BASAVESHWAR ENGINEERING COLLEGE, BAGALKOTE

DEPARTMENT OF BIOTECHNOLOGY

SCHEME OF TEACHING AND EXAMINATION
B. E. III SEMESTER
2023-24

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	22UMA301C	Partial definition equation and integral transforms	03	3	0	0	50	50	100
2.	IPCC	22UBT302C	Microbiology + Lab	04	3	0	2	50	50	100
3.	IPCC	22UBT303C	Unit Operations + Lab	04	3	0	2	50	50	100
4.	PCC	22UBT304C	Biochemistry	03	3	0	0	50	50	100
5.	PCC	22UBT305C	Bioprocess Principles and Calculations	03	2	2	0	50	50	100
6.	BSC	22UBT340C	Biology for Engineers	02	2	0	0	50	50	100
7.	PCCL	22UBT306L	Biochemistry Lab	01	0	0	2	50	50	100
8.	MC	22UHS001M 22UHS002M 22UHS003M	Yoga NSS PE	00	0	0	2	100	-	-
			Total	**20**	**16**	**2**	**8**	**450**	**350**	**700**

22UMA301C	PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL TRANSFORMS	03 - Credits (3 : 0 : 0)
Hours / Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – I	10 Hrs.

Partial Differential Equations_I : Introduction to PDE, Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivatives with respect to one independent variable only. Solution of Lagrange's linear PDE.

(RBT Levels: L1, L2 and L3)

UNIT – II	10 Hrs.

Partial Differential Equations_II : Solutions of PDE by the method of separation of variable. Derivation of one-dimensional heat and wave equations and their solutions by explicit method, solution of Laplace equation by using five point formulas.

(RBT Levels: L1, L2 and L3)

UNIT – III	10 Hrs.

Fourier series :Periodic functions, Conditions for Fourier series expansions, Fourier series expansion of continuous and functions having finite number of discontinuities, even and odd functions. Half-range series, practical harmonic analysis.

(RBT Levels: L1, L2 and L3)

UNIT – IV	10 Hrs.

Fourier transforms and z-transforms : Infinite Fourier transforms and inverse Fourier transforms- simple properties, Fourier sine and Fourier cosine transforms, Inverse Fourier sine and cosine transforms. Z-transforms-definition, standard forms, linearity property, damping rule, shifting rule-problems. Inverse Z-transforms.

(RBT Levels: L1, L2 and L3)

References:

1. Numerical Methods for Engineers by Steven C Chapra &Raymond P Canale.
2. Higher Engineering Mathematics by Dr. B.S. Grewal, Khanna Publishers, New Delhi.
3. Advanced Engineering Mathematics By H. K. Das, S. Chand & company Ltd. Ram Nagar, New Delhi
4. Advanced Engineering Mathematics by E Kreyszig ,John Wiley & Sons.

Course Objectives:

1. PDE's provides a powerful tool for quantifying rates of change optimizing functions, and modeling complex systems.
2. To provide a way, to represent periodic functions in terms of simple trigonometric functions.
3. To transform a function from the time domain to the frequency domain.
4. Provides a powerful mathematical tool for analyzing, designing, and manipulating

discrete time signals and systems.

Course Outcomes:

After completion of the course the students shall be able to,

1. Identify different types of PDEs including linear vs nonlinear, first order vs higher-order, and partial derivatives of different variables.
2. Learn various analytical techniques to solve to specific types of PDEs, such as variable separable and explicit method.
3. Grasp the concept of representing periodic functions as an infinite sum sinusoidal (sine and cosine) with different frequencies.
4. Grasp the concept of the Fourier transform as a mathematical tool that converts a function from the time domain into the frequency domain.

Evaluation Scheme:

Assessment	Marks	Weightage
CIE-I	40	20
CIE-II	40	20
Assignments/ Quizzes/Case Study/ Course Project/Term Paper/Field Work	10	10
SEE	100	50
Total	**190**	**100**

Question paper pattern for CIE-I and CIE-II:

Question paper consists Part-A and Part-B. Part A is compulsory, it consists of short answer questions of 1 or 2 marks, covering Unit-I and Unit-II (no multiple choice questions and No true or false questions).

1. In Part-B, four questions are to be set as per the following table.

CIE	Number of questions / Maximum marks	Sub divisions	Covering entire unit
	Two questions of 15 marks (Solve any one)	Sub divisions shall not be mixed within the unit	Unit-I

I	Two questions of 15 marks (Solve any one)	Sub divisions shall not be mixed within the unit	Unit-II
II	Two questions of 15 marks (Solve any one)	Sub divisions shall not be mixed within the unit	Unit-III
	Two questions of 15 marks (Solve any one)	Sub divisions shall not be mixed within the unit	Unit-IV

Question paper pattern for SEE:

1. Question paper consists Part-A and Part-B. Question number 1 is compulsory, it consists of short answer questions of 1 or 2 marks, covering entire syllabus (no multiple choice questions and No true or false questions, 50% of questions must be L3 and L4 level).
2. In Part-B total of eight questions with two from each unit; with internal choice to be set uniformly covering the entire syllabus.
3. Each question carries 20 marks and should not have more than four subdivisions.
4. In Part-B, any FOUR full questions are to be answered choosing at least one from each unit.
5. Sketches, figures and tables if any should be clearly drawn, as the same is scanned for printing.
6. The question paper should contain all the data / figures / marks allocated, with clarity.

22UBT302C	MICROBIOLOGY	Credits: 04
L: T: P - 3: 0: 2		CIE Marks: 50
Total Hours/Week: 5		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction:

Scope of microbiology, History of microbiology-Evolution of microbes. Contributions of Scientist for the development of microbiology. Microbial diversity & taxonomy, Prokaryotes & Eukaryotes. Microscopy: Principles and applications of Bright field microscopy, Dark-Field Microscopy, Phase contrast microscopy, Fluorescence Microscopy and Electron microscopy (SEM & TEM).

UNIT–II	10Hrs.

Microorganisms:

Bacteria- Morphology and ultra structure of Bacteria, Culturing of bacteria, reproduction and growth pattern (continuous and batch).Viruses, fungi, algae, protozoa, actinomycetes-structure and modes of reproduction. Fastidious microorganisms. Microbial toxins. Microbial Techniques: Pure culture techniques- Aerobic and Anaerobic culture techniques. Fermentation (acid & alcohol).

