Title of the Course:Applied Mathematics Course Code:UBIO0301	L	T	P	Credits
	3	1	---	4

Course Pre-Requisite: Basic terminologies of differential equations, concepts of probability, rules and formulae of integration

Course Description: This course contains linear differential equations, Laplace transform, statistics and probability

Course Learning Objectives:

1. To develop abstract, logical and critical thinking and the ability to reflect critically upon their work.
2. To study various mathematical tools like differential equations, integral transforms, vector calculus, probability and statistics to devise engineering solutions for given situations.
3. The student must be able to formulate a mathematical model of a real life and engineering problem, solve and interpret the solution in real world.

Course Outcomes:

COs	After the completion of the course the student will be able to	Bloom's taxonomy level
CO1	Illustrate method of least squares to fit the curves for given bivariate data and find coefficient of correlation.	Understanding
CO2	Solve linear differential equations with constants coefficients.	Applying
CO3	Make use of appropriate probability distribution for finding probabilities of events.	Applying
CO4	Find Laplace transforms of given functions and use it to solve LDEs.	Applying
CO5	Make use of guidelines of Testing of Hypothesis and apply for data.	Applying
CO6	Apply the knowledge of Analysis of variance to solve biological problems.	Applying

CO-PO-PSO Mapping:

Course Objective	Programme Outcomes												Programme specific outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2													
CO2	3	2													
CO3	3	2													
CO4	3	2													
CO5	3	2													

CO6	3	2													

Assessments :

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three units)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three units) covered after MSE.

Course Contents:

Unit 1: Linear Differential Equations with Constant Coefficients — 8 **Hrs.**

Definition, general form, complete solution

1.1 Rules for finding complementary function
1.2 Short methods for finding particular integral
1.3 General Rule for finding particular integral
1.4 Cauchy's homogeneous linear differential equation

Unit 2: Laplace Transform — 6 **Hrs.**

2.1 Definition, transforms of elementary functions, properties of Laplace transform
2.2 Transforms of derivative and integral
2.3 Inverse Laplace transform
2.4 Inverse Laplace transforms by using partial fractions and convolution theorem.
2.5 Solution of linear differential equations with constant coefficients by Laplace transform method.

Unit 3: Statistical Techniques — 8 **Hrs.**

3.1 Correlation and Coefficient of correlation
3.2 Lines of regression of bivariate data
3.3 Fitting of curves by method of least-squares
3.3.1 Fitting of straight lines.
3.3.2 Fitting of exponential curves.

Unit 4: Probability and Probability distributions — 8 **Hrs.**

4.1Statistical Probability with simple problems.
4.2 Conditional probability.
4.3 Random Variable, Probability mass function and density function.
4.4 Discrete Distributions: Binomial, Poisson distribution and properties.
4.5 Continuous Distributions: Normal distribution and properties.

Unit 5: Test of Significance — 8 **Hrs.**

5.1 Sampling distribution of mean and standard error
5.2 Large sample tests: Test for an assumed mean and equality of two population means.
5.3 Small sample tests : t-test for an assumed mean and equality of means of two populations, Paired t-test.
5.4Test by using Chi – square distribution.

5.4.1 Goodness of fit test. 5.4.2 Test for independence of attributes Yates's Correction.	
Unit 6: Experimental Design 6.1 Principles of experimental designs. 6.2 F- distribution and introduction to F- Test. 6.3Analysis of variance (ANOVA) and its uses in the designs. 6.4 One and Two Way Analysis of variance followed by t test (pair wise).	6 **Hrs.**
Recommended Books: 1. Higher Engineering Mathematics by Dr. B. S. Grewal, Khanna Publishers, Delhi. 2. A Text Book of Applied Mathematics, Vol. I and vol. II by P. N. Wartikar& J. N. Wartikar, PuneVidyarthiGrihaPrakashan, Pune. 3. Statistics & Experimental Design - An Introduction for Biologists &Biochemists - Geoffrey Clark	
Reference Books: 1. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley India Pvt. Ltd. 2. Advanced Engineering Mathematics by H. K. Dass, S. Chand, New Delhi. 3. A text book of Engineering Mathematics by N. P. Bali, Iyengar, Laxmi Publications (P) Ltd., New Delhi. 4. Mathematics for Engineers Vol-I &Vol-II by RakeshDube, Narosa Publishing House. 5. Fundamentals of Statistics- Gupta S.C. 6. Biostatistics: A Foundation for Analysis in the Health. Daniel W.W, 7. Introduction to Biostatistics and Research Methodology – Rao& Richard. 8. Mathematical Models in Biology – Allman & Rhodes.	
Unit wise Measurable Learning Outcomes: **Unit 1: Linear Differential Equations with Constant Coefficients and Its Applications** Students are able to a) Solve linear differential equations with constant coefficients. b) Solve the problems on free oscillation, damped oscillation and forced vibrations. **Unit 2: Laplace Transform** Students are able to a) Find Laplace transform by using definition b) Recall properties of Laplace transform and use to find transforms of given functions. c) Use Laplace transform method to solve linear differential equations. **Unit 3: Statistical Techniques** Students are able to a) Compute coefficient of correlation for given data. b) Find lines of regression for the given bivariate data. c) Fit straight lines, exponential curves for given data. **Unit 4: Probability and Probability distributions** Students are able to a) Verify the function as probability mass and densityfunction. b) Use probability distributions in solving physicaland engineering problems. **Unit 5: Test of Significance** Students are able to, a) Apply test of significance of Large sample and small sample data. b) Solve physical sciences and Engg problems by using concepts of testing of hypothesis. **Unit 6:Experimental Design** Students are able to,	

a) State the concept of design of experiment.
b) Solve problems of Analysis of variance (ANOVA).

Title of the Course: FLUID MECHANICS	**L**	**T**	**P**	**Credit**
Course Code: UBIO0302	3	-	-	3

Course Pre-Requisite: Basic knowledge of mathematics

Course Description:

The basic purpose of this course is to introduce students to the concepts of fluid statics and dynamics and its applications in bioprocess industries where fundamentals of biochemical engineering are used.

Course Learning Objectives:

1. To introduce fluid statics for different process fluids in Bioprocess industry.

2. To describe fluid dynamics (mechanics) for different process fluids.

3. To illustrate the basic principles of flow measuring devices.

4.To explain the general theory of laminar and turbulent boundary layer fundamentals and flow past immersed bodies.

5. To explain selection and scale up of agitation system.

6. To explain screen analysis

Course Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's taxonomy level**
CO1	Define hydrodynamic equilibrium	Remembering
CO2	Classify different types of flow	Understanding
CO3	Find pump power requirement	Application
CO4	Find pressure drop for fluid flow through pipe.	Application
CO5	Select an appropriate agitator and perform scale up of agitation system	Analyze
CO6	Apply the basic equations to perform design calculations (flow, pressure drop, power) for processing fluids.	Application

CO-PO-PSO Mapping:

Course Objective	**Programme Outcomes**												**Programme specific outcome**		
	PO	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO1**	**PO1**	**PO12**	**PSO**	**PSO**	**PSO**
CO1	**3**	2											**2**		
CO2	3														

CO3		3	2										**2**	
CO4		2	3										**2**	
CO5			3										**2**	
CO6			3										**2**	

Assessments :
Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:---Fluid statics and its Applications Hydrodynamic equilibrium, Hydrodynamic equilibrium in a centrifugal field, Applications of fluid statics: manometers, continuous gravity decanter, centrifugal decanter	6 **Hrs.**
Unit 2:--- Fluid flow through pipes Types of flow, shear rate and shear stress, rheological properties of fluids, Continuity equation, Bernoulli equation, Pump power calculations. Shear stress distribution in a cylindrical tube, laminar and turbulent flow in pipes, effect of roughness, friction factor chart, Pressure drop calculations across fittings.	8**Hrs.**
Unit 3:--- Transportation and metering of fluids Pumping devices for gases:fans,blowers and compressors, Measurement of flowing fluids:venturimeter, orifice meter, rotameter, pitot tube	6 **Hrs.**
Unit 4:--- Flow past immersed bodies Drag and drag coefficients, Friction in flow through beds of solids, Motion of particles through fluids, Fluidization	4 **Hrs.**
Unit 5:--- Mixing Agitated vessels, flow patterns in agitated tanks ,mechanism of mixing ,power requirements for mixing Agitator selection and scale up	6 **Hrs.**
Unit 6:--- Screening Types of screens, Screen efficiency, Average particle diameter, Comparison of ideal and actual screens, Industrial screening equipment .	6 Hrs.

Textbooks:
1. 'Unit Operations of Chemical Engineering', W. L. McCabe, W. L. Smith, and P. Harriot, McGraw-Hill International Edition (Sixth edition) (2001).
2. 'Bioprocess Engineering Principles' Pauline M. Doran, Elsevier Science & Technology Books, May 1995

Reference Books:
1. R. W. Fox and A. T. McDonald, Introduction to Fluid Mechanics (Fourth Edition) Wiley

Singapore (1995).
2. J. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall (1999).
3. R. B. Bird, W. L. Stewart and E. L. Lightfoot, Transport Phenomena (Second edition), Wiley Singapore (2002).
5. M. M. Denn, Process Fluid Mechanics, Prentice Hall (1980).

Unit wise Measurable students Learning Outcomes:

1. Student should able to apply hydrostatic equilibrium principle

2. Student should able to perform calculations regarding flow of incompressible fluids through pipes

3. Student should able to perform calculations related to power consumption in case of fans, blower and compressor

4.Student should able to perform calculations related to motion of particles through fluids

5.Student should able to calculate power requirements for mixing

6. Student should able to perform calculations related to screening and sedimentation.

Title of the Course: MICROBIAL TECHNOLOGY **Course Code:** UBIO0303	**L**	**T**	**P**	**Credit**
	3	**-**	**-**	**3**

Course Pre-Requisite: Basic knowledge of prokaryotes

Course Description: This course explains the basics of microbiology and applied microbiology

Course Objectives:

1 To acquaint students with the world of microorganisms, their types and characteristics.
2 To demonstrate about growth requirements and their role in bacterial growth.
3 To describe disinfection and sterilization techniques.
4 To explain role of various environmental factors in microbial growth.

Course Learning Outcomes:

Students are able to -

1. Describe, categorize, compare and differentiate microorganisms.
2. Able to assess various control measures for microbial growth.
3. List the range of media constituents, types of media and various culturing methods used for bacterial growth
4. Apply suitable methods to control microbes.

CO-PO-PSO Mapping:

COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	3	3	1	1	3	2	1	1	2	3	2	
CO2	3	3	2	3	3	2		2	2	1	3	2	2	3	
CO3	3	3	3	3	3	1			2	1	3	2	2	3	
CO4	1	2	3	2	2	3	3	3	3	3	2	3	3	3	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Introduction to microorganisms — **6 Hrs.**

- History of Microbiology :- Spontaneous generation, Germ theory of diseases.
- Prokaryotic cell structure :- The bacterial nucleus, cell wall, cell membrane, capsules and slimes, flagella, pili, reserve materials and other cellular inclusions, endospores.

