Routledge, 2016.
4. Adams MR, Moss MO, Moss MO, “Food microbiology”, 1st edition, Royal Society of Chemistry”, 2000.

22BT953 METAGENOMICS

Source: Metagenomics - DTU Health Tech

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Microbiology and Fermentation Technology, Bioinformatics.

COURSE DESCRIPTION AND OBJECTIVES:

This course teaches analysis of genetic data from large microbial communities and also allows to gain knowledge on metagenomics experimental design and next-generation sequencing. It allows comparative analyses to understand how genes, pathways, and environmental factors could translate into ecosystem-level knowledge.

MODULE-1

UNIT-1 **9L+0T+6P=15 Hours**

FROM GENOMICS TO METAGENOMICS

Bacterial functional genomics, Genomesequence analysis, The Soil-resistome Project, The Human-Microbiome Project, Cloning the metagenome, Culture-independent access to the diversity and functions of the uncultivated microbial world, 16S and 18S analysis, Antibiotic resistance sequence detection.

UNIT-2 **15L+0T+10P=25 Hours**

BIOINFORMATICS ANALYSIS OF METAGENOMICS DATA

MGmapper, Qiime2, ResFinder database, Metagenomic classification using KRAKEN, Analysis and visualization of read countdata, Metagenomic assembly and binning - reconstructing genomes from reads, Application of metagenomics insurveillance - methods, Meta transcriptomics.

PRACTICES:

- 16S Microbial Analysis with mothur workflow.
- Antibiotic resistance sequence detection.
- Meta transcriptomics analysis using microbiome RNA-seqdata.
- Assembling the metagenomes (SqueezeMeta).

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

METAGENOMICS DATA ACQUISITION

Mapping on databases (Silva, GreenGenes, NCBI), Hypervariable regions of ribosomal RNA and full genome databases, Mapping to a reference database, Generating the Abundance Table, Hypervariable regions (HVRs), Batch Effect Correction, Non-significant reads, Normalization, Sequencing depth & classification, Microbiome variability, Composition based on amplicon sequencing (DADA2 pipe line).

UNIT-2 **15L+0T+10P=25 Hours**

NGS FOR METAGENOMIC SEQUENCING ANALYSIS

Quality Check & Filtering (FastQC, Cutadapt), Prepare mapping file containing features and barcodes - Demultiplexing and quality filtering sequence reads-OTU sidentification (Qiime), Diversity Analysis, Taxonomic composition and relative abundance plots, Taxonomic Heatmap Analysis, Estimation of species richness and sampling depth analysis, Species enrichment plots for eachs ample (KRONA).

SKILLS:

- ✓ *Conduction of computational quality check on metagenomics data.*
- ✓ *Analysing microbiome using mothur workflow and Qiime2.*
- ✓ *Perform Meta transcriptomics using RNA-seq data*

PRACTICES:

- Taxonomic binning of the communities (NR,COG, KEGG Data base)-Cluster edintogenome bins-Bin refinement-Visualize the community and the extractedbins (RandAnvio).
- Find the abundance of the draft genomes (bins) across the samples-Re-assemble the consolidated binset & Visualization the bin.
- Determine the taxonomy of each bin-Functional annotation of bins-Path way enrichment-Phylogenetic analysis.
- Brain-GutAxis: how is the gutmicrobiome affected by diet and does it have an effec to nanxiety a part from the dietitself? How can donor microbiomes help tackle this psychological and physiological condition.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Adopt appropriate *insilico* platforms for metagenomic analysis.	Apply	1	2,4,5,9,10
2	Evaluate the metagenomic data to study taxonomic diversity, functional potential, and ecological relevance of microbial communities.	Evaluate	1	1,3,6,7,9,10
3	Analyze the public datasets to identify the commensal microbiome.	Analyze	2	2,4,5,9,10
4	Apply NGS in analysis of community microbial genome.	Apply	2	1,2,4,7,9,10

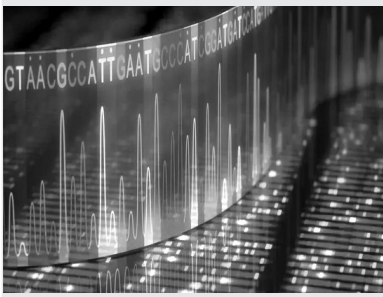
TEXT BOOKS:

1. Jonathan H. Badger, Pauline C. Ng, J. Craig Venter, Karen E. Nelson, “Metagenomics of the Human Body” 1st edition, Springer-Verlag New York, 2011.
2. Streit,WR, DanielR, “Metagenomics”,1st edition, Springer New York, 2017.