UNIT–III	10 Hrs.

Control of Microorganisms:

Control of microorganisms by Physical methods and chemical methods, antibiotics, chemotherapeutic agents and Phage biotics. Medical Microbiology: Normal microflora, common diseases caused by microbes-pathogenesis, symptoms, diagnosis, treatment, prevention.

UNIT–IV	10 Hrs.

Agricultural and Environmental Microbiology:

Microbiology of soil, Air and Aquatic Microbiology, Bio-fertilizer, Plant endophytes, Microbes in bioremediation and bio-control agents.

Industrial Microbiology: Microbial processes using yeasts and bacteria (production of alcohol, vinegar, cheese), Microbes as source of protein (SCP), gelatin agents (alginate, xanthin, agar agar) Microbial insecticides, Enzymes from Microbes (amylase, protease), Useful products from microorganisms using recombinant DNA technology (vaccines and antibiotics).

REFERENCE BOOKS *

1. Pelczar, Chan and Noel Kreig, “Microbiology”- 5th Edition Tata Macgraw Hill, 2010.
2. Tortora, Funke and Case, “Microbiology an Introduction” -8th Edition, Pearson Education, 2006.
3. Stainer R.Y., Ingraham J.L., “General Microbiology”- 5th Edition Mc.Millan Press, 2010.
4. Madigan, Martinko, Parker, Brock’s, “Biology of Microorganisms” - 10th Edition, Prentice Hall, Pearson Education, 2003.
5. Prescot and Dunn, “Industrial Microbiology”-Agribios India, 2002.
6. J. Salle, “Fundamental Principles of Bacteriology” – 7th Edition, Tata Macgraw Hill, 2007.

7. E Alcamo I "Fundamentals of Microbiology"6th Ed, Jones &Bartlet, Pub. 2001.
8. Prescott, Harley & Klein, "Microbiology" -7th Edition, WCB/McGraw Hill, Int. Edition, 2008.

COURSE OUTCOMES**

- Ability to know the basic concepts of Microbiology, scope ,organization and understand the techniques to study microorganisms through microscopy
- Ability to analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes
- Ability to discuss the causative organisms of the disease and their effect on society
- Ability to analyse the applied techniques in the environment and create awareness to society

LIST OF EXPERIMENTS

1. Study of microscopes: Types, working principle, parts of the microscope, handling (operating) & caring.
2. Media preparation: NA, Peptone broth, PDA, Macconkeys agar.
3. Isolation of bacteria by serial dilution, pour plate ,spread plate and streak plate techniques
4. Isolation and identification of bacteria and fungi from different sources.
5. Study of colony characteristics and Morphology of bacteria, yeasts and fungi.
6. Study of different staining techniques. (Simple staining differential staining)
7. Enumeration of microorganisms using colony counter
8. Fermentation of Carbohydrates (gas production)
9. Growth curve of bacteria and yeast.
10. Antibiotic susceptibility testing of bacteria & Observation of motility by hanging drop technique.

COURSE OUTCOMES**

1. Ability to know the basic concepts of Microbiology, scope ,organization and understand the techniques to study microorganisms through microscopy
2. Ability to analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes
3. Ability to discuss the causative organisms of the disease and their effect on society
4. Ability to analyse the applied techniques in the environment and create awareness to society

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2	2			2		2					1	1	1
CO 2	2	2	2		2	3		1					2	1	2
CO 3	3	3	2		2	2		1				1	1	1	2
CO 4	3	3	3		2	3		2				1	2	1	3

22UBT303C	UNIT OPERATIONS	Credits: 04
L:T:P – 3:0:2		CIE Marks: 50
Total Hours/Week: 05		SEE Marks: 50

UNIT-I	10 Hrs.

Fundamentals of Fluid Mechanics:

Units and Dimensions- Basic and Derived units, Dimensional homogeneity, Dimensional Analysis, Fluid definition and classification of fluids, Properties and Rheological behaviour of fluids, Newton's Law of viscosity, Newtonian and Non-Newtonian types of Fluids, Hydrostatic equilibrium, Barometric equation and Pressure measurement using manometers, Conceptual numericals, Types of Fluid flow- Laminar and Turbulent, Reynolds number and its Importance.

UNIT–II	10 Hrs.

Fluid Flow and Measurement:

Basic equations of fluid flow - Continuity equation and Bernoulli theorem and equation; Derivation of Bernoulli's equation, Correction for Bernoulli's equation, Flow through circular and non-circular conduits, Flow Measurement, Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter), Pumps- Classification of Pumps (Centrifugal & Reciprocating pumps), Construction and working of Centrifugal pump, characteristics of pumps and Characteristic Curves.

UNIT–III	10 Hrs.

Filtration and Sedimentation:

Theory of Filtration, Types of Filtration, Distribution of overall pressure drop (Resistances), Filter medium, Characteristics of filter medium, Filter aids, Factors Affecting Rate of Filtration, Filtration equipment's - Plate and Frame Filter Press, Rotary Drum Filter. Theory of Settling and Sedimentation, Types of Settling - Free and Hindered, Stoke's law, Newton's law, Terminal settling velocity, Batch sedimentation, Equipment (cyclones, thickeners), Conceptual numericals

UNIT–IV	10 Hrs.

Size Separation and Mixing:

Size Separation: Concept and Importance of screening operation, Type of Screen Analysis, Effectiveness of a Screen, Factors affecting performance of screens. Concept Of Mixing, Homogeneous and Heterogeneous Mixtures, Importance of Mixing and Agitation, Mixing liquids with liquids, Construction and Flow Patterns of Impellers, Mixing Of Gases With Liquids

List of Experiments in Unit Operations Laboratory

1. **Verification of Bernoulli's theorem**
2. **Study of packed bed characteristics**
3. **Orifice meter**

4. **Venturimeter**
5. **Rotameter**
6. **Batch sedimentation test**
7. **Screen effectiveness and Sieve analysis**
8. **Filtration**
9. **Settling**
10. **Mixing**

Text Books and Reference Books *

1. McCabe W. L, Smith J. C and Harriott (2005) Unit operations of Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA.
2. Gavhane K. A (2014) Unit Operations I, Fluid Flow and Mechanical operations, 24nd Edition. Nirali Prakashan, India.
3. Alan S Foust, Wenzel LA, Clump CW, Maus L, and Anderson LB (2008) Principles of Unit Operations. 3rd Edn. John Wiley & Sons, USA.
4. Coulson and Richardson's Chemical Engineering Volume 1A: Fluid Flow: Fundamentals and Applications. 7th Edition, Elsevier, USA. Edited by R. P. Chhabra V. Shankar (2017)