Unit 2:---General characteristics of microorganisms :- — **6Hrs.**

- Archaebacteria,
- Actinomycetes,
- Fungi
- Viruses
- Rickettsia, Mycoplasma, Chlamydia,

Unit 3:--- MICROBIAL NUTRITION AND IDENTIFICATION AND CHARACTERIZATION OF BACTERIA — **6Hrs.**

- Requirement for C, N, S and growth factors, Role of oxygen
- Various types of culture media, pure culture techniques, aerobic and anaerobic culturing,

SECTION – II

(Production of each bio-product to be discussed with respect to upstream process details, History, microorganisms, biosynthetic pathway, fermentation process details, recovery and flow sheet.**)**

Unit 4:--- MICROBIAL GROWTH — **6Hrs.**

- Microscopy, types of staining, analysis of Cultural characteristics, Culture preservation methods
- Nutritional categories among microorganisms, Typical growth curve, Diauxic growth, synchronous growth, batch and continuous culture

Unit 5:--- EFFECT OF ENVIRONMENTAL FACTORS AND ANTIBIOTICS ON GROWTH OF MICROORGANISMS — **6Hrs.**

- Effects of solutes on growth and metabolism, effect of temperature on microbial growth, effect of ion concentration, effect of hydrostaticpressure, effect of heavy metal ions on microbial growth
- Antibiotics :- historical highlights, characteristics of antibiotics and their mode of action, microbial susceptibility testing of antibiotics and resistance to antibiotics

Unit 6:--- THE CONTROL OF MICROORGANISMS — **6Hrs.**

- Physical agents :- High Temperature a) Moist heat - Stem under

pressure, Fractional sterilization, boiling water, pasteurization, b)Dry heat – Hot air sterilization, Incineration, c) Desiccation, d) Osmotic pressure, e)Radiations- ionizing and non-ionizing f) Filtration • Chemical agents:- Definations and terms , Phenol, Alcohol, Halogens, Heavy metals, gaseous agents	

Textbooks:

1. General Microbiology, 5th Ed. – Stanier R.Y. *et al*. (Macmilan press)
2. Microbiology, 5th Ed. – Pelczar, Jr. *et. al.* (Tata McGrawHill)

References:

1. Microbiology – Fundamentals and Application, 6th Ed. –Purohit, S.S. (Agrobios)
2. General Microbiology, 7th Ed. – Schlegel H.G. (CambridgeUniversity Press)
3. Brock biology of microorganism by T H Madigan.
4. Comprehensive Biotechnology: Vol 3- M. M. Young. (Pergamon Press, Oxford)
5. A textbook of Industrial Microbiology: second edition- WulfCrueger&Anneliese Cruger (Panima Publishing Corporation)
6. Biotechnology- KeshavTrehan (New Age International Pvt. Ltd)
7. Process Biotechnology Fundamentals- S.N. Mukhopadhyay, I. Campbell, F.G. Priest (Viva Books Ltd)
8. Industrial microbiology – Prescott & Dunn (Agrobios)

Unit wise Measurable students Learning Outcomes:

Students are able to do -

Unit 1

1. To understand the general history, physiology and anatomy of microorganisms.

Unit 2

1. To explain various types of microorganisms

Unit 3

1. List the range of media constituents and types of media for bacterial growth
2. Describe various culturing methods

Unit 4

1. To learn growth analysis methods
2. To explain various types of bacterial growth

Unit 5

1. Enlist various microbial growth affecting environmental factors
2. Describe effect of environmental factors on growth
3. Explain role of various chemicals in chemotherapy

Unit 6

1.To impart knowledge of general theory of sterilization, equipments and their applications to control cell growth

Title of the Course: BIOCHEMISTRY	**L**	**T**	**P**	**Credit**
Course Code:UBIO0304	**4**	**-**	**-**	**4**

Course Pre-Requisite:

1. The students should have the basic understanding of the living cells
2. The students should know basic biophysics and bioorganic chemistry in order to follow the physicochemical properties and metabolic reactions of biomolecules
3. The students should know the concept of equilibrium and thermodynamics for chemical reactions

Course Description:

1. This course is related to the metabolism of biomolecules
2. This course compares the biochemical catabolic and anabolic pathways inside a cell and its relation to cellular growth and product formation in fermentations

Course Learning objectives:

1. To state properties and functions of biomolecules
2. To explain metabolism of biomolecules
3. To apply the knowledge of biomolecules in various biotechnological sectors
4. To analyze the structure-function relationship of biomolecules

Course Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive Level**
CO1	State properties and functions of biomolecules	Remembering
CO2	Explain metabolism of biomolecules	Understanding
CO3	Apply the knowledge of biomolecules in various biotechnological sectors	Applying
CO4	Analyze the structure-function relationship of biomolecules	Analyzing

CO-PO-PSO Mapping:

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2											3	2		
CO2	2	3	2	2								3	2	3	
CO3	3	3	3	3	2	3	3	2	3	2	2	3	3	3	3
CO4	3	3	2	2	2	2	2	2				3	2	2	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weight age for course content (normally last three modules) covered after MSE.	
Course Contents:	
SECTION-I **Unit 1:-Amino acids and Proteins–** Classification, properties of amino acids and applications, Protein (and Enzymes) structure, Protein physiological function (protein –ligand interactions – haemoglobin, enzyme-substrate interactions, Applications of proteins and enzymes	**10Hrs.**
Unit 2:-Enzymes, kinetics and inhibition Classification and nomenclature, concept of enzyme activity, Kinetics of single substrate enzyme catalyzed reaction- Michaelis-Menten equation, significance of Km and Vmax, turnover number, catalytic efficiency, modifications of Michaelis-Menten plot, allosteric enzymes, enzyme inhibition- reversible and irreversible inhibition, kinetics of inhibition	**8 Hrs.**
Unit 3:- Enzyme immobilization Concept and need of enzyme immobilization,Methods of immobilization- Carrier free and carrier bound, immobilization using nanomaterials, case studies on immobilization methods, concept of immobilization yield, the immobilization efficiency and the activity recovery	**6 Hrs.**
SECTION – II **Unit 4:--- Metabolism of Carbohydrates** Basics of bioenergetics in metabolism(anabolism and catabolism), Classification and chemical properties of carbohydrates- monosaccharides, disaccharides, oligo and polysaccharides,Glycoconjugates (proteoglycans, glycoprotein, glycolipids) Metabolism of carbohydrates : Glycolysis and alternate pathways,TCA cycle, Electron transport chain, fermentation pathways,Gluconeogenesis	**10 Hrs.**
Unit 5:-Metabolism of Lipids Classification and chemical properties of lipids**,** Function of lipids (simple- storage and functional-membrane lipids) Metabolism of lipids: β oxidation of saturated and unsaturated fatty acid, propionate pathway, Biosynthesis of lipids	**8 Hrs.**
Unit 6:--- Metabolism of amino acids and nucleotides Catabolism amino acids, Biosynthesis of amino acids, Catabolism of purines and pyrimidines, Biosynthesis of purines and pyrimidines	**6 Hrs.**
Textbooks: 1. Text book of Biotechnology by H. K. Das – John Wiley Pub. 2. Enzymes, Second edition, Travor Palmer and Philip Bonner, Horwood Publishing Series	
References: 1] Lehninger- Principles of Biochemistry by Nelson and Cox – W. H. Freeman and Company Pub. 2] Biochemistry by Berg, Tymoczko and Stryer - W. H. Freeman and Company Pub. 3] Text Book of Biochemistry- Rao Rama V.S.S.; Narosa Pub. House, New Delhi.	
Unit wise Measurable students Learning Outcomes: **Unit 1**. At the end of the unit the student will be able to- 1. Statethe physicochemical properties ofamino acids and proteins and their physiological and commercial significance 2.Explain the different levels of protein conformation 3.Discuss the factors influencing protein conformation **Unit 2.** At the end of the unit the student will be able to- 1. Explain the concept of enzyme activity,Michaelis-Menten kinetics including significance of Km &Vmax and modified Michaelis-Menten plots	

2. Compare the effect of reversible and irreversible enzyme inhibitors on Michaelis-Menten kinetic behavior of enzymes

Unit 3. At the end of the unit the student will be able to-

1. Explain the concept enzyme immobilization
2.Discuss different enzyme immobilization methods with case studies

Unit 4. At the end of the unit the student will be able to-

1.Relate and compare the physicochemical properties ofcarbohydrates and their physiological and commercial significance
2.Make use of carbohydrates for applications in various biotechnological sectors

Unit 5. At the end of the unit the student will be able to-

1.Identify the physicochemical properties of lipids and their physiological and commercial significance
2.Classify the lipids based on functional importance

Unit 6. At the end of the unit the student will be able to-

1. Understand metabolism of amino acids
2. Understand metabolism of nucleic acids

Title of the Course: CELL AND MOLECULAR BIOLOGY	**L**	**T**	**P**	**Credit**
Course Code: UBIO0305	**4**	**-**	**-**	**4**

Course Pre-Requisite:

Student must have a basic knowledge of macromolecules and organelle's basic structure, organization and characteristics.

Course Description:

The course contains basic features of cellular organelle's, cell cycle and control, stem cells, DNA analysis and its expression.

Course Objectives:

1. Define the basics of Cell organelle, cell cycle control and stem cells
2. Explain the DNA expression in the form of replication, transcription and translation
3. Identify and analyze the various techniques of genetic mutation, repair and recombination..

Course Learning Outcomes:

The students will able to

CO	**After the completion of the course the student should be able to**	Bloom's taxonomy level
CO1	To acquaint students with fundamental of cellular organelles,cell cycle control and stem cells	Acquaint
CO2	To get the knowledge with the necessary background and technical skills to work professionally in r-DNA Technology and Molecular Biology.	Get
CO3	Analyze the gene manipulation, mutation and recombination.	Analyze

CO-PO-PSO Mapping:

Course Objective	**Programme Outcomes**	**Programme specific outcome**

	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO12	PSO	PSO	PSO
CO1	3	3	3	2	2	3				3		2	3		
CO2	2	3	3			3						2	3		
CO3	2	2	3						2	2	2	2	3		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Cell structure — 8 **Hrs.**

Introduction to Prokaryotes and eukaryotes

1. The compartmentalization of higher cells, the cytosol, the endoplasmic reticulum, the Golgi apparatus, lysosomes and peroxisomes, mitochondria and chloroplasts
2. The nucleus: Nuclear membrane, nuclear pores, chromosomes, nucleolus and other nuclear bodies

Unit 2:--- Cell signaling and transport — 8 **Hrs.**

1. Molecular mechanism of signal transduction
2. Principles and importance of cell signaling
3. Signaling through G- protein linked receptors
4. Signaling through enzyme linked cell surface receptors
5. Ion channel gated receptors, active and passive transport

Unit 3:--- Cell Cycle and Stem cell biology — 6 **Hrs.**

1. Components of cell cycle control system,
2. Cell division: Mitosis and Meiosis
3. Introduction to stem cells, classification- ES cells and adult stem cells
4. Unipotency, pluripotency, multipotency and differentiation of stem cells.

Unit 4:--- Organization of genetic material — 8 **Hrs.**

1. Different forms of DNA
2. Central dogma of Molecular Biology
3. Viruses: Nature of genetic material, unfolding and packing
4. Organization of genetic material in prokaryotes
5. Eukaryotes: Nucleosomes, Chromatin and heterochromatin, histones and non-histone proteins, Giant chromosomes, satellite DNA. Structure of class I, class II and class III genes.
6. Split genes and overlapping genes.

