NORTH MAHARASHTRA UNIVERSITY,

JALGAON (M.S.)

Second Year Engineering

(Biotechnology Engineering)

Semester - III

Faculty of Science and Technology

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

COURSE OUTLINE

W.E.F. 2018 – 19

NORTH MAHARASHTRA UNIVERSITY, JALGAON

STRUCTURE OF TEACHING & EVALUATION

S.E. (BIOTECHNOLOOGY Engineering) W.E.F.2018-2019

Syllabus Structure for Second Year Engineering (Semester – III) (Bio. Tech.) (w.e.f. 2018 – 19)

Name of the Course	Group	Teaching Scheme				Evaluation Scheme					Credits
						Theory		Practical		Total	
		Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE	ESE	ICA	ESE		
Biology	B	3	1	-	4	40	60	-	-	100	4
Bioprocess Calculations	C	3	-	-	3	40	60	-	-	100	3
Unit Operations	C	3	-	-	3	40	60			100	3
Microbiology	D	3	-	-	3	40	60	-	-	100	3
Bioprocess Industrial Economics & Management	A	3	-	-	3	40	60	-	-	100	3
LAB Unit Operations	C	-	-	2	2	--	-	25	25 (OR)	50	1
LAB Microbiology	D	-	-	2	2	--	-	25	25 (PR)	50	1
LAB Good Manufacturing Practices	D	1	-	2	3	-	-	25	25 (OR)	50	2
		16	**1**	**6**	**23**	**200**	**300**	**75**	**75**	**650**	**20**

ISE: Internal Sessional Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

Syllabus Structure for Second Year Engineering (Semester – IV) (Bio. Tech.) (w.e.f. 2018 – 19)

Name of the Course	Group	Teaching Scheme				Evaluation Scheme					Credits
						Theory		Practical		Total	
		Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE	ESE	ICA	ESE		
Biostatistics	B	3	1	-	4	40	60	-	-	100	4
Process Heat Transfer	C	3	-	-	3	40	60	-	-	100	3
Immunology	D	3	-	-	3	40	60	-	-	100	3
Biochemistry	D	3	-	-	3	40	60	-	-	100	3
IPR& Entrepreneurship	A	3	-	-	3	40	60	-	-	100	3
Process Heat Transfer	-	-	-	2	2	-	-	25	-		1
LAB Immunology	-	-	-	2	2	-	-	25	25 (PR)	50	1
LAB Biochemistry	-	-	-	2	2	-	-	25	25 (PR)	50	1
LAB- Environmental Biotechnology	D	1	-	2	3	-	-	-	25 (OR)	50	2
Environmental Science*	H	-	-	-	-	-	-	-	-		
		16	**1**	**8**	**25**	**200**	**300**	**75**	**75**	**650**	**21**

*Environmental Studies will be applicable to the Direct Second Year Admitted Students Only

ISE: Internal Sessional Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

Biology					
COURSE OUTLINE					
Course Title:	*Biology*	**Short Title:**	*Bio*	**Course Code:**	

Course description:

This course is introduced for learning the basic fundamentals of Life sciences (zoology & Botany) to undergraduate students. The prospectus includes a prior knowledge of Biotechnology. The goals of the course are to understand the basic principles of Biology and its applications in the field of Engineering.

	Hours/week	**No. of Weeks**	**Total hours**	**Semester credits**
Lecture	03	14	42	04
Tutorial	01	14	14	

Prerequisite course(s):- ---

Course objectives:

1. Students will understand the structures and characteristics or functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
2. Students will learn the basic principles of inheritance at the molecular, cellular and Organism levels.
3. Students will test and deepen their mastery of genetics by applying this knowledge in a variety of problem-solving situations.

Course outcomes:

After successful completion of this course the student will be able to:

1. Use current techniques and analysis methods in molecular biology and genetics.
2. Understand the current concepts in Cell Biology, Stem Cell Biology and Development.
3. Know the structure/function of the basic components of prokaryotic and eukaryotic cells including macromolecules and organelles.
4. Demonstrate proficiency with at least one instrument commonly used in biological research (microscope, etc).

COURSE CONTENT

Name of the Subject: Biology		**Semester:**	III
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Diversity of Organism and Cell Biology

Introduction: Living systems, Bio-mimicry, Metabolism, Taxonomy, Concept of species, Structural organization of life, Concepts of modern cell, history of cell, Cell theory, Structure of cell:- Cell shape, size and cell number, Types of cells:- Prokaryotic cells and Eukaryotic cells,

Chemistry of cells.

Cell Division: Cell cycle, mitosis, meiosis, mitotic cell division, cell cycle check points, meiotic cell division, embryonic cell division, cell death.

Unit–II:	No. of Lectures: 08 Hours	Marks: 12

Plant and Animal Kingdom

Plant Kingdom:

Introduction to plants, Salient features of major plant groups: Bryophyta, Pteridophyta, Gymnospermae, Angiospermae,

Plant Growth & Development: Introduction, Seed Dormancy, Seed Germination, Phases of growth, Plant growth hormones.