. Coulson and Richardson's Chemical Engineering Volume 2A: Particulate Systems and Particle Technology. 6th Edition, Elsevier, USA. Edited by R. P. Chhabra and Basavaraj Gurappa (2019)

Course Outcomes**

After completion of the course student will be able to

1. Understand the application of dimensional analysis and can state and describe the nature and properties of the fluids.
2. Apply the knowledge of fluid mechanics and determine the flow rate, discharge of transportation fluids
3. Apply the knowledge of filtration and sedimentation in Engineering applications
4. Apply the knowledge of Size Separation and Agitation techniques in Engineering applications

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	1	1	-	-	-	-	-	-	-	3		
CO2	3	2	3	2	1	-	-	-	-	-	-	-	3		
CO3	2	3	3	1	1	-	-	-	-	-	-	-	2		
CO4	2	3	3	1	1	-	-	-	-	-	-	-	2		

22UBT304C	BIOCHEMISTRY	Credits: 03
L: T: P - 3: 0: 0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT – 1	12 Hrs.
Carbohydrate Metabolism: Glycolysis, TCA cycle, Glyoxylate cycle, Gluconeogenesis and regulation of gluconeogenesis, pentose phosphate pathwayand Electron transport chain, oxidative phosphorylation, bioenergetics, Structure and properties of ATP. Disorders of carbohydrate metabolism.	
UNIT – 2	**10 Hrs.**
Lipid Metabolism: Biosynthesis of fatty acids. cholesterol, phospholipids and glycolipids. Regulation of fatty acid biosynthesis, biodegradation of fatty acid. Ketone bodies production during starving and diabetes. Disorders of lipid metabolism.	
UNIT – 3	**10 Hrs.**
Nucleic acid Metabolism: Biosynthesis of purines - origin of ring atoms, formation of IMP, conversion of IMP to AMP and GMP. De novo synthesis of pyrimidine nucleotides - biosynthesis of UTP & CTP. Biodegradation of purines & pyrimidines. Recycling of Purine and Pyrimidine nucleotides by salvage pathways. Disorders of nucleic acid metabolism.	
UNIT – 4	**10 Hrs.**
Amino Acid Metabolism: Biosynthesis of amino acids starting from acetyl CoA (with reference to oxaloacetate family) - Aspartate, Asparagine, Methionine, Lysine, Threonine. Biodegradation of amino acids-deamination, transamination and urea cycle. Disorders of amino acid metabolism.	

REFERENCES*

1. David L. Nelson and Michael Cox (2017). "Lehninger Principles of Biochemistry" **7th** edition W.H Freeman & Co., Pub.
2. Lubert Stryer (2010)., "Biochemistry" -5th edition Freeman & Co., Pub.
3. Voet&Voet (2011). "Biochemistry"- 4th edition, John Wiley,New York Pub.
4. Thomas M. Davlins (2010). " Biochemistry with clinical correlations" 7th edition Wiley-Liss;.
5. Mathews, Vanholde & Arhen (2010). "Biochemistry" -3rd edition, Pearson Education Pub
6. Elliot & William H (2011). "Biochemistry & Molecular Biology"3rd edition, John Wiley.
7. U. Sathyanarayana (2022). "Biochemistry" -5th edition, Books and Allied Pub.

COURSE OUTCOMES**

After completion of the course student will have the ability

1. To understand the metabolic pathways in the carbohydrates along with its energetic and interpret the metabolic disorders.
2. To understand lipid metabolism and comprehend the regulation of along with the in born errors of metabolism.
3. To understand the origin of atoms in purine and pyrimidine & also interpret the pathways in the nucleic acid metabolism and also its disorders
4. To understand pathways involved in amino acid metabolism and its disorders.

* **Books to be listed as per the format with decreasing level of coverage of syllabus**
**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	1	2	3	2			3	3				3	2	3	
CO 2	2	3	3	3		3	2	3				3	2	1	2
CO 3	2	2	3	3		3	2	2				3	3	2	
CO 4	2	2	2	2		2	2	2				2	2	2	

22UBT305C	BIOPROCESS PRINCIPLES AND CALCULATIONS	03 - Credits (2 : 2 : 0)
Hours / Week : 04		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – 1	7 + 3 Hrs.

Introduction to Engineering Calculations

Dimensions and System of Units:

Introduction, Fundamental and Derived Units, Fundamental and Derived Quantities; System of Units (FPS, CGS, MKS, SI); Conversion of Units, Inter-conversion; Conceptual Numericals

Basic Chemical Engineering Calculations:

Atomic, Molecular and Equivalent weights, molar concept, Gram atom, Gram mole; Equivalent Weight; Concept of Normality, Molarity and Molality. Method of Expressing the Composition of Mixtures and solutions, weight fraction, mole fraction, Percentage by weight, mole percent and volume percent; Concept of PPM (Parts Per Million); Conceptual Numericals;

Gases, Ideal Gas Law, Dalton's Law, Partial Pressure, Amagat's Law, Gaseous Mixtures, Relationship between Partial Pressure and Mole Fraction of Component Gas; Average Molecular Weight of Gas Mixture; Density of Gas Mixture; Conceptual Numericals

UNIT – 2	7 + 3 Hrs.

Introduction to Bioprocesses:

Bioprocess Engineering, Role of a bioprocess engineer in the biotechnology industry, unit operations involved in bioprocesses

Material Balance without Chemical Reactions

General material balance equation for steady and unsteady states.

Generalized Block Diagram of process showing input and output; Material balance equations for Unit Operations like Distillation, Evaporation, Crystallization, Mixing, Drying, Extraction; Material balances and calculations on Distillation, Evaporation, Crystallization and Mixing Unit Operations- Conceptual Numericals

UNIT – 3	7 + 3 Hrs.

Material Balance Involving Chemical Reactions

Generalized material balance equations, stoichiometry, Principles of stoichiometry, stoichiometric ratio, proportion, Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, selectivity, Material Balance and Conceptual Numericals on different Unit processes

UNIT – 4	7 + 3 Hrs.