Unit 5:---DNA Replication, damage, repair and recombination 1. Prokaryotic DNA replication 2. Eukaryotic DNA replication 3. Organelle DNA replication – chloroplasts and mitochondria. 4. Plasmid – replication and general properties 5. Types of damages, damaging agents, repair mechanisms - Photo- reactivation, dark repair, postreplicational recombination repair, SOS repairs. 6.Homologous recombination, Site-specific recombination, Consequences ofrecombination event.	8**Hrs.**
Unit 6:--- Transcription and Translation 1. Transcription in prokaryotes and eukaryotes, RNA processing, structures of rRNA, tRNA and mRNA, post-transcriptional processes, Novel structural motifs in transcription factors in eukaryotes and prokaryotes. 2. Genetic code-Deciphering of genetic code and important properties of genetic code. 3. Translation in prokaryotes and eukaryotes, 4. Molecular aspects of gene regulation and expression operon models-lactose, tryptophan and arabinose, Post-translational modifications.	**6 Hrs.**
Textbooks: 1. Cell Biology – Roy S.C. and De Kalyan Kumar (New Central Book Agency 2. Cell Biology – Fundamantal and Application, - Gupta M.L. and Jangir M.L. (Agrobios) 3. Cell and Molecular biology, 8th Ed. – De Robertis E.D.P. and De Robertis, Jr. E.M.F. (Lippincott Williams & Wilkins) 4. Cell and Molecular Biology by Gerald Karp. 5th Edition	
References: 1) 1] Molecular Biology of the Cell, 2nd Ed. – Alberts B. et al (Garland Publishing) 2) Molecular Cell Biology, 2nd Ed. – Lodish et.al. **3)** Cell & Molecular Biology-Concepts & experiments, 3rd ed.-Gerald Karp (John Wiley and sons. New York 4) Molecular Biology of the genes –James D. Watson et al, Seventh edition, (2013) Pearson and Benjamin Cummings Publication. 5) Molecular Biology –David Freifelder, (1987) Jones and Bartlett Publication. 6) Genes and Genomes –Maxine Singer and Paul Berg, (1991) University Science book, Mill Vally California Publication. 7) Genes VIII – Benjamin Lewin (2004) Pearson Prentice Hall Publication. 8) Molecular Biology – Robert Franklin (2005) Weaver McGraw-Hill Publication. 9) Molecular Biology of cell – Harvey Lodish et al (2003).	
Unit wise Measurable students Learning Outcomes: 1. Student should able to acquaint basic cell biology principle, and cell organelles structure. 2. Student should able to describe Cell signalling and transport. 3. Student should able to understand Cell Cycle and Stem cell biology. 4. Student should able to get the knowledge of genetic organization, DNA expression.	

5. Student should able to analyzegene manipulation, mutation and recombination.
6. Student should able to analyze transcription, translation and genetic control.

Title of the Course: Fluid mechanics (Lab)	**L**	**T**	**P**	**Credit**
Course Code:UBIO0331	**0**	**0**	**2**	**1**

Course Pre-Requisite: Basic knowledge of mathematics

Course Description: The purpose of this lab is to study. Properties of fluids and fundamental concepts, Fluid statics and its applications, Kinematics of fluids, Conservation equations in fluid flow and its application

Course Learning Objectives:

1. To acquire practical knowledge about fluid statics and dynamics for different process fluids used in Bioprocess industry.
2. To understand and analyze the basic principles of flow measuring devices.
3. To learn selection of agitation system and their scale up in bio-industry.
4. To Understand importance of particle size of material.

Course Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's taxonomy level**
CO1	Identify, name, and characterize flow patterns and regimes.	understanding
CO2	Students will be able to understand the operational principles of flow measuring devices and their analytical usage	understanding
CO3	Discuss the differences among measurement techniques.	application
CO4	Students will be able to understand particle size analysis	understanding

CO-PO Mapping:

Course Objective	**Programme Outcomes**												**Programme specific outcome**		
	PO	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO1**	**PO1**	**PO12**	**PSO**	**PSO**	**PSO**
CO1	**3**														
CO2	3														
CO3	3														
CO4	3												**2**		

Assessments :

One component of In Semester Evaluation (ISE) of 100% weightage

Assessment	Marks
ISE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

Course Contents:

Experiment No. 1:---Reynold's experiment **Aim and Objectives:** To study the Laminar and Turbulent flow by Reynold's apparatus.	2-- **Hrs.**
Experiment No. 2:--- Venturimeter **Aim and Objectives:** To calculate coefficient of discharge of venturimeter	-2- **Hrs.**
Experiment No. 3:--- Orifice meter **Aim and Objectives:** To calculate coefficient of discharge of Orificemeter	2-- **Hrs.**
Experiment No. 4:--- Bernoulli's experiment **Aim and Objectives:** to study and verify the Bernoulli's theorem	2-- **Hrs.**
Experiment No. 5:--- Rotameter **Aim and Objectives:** to calibrate and find accuracy of rotameter	2-- **Hrs.**
Experiment No. 6:---Pitot tube **Aim and Objectives:** To calculate coefficient of discharge of pitot tube	2-- **Hrs.**
Experiment No. 7:---Friction factor **Aim and Objectives:**To determine friction factor	2-- **Hrs.**
Experiment No. 8:---Screening **Aim and Objectives:**To calculate average particle size	2-- **Hrs.**

Textbooks:

1. 'Unit Operations of Chemical Engineering', W. L. McCabe, W. L. Smith, and P. Harriot, McGraw-Hill International Edition (Sixth edition) (2001).
2. 'Bioprocess Engineering Principles' Pauline M. Doran, Elsevier Science & Technology Books, May 1995.

Reference Books:

1] R. W. Fox and A. T. McDonald, Introduction to Fluid Mechanics (Fourth Edition) Wiley Singapore (1995).
2]J. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall (1999).
3]R. B. Bird, W. L. Stewart and E. L. Lightfoot, Transport Phenomena (Second edition), Wiley Singapore (2002).
4]M. M. Denn, Process Fluid Mechanics, Prentice Hall (1980).

Experiment wise Measurable students Learning Outcomes:

1. Student should be able to identify, laminar ,turbulent transition flow patterns and regimes
2. Student should be able to calculate discharge coefficient for Venturimeter.
3. Student should be able to calculate discharge coefficient forOrifice meter,
4. Student should be able to verify the Bernoulli's theorem.
5. Student should be able to find the accuracy of rotameter.
6. Student should be able to calculate coefficient of discharge of pitot tube.
7. Student should be able to calculate thefriction factor for fluid flowing through pipe.
8. Student should be able to calculate average particle size from screen analysis

Title of the Course: Microbial Technology (Lab) **Course Code:** UBIO0332	**L**	**T**	**P**	**Credit**
	0	**0**	**2**	**1**
Course Pre-Requisite: The students should have a basic knowledge of bacteria				
Course Description: This course explains microbiological staining and culturing				

techniques.

Course Objectives:

1. To demonstrate about staining techniques.
2. To acquaint students with the world of microorganisms and their body parts.
3. To describe media preparation and describe sterilization techniques.
4. To explain role of various physical, chemical, biological factors in microbial growth.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's taxonomy
CO1	Demonstrate the staining techniques	Applying
CO2	Demonstrate growth requirements to perform various tests and their role in bacterial identification	Applying
CO3	Assess the microorganisms and their metabolic activities	Evaluating
CO4	Analyze role of various techniques for microbial identification	Remembering

CO-PO-PSO Mapping:

	POs												**PSOs**		
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO01	3	2				3					2		3	3	
CO02	2	2	2	3		2	3						2	3	
CO03	2	3	3	2		3					3		3	2	
CO04	3	3	3	2		3	3				3	2	3	3	

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

Course Contents:

Experiment No. 1:--- Washing of glassware, Preparation of plug, wrapping of glassware, pipettes, standard practicing of tagging

Aim and Objectives: To Learn various laboratory practices

Outcomes: Able to do various laboratory practices

Experiment No. 2:--- Preparation of nutrient broth and nutrient agar bacteriological media sterilization using autoclave, sterilization of heat sensitive material, sterilization of glassware using autoclave or hot air oven, preparation of slants and stabs, liquid culturing , aseptic transfers using wire loop and needle
Aim and Objectives: To Learn preparation of media, sterilization techniques and aseptic transfers
Outcomes: Able to prepare media, its sterilization, and learn aseptic transfers

Experiment No. 3:--- Spread, pore, streak - Plating methods for pure culture, Observation of growth and its interpretation
Aim and Objectives: To learn various culturing techniques
Outcomes: Able to grow microbes in laboratory and do further analysis

Experiment No. 4:--- Effect of temperature on microbial growth.
Aim and Objectives: To examine effect of temperature on metabolic activities of microorganisms
Outcomes: Able to find out optimum temperature for growth of microorganisms and learn its application

Experiment No. 5:--- Effect of pH on microbial growth.
Aim and Objectives: To examine effect of pH on metabolic activities of microorganisms
Outcomes: Able to find out optimum pH for growth of microorganisms and learn its application

Experiment No. 6:--- Effect of antibiotics on microbial growth
Aim and Objectives: Aim and Objectives: To examine effect of various antibiotics on metabolic activities of microorganisms
Outcomes: Able to study effect of various antibiotics on microorganisms and learn its application

Experiment No. 7:--- Gram staining
Aim and Objectives: To perform gram staining
Outcomes: Able differentiate between gram positive and gram negative bacteria

Experiment No. 8:--- Motility testing
Aim and Objectives: To perform motility testing
Outcomes: Able differentiate between motile and non- motile bacteria

Textbooks:

1. General Microbiology, 5th Ed. – Stanier R.Y. *et. al.*(Macmilan press)
2. Microbiology, 5th Ed. – Pelczar, Jr. *et. al.* (Tata McGrawHill)

References:

1. Microbiology – Fundamentals and Application, 6th Ed. –Purohit, S.S. (Agrobios)
2. General Microbiology, 7th Ed. – Schlegel H.G. (CambridgeUniversity Press)
3. Brock biology of microorganism by T H Madigan.

Experiment wise Measurable students Learning Outcomes:
1Learn to do various laboratory practices
2 Demonstrate growth requirements to perform various tests and their role in bacterial identification, learn sterilization techniques

3 Use various culturing techniques for different applications **4** Analyzeand justify behavior of bacteria as a response to varying temperature **5** Analyzeand justify behavior of bacteria as a response to varying pH **6** Assess various antibiotics and study their effect on growth of microorganisma **7** Demonstrate the staining techniques **8** Demonstrate motility of bacteria

Tile of the Course: Biochemistry (LAB)	**L**	**T**	**P**	**Credit**
Course Code: UBIO0333	**-**	**-**	**2**	**1**

Course Pre-Requisite:

1. The students should have the basic understanding of preparation of solutions and buffers
2. The students should be able to handle few basic lab requisites such as pippets, weighing balance etc

Course Description:

This lab is related to the qualitative and quantitative analysis of biomolecules to know the presence and concentration of biomolecules respectively in given sample.

Course Learning objectives:

1. To analyze the biomolecules qualitatively and quantitatively in a given sample

Course Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level
CO1	Analyze the biomolecules qualitatively and quantitatively from given sample	Analyze

CO-PO Mapping:

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3	3	3	2							3		3

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group

Discussion/ Internal oral etc. ESE: Assessment is based on oral examination	
Lab Experiment Contents:	
Experiment No. 1:--- Practice of preparation of solutions and buffers **Aim and Objectives:** To prepare solutions and buffers	**02 Hrs.**
Experiment No. 2:---Spectrophotometry **Aim and Objectives:** To identify absorption maximum wavelength and verify Beer's law	**02 Hrs.**
Experiment No. 3:---Carbohydrate analysis – qualitative and quantitative detection **Aim and Objectives:** To analyze presence carbohydrates both qualitatively and quantitatively	**02 Hrs.**
Experiment No. 4:--- Amino acid analysis – qualitative and quantitative detection **Aim and Objectives:** To analyze presence of different types of amino acids.	**02 Hrs.**
Experiment No. 5:--- Protein analysis – qualitative and quantitative detection **Aim and Objectives:** To analyze presence of different types of proteins.	**02 Hrs.**
Experiment No. 6:--- Enzyme assay **Aim and Objectives:** To determine the activity of alpha amylase on starch using DNS method (other combinations of enzyme-substrate can also be chosen)	**02 Hrs.**
Experiment No. 7:--- Enzyme immobilization **Aim and Objectives:** To perform enzyme immobilization by entrapment in alginate beads or by any other method.	**02 Hrs.**
Experiment No. 8:--- Nucleic acid analysis – qualitative and quantitative detection **Aim and Objectives:** To analyze presence of nucleic acid qualitatively and quantitatively	**02 Hrs.**
Experiment No. 9:--- Lipid analysis – qualitative and quantitative detection **Aim and Objectives:** To analyze presence of lipids qualitatively and quantitatively	**02 Hrs.**
ANY 8 EXPERIMENTS OUT OF 9 MAY BE CONDUCTED	
References: 1] Biochemistry & Biotechnology - A Laboratory Manual; Yadav V.K; Pointer	

Publishers,Jaipur
2] Introduction to Practical Biochemistry 3rd Ed.- Plummer D. T.; TMH Pub.New Delhi.
3] Laboratory Manual in Biochemistry- J. Jayaraman New Age International

Title of the Course: CELL AND MOLECULAR BIOLOGY (Lab) **Course Code: UBIO0334**	**L**	**T**	**P**	**Credit**
	-	**-**	**2**	**1**

Course Pre-Requisite:
Student must have a basic knowledge of macromolecules and organelle's basic structure, organization and characteristics.