Animal Kingdom:

Animal Classification, Salient features of non-chordates upto phylum level: Phylum porifera, phylum Cnidaria, Phylum Ctenophora, Phylum Platyhelminthes.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

Plant Cell and Animal cell culture and Applications

Plant Cell Culture:

Brief introduction to cell culture with respect to the properties of plant cells, Media requirements, Typical media used, Classification of tissue culture, callus culture, cell suspension culture, Application of callus culture and cell suspension culture, Plant cell cultivation Bioreactors

Animal Cell Culture:

Brief introduction to animal cell culture, Culture medium: Natural and Artificial media, introduction to balanced salt solutions and simple growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, Animal Bioreactors.

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

Microbial Culture and Applications:

Introduction, Microbial Culture Techniques, growth curve, Pure culture techniques – microbial culture media, isolation, identification and maintenance of cultures, incidences of microorganisms in soil, water, air, food and sewage, food spoilage organisms, Applications of Microbial Culture Technology.

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Biotechnology and its Applications:

Definitions, scope of Biotechnology, Recombinant DNA Technology: Making Recombinant DNA, Tools in Genetic Engineering, Polymerase Chain reaction (PCR).

Applications of Biotechnology:

Bioinformatics, Biomechanics, Biotechnology of waste treatment, Biosensors, Forensic science, Food Biotechnology, Fermentation Technology.

Text Books:

1. B.D. Singh " Genetics" Kalyani Publications Third Edition.
2. C.B. Pawar"Cell Biology" Himalaya Publications, Third Edition.
3. C.B. Pawar"Cell and Molecular Biology" Himalaya Publications.
4. Text book of Zoology by V.K. Agrawal, S. Chand Publication.
5. Text book of Botany by Dr. B.P. Pandey S. Chand Publication.

6. Text book of Biotechnology by R.C. Dubey, S. Chand Publications.

Reference Books:

1. P. K Gupta, Introduction to Biotechnology, Rastogi Publications.
2. B.D.Singh, Biotechnology: Expanding Horizons, Kalyani Publishers, New Delhi, Second Revised Edition, 2008.
3. S.S.Purohit, Biotechnology: Fundamentals and Applications, Agrobios (India), 4th Edition, 2005.
4. Andreas D. Boxevanis, Bioinformatics, Wiley International
5. David W. Mount, Bioinformatics: Sequence and Genome analysis, Cold Spring Harbour.
6. Bruce E Rittmann, Rurry L.Mc carty, Environmental Biotechnology:Principles and Applications, Mcgraw Hill international.
7. B. Sivashankar, Food Processing and Preservation, Prentice Hall ,India
8. Bhojwani, S.S.and Rajdan, Plant Tissue Culture: Theory and Practice, Revised Edition, Elsevier
9. Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005
10. M.J. Pelczar, Jr. E.C.S. Chan and N.R. Krieg, Microbiology 5th Ed., TMH Book Company.

Bioprocess Calculations					
COURSE OUTLINE					
Course Title:	*Bioprocess Calculations*	**Short Title:**	*BPCAL*	**Course Code:**	

Course description:

The goals of the course are to understand the basic principles of Bioprocess Calculations and their applications in different areas. It is highly essential to know the stoichiometry of the processes, conditions to achieve maximum product formation and recycle of the unused materials for better economy. Therefore, knowledge of process calculations is the first and foremost requirement for the success of a Biotechnology Engineering student

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):----

Course objectives:

1. To make the student familiar with the basic chemical calculations
2. To study the material balance of unit operations used in process industries.
3. To study the material balance of bioreactions.
4. To understand the energy balance of physical operations.
5. To understand energy balance of bioreactions.
6. To make student familiar with psychrometric chart, steam table etc.
7. To make the student familiar with combustion of fuels.

Course outcomes:

After successful completion of this course the student will be able to:

1. Differentiate between different units and dimensions and solve relevant problems.
2. Have the ability to identify, formulate and solve engineering problems.
3. Have gained fundamental skills in solving material balance problems with and without bioreactions.
4. Have gained fundamental skills in solving energy balance problems with and without bioreactions.
5. Understand humidity, humid heat, humid volume, dry-bulb temperature, wet-bulb temperature, psychometric chart & steam table.
6. Find out the energy requirements for combustion of fuels.

COURSE CONTENT			
Bioprocess Calculations		**Semester:**	III
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	No. of Lectures: 08 Hours	Marks: 12

Units & Dimensions:

Basic & Derived Units, Dimensional Analysis, Dimensional & Empirical Equations. Different Ways of Expressing Units of Quantities & Physical Constants.

Properties of Gases, Liquids &Solids: Ideal & Real Gas Laws, Critical Properties, Properties of Mixtures & Solutions , Kay