Stoichiometry of Microbial growth and Product formation

Stoichiometry of cell Growth and Product Formation- elemental balances, degrees of reduction of substrate and biomass; available-electron balances; yield coefficients of biomass and product formation

REFERENCES

Chemical Process Calculations by D. C. Sikdar, PHI Learning Private Limited, Delhi, 2013

Introduction to Process Calculation by K A Gavane, Nirali Publications,2016

Stoichiometry by B. I. Bhatt and S. M. Vora, Tata McGraw Hill Publishing, 4th Edition, 2004

Basic Principles and Calculations in Chemical Engineering by David Himmelblau, PHI Learning Private Limited, 2005

Bioprocess Engineering Principles by Pauline M. Doran, Academic Press, 2012

Biochemical Engineering Fundamentals: by J. E. Bailey & D. F. Ollis, McGraw Hill, 2005

Bioprocess Engineering by Shule and Kargi, Prentice Hall, 2010

COURSE OUTCOMES

After completion of the course student will be able to

1. Describe and Perform Basic Biochemical Calculations involving compositions of Mixtures and solutions
2. Apply the knowledge of Material Balances and Solve the Bioprocess Engineering Problems involving Unit Operations
3. Apply the knowledge of Material Balances and Solve the Bioprocess Engineering Problems involving Unit Processes
4. Solve the Bioprocess Engineering problems applying Stoichiometry knowledge of Microbial cells

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	3									2	2	1	
CO 2	2	3	3									2	2	1	
CO 3	3	3	3									1	2	1	
CO 4	3	3	3									1	2	1	

22UBT340C/22UBT440C	BIOLOGY FOR ENGINEERS	02 - Credits (2: 0 : 0)
Hours / Week : 02		CIE Marks : 50
Total Hours : 26		SEE Marks : 50

UNIT-I	06 Hrs.

Nature Bioinspired Materials And Mechanisms

Bio inspiration - Introduction, Alliance between Engineering and Biology, Biomimicry - Science mimicking nature. Human Blood substitutes-hemoglobin based oxygen carriers (HBOCs) and perflourocarbons (PFCs). Artificial Intelligence for disease diagnosis. Bioichips & their applications.
Biosensors & their applications. Nanobiomolecules in medical science. Biofilms in dental treatment

UNIT–II	06 Hrs.

Bio Inspiration Models Used In Engineering:

BioEcholocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf), Respiration (MFCs), Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Gecko Feet, Plant burrs (Velcro), Shark skin (Friction reducing swimsuits), Kingfisher beak (Bullet train), Fire fly LED.

UNIT–III	07 Hrs.

Human Organ Systems And Bio Designs

Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease).

Heart as a pump system (architecture, electrical signalling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators).

Lungs as purification system gas exchange mechanisms, spirometry, Ventilators, Heart-lung machine).

Eye as a Camera system, bionic eye. **Kidney** as a filtration system - dialysis systems. **Muscular and Skeletal Systems** as scaffolds, bioengineering solutions for muscular dystrophy and osteoporosis.

UNIT–IV	07 Hrs.

Trends In Bioengineering

Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods, electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Self-healing Bioconcrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes) and Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury, Arsenic). Bio-bleaching.

Reference Books *

1. Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022
2. Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012
3. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
4. Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011
5. Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2020.
6. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, CRC Press, 2012
7. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008
8. Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N GeethaA C Udayashankar Lambert Academic Publishing, 2019
9. 3D Bioprinting: Fundamentals, Principles and Applications by Ibrahim Ozbolat, Academic Press, 2016
10. Electronic Noses and Tongues in Food Science, Maria Rodriguez Mende, Academic Press, 2016

Web links and Video Lectures (e-Resources)

- VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource
- https://nptel.ac.in/courses/121106008
- https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists
- https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009
- https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006
- https://www.coursera.org/courses?query=biology
- https://onlinecourses.nptel.ac.in/noc19_ge31/preview
- https://www.classcentral.com/subject/biology
- https://www.futurelearn.com/courses/biology-basic-concepts

Course Outcomes**

After completion of the course student will be able to

1. Corroborate the concepts of biomimetics for specific requirements.
2. Elucidate the basic biological concepts via relevant industrial applications and case studies.

3. Evaluate the principles of design and development, for exploring novel bioengineering projects.
4. Think critically towards exploring innovative biobased solutions for ecofriendly and socially relevant problems.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3		2	1		3						1			
CO 2	3	2	1	1		3						1			
CO 3	3		3	1		3						1			
CO 4	3		1	2		3	3					1			

22UBT306L	BIOCHEMISTRY LAB	Credits: 01
L: T: P - 0: 0:2		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

LIST OF EXPERIMENTS **12 Hrs.**

1. pH measurements, concentration of solutions and units, conversion factors, accuracy.
2. Preparation of buffers of constant strength.
3. Qualitative tests for carbohydrate and lipids.
4. Qualitative tests for amino acids and proteins.
5. Estimation of sugar by Folin Wu and O-toluene method.
6. Estimation of amino acid by ninhydrin method
7. Estimation of protein by Lowry's method.
8. Estimation of nitrogen by Kjeldahl method.
9. Estimation of urea by diacetylmonooxime method.
10. Determination of Saponification value of lipids.
11. Determination of Iodine value of lipid.
12. Determination of acid value of a lipid.

REFERENCE BOOKS*

1. Plummer D. T (2017)"Practical Biochemistry" – 3rd edition McGraw Hill Education pub.
2. T N. Pattabhiraman, (2017) "Laboratory Manual & Practical Biochemistry" 4th Edition, All India Publishers & Distributors
3. Sadasivam, S. and Manickam (2017) A Biochemical Method. 3rd Edition, New Age International Publishers, New Delhi.
4. Rodney Boyer, "Modern Experimental Biochemistry" 3rd edition, Pearson Education Pub, (2000).
5. Keith Wilson(2003). "Practical Biochemistry" 3rd edition Cambridge University Pub.
6. Beedu SashidharRao and Vijay Deshpande (2005) "Experimental Biochemistry"I.K International Pvt. Ltd.