Course Description:
The course contains basic features of cellular organelle's, cell cycle and control, stem cells, DNA analysis and its expression.

Course Objectives:
1. To perform and study isolation of Cell organelles and cell cycle control
2. To isolate and estimate DNA and RNA from various sources
3. To identify and analyze the technique of in vitro transcription

Course Learning Outcomes:
The students will able to

CO	**After the completion of the course the student should be able to**	Bloom's taxonomy level
CO1	Acquaint students with isolation and define of cellular organelles andcell cycle control.	Acquaint
CO2	Isolate and estimate DNA and RNA from various sources	Get
CO3	Identify and analyze the technique of in vitro transcription	Analyze

CO-PO-PSO Mapping:

Course Objective	**Programme Outcomes**												**Programme specific outcome**		
	PO	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO1**	**PO1**	**PO12**	**PSO**	**PSO**	**PSO**
CO1	3	3	3	2	2	3				3		2	3		
CO2	2	3	3			3						2	3		
CO3	2	2	3						2	2	2	2	3		

Assessments :
Teacher Assessment:
One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.
ESE: Assessment is based on oral examination

Course Contents:

Experiment No. 1:--- **Aim:** Isolation of Cellular Organelles and visualize under microscope. **Outcome:** Isolate the Mitochondria or chloroplast from eukaryotic sources.	2 **Hrs.**
Experiment No. 2:--- **Aim:** Perform and observe cell division and cell cycle. **Outcome:** Visualize and observe meiosis from onion root tips.	2 **Hrs.**
Experiment No. 3:--- **Aim:** Isolation of Cellular Organelles and visualize under microscope. **Outcome:** Isolate the nucleus from eukaryotic sources.	2 **Hrs.**
Experiment No. 4:--- **Aim:** Perform and observe cell division and cell cycle. **Outcome:** Visualize and observe Mitosis from onion root tips.	2 **Hrs.**
Experiment No. 5:--- **Aim :** To perform agarose gel electrophoresis of DNA or RNA **Outcomes:** To visualize separated DNA fragments according to their molecular size by applying an electric current to the gel matrix.	2 **Hrs.**
Experiment No. 6:--- **Aim:** Spooling of chromosomal DNA from onion cells. **Outcomes: 1.** Isolation and partial purification of DNA from mashed onion. 2. Precipitation of DNA by Ethanol. 3. Observation and spooling of precipitated DNA.	2 **Hrs.**
Experiment No. 7:--- **Aim:** To measure the concentration of DNA from given sample **Outcome:** To calculate the concentration of DNA from given formulaby spectrophotometric method	2 **Hrs.**
Experiment No. 8:--- **Aim:** To isolate plasmid DNA from bacteria by alkaline lysis method. **Outcome:** 1. To isolate plasmid DNA from *E. coli* bacteria by alkaline lysis method.	2 **Hrs.**

Textbooks:

1. Cell Biology – Roy S.C. and De Kalyan Kumar (New Central Book Agency
2. Cell Biology – Fundamantal and Application, - Gupta M.L. and Jangir M.L. (Agrobios)
3. Cell and Molecular biology, 8th Ed. – DeRobertis E.D.P. and De Robertis, Jr. E.M.F. (Lippincott Williams & Wilkins)
4. Cell and Molecular Biology by Gerald Karp. 5th Edition

References:

1) Molecular Cloning Vol. I, II, III, 2002 Ed. – Sambrook&Rusell (Cold Spring Harbor University Publishing)
2) Molecular Cell Biology, 2nd Ed. – Lodish et.al.
3) Cell & Molecular Biology-Concepts & experiments, 3rd ed.-Gerald Karp (John Wiley and sons. New York
4) Molecular Biology of the genes –James D. Watson et al, Seventh edition, (2013) Pearson and Benjamin Cummings Publication.
5) Molecular Biology –David Freifelder, (1987) Jones and Bartlett Publication.
6) Genes and Genomes –Maxine Singer and Paul Berg, (1991) University Science book, Mill Vally California Publication.
7) Genes VIII – Benjamin Lewin (2004) Pearson Prentice Hall Publication.

8) Molecular Biology – Robert Franklin (2005) Weaver McGraw-Hill Publication.
9) Molecular Biology of cell – Harvey Lodish et al (2003).

Unit wise Measurable students Learning Outcomes:

1. Student should able to isolate the Mitochondria or chloroplast from eukaryotic sources.
2. Student should able to visualise and observe meiosis from onion root tips.
3. Student should able to isolate the nucleus from eukaryotic sources.
4. Student should able to visualise and observe Mitosis from onion root tips
5. Student should able to perform agarose gel electrophoresis of DNA or RNA
6. Student should able to perform Spooling of chromosomal DNA from onion cells
7. Student should able to measure the concentration of DNA from given sample
8. Student should able to isolate plasmid DNA from *E. coli* bacteria by alkaline lysis method.

Title of the Course: Soft Skills	**L**	**T**	**P**	**Credit**
Course Code: UBIO0361	**3**	**-**	**-**	**--**

Course Pre-Requisite: Students must know importance of soft skills other than technical skills**.**

Course Description: The major objective of this course is to help students to develop their soft skills and people skills like Communication skills, Presentation skills, Leadership skills which will make the transition from college to workplace smoother and help them to excel in their jobs.

Course Objectives:

1 To acquaint students with meaning, importance of Soft skills in their professional life.
2 To describe importance of effective communication and Listening Skills.
3 To explain role of oral presentation and how to prepare checklist for making presentation
4 To learn time management and stress management techniques.
5 To understand collaboration skills and team development process.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's taxonomy level
CO1	Demonstrate effective communication and Listening Skills.	Demonstrate
CO2	Demonstrate good oral presentation skills and prepare checklist for making presentation	Demonstrate
CO3	Identify the applications of time management and stress management techniques.	Identify
CO4	Analyze collaboration skills and implement team development process	Analyze

CO-PO-PSO Mapping:

Course Objective	**Programme Outcomes**	**Programme**

													specific outcome		
	PO	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO1**	**PO1**	**PO12**	**PSO**	**PSO**	**PSO**
CO1	**3**	2						**2**							
CO2		2	2	2				2		2	2				
CO3	2	3	3	3		2	2			2	2				
CO4		3	3	3		2		2		2	2				

One component of In Semester Evaluation (ISE) of 100% weightage

Assessment	Marks
ISE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

Course Contents:

Unit 1:--- Soft skills What are soft skills? , global competition, hard skills (technical skills) versus soft skills, emotional intelligence, interpersonal skills, motivation, leadership skills, decision making, negotiation skills, business etiquette, problem solving skills, conflict management, stress management, crisis management, social understanding, behaviors traits, teamwork.	6-- **Hrs.**
Unit 2:--- Communication skills Importance of communication, types, barriers of communication, effective communication, Listening Skills- Empathic listening, Avoid selective listening. (Activity*)	6-- **Hrs.**
Unit 3:--- Presentation skills Importance of oral presentation, planning the presentation, preparing the presentation, organizing your presentation, rehearsing presentation, checklist for making presentation.(Activity*)	6-- **Hrs.**
Unit 4:--- Leadership skills Leaders role, responsibilities and skills required -Understanding good Leadership behaviors,Defining Qualities and Strengths of leadership, Interpersonal Skills, Learning about Commitment and How to Move Things Forward, Making Key Decisions, Motivating and Inspiring Others, Leading by example, effective feedback. (Activity*)	6-- **Hrs.**
Unit 5:--- Time Management and stress management Importance & significance of time, proper utilization, Time management matrix, how toplan ahead, how to handle interruptions , to maximize your personal effectiveness, how to say "no" to time wasters, develop your own individualized plan of action , Stress management -- understanding the stress & its impact, techniques of handling stress. (Activity*)	6-- **Hrs.**
Unit 6:--- Teamwork/collaboration skills	6-- **Hrs.**

Meaning and importance of team work, Team Communication. Team Conflict Resolution, Team Goal Setting, Team Motivation, and Understanding Team Development, team Problem Solving, Multicultural team activity. (Activity*)	

References:

1. Krishna Mohan and NeersBanarge (1996), Developing Communication Skills, Macmillan India Ltd.
2. .M Ashraf Rizvi , Effective technical communication, Mcgraw Hill
3. Organizational Behavior by Don Hellriegel, Jhon W. Slocum,Richard W. Woodman
4. Meenakshi Raman "Technical Communication: Principles and practice"Oxfored University press, India

Unit wise Measurable students Learning Outcomes:

1. Students will understand importance of soft skills.
2. Students will understand Importance of communication, types, barriers of communication.
3. Students will understand Importance of oral presentation, how to plan the presentation, how to prepare the presentation
4. Students will understand Leaders role, responsibilities and skills required by good leader
5. Students will understand Importance & significance of time, proper utilization, Time management matrix, how to plan ahead.
6. Students will understand Meaning and importance of team work, Team Communication. Team Conflict Resolution

Title of the Course:Bioprocess Calculations	**L**	**T**	**P**	**Credit**
Course Code: UBIO0401	3	-	-	3

Course Pre-Requisite: Basics of mathematics, metric prefixes, units and conversions

Course Description:

The course will cover concepts ranging from basics such as units and dimensions, stoichiometry to the simultaneous application of material and energy balances with and without occurrence of biochemical reaction

Course Learning Objectives:

1. Recall students to Engineering Calculations.

2. To explain the general theory of material balance.

3. To discuss the basic principles of mass and energy balances for reactions with and without reaction.

4. To compute mass and energy balances on various process equipment's with and without reaction.

5. To explain the general theory of unsteady state material and energy balances

Course Outcomes:

CO	After the completion of the course the student should be able to	Bloom's taxonomy level
CO1	List different units and conversions in bioprocess calculations	Remembering
CO2	Apply material balance fundamentals to different unit processes	Understanding
CO3	Analyse material balance and energy balance problems and find solutions to these problems.	Application
CO4	Evaluate unsteady state material and energy balance problems	Application

CO-PO-PSO Mapping:

Course Objective	Programme Outcomes												Programme specific outcome		
	PO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO11	PO12	PSO	PSO	PSO
CO1	**3**														
CO2	3														
CO3		3											**2**		
CO4		3											**2**		

Assessments :

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:---Introduction to Engineering Calculations: Units and Conversions, , Density, Specific Gravity; specific volume , Mole Concept, chemical composition, Pressure, Temperature , std. Conditions, physical and chemical data, stoichiometry, atomic mass, molar mass, Equivalent mass, Normality, Molarity, Molality.	4 **Hrs.**
Unit 2:--- Material Balances without Biochemical Reaction: Material balances, Thermodynamic Preliminaries, Law of Conservation of Mass, Procedure for Material-Balance Calculations, Material-Balance for industrially important operationscontinuous filtration, batch mixing, extraction, drying	8**Hrs.**
Unit 3:--- Material Balances with Biochemical Reaction: Definition of terms involved, guidelines for solving problems, Material-Balance for industrially	6 **Hrs.**

important operations: continuous acetic acid fermentation, Xanthan gum production, Material Balances With Recycle, By-Pass and Purge Streams, Stoichiometry of Growth and Product Formation	
Unit 4:--- Energy Balance without reaction: Basic Energy Concepts, General Energy-Balance Equations, Enthalpy Calculation Procedures, Enthalpy Change in Non-Reactive Processes, Procedure for Energy-Balance Calculations without Reaction, Energy-Balance for industrially important operations: Continuous water heater, cooling in downstream processing	6 **Hrs.**
Unit 5:--- Energy Balance with reaction: Enthalpy Change Due to Reaction, Heat of Reaction For Processes With Biomass Production, Energy-Balance Equation For Cell Culture, Energy-Balance for industrially important operations: Continuous ethanol fermentation, Citric acid production	6 **Hrs.**
Unit 6:--- Unsteady state material and energy Balance: Unsteady-State Material-Balance Equations, Unsteady-State Energy-Balance Equations, Unsteady-State Mass Balance for industrially important operations: CSTR, Unsteady-State Energy Balance for industrially important operations: solvent heater	6 Hrs.