REFERENCE BOOKS:

1. Wren B Dorrell N, “Functional Microbial Genomics Methods in Microbiology”, 1st edition, Academic PressInc., 2002.
2. Kalia VC, Shouche Y, Purohit HJ, Rahi P, “Mining of microbial wealth and metagenomics”, 1st edition, Springer, 2017.
3. Norman Grossblatt, “The new science of metagenomics”, 1st edition, National Academic Press, Washington, 2007.
4. Chopra RS, Chopra C, Sharma NR, “Metagenomics: Techniques, Applications, challenges and opportunities”, 1st edition, Springer, 2020.

22BT954 NEXT GENERATION SEQUENCING



Source: https://www.labmanager.com/product-focus/the-third-wave-of-next-generation-sequencing-22898

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Cell and Molecular Biology, Algorithms in Bioinformatics.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the sequencing of genomic DNA using NGS tools. It also emphasizes applications in gene expression and exploration of sequencing genomic data.

MODULE -1

UNIT-1 **9L+0T+6P=15 Hours**

OVERVIEW OF SEQUENCING TECHNOLOGIES

Overview of model sequencing technologies, Sanger Sequencing, Next Generation sequencing platforms, Whole genome sequencing, Next generation sequencing data analysis: Data acquisition, base calling, Quality of sequencing data, Read mapping, genome assembly. Structural and functional annotation of genomes, Statistics and algorithms used in different steps in data analysis.

UNIT-2 **15L+0T+10P=25 Hours**

TECHNOLOGIES FOR TRANSCRIPTOMICS AND REGULATORY GENOMICS

Chip-seq analysis, Peak-finding, Motif discovery, RNA-seq analysis, Differential gene expression analysis, Exome sequencing and analysis.

PRACTICES:

- Exploring genomic data using different NGS sequencing Platforms.
- Analysis of DNA sequence data from databases.
- Explore various NGS resources, tools and databases for genomic data analysis.
- Performing whole genome sequencing and exome sequencing.

MODULE -2

UNIT-1 **9L+0T+6P=15 Hours**

SOFTWARE AND PIPELINES FOR NGS DATA ANALYSIS

Chip-seqanalysis Piplines, RNA-seqanalysis Pipe lines, Software used for assembly and differential gene analysis, Basics of Genome Browsers, Annotation pipelines.

UNIT-2 **15L+0T+10P=25 Hours**

GENOME SEQUENCING ANDAPPLICATIONSINGENETICS STUDIES

Algorithms and application in studying regulation of gene expression, Emerging technologies of single-cellgene expression analysis, Meta genomics, Variant detection, Time series analysis, Pathway Analysis.

SKILLS:

- ✓ *Genomic data analysis obtained from different sequencing platforms.*
- ✓ *Identifying gene expression levels from RNA and DNA sequencing data.*

PRACTICES:

- Galaxy usage for analyzing NGS datasets.
- Assembling NGS data using Velvet.
- Perform gene ontology and pathway analysis.
- Identification of variants from tumor and normal sample pairs.
- Mapping and molecular identification of phenotype-causing mutations.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply Next Generation Sequencing tools in healthcare.	Apply	1	1,2,5,6,9,10
2	Analyze the various platforms in NGS.	Analyze	1	2,4,5,9,10
3	Apply the tools and techniques in NGS data analysis.	Apply	2	1,4,5,9,10
4	Evaluate the GWAS using NGS.	Evaluate	2	3,4,5,9,10

TEXT BOOKS:

1. Genomic Data Analysis by Megahed Mohammad, LAP Lambert Academic Publishing, 2020 edition, 2020.
2. Deep Sequencing Analysis by Noam Shomrom, 2nd edition, Humana Press.

REFERENCEBOOKS:

1. JM Bower and H Bolouri, “Computational modeling of genetic and biochemical networks”, MIT Press,1st edition, 2005.
2. Fall, C.P., Marland, E.S., Wagner, J.M., Tyson,J.J, “Computational Cell Biology”, Springer, 1st edition, 2002.
3. Choi Sangdun, “Introduction to System Biology”, Humana Press / Trtowa / NewJersey, 1st edition, 2010.