COURSE OUTCOMES**

After completion of the course student will have the ability

1. To understand the importance of pH & learn the different strength of solution & buffer preparations.
2. To identify various biomolecules by means of qualitative analysis.
3. To quantify the concentrations of the biomolecules in the given sample.
4. To apply knowledge of acid & iodine value to determine the quality of lipids.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3

CO 1	1	2	3	2			3	3				1	2	3	
CO 2	2	3	2	2			2	3					1	3	
CO 3	2	3	3	3		3	2	2					2	1	
CO 4	2	3	3	2		2	2	2					3	1	

B. E. IV SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			Examination Marks		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	22UBT401C	Biostatistics & Biomodeling	03	2	2	0	50	50	100
2.	IPCC	22UBT402C	Immunotechnology + Lab	04	3	0	2	50	50	100
3.	IPCC	22UBT403C	Heat & Mass Transfer + Lab	04	3	0	2	50	50	100
4.	IPCC	22UBT404C	Molecular Biology	03	3	0	0	50	50	100
5.	PCC	22UBT405C	Cell culture techniques	02	2	0	0	50	50	100
6.	AEC		Advance programming lab / IoT/AI & ML/ Robotics/	01	0	0	2	50	50	100
7.	PCCL	22UBT406L	Cell culture & Molecular Biology Lab	01	0	0	2	50	50	100
8.	HSMC	22UHS424C	UHV-II	01	1	0	0	50	50	100
9.	PCCL	22UBT407L	Biostatistics lab	01	0	0	2	50	50	100
10.	MC	22UHS001M 22UHS002M 22UHS003M	Yoga NSS PE	00	0	0	2	100	-	-
			Total	**20**	**14**	**2**	**12**	**550**	**450**	**900**

22UBT401C	BIOSTATISTICS & BIO-MODELING	Credits: 03
L: T: P - 2: 2: 0		CIE Marks: 50
Total Hours/Week: 4		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction and Descriptive Statistics:

Scope of biostatistics, presentation of data, Diagrammatic and graphical represent,(simple, multiple, component bar diagrams, pie chart, histogram, frequency polygon, frequency curve, ogive curve). Measure of central tendency (meaning of central tendency, arithmetic mean, median, Quartiles, mode, geometric mean, harmonic mean their merits and demerits). Measure of dispersion: meaning, range, quartile deviation, mean deviation and standard deviation, coefficient of variation, skewness and kurtosis. Correlation and linear regression analysis, curve fitting straight line).

UNIT–II	10Hrs.

Probability and Probability Distributions:

Definition of probability, Event, Mutual Exclusive, Independent, Complimentary Events Addition and Multiplication theorem of probability and examples. Discrete probability distributions: Bernoulli's , Binomial and Poisson distribution. Continuous probability distribution – normal, Standard normal variate, properties of normal curve, T, F and $\chi 2$ (Chi square -goodness of fit test) distributions and their applications in Biology.

UNIT–III	10 Hrs.

Statistical Inference , ANOVA and Design of Experiments:

Estimation theory and testing of hypothesis point estimation, interval estimation. Sample, population, sample size determination. Methods of Sampling techniques- random (simple, stratified and systematic) non random sampling - (Judgement and convenience). Definition of analysis of variance(one way and two way classifications), Basic principles of experimental design and limitations-randomization, replication, local control, Types of statistical designs of biological experiments and limitations-CRD, RCBD, LSD, Plackett-Burmann design, Response surface methodology(RSM).

UNIT–IV	10 Hrs.

Bio-modeling:

Microbial Growth in a Chemo-stat, Growth Equations of Microbial Populations, product formation models, Models of Commensalisms, Batch culture model, Mutualism, Predation and Mutation. Simple Prey predator model, Volterra's Model for n Interacting Species. Basic Models for Inheritance, Applications of probability in genetics, Hardy - Weinberg law. Selection and Mutation Models, Genetic Inbreeding Models. Dose response studies.

REFERENCE BOOKS *

1. Khan and Khanum, (2008),Fundamentals of Biostatistics(3rd edition), Ukaaz Publication
2. Kapur J.N. (2001),Mathematical Models in Biology and Medicine(1st edition), New age international Pvt. Ltd.

3. Agarwal B.L. (2009), Basic statistics(5th edition), New age international Publishers
4. Rastogi V. B.(2006), Fundamentals of Biostatistics, Ane Books

COURSE OUTCOMES**

After completion of the course student will be able to

1. Interpretation of the data using different statistical methods.
2. Investigate the probability distributions of the data.
3. Design and analyze the experimentation using statistical tools.
4. Apply the biomodelling concepts in various biological studies.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	-	3	2	-	-	-	-	3	-	2	3	2	-
CO2	2	2	-	3	1	-	-	-	-	2	-	-	3	1	-
CO3	1	3	3		3	-	-	-	-	2	-	2	3	-	-
CO4	3	2	-	2	2	-	-	-	-	1	-	2	2	2	-

22UBT402C	IMMUNOTECHNOLOGY	Credits: 04
L: T: P - 3 : 0: 2		CIE Marks: 50
Total Hours/Week: 5		SEE Marks: 50

UNIT-I	10Hrs.

The immune system:

Introduction, Cells and Organs of the immune system: Lymphoid cells and myeloid cells. Primary (thymus, bone marrow and lymphatic system) and secondary Lymphoid organs (lymph nodes, spleen, MALT). Innate and adaptive immunity. Antigens: Chemical and biological Factors affecting antigenicity/Immunogenicity and molecular nature, Haptens, adjuvants. Antibodies: their structure and function, Immunoglobulin classes (IgG, IgA, IgE, IgD and IgM) and subclasses (isotypic, allotypes, idiotypes and anti-idiotytopic antibodies). Cytokines and their role in immune response.

UNIT–II	10 Hrs.

Humoral and cell mediated immunity:

Introduction to humoral and cell mediated immunity. B-lymphocytes maturation and mechanism of activation. Thymus derived lymphocytes (T cells) and types, T-cell maturation and mechanism of activation. Major Histocompatibility Complex: MHC I and MHC II structure and functions. Antigen processing and presentation process.

UNIT–III	10 Hrs.

Immunological disorders:

Complement system and its pathways (classical, alternative and lectin pathway) regulation and biological consequences of compliment activation. Hypersensitivity reactions and its types. Autoimmune disorders- Organ specific, Systemic Autoimmune disorders, types and treatment of autoimmune disease. Primary and secondary immunodeficiency disorders (AIDS). Transplantation Immunology: immunological basis of graft rejection, Types of transplantations.

Vaccines: Active and Passive immunization. Designing vaccines for active immunization: Live, attenuated vaccines. Inactive vaccines, subunit vaccines, recombinant vector vaccines and DNA vaccines.

UNIT–IV	10Hrs.