Text and Reference Books: 1. Bioprocess Engineering Principles-, Pauline Doran. (Academic Press).
2. Stoichiometry -Bhat B.I and S.M.Vora .(Tata McGraw Hill)
3. Basic Principles and Calculations in Chemical Engineering David M.Himmelblau. (Prentice Hall of India Pvt Ltd).
4. Bioprocess Engineering: Basic Concepts Michael Shuler and FikretKargi. (Prentice Hall).
..

References:
1 Chemical Process Principles -A.Hougen, K.M.Watson and R.A.Ragatz. (John Wiley and Asia Publishing Co.)
2. Elementary Principles of Chemical Processes. Richard Felder and Ronald W.Rausseau. (John Wiley & Sons).

Unit wise Measurable students Learning Outcomes:

1Students should able to perform conversions in engg. calculation.

2.Students should able to apply procedure for material balance calculation for the process without reaction.

3 Students should able to apply procedure for material balance calculation for the process with reaction

4Students should able to apply procedure for energy balance calculation for the process without reaction.

5 Students should able to apply procedure for energy balance calculation for the process with reaction.

6 Students should able to apply procedure for material balance calculation for the unsteady state process.

Title of the Course: Heat Transfer	**L**	**T**	**P**	**Credit**
Course Code: UBIO0402	4	-	-	4

Course Pre-Requisite: The prerequisites for this course are very basic knowledge in thermodynamics and detail concepts in fluid mechanics. The students should also have a good knowledge of units ,dimensions and conversions

Course Description: The course will introduce the fundamental concepts of various modes of heat transfer. It will further elaborate these concepts with theories and applications to the solutions of practically relevant biochemical engineering problems. Some aspects of process design principles of various heat transfer equipment will be taken up in the later part of this course.

Course Learning Objectives:

1. To introduce basic modes of heat transfer.
2. To illustrate the basic principles of heat transfer operations
3. To explainheattransfertofluids withoutphasechange and with phase change
3 To explain different types of heat exchange equipment's.
4. To explain performance and design of evaporator

Course Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's taxonomy level**
CO1	List basic modes of heat transfer.	Remembering
CO2	Develop equationsforrateofheattransfer,overallandindividualheattransfer coefficient.	Understanding
CO3	Develop design calculations for heat exchangers.	Application
CO4	Develop design calculations for evaporators	Application

CO-PO-PSO Mapping:

Course Objective	**Programme Outcomes**												**Programme specific outcome**		
	PO	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO1**	**PO1**	**PO12**	**PSO**	**PSO**	**PSO**
CO1	**3**														
CO2	3														
CO3		3											**2**		
CO4		3											**2**		

Assessments :

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks

ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:---:--- Mechanismof heatflow Conduction, Convection, radiation. Heat transfer by conduction in solids: Fourier's law, steady state heat conduction through walls, single and multilayer. Heat flow through a cylinder, Sphere, unsteady state heat conduction, equation for one and three dimensional conduction, and introduction to semi-infinite solid and critical radius of lagging, Problems	8 **Hrs.**
Unit 2:--- Principlesofheatflowinfluids: Typicalheatexchange equipment,co-currentand countercurrentflow.Energy balances,rateofheattransfer,overallandindividualheattransfer coefficient. Calculationofoverallheattransferco-efficientsfromindividualheattransfer coefficientsfoulingfactors.Transferunitsinheatexchangers,Problems.	8**Hrs.**
Unit 3:--- :--- Heattransfertofluids withoutphasechange:, Thermalboundary layer,heattransferby forced convection inlaminarflow.Heattransferbyforcedconvectioninturbulentflow, Heat transferintransition region, heat transferbyforced convection outsidetubes,naturalconvection,Problems.	**8Hrs.**
Unit 4:--- Heat transfer to fluids with phase change Heat transfer from condensing Vapors, drop wise and film wise condensation,. Heat transfer to boiling liquids : Types of boiling, boiling of saturated liquid maximum flux and critical temperature drop, minimum heat flux film boiling and sub cooled boiling	8 **Hrs.**
Unit 5:--- Heat exchange equipment Types of heat exchangers, single and multipass exchangers, correction of LMTD for multipass exchangers. Simple design calculations of heat exchangers.	8**Hrs.**
Unit 6:--- :--- Evaporation Types of evaporators, Performance of tubular evaporator-capacity, economy, enthalpy balances for single and multiple effect evaporators, Methods of feeding, Single and multiple effect calculations.	8 Hrs.

Textbooks:

1. 'Bioprocess Engineering Principles' Pauline M. Doran, Elsevier Science & Technology Books, May 1995
2."Unit Operations of Chemical Engineering", McCabe, W. L.,Smith, J. C., and Harriott,P., McGraw-Hill, 6th.Ed., 2001

References:

1. Holman J.P.,"Heat Transfer", McGraw-Hill, 9th.Ed., 2002
2. Dutta B.K.,"HeatTransfer:Principles and Applications",PHI, 2001
3. Kern D. Q.,"Process Heat Transfer", Tata McGraw-Hill Edition, 1997

4. Coulson, J.M., Richardson, J.F.,"ChemicalEngineering",Vol. I.,Pergamon and ECBS, 1970.
5. Chapman,A.J."Heat Transfer", 4th edn. Maxwell Macmillan International Edition, 1984.
6. Holman, J.P.,"HeatTansfer", 9th edn. The McGraw-Hill Companies, 2008.

Unit wise Measurable students Learning Outcomes:

1. Student should able to apply Basic laws of heat transfer, to derive different equations
2.Student should able to write energy balances and calculate rateofheattransfer,overallandindividualheattransfer coefficient.
3. Student should able to solve problems on heattransferbyforcedconvectioninlaminarflow andforcedconvectioninturbulentflow.
4. Student should able to solve problems onHeat transfer to fluids with phase change.
5. Students should able to design (process design) heat exchange equipments like Double pipe heat exchanger, Shell and tube heat exchanger.
6**.** Students should able to calculate heat transfer area for single effect and multiple effect evaporation system

Title of the Course: IMMUNOLOGY	**L**	**T**	**P**	**Credit**
Course Code: UBIO0403	**4**	**-**	**-**	**4**

Course Pre-Requisite: Students admitted for this course will be expected to have sufficient background knowledge of Cell biology & general biology.

Course Description:The course covers central topics in immunology .The focus is on the immune system in health & disease situations where faulty B:T cell interactions are involved. Thus, central topics are hypersensitivity, autoimmunity and cancer immunology. Furthermore, attempts to manipulate the immune response are described. The course also integrates general immunology and cell biology, with a focus on antigen presentation. The topics are presented as lectures, and the students are required to read review articles as well as a textbook in immunobiology. Each student presents a research article for the group.

Course Learning Objectives:
1. To write the structure, component, function and mechanism of immune system.
2. Primary emphasis of this course is to explain mechanisms involved in immune system development and responsiveness
3. To demonstrate the fundamental concepts of immunology and the associated vocabulary
4. To identify & apply immunological knowledge to solving new problem
5. To become proficient with selection & the use of the major investigation tools in immunology
6. To become comfortable discussing immunological ideas with various audiences

Course Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's taxonomy level

CO1	Recall the immune System , the immunotechnology and its applications to Biotechnology	Knowledge
CO2	Explain recall the immune System & the immunotechnology applications	Comprehension
CO3	Construct the immunodiagnostics setup for a industry or diagnostic kit	Application
CO4	Justify to innovate and patent a immunodiagnostic idea, instrument or kit	Analysis
CO5	Combine antigen –antibody interactions, work in immunology R & D Lab, Industry	Synthesis
CO6	Discuss immunological ideas with various audiences such as evaluate, defend, criticize, conclude & summarize	Evaluation

CO-PO-PSO Mapping:

Course Objective	**Programme Outcomes**												**Programme specific outcome**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO**	**PSO**	**PSO**
CO1	3				2										
CO2	3														
CO3			2			2		2	2	3					
CO4		2	2			2	3		2	3					
CO5		3			2						2				
CO6	3			2	3				2	2					

Assessments :

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Unit 1:--- Outlines of Immunology - Types of Immunity, Primary and Secondary lymphoid organs, Antigen structure and Function, Antibody structure and Function	8 **Hrs.**
Unit 2:--- Immune Response - Cells of Immune system- Macrophages, T cells, B Cells, NK Cells, Mast cells. MHC and its significance. Subtypes of T Cells and their functions: Cytotoxic T cells, Helper T cells, Suppressor T cells and Regulatory T cells. Cytokines and their biological role; Phagocytosis; Humoral and Cell mediated Immune Response	8 **Hrs.**
Unit 3:--- Immunity of diseases - CD4 and CD8 mediated antibacterial, antihelmenthic, antiviral immunity. Hypersensitivity Type I, II, III, IV	8 **Hrs.**
Unit 4:--- Transplantation and Tumor Immunity -Transplantation - immunological basis of graft rejection, Immunological tolerance sub- acute, acute and chronic graft rejection Tumor immunology – ADCC, natural killer cell and CTL mediated Immunity	8 **Hrs.**
Unit 5:--- Autoimmune diseases and Immunodeficiencies - SLE, Rheumatoid Arthritis. T cell mediated immunodeficiency,B cell mediated immunodeficiency,T/ B combined cell mediated immunodeficiency,Disorders of phagocytosis, Disorders of complement	8 **Hrs.**
Unit 6:--- Immune Techniques - Antigen – Antibody interactions- cross reactivity, precipitation, agglutination, neutralization, opsonizationetc and their applications	8 **Hrs.**

Textbooks:

1. Immunology: Lydyard, P.M., Whelan,A., Fanger, M.W. , 1st Ed., Viva Books
2. Essential Immunology, Roitt, I.M., 9th Ed. (1997), Blackwell Scientific, Oxford, UK
3. Immunology, Kuby, J. 3rd Ed. (1997), Freeman, W.H. ,Oxford, 4^{th} , 5^{th}& 6^{th} Edition.
4. Cellular and molecular Immunology – Abbas A.K., Lichtman A.H. and Pober, J.S.
5. Fundamental Immunology – Paul
6. Immunobiology 3rd ed. – Janeway Travers C. Janeway, et al., Garland Science, 2004.
7. Short Protocols in Immunology by John E. Coligan
8. Practical Immunology, 4th Edition, Frank C. Hay, Olwyn M.R. Westwood

References: 1. Fundamental immunology, fifth edition, Edited by William E Paul , Lippincott Williams & Wilkins, Philadelphia, 2003.