Immunodiagnosis:

Antigen-antibody reactions- Precipitation reactions, agglutination reactions, Blood typing A, B, ABO & Rh. Principal and applications of ELISA, Radio immuno assay (RIA), western blot analysis, Immuno-electrophoresis, Immunofluorescence, chemiluminescence assay, flow cytometry, fluorescence activated cell sorting (FACS) analysis. Production of monoclonal antibodies.

Laboratories:

1. Agglutination Technique: Blood group identification and Rh factor
2. Laboratory diagnosis of diseases-Widal test (Tube agglutination) and VDRL
3. Ouchterlony Double Diffusion (ODD)
4. Radial Immunodiffusion (RID)
5. Countercurrent immunoelectrophoresis (CCIEP)
6. Rocket immunoelectrophoresis (RIEP)
7. Western blot (IGg Purification)
8. ELISA**/** DOT Blot.

REFERENCE BOOKS *

1. Roitts, (2017), Essential Immunology (13th edition), Wiley Blackwell
2. Kuby, J.(2019), Immunology(8th edition), W H Freeman publishers
3. Chakravarthy, A.K.(2006),Immunology & Immunotechnology, Oxford University Press
4. Rastogi, S. C. (2005), Immunodiagnostics (1st Edition), New Age International

COURSE OUTCOMES**

After completion of the course student will be able to

1. Interpret the properties and functions of immune system.
2. Asses the functions of humoral and cell mediated immune system.
3. Develop the vaccines by analyzing the immunological disorders
4. Identify the diseases using different immunodiagnostic tools.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	-	3	1	2	-	-	-	-	-	-	-	1	-	2	-
CO 2	-	2	-	3	-	-	-	-	-	1	-	1	-	3	-
CO 3	-	-	3	-	3	2	-	-	-	-	2	2	-	3	1
CO 4	-	2	-	2	3	-	-	-	-	2	-	2	2	3	-

22UBT403C	HEAT AND MASS TRANSFER	04- Credits (3 : 0 : 2)
Hours / Week : 05		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT-I	10 Hrs.

Fundamentals of Heat Transfer:

Modes of heat transfer; Conduction – steady state heat conduction through uni-layer and multilayer plane wall, sphere and cylinder, Conceptual numericals on conduction; Forced and Natural convection, Conceptual Numericals on convection; Significance of Dimensionless numbers (Nu, Gr, Pr, Re, Pe numbers only); Heat transfer to fluids without phase change; heat transfer in laminar and turbulent flow inside closed conducts.

UNIT–II	10 Hrs.

Heat Transfer concept in Heat Exchangers:

Heat transfer with phase change - Condensation – film wise and drop wise; Boiling – types of boiling; Flow arrangements in Heat transfer equipment's - co current and counter current flow; LMTD, Elementary design of double pipe heat exchanger and shell and tube heat exchanger; Concepts of Heat transfer coefficients- Individual and overall; Fouling factor and Resistance for heat transfer; Conceptual numericals

UNIT–III	10 Hrs.

Mass transfer concepts

Diffusion - Fick's law of diffusion; Measurement of diffusivity, Two film theory of mass transfer, Mass transfer coefficients and their correlations. Liquid-Liquid, Solid-Liquid, Liquid-Gas, Solid-Liquid-Gas mass transfer. Principles, mass transfer considerations in unit operations like Extraction, Absorption, Adsorption, Crystallization and Evaporation

UNIT–IV	10 Hrs.

Mass transfer Operations

Methods of distillation –Simple, Flash, and Fractional distillation of binary mixtures, Continuous Distillation with reflux, relative volatility, fractionation of binary mixtures -McCabe Thiele method, Extractive and Azeotropic distillation, Drying, Principle of Drying, Drying rate, drying curve.

LIST OF EXPERIMENTS (ANY 10)

1. **Thermal conductivity of material (solid or liquid)**
2. **Heat transfer in a composite wall by conduction**
3. **Heat transfer by Natural Convection**
4. **Heat transfer by Forced convection**
5. **LMTD and Effectiveness in Heat Exchanger – Co-current**
6. **LMTD and Effectiveness in Heat Exchanger – Counter-current**
7. **Distillation**
8. **Extraction**

9. **Drying**
10. **Leaching**

Reference Books *

1. McCabe WL, Smith JC and Harriott (2005) Unit operations in Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA
2. Treybal RE (2012) Mass Transfer Operations, 3rd Edition, McGraw-Hill Publications, USA.
3. R. P. Chhabra V. Shankar (2017) Coulson and Richardson's Chemical Engineering Volume 1A: Fluid Flow: Fundamentals and Applications. 7th Edition, Elsevier, USA.
4. Heat and Mass Transfer: Fundamentals and Applications, 7th Edition, Butterworth-Heinemann
5. Pauline Doran (2012) Bioprocess Engineering Principles, 2nd Edition, Academic Press
6. Alan S Foust, Wenzel LA, Clump CW, Maus L and Anderson LB (2008). Principles of Unit Operations, 2nd Edn. John Wiley & Sons, USA.
7. Kern (2001). Process Heat Transfer, 2nd Edn. McGraw-Hill Publications, USA.
8. Perry RH and Green DW (2008). Perry's Chemical Engineering Hand Book, 8th Edn. McGraw- Hill Publications.

Course Outcomes**

After completion of the course student will be able to

1. State the different modes of heat transfer and solve basic heat transfer problems
2. Apply the knowledge of Heat Exchangers in Biochemical Engineering applications
3. Apply the knowledge of Mass Transfer in Unit Operations to solve Biochemical Engineering problems
4. Apply the knowledge of Distillation and Drying Unit Operations in Bioprocess Industries

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2	2	2	1							1	2		
CO 2	3	2	3	3	2							2	2		
CO 3	2	3	2	2	1							1	2		
CO 4	3	2	1	1	1							1	2		

22UBT404C	MOLECULAR BIOLOGY	Credits-3
L: T: P - 3 : 0: 0		CIE Marks : 50
Total Hours/week : 03		SEE Marks : 50

UNIT – 1	12 Hrs.

Introduction

Genes and their location. Information flow in biological systems: central dogma, updated central dogma. Signalling (signal transduction)-molecular mechanism. Reverse genetics, Genetic code-its features, codon and anticodon.

Replication:

Replication-basic concepts, structure and function of DNA polymerases, ligases, helicase. mechanism of DNA replication in prokaryotes and eukaryotes, End replication problem in eukaryotes, telomerase and its role, DNA damage & Repair (Photo reactivation, excision repair, recombinational repair, SOS repair).

UNIT – 2	10 Hrs.

Transcription

Mechanism of transcription in prokaryotes and eukaryotes, Bacterial RNA polymerase, structure and function of RNA polymerases (prokaryotes & eukaryotes), general transcription factors, post transcriptional processing, Si RNA, Antisense RNA technology.

Translation:

Protein synthesis: Initiators, Elongation factors, termination codons, Mechanism of translation, Structure and function of prokaryotic and eukaryotic ribosomes, Post translational modification. Differences between prokaryotic and eukaryotic protein synthesis, inhibitors of translation.

UNIT – 3	10 Hrs.

Gene Expression in Prokaryotes

Regulation of gene expression in prokaryotes: Operon model-structure and function, galactose and lactose operon, tryptophan Operon-regulation by attenuation mechanism; positive versus negative regulation, cyclic AMP effect/catabolite repression.

Gene Expression in Eukaryotes:

Regulation of eukaryotic gene expression, hormonal regulation- peptide and steroid hormones, transcriptional control, super secondary structures-Helix turns Helix. Zinc fingers and Leucine Zippers. Gene silencing- methylation, chromatin modification.

UNIT – 4	10 Hrs.

Transposons and Oncogenes

Transposons-replicative and non replicative mechanisms, Insertion sequences, AC/DS elements, transposition in maize (Mc Clintock's work), Cut and paste transposition, Oncogenes and Protooncogenes, Tumour suppressor genes, retroviruses and its life cycle.

Genetic Recombination and Molecular markers:

Genetic recombination in bacteria- transformation, transduction and recombination, Mechanism of recombination-homologous (Holliday model), site specific recombination.

REFERENCES*

1. David Nelson and Michael Cox, (2017), Lehninger Principles of Biochemistry (6th Edition), W.H. Freeman
2. James Watson (2008), Molecular Biology of the Gene (5th Edition) Pearson Education
3. David Freifelder, (2008), Essentials of Molecular Biology (2nd Edition), Narosa Publishing House

COURSE OUTCOMES**

1. Apply the knowledge of the basic aspects of molecular biology and classify the mechanism of DNA repair processes along with replication.
2. Acquire working knowledge on the mechanism of transcription, translation and post translational processes along with their applications in research.
3. Use research-based knowledge of gene regulation mechanism in prokaryotes and eukaryotes in the field of Biotechnology.
4. Select and apply the steps of transposition, Proto-oncogenes conversion and molecular mechanism of genetic recombination in treating diseases.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	1	3	2	1	-	-	-	-	-	2	1	1
CO2	1	-	1	3	3	2	2	-	-	-	-	-	2	2	1
CO3	1	-	1	3	2s	1	1	-	-	-	-	-	1	1	1
CO4	1	-	3	3	3	2	3	-	-	-	-	-	2	2	1

22UBT405C	CELL CULTURE TECHNIQUES	Credits: 02
L: T: P - 2: 0: 0		CIE Marks: 50
Total Hours/Week: 2		SEE Marks: 50

UNIT – 1	8 Hrs.
Plant cell culture: History and introduction, requirements, lab organisation, media constituents, choice of media sterilization of media, explant selection, sterilisation and preparation for inoculation, role of growth hormones in cell culture.Cellular totipotency, cytodifferentition, organogenic differentiation, somatic embryogenesis. Plant growth hormones - auxins, gibberlins, cytokinins. Stoichometry of cell growth and product formation.	
UNIT – 2	**6 Hrs.**
Culture techniques and applications: Protoplast culture, somatic hybridization, haploid production, micro propagation,somaclonal variation, crop improvement, hairy root culture, synthetic seeds. Regeneration of plantlets-shooting, rooting and hardening.	
UNIT – 3	**6 Hrs.**
Animal cell culture Techniques History and development of mammalian cell culture. lab layout and equipments, cell culture media (Natural and Artificial) - components of the medium, functions of media components. Role of antibiotics in media. Types of primary culture, establishment of primary culture, cell lines – mechanical and enzymatic mode of desegregation. Subculture - passage number, split ratio, seeding efficiency, criteria for subculture.	
UNIT – 4	**6 Hrs.**
Cell line Characterization and Maintenance Measurement of Cell viability and Cytotoxicity assay –MTT, LDH dehydrogenase, . Dye exclusion and inclusion tests, clonogenic assay. Characterization. Cell line contaminations, detection and control. Stem cells & their applications	

REFERENCES BOOKS*

1. Culture of Animal cells-3rdEdition-R.IanFreshney.Wiley Less, 2010
2. Introduction to Plant biotechnology by H. S. Chawla, 2nd Edition, Oxford and IBH Publishers, 2010
3. Biotech Expanding Horizons-B. D. Singh, Kalyani Publishers,2010.
4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter Molecular biology of The Cell, GS publishers,2002

COURSE OUTCOMES**

1. To use the plant cells to produce in vitro cultures
2. To comprehend the applications of plant tissue culture techniques in various fields
3. To acquire working knowledge of culture of animal cells in *in vitro* conditions.
4. To identify, and classify the cell culture techniques

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3												1	1	1
CO 2	1				3									2	2
CO 3	1				3			1			1		3	3	
CO 4	3				3									3	

22UHS424C	UNIVERSAL HUMAN VALUES-II	Credit: 01
L:T:P - 1 : 0: 0		CIE Marks: 50
Total Hours/Week:01		SEE Marks: 50

UNIT-I	04 Hrs.
Introduction to Value Education: Right Understanding; Relationship and Physical Facility; Understanding Value Education; Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity -the Basic Human Aspiration-Current Scenario and Method to Fulfill the Basic Human Aspirations.	
UNIT–II	**04 Hrs.**
Harmony in the Human Being: Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.	
UNIT–III	**04Hrs.**
Harmony in the Family and Society and Nature: Harmony in the Family – the Basic Unit of Human Interaction; 'Trust' – the Foundational Value in Relationship; 'Respect' – as the Right Evaluation: Other Feelings, Justice in Human-to-Human Relationship; Understanding Harmony in the Society; Vision for the Universal Human Order; Understanding Harmony in the Nature; Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature.	
UNIT–IV	**03 Hrs.**
Implications of the Holistic Understanding – a Look at Professional Ethics Definitiveness of (Ethical) Human Conduct; A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order; Competence in Professional Ethics; Holistic Technologies, Production Systems and Management Models; Strategies for Transition towards Value-based Life and Profession	