Unit wise Measurable students Learning Outcomes:

After completing the course students will:

1. Have a detailed understanding of lymphnode microanatomy and know how B and T cells encounter antigen and develops in different locations.
2. Know antigen presentation and autophagy on a detailed molecular level
3. Understand immunology of mucosal surfaces and the interplay between commensal flora and the immune system in the gut
4. Have a in depth knowledge of the cellular and molecular basis for autoimmune disease and allergies.
5. Have basic knowledge of tumor immunology and the development of novel recombinant antibodies for treatment of cancer and autoimmune disease
6. Gain in depth knowledge of a relevant field of immunological research and critically discuss this with the group.

Title of the Course: GENETIC ENGINEERING	L	T	P	Credit
Course Code: UBIO0404	4	-	-	4

Course Pre-Requisite: Student must have a knowledge of basic Molecular Biology

Course Description: Course contain basic processes used in Genetic Engineering ,Gene Manipulation techniques and their applications

Course Objectives The student will be able to:

1) To define Biohazards and bioethics as well as need of Genetic Engg.
2)To categorize, select and use most suitable enzymes as well as vectors for gene manipulation
3) To explain and apply the basic principles of cloning, genetic manipulations and DNA library
4) To analyze and design various molecular techniques for r DNA technology
5) To evaluate heterologous protein expression and applications in Protein Engineering

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's taxonomy level
CO1	Define Biohazards and bioethics as well as need of Genetic Engineering	Define
CO2	Categorize, select and use most suitable enzymes as well as vector manipulation	Categorize
CO3	Explain and apply the basic principles of cloning, genetic manipul DNA library	Apply
CO4	Analyze and design various molecular techniques for r DNA technology	Analyze
CO5	Evaluate heterologous protein expression and host expression system	Evaluate

CO-PO-PSO Mapping:

Course Objective	Programme Outcomes												Programme specific outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO12	PSO	PSO	PSO

CO1	3						3		2		3		3		
CO2	3	3	2	3									3		
CO3	2	3	3	3									3		
CO4	2	3	3	3	3	2			2	3	2	2	3		
CO5	3	2	2	3								2	3		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: Recombinant DNA technology The recombinant DNA concept, Important Discoveries, Principles of cloning, Biohazards; risk for human health, environment, agriculture, interaction with non-target organism and Bioethics of Genetic Engineering	4 **Hrs.**
Unit 2: The Tools – Enzymes Enzymes; Nucleases, Restriction Endonucleases Type I, II, III, star activity, isoschizomersPhosphodiesterase, Polynucleotide kinase, DNA ligase, DNA polymerase I, Reverse transcriptase, Terminal deoxynucleotidyltransferase, Poly A polymerase.	8 **Hrs.**
Unit 3: The Tools – Vectors Vector Systems -*E coli* systems – the host cells,Plasmid Vectors, Bacteriophage vectors, Plasmid-Phage combination vectors, Eukaryotic Host-Vector Systems: Yeast, Animals, Plants.	10 **Hrs.**
Unit 4: The Means: Constructing, Cloning, and Selecting Restriction Mapping, Inserts, Ligating vectors to insert, Infection, Transfection, and Cloning, Screening Cloned Populations of Recombinants, Genomic Libraries:- construction of genomic library, cDNA library: isolation of mRNA, synthesis of cDNA screening of cDNA clone.	8 **Hrs.**
Unit 5: Molecular research procedures DNA sequencing techniques; Maxam and Gilbert's chemical degradation method, Sanger and Courlson'sdideoxynucleotide chain termination method, PCR and its types, Blotting Techniques; southern, northern and western blotting Gene silencing	8 **Hrs.**

techniques, RNAi, Knockout Technology.	
Unit 6: Methods of protein engineering Random and Site directed mutagenesis, PCR and error PCR based strategies for protein engineering, DNA/Gene Shuffling, Directed molecular evolution strategy-Phage Display systems, Cell Surface display systems.	6 **Hrs.**

Textbooks:

1.Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard J. Glick, Jack J. Pasternak, Cheryl L. Patten (American Society for Microbiology)
2. Genes VIII – Benjamin Lewin (Benjamin Cummings)
3. Molecular Biology – David Freifelder (Jones and Bartlett Publishers International)
4. Principles of gene manipulations – Old RW and Primrose SB (Wiley-Blackwell)
5. Recombinant DNA: A short course: By J D Watson, J Tooze and D T Kurtz. Scientific American books (W H Freeman)
6. A textbook of biotechnology- R.C. Dubey (S. Chand publications)

References:

1] Molecular biology of the Cell - Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (Garland Science)
2] Molecular Biology of the Cell– by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter (Garland Science)
3] Genes and Genomes – Singer M and Berg P (uscibooks)

Unit wise Measurable students Learning Outcomes:

1) Student will be able to understand various Biohazards and Bioethics and basic concepts of Genetic Engineering
2) The student will be able to use different enzymes required for genetic manipulation
3) The student will be able to design various DNA cloning vectors required for genetic manipulation
4) The student will be able to explain basic Principles, components and applications in Genetic Engineering
5) The student will be able to explain basic characteristics of cloned DNA by screening and molecular techniques.
6) The student will be able to understand Prokaryotic and eukaryotic gene expression and their relevance to applications.

Title of the Course: Bioinformatics	**L**	**T**	**P**	**Credit**
Course Code: UBIO0405	3	-	-	3

Course Pre-Requisite: Biochemistry, Molecular Biology, Genetic Engineering, Chemistry, Mathematicsand Computer Literacy.

Course Description:
Bioinformatics- an emerging field which integrates knowledge and application of biology,

information technology and computer science for collection, organisation, analysis, manipulation, presentation and sharing of biological data to solve biological problems.

This subject provides information of biological databases, basics of matrices, molecular phylogenetics, various applications of bioinformatics and various soft-wares to be used in Bioinformatics.

Course Learning Objectives:

1. To introduce students to the importance,opportunities and challenges of Bioinformatics.
2. To impart the understanding of databases of Bioinformatics and also discuss the differences between various databases.
3. To learn and demonstrate tools of bioinformatics like BLAST, FASTA, Clustal Wetc.,and to access various sequences for study.
4. To propose the tools required to answer the questions related to evolutionary relationship studies, plasmid mapping,etc.
5. To provide the opportunity to think, apply the tools and methods used in the course eg: to address the issues related to molecular interactions, evolutionary studies.

Course Outcomes:

CO	After the completion of the course the student should be able to	Bloom's taxonomy level
CO1	Explain the importance,opportunities and challenges of Bioinformatics.	Understand
CO2	To describe the understanding of databases of Bioinformatics and also discuss the differences between various databases.	Comprehension
CO3	To demonstrate tools of bioinformatics like BLAST, FASTA, Clustal Wetc., to access various sequences for study.	Apply
CO4	To propose the tools required to answer the questions related to evolutionary relationship studies, plasmid mapping, etc.	Evaluate
CO5	To think, apply the tools and methods used in the course eg: to address the issues related to molecular interactions, evolutionary studies.	Identify

CO-PO-PSO Mapping:

Course Objective	Programme Outcomes												Programme specific outcome		
	PO1	PO	PO3	PO4	PO	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1												3	2		
CO2	3	3		2	3				2		2	3	3		
CO3	3	3		3	3	3	3	3	3	2	2	3	3		
CO4	3	3		3	3	3	2	3	3	2	2	3	3		
CO5	3	3	3	3	3	3	2	3	3	2	2	3	3		

Assessments :

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10

MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Introduction to Bioinformatics History, importance, opportunities and challenges of Bioinformatics.	**4 Hrs.**
Unit 2:--- Introduction to Databases Primary sequence databases, Secondary sequence databases, Composite sequence databases, Structural (Protein) databases, Bibliographic databases, Taxonomic Databases, Derived database -SCOP, CATH, PROSITE, PRINTS, BLOCKS, Pfam	8**Hrs.**
Unit 3:--- Importance of Databases NCBI (Entrez),EBI,CIB, DDBJ, Genbank, EMBL,SWISSPROT, PDB, PROSITE, PIR, TREMBL, KEGG.	**8 Hrs.**
Unit 4:---- Sequence Alignment Concept: Homology vs Similarity, Similarity vs Identity.Introduction of sequence alignment-local and Global alignments, Types of Sequence alignment - Pairwise and Multiple sequence alignment (Clustal-W), Alignment algorithms (Needleman-Wunsch algorithm and Smith-Waterman algorithm), Scoring matrices, Statistical significance of sequence alignment.	**8 Hrs.**
Unit 5:--FASTA, BLAST, MATRICES AND MOLECULAR PHYLOGENETICS FASTA, BLAST and its types, PAM and BLOSUM Matrices, Phylogenetics: Distance based methods (MP and ML methods), Bootstrappig, Jackkniffing (subtree reliability evaluation).	**8 Hrs.**
Unit 6:--- Applications of Bioinformatics Human Genome Project,ExPASY(a resource portal), Homology Modelling, Molecular docking, Drug discovery, Chemo-informatics, Health-informatics, Microarray Technology, Plasmid Mapping, Primer design, Use of Clustal-W for Phylogenetic analysis,etc.	6 Hrs.

Textbooks:

1. Bioinformatics: Methods and Applications- Rastogi S. C., N. Mendiratta., P Rastogi.
2. Bioinformatics: Databases, Tools, Algorithms ,BosuDripta,Thukral S.K., Oxford Univ Press , New Delhi
3. Fundamentals of Bioinformatics by S. Harisha, I K Internationl Delhi.

Reference Books:

1.Bioinformatics: sequence and genome analysis by David Mount, cold springer harbour press, 2004.
2. Introduction to bioinformatics – T.K. Attwood and Parry-Smith D.J.

Unit wise Measurable students Learning Outcomes:

1.Student should able to explain the importance, opportunities and challenges of Bioinformatics.

2.Student should able to identify the differences between primary and secondary databases databases.

3.Student should able to explain the importance of databases and use them when necessary.

4.Student should able to explain the concepts,types and alignment algorithms related to sequence alignment.

5.Student should able to explain the softwares required for sequence alignment, also should know the concept of molecular phylogenetics.

6. Student should able to explain the wide range of applications of Bioinformatics.

Title of the Course: Heat Transfer (Lab) **Course Code:**UBIO0431	**L**	**T**	**P**	**Credit**
	0	**0**	**2**	**1**

Course Pre-Requisite: The prerequisites for this course are very basic knowledge in thermodynamics and detail concepts in fluid mechanics.

Course Description: To understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries.

Course Learning Objectives:

1. To acquire practical knowledge about basic modes of heat transfer.
2. To understand basic principles involved in various heat transfer operations.
3. To have knowledge about different types of heat exchange equipment and their successive use in biotech industry.

Course Outcomes:

CO	After the completion of the course the student should be able to	Bloom's taxonomy level
CO1	Demonstrate basic heat transfer modes.	Understanding
CO2	Find experimentally thermal conductivity of various materials.	Understanding
CO3	To find experimentally heat transfer coefficient for natural and forced convection	Application
CO4	To determine experimentally effectivenessof double pipe heat exchangers for parallel and counter flow.	Application

CO-PO Mapping:

Course Objective	Programme Outcomes												Programme specific outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2	3														
CO3	3														
CO4	3												2		

Assessments :

One component of In Semester Evaluation (ISE) and ESE having 50% weightage respectively

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE –Assessment based on oral examination.

Course Contents:

Experiment No. 1:---Heat transfer in metal rod **Aim and Objectives:** To determine thermal conductivity of metal	2-- **Hrs.**
Experiment No. 2:--- Heat transfer through insulating powder **Aim and Objectives:**To determine thermal conductivity of insulating powder	-2- **Hrs.**
Experiment No. 3:--- Double pipe heat exchanger **Aim and Objectives:** To determine experimentally Log Mean Temperature Difference (LMTD), Overall heat transfer coefficient (U) and Effectiveness (ε) of Parallel flow and Counter flow Heat Exchangers	2-- **Hrs.**
Experiment No. 4:--- Shell & tube heat exchanger **Aim and Objectives;**To explain construction and working of shell and tube heat exchanger	2-- **Hrs.**
Experiment No. 5:--- Forced convection **Aim and Objectives:** To determine average heat transfer coefficient in forced convection between hot air and cylinder during internal flow	2-- **Hrs.**

Experiment No. 6:---Natural convection **Aim and Objectives:** To determine heat transfer coefficient for a vertical heated cylinder loosing heat by natural/free convection.	2-- **Hrs.**
Experiment No. 7:---Heat transfer through Lagged pipe **Aim and Objectives:** To determine thermal conductivity of insulating material used in lagged pipe and plot the radial temperature distribution	2-- **Hrs.**
Experiment No. 8:---Heat transfer through composite wall **Aim and Objectives:** To determine the equivalent thermal resistance of composite wall	2-- **Hrs.**

Textbooks:

Textbooks:

1. 'Bioprocess Engineering Principles' Pauline M. Doran, Elsevier Science & Technology Books, May 1995.
2. "Unit Operations of Chemical Engineering", McCabe, W. L.,Smith, J. C., and Harriott,P., McGraw-Hill, 6th.Ed., 2001.

References:

1] Holman J.P.,"Heat Transfer", Mc Graw-Hill, 9th.Ed., 2002.
2]Dutta B.K.,"HeatTransfer:Principles and Applications",PHI, 2001.
3]Kern D. Q.,"Process Heat Transfer", Tata Mc Graw-Hill Edition, 1997.
4]Coulson, J.M., Richardson, J.F.,"ChemicalEngineering",Vol. I.,Pergamon and ECBS, 1970.
5] Chapman,A.J."Heat Transfer", 4th edn. Maxwell Macmillan International Edition, 1984.
6] Holman, J.P.,"HeatTansfer", 9th edn. The McGraw-Hill Companies, 2008.

Experiment wise Measurable students Learning Outcomes:

1.Student should able to determine thermal conductivity using different experimental setups.
2. Student should able to compareEffectiveness (ε) of Parallel flow and Counter flow double pipe Heat Exchangers
3.Student should able to calculateaverage heat transfer coefficient in forced convection between hot air and cylinder during internal flow
4. Student should able to calculate heat transfer coefficient for a vertical heated cylinder loosing heat by natural/free convection.

Title of the Course: Immunology (Lab) **Course Code:**UBIO0432	**L**	**T**	**P**	**Credit**
	0	**0**	**2**	**1**

Course Pre-Requisite: Students admitted for this course will be expected to have sufficient background knowledge of Cell biology & general biology.

Course Description:

The course covers central topics in immunology .The focus is on the immune system in health & disease situations where faulty B:T cell interactions are involved. Thus, central topics are hypersensitivity, autoimmunity and cancer immunology. Furthermore, attempts to manipulate the immune response are described.The course also integrates general immunology and cell biology, with a focus on antigen presentation.The topics are presented as lectures, and the students are required to read review articles as well as a textbook in immune-biology. Each student presents a research article for the group.

Course Learning Objectives:

1.To write the structure, component, function and mechanism of immune system.

2. Primary emphasis of this course is to explain mechanisms involved in immune system development and responsiveness

3.To demonstrate the fundamental concepts of immunology and the associated vocabulary

4. To identify & apply immunological knowledge to solving new problem

5. To become proficient with selection & the use of the major investigation tools in immunology

6. To become comfortable discussing immunological ideas with various audiences

Course Outcomes:

CO	After the completion of the course the student should be able to	Bloom's taxonomy level
CO1	Students will be able to recall the immune System , the immunotechnology and its applications to Biotechnology	Knowledge
CO2	Students will be able to explain recall the immune System & the immunotechnology applications	Comprehension
CO3	Students will be able construct the immunodiagnostics setup for a industry or diagnostic kit	Application
CO4	Students will be able to justify to innovate and patent a immunodiagnostic idea, instrument or kit	Analysis
CO5	Students will be able to combine antigen –antibody interactions, work in immunology R & D Lab, Industry	Synthesis
CO6	Students will be comfortable discussing immunological ideas with various audiences such as evaluate, defend, criticize, conclude & summarize	Evaluation

CO-PO Mapping:

Course Objective	Programme Outcomes												Programme specific outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	2	1	1	1	1	1	1				
CO2	3	1	1	1	1	1	1	1	1	1	1				
CO3	1	1	2	1	1	2	0	2	2	3	1				
CO4	1	2	2	1	1	2	3	0	2	3	1				
CO5	1	3	1	1	2	1	1	1	1	1	2				
CO6	3	1	1	2	3	1	0	1	2	2	1				

Assessments :
One component of In Semester Evaluation (ISE) and ESE having 50% weightage respectively

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.
ESE –Assessment based on oral examination.

Course Contents:

Experiment No. 1:---Precipitation assay **Aim and Objectives:** To perform Precipitation assay	2-- **Hrs.**
Experiment No. 2:--- To examine the cells that comprise the immune system (counts and morphology) **Aim and Objectives:** To perform theexamination of the cells that comprise the immune system (counts and morphology)	-2- **Hrs.**
Experiment No. 3:--- Immunization, collection of serum. **Aim and Objectives:** To perform Immunization, collection of serum.	2-- **Hrs.**
Experiment No. 4:--- Immunological detection of blood group typing.(A,B, AB and O, Rh Factor) **Aim and Objectives:** To perform blood group typing.	2-- **Hrs.**
Experiment No. 5:--- Ouchterlony double diffusion **Aim and Objectives:** To performOuchterlony double diffusion	2-- **Hrs.**
Experiment No. 6:---Radial immunodiffussion **Aim and Objectives:** To performRadial immunodiffussion	2-- **Hrs.**
Experiment No. 7:---Immunoelectrophoresis **Aim and Objectives:**To performImmunoelectrophoresis	2-- **Hrs.**
Experiment No. 8:---ELISA **Aim and Objectives:**To perform ELISA	2-- **Hrs.**
Experiment No. 9:---Western blotting **Aim and Objectives:**To perform western blotting	2-- **Hrs.**
Experiment No. 10:---Detection of pregnancy by HCG technique **Aim and Objectives:**To perform HCG technique	2-- **Hrs.**
Experiment No. 11:---Purification of Immunoglobulin G with DEAE Column Chromatography **Aim and Objectives:**To perform purification of Immunoglobulin G with DEAE Column Chromatography	2-- **Hrs.**
Experiment No. 12:---Immunohistochemical detection and localization of specific antigens. **Aim and Objectives:**To performImmunohistochemical detection and localization of specific antigens.	2-- **Hrs.**

Textbooks:

1. Short Protocols in Immunology by John E. Coligan
2. Practical Immunology, 4th Edition, Frank C. Hay, Olwyn M.R.

Reference Books:

1]Fundamental Immunology – Paul

2] Immunology, Kuby, J. 3rd Ed. (1997), Freeman, W.H.,Oxford, 4^{th} , 5^{th} & 6^{th} Edition.

Experiment wise Measurable students Learning Outcomes:

1Student should able toperform Precipitation assay
2Student should able to perform the examination of the cells that comprise the immune system (counts and morphology)
3Student should able to perform Immunization, collection of serum
4 Student should able to perform blood group typing.
5 Student should able to perform Ouchterlony double diffusion
6 Student should able to perform Radial immunodiffussion
7 Student should able to perform Immunoelectrophoresis
8 Student should able to perform ELISA
9 Student should able to perform western blotting
10 Student should able to perform HCG technique
11 Student should able to perform purification of Immunoglobulin G with DEAE Column Chromatography.
12 Student should able toperformImmunohistochemical detection and localization of specific antigens.

Title of the Course: GENETIC ENGINEERING	**L**	**T**	**P**	**Credit**
Course Code: UBIO0433	**-**	**-**	**2**	**1**

Course Pre-Requisite: Student must have a knowledge of basic Molecular Biology

Course Description: Course contain basic processes used in Genetic Engineering ,Gene Manipulation techniques and their applications

Course Objectives The student will be able to:

1) To perform restriction digestion and mapping of DNA
2)To demonstrate and design PCR reaction of nucleic acid
3) To explain and apply size determination of DNA or RNA
4) To analyze and perform transformation of DNA in *E. coli*

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Perform restriction digestion and mapping of DNA	cognitive	Define
CO2	Demonstrate and design PCR reaction of nucleic acid	Cognitive	Categorize
CO3	explain and apply size determination of DNA or RNA	Cognitive	Apply
CO4	Analyze and perform transformation of DNA in *E. coli*	Cognitive	Analyze

CO-PO-PSO Mapping:

Course Objective	Programme Outcomes												Programme specific outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO	PSO	PSO
CO1	3						3		2		3		3		
CO2	3	3	2	3									3		
CO3	2	3	3	3									3		
CO4	2	3	3	3	3	2			2	3	2	2	3		

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

Course Contents:

Experiment No. 1:--- Restriction digestion of DNA. **Aim:** To perform **r**estriction digestion of DNA. **Outcome:** DNA can be cleaved at specific site by RE enzymes and used for gene manipulation.	2 **Hrs.**
Experiment No. 2:--- Restriction mapping of Plasmid DNA. **Aim:** To perform **r**estriction mapping of Plasmid DNA. **Outcome:** DNA can be cleaved at specific site by RE enzymes and used for formation of restriction map of DNA.	2 **Hrs.**
Experiment No. 3:--- Demonstrate and Perform PCR reaction of nucleic acid. **Aim:** To demonstrate and perform PCR reaction of nucleic acid. **Outcome:** By using this advanced technique, specific segment of DNA can be amplified in vitro.	2 **Hrs.**
Experiment No. 4:--- Size determination of DNA or RNA **Aim:** To perform size determination of DNA or RNA. **Outcome:** Based on molecular marker and semi log graph size of unknown DNA	2 **Hrs.**

molecule can be determined.	
Experiment No. 5:--- Plant DNA from CTAB method **Aim:** To isolate plant DNA from CTAB method. **Outcome:** 1. To isolate plant DNA using CTAB method in purified form.	2 **Hrs.**
Experiment No. 6:--- Karyotyping of chromosomes **Aim:** To perform karyotyping of chromosomes **Outcomes:** Karyotype of chromosome is useful to identify genetic diseases and analysis.	2 **Hrs.**
Experiment No. 7:--- Transformation **Aim:** To prepare competent *E. Coli* cells for transformation **Outcome:** The bacterial culture get revived and treated with $Cacl_2$ for making them competent for transformation.	2 **Hrs.**
Experiment No. 8:--- Transformation and Screening transformants **Aim:**To perform transformation and screening transformants. **Outcome:** The bacterial cultures get transformed by heat shock treatment and later on screened for transformants by blue white screening.	2 **Hrs.**

Textbooks:

1.Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard J. Glick, Jack J. Pasternak, Cheryl L. Patten (American Society for Microbiology)
2. Genes VIII – Benjamin Lewin (Benjamin Cummings)
3. Molecular Biology – David Freifelder (Jones and Bartlett Publishers International)
4. Principles of gene manipulations – Old RW and Primrose SB (Wiley-Blackwell)
5. Recombinant DNA: A short course: By J D Watson, J Tooze and D T Kurtz. Scientific American books (W H Freeman)
6. A textbook of biotechnology- R.C. Dubey (S. Chand publications)

References:

1] Molecular biology of the Cell - Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (Garland Science)
2] Molecular Biology of the Cell– by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter (Garland Science)
3] Genes and Genomes – Singer M and Berg P (uscibooks)
4] Molecular Cloning Vol. I, II, III, 2002 Ed. – Sambrook & Rusell (Cold Spring Harbor University Publishing)

Experiment wise Measurable students Learning Outcomes:

1) Student will be able to **r**estriction digestion of DNA as basic concepts of Genetic Engineering
2) The student will be able to perform **r**estriction mapping of Plasmid DNA for genetic manipulation
3) The student will be able to design various DNA cloning vectors required for genetic manipulation
4) The student will be able to explain basic Principles, components and applications PCR.
5) The student will be able to isolate plant DNA using CTAB method in purified form.
6) The student will be able to perform karyotyping of camera lucida chromosomal image.
7) The student will be able to prepare competent *E. Coli* cells for transformation.
8) The student will be able to perform transformation and screening transformants.