Reference Books

1. R R Gaur, R Sangal, G P Bagaria, 'Human Values and Professional Ethics', , Excel Books, New Delhi, 2010
2. A. Nagaraj, Jeevan VidyaEkParichaya, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. A.N. Tripathi, Human Values, New Age Intl. Publishers, New Delhi, 2004.
4. Annie Leonard,The Story of Stuff (Book), Simon & Schuster, 2011.
5. Mohandas Karamchand Gandhi,The Story of My Experiments with Truth, Public Affairs Press of Washington, DC. 1948
6. E. F Schumacher, Small is Beautiful,. Blond & Briggs, 1973

7. Cecile Andrews, Slow is Beautiful, New Society Publishers, 2006.
8. J C Kumarappa, Economy of Permanence, Akhil Bharat Sarva-Seva-Sangh, Rajghat, Kashi, 1958.
9. Pandit Sunderlal, Bharat Mein Angreji Raj,Publications Division, M/O Information & Broadcasting, Govt. of India, 2016
10. Dharampal,Rediscovering India, Society for Integrated Development of Himalayas, 2003
11. Gandhi, Mohandas K. Hind Swaraj or Indian Home Rule Ahmedabad, Nava jivan Pub. House, 1946.
12. India Wins Freedom, Maulana Abdul Kalam Azad, Orient Black Swan, 1988.
13. Romain Rolland, Gandhi, Romain Rolland (English), Srishti, 2000.

Course Outcomes

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

CO1: Explore holistic vision of life - themselves and their surroundings.

CO2: Develop competence and capabilities for maintaining Health and Hygiene.

CO3: Analyse various problems in life, family,Society and in handling problems with Sustainable Solutions.

CO4: Apply values to their own self in different day-to-day settings in real life and in handling problems with sustainable solutions.

CO5: Adopt the value of appreciation and aspiration for excellence and gratitude for all.

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
No	Programme Outcomes Course Outcomes															
Upon successful completion of course the Students will																

be able to:																
1	Explore holistic vision of life - themselves and their surroundings.							3	2	3			1			
2	Develop competence and capabilities for maintaining Health and Hygiene.						3	3	1	1			1			
3	Analyse various problems in life, family,Society and in handling problems with Sustainable Solutions.						3	3	2	1			1			
4	Apply values to their own self in different day-to-day settings in real life and in handling						2	2	3	2			1			

	problems with sustainable solutions.															
5	Adopt the value of appreciation and aspiration for excellence and gratitude for all.								3				1			

22UBT406L	CELL CULTURE AND MOLECULAR BIOLOGY LAB	Credits: 01
0:0:2 - N_L : N_T: N_P		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

1. Callus Induction Technique- Stock preparation, Media preparation.
2. Explants preparation and inoculation technique.
3. Development of suspension culture from callus
4. Animal cell culture techniques
5. Study of absorption spectra of nucleic acids.
6. UV Vis survival curve of bacteria.
7. Agarose gel electrophoresis.
8. Isolation of genomic DNA from plant sources.
9. Isolation of plasmid DNA from E. coli.
10. Estimation of DNA by diphenyl method.
11. Estimation of RNA by orcinol method.
12. Purity of nucleic acids by UV-Vis Spectrophotometer.
13. Standard Operating Procedure for Centrifuge and Gel Documentation Unit.

Reference Books *

1. Sadashiva and Manickam, (2017), Biochemical Methods, (2nd Edition), W.H. Freeman
2. R.A. Dixon & Gonzales, (1995), Plant Cell Culture: A Practical Approach by IRL Press. (2nd Edition),
3. Sambrook& Russell, (2002), Molecular Cloning, (3rd Edition), Cold Spring Harbor Lab.

Course Outcomes**

After completion of the course student will be able to

1. Conduct and analyze the growth of plant and animal cells by plant and animal tissue culture techniques.
2. Apply absorption spectra and analyze SOP for various lab equipments.
3. Conduct and analyze the concentration and purity of DNA.
4. Conduct observations and experiments including Genomic DNA/plasmid DNA /RNA/protein.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	1	3	1	-	-	-	-	-	1	1	3	1
CO2	1	2	2	1	3	2	-	-	-	-	-	1	1	3	1
CO3	1	2	2	1	3	1	-	-	-	-	-	1	1	3	1
CO4	2	2	3	2	3	2	-	-	-	-	-	1	1	3	1

22UBT407L	BIOSTATISTICS LAB	Credits: 1
L: T: P - 0:0:2		CIEMarks:50
Total Hours/Week: 02		SEEMarks:50

LIST OF EXPERIMENTSIN BIOSTATISTICS LABORATORY

1. Procedure for creating Data file, Diagram and Graphs.
2. Procedure and calculation of Mean, Median, Mode, Standard Deviation and Variance.
3. Procedure and calculation of t test.
4. Calculation of Chi-square test.
5. ANOVA- one-way analysis
6. ANOVA- two-way analysis.
7. Experimental Research Design – CRD- Analysis.
8. Experimental Research design – RBD- Analysis.
9. Experimental Research design – Latin square Design- Analysis.
10. Placket-Burman Design for media optimization.
11. Response Surface Methodology for media optimization.

REFERENCE BOOKS *

1. Khan and Khanum, (2008),Fundamentals of Biostatistics(3rd edition), Ukaaz Publication
2. Kapur J.N.(2001),Mathematical Models in Biology and Medicine(1st edition), New age international Pvt. Ltd.
3. Agarwal B.L. (2009), Basic statistics(5th edition), New age international Publishers
4. Rastogi V. B.(2006), Fundamentals of Biostatistics, Ane Books

COURSE OUTCOMES**

After completion of the course student will be able to

1. Create data file, draw graphs, charts using statistical software tools.
2. Calculate measures of dispersion and central tendency.
3. Analyse the data using ANOVA.
4. Design experimental set up using statistical software tools.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	1	3	-	-	-	-	-	-	1	2	2	1	1
CO 2	3	3	2	3	3	-	-	-	-	-	2	2	2	1	-
CO 3	2	3	3	2	2	2	-	-	-	-	-	3	2	1	-
CO 4	3	3	1	3	3	2	-	-	-	-	-	3	2	1	2