Title of the Course: Bioinformatics (Lab)	L	T	P	Credit
Course Code:UBIO0434	0	0	2	1

Course Pre-Requisite:

1.The students should know the basics of molecular biology, genetic engineering
2. The students should have the basic understanding of sequences of nucleotides and structure of proteins.
3. The students should be compatible with the functioning of computers.

Course Description:

1.This course introducesstudents to the resource to access scientific data and bioinformatics tools
2. This course explains the retrieval of sequences from various databases.
3. This course compares between the different software tools to assess the sequence similarities and also software's for evolutionary studies.
4. This course deals tools used in protein visualization.

Course Learning Objectives:

1. To understand the basics of tools in the bioinformatics.
2. To exploit various software's for sequence retrieval and their analysis.
3. To analyse the differences in the sequences and multiple sequence alignment results.
4. To compare different platforms for sequence alignment and evolutionary studies.
5. To select the platforms for performing tasks to address the problems in Biotechnology.

Course Outcomes:

CO	After the completion of the course the student should be able to	Bloom's taxonomy level
CO1	Explain the basics of tools used in Bioinformatics.	Understanding
CO2	Make use of software's for sequence retrieval and their analysis.	Applying
CO3	Analyse the differences in the sequences and multiple sequence alignment results.	Analyzing
CO4	Compare different platforms for sequence alignment and evolutionary studies.	Evaluating
CO5	To choose the appropriate platform for performing tasks that addresses the problems in Biotechnology.	Creating

CO-PO Mapping:

Course Objective	Programme Outcomes												Programme specific outcome		
	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO12	PSO	PSO	PSO
CO1										3		3			
CO2	3	3		3	3	3	3		3	3	2	3	3		
CO3	3	3		3	3	3	3	3	3	3	2	3	3		
CO4	3	3		3	3	3			3	3	2	3	3		
CO5	3	3		3	3	3	3	3	3	2	2	3	3		

Assessments :

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	50
ESE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

Course Contents:

Experiment No. 1:---Introduction to NCBI **Aim:** To understand the features of NCBI **Objective** : To use Pubmed and PMC(retrieval of scientific literature) **Outcomes:** The student will be able to explain the features of NCBIand demonstrate the retrieval of scientific literaturefrom NCBI.	2-- **Hrs.**
Experiment No. 2:---Retrieving sequence records with NCBI (Entrez) , EMBL,PROSITE,SWISSPROT,etc. **Aim:** To retrieve nucleotide and protein sequence. **Objectives:** Toretrieve nucleotide and protein sequence from Entrez and EMBL. **Outcomes:** The student will be able to demonstratethe retrieval of at least one nucleotide and one protein sequence of his/her choice from Entrez and EMBL each.	-2- **Hrs.**
Experiment No. 3:---BLAST **Aim :** To study BLAST **Objectives**: To execute sequence similarity search using BLAST **Outcomes:** The student will be able to demonstratethe sequence similarity search of at least one nucleotide and one of his/her choice using BLAST	2-- **Hrs.**
Experiment No. 4:---FASTA **Aim :** To study FASTA **Objectives**: To execute sequence similarity search using FASTA **Outcomes:** The student will be able to demonstratethe sequence similarity search of at least one nucleotide and one of his/her choice using FASTA	2-- **Hrs.**
Experiment No. 5:---CLUSTAL-W. **Aim :** To study multiple sequence alignment (rooted and unrooted trees) **Objectives**: To execute multiple sequence alignment with minimum 3 sequences (nucleotides and proteins) **Outcomes:** The student will be able to demonstrate multiple sequence alignment with minimum 3 sequences (nucleotides and proteins) of his/her choice.	2-- **Hrs.**
Experiment No. 6:---Protein structure visualization. **Aim :** To study PDB, Rasmol/Pymol for protein structure visualization. **Objectives**: To execute the structure visualization of protein. **Outcomes:** The student will be able to demonstrate the structure visualization of proteins of his/her choice using Rasmol/Pymol.	2-- **Hrs.**
Experiment No. 7:---DAMBE software (XiaLab) **Aim :**To study codon adaptation Index (CAI) and sequence alignment using DAMBEsoftware.	2-- **Hrs.**

Objectives: To execute codon adaptation index (CAI) of the sequence of his/her Interest. **Outcomes:** The students will be able to demonstrate CAI, sequence alignment using DAMBE software.	
Experiment No. 8 :--- DAMBE software : Sequence alignment **Aim:**To study sequence alignment using DAMBE. **Objectives** : 1) To perform sequence alignment using DAMBE software. **Outcomes:** The students will be able to demonstrate sequence alignment using DAMBE software.	2-- **Hrs.**

Textbooks:

1. Bioinformatics Theory and Practice ,Chikhale N.J., Gomas V.S., Himalaya Pub. House, Mumbai
2. Baxevanis, A. D. and Ouellette, B, F, F.: Bioinformatics: A practical guide to the analysis of genes and Proteins. 2nd Ed..2002. John wiley and ons, Inc. publications, New York.
3. DAMBE software manual.

Reference Books:

1.Bioinformatics: sequence and genome analysis by David Mount, cold springer harbour press, 2004.

2. Introduction to bioinformatics – T.K. Attwood and Parry-Smith D.J.

Experiment wise Measurable students Learning Outcomes:

Experiment No.1: The students will be able to explain the features of NCBI and demonstrate the retrieval of scientific literaturefrom NCBI.

Experiment No.2: The students will be able to demonstratethe retrieval of at least one nucleotide and one protein sequence of his/her choice from Entrez and EMBL each.

Experiment No.3: The students will be able to demonstratethe sequence similarity search of at least one nucleotide and one of his/her choice using BLAST.

Experiment No.4: The students will be able to demonstratethe sequence similarity search of at least one nucleotide and one of his/her choice using FASTA.

Experiment No.5: The students will be able to demonstrate multiple sequence alignment with minimum 3 sequences (nucleotides and proteins) of his/her choice.

Experiment No.6: The students will be able to demonstrate the structure visualization of proteins of his/her choice using Rasmol/Pymol.

Experiment No.7: The students will be able to demonstrate CAI, sequence alignment using DAMBE software.

Experiment No. 8: The students will be able to demonstrate sequence alignment using DAMBE software.

Title of the Course: Audit Course – I: Environmental Studies **Course Code:** UBIO0461	**L**	**T**	**P**	**Credit**
	2	-	-	Audit Course

Course Pre-Requisite:

Students shall have knowledge of:

- Science
- Technology

Course Description:

The objective of the course is imparting fundamental knowledge and awareness of Environmental science among students *and importance of conservation of environment.*

Course Objectives:

At the end of the course students will be able to

1. Study scope and importance of natural resources, ecosystems, biodiversity for creating awareness and their conservation in multiple disciplines.
2. Learn various types of pollution, their impacts and control measures for minimizing pollution and sustainable development.
3. Understand social issues related environment, environmental ethics and human rights towards environment.
4. Study various laws & regulations related to environment and its applicability in society and industries.
5. Choose one of the sectors of environment for detail study as project.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Descriptor**
CO1	Describe natural resources, importance of ecosystem & conservation of biodiversity with respect to multiple disciplines.	Cognitive
CO2	Explain causes, effects, solutions for various pollution problems and its minimization strategies.	Cognitive
CO3	Discuss environmental ethics & their implementation for betterment of environment & human life.	Cognitive
CO4	Differentiate between requirements of laws & regulations for environmental conservation and applicability of legislations in society and industries.	Cognitive
CO5	Prepare detailed project report on selected topic based on environmental issues/problems.	Cognitive

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1							2					
CO2	3											

CO3								2				
CO4						2						
CO5										2		

Assessments :

Assessment	Weightage (Marks)
ESE	50

ESE: Assessment is based on 100% course content.

Course Contents:

Module 1:Nature of Environmental Studies Definition, scope and importance, Multidisciplinary nature of environmental studies, Need for public awareness.	**4 Hours**
Module 2: Natural Resources and Associated Problems a) Forest resources: Use and over-exploitation, deforestation, dams and their effects on forests and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams benefits and problems. c) Mineral resources: Usage and exploitation. Environmental effects of extracting and using mineral resources. d) Food resources: World food problem, changes caused by agriculture effect of modern agriculture, fertilizer-pesticide problems. e) Energy resources: Growing energy needs, renewable and nonrenewable energy resources, use of alternate energy sources. Solar energy, Biomass energy, Nuclear energy. f) Land resources: Solar energy , Biomass energy, Nuclear energy, Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individuals in conservation of natural resources.	**4 Hours**
Module 3: Ecosystems Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers. Energy flow in the ecosystem, Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristics features, structure and function of the following ecosystem :- a) Forest ecosystem, b) Grassland ecosystem, c) Desert ecosystem, d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).	**6 Hours**
Module 4:Biodiversity and its conservation Introduction- Definition: genetic, species and ecosystem diversity. Bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. India as a mega- diversity nation, Western Ghat as a biodiversity region. Hot-spot of biodiversity. Threats to biodiversity habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	**6 Hours**

Module 5:Environmental Pollution Definition: Causes, effects and control measures of: Air pollution, Water pollution, soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of a individual in prevention of pollution.	**6 Hours**
Module 6: Social Issues and the Environment Disaster management: floods, earthquake, cyclone, tsunami and landslides. Urban problems related to energy Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issue and possible solutions. Global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products.	**8 Hours**
Module 7:Environmental Protection From Unsustainable to Sustainable development. Environmental Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Population Growth and Human Health, Human Rights.	**8 Hours**

Textbooks:

1. Environmental Studies by Dr. P.D.Raut (Shivaji University, Kolhapur)

References:

1. Miller T.G. Jr., Environmental Science. Wadsworth Publications Co.(TB).
2. Odum, E.P.1971, Fundamentals of Ecology, W.B.Saunders Co. USA,574p
3. Trivedi R.K. Handbook of Environmental Laws, Rules, Guidelines,Compliances and Standards, vol. I and II, Environmental Media (R)

Unit wise Learning Outcomes:

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

UO 1	Describe scope and importance of environmental studies.
UO 2	Describe types of natural resources, their use and conservation.
UO 3	Explain structure and functions of ecosystem, their types and importance.
UO 4	Discuss biodiversity, endangered species and methods of biodiversity conservation.
UO 5	Explain causes, effects and solutions to pollution problems.
UO 6	Discuss environmental ethics and various social issues related to environment.
UO 7	Discuss laws and regulations for conservation of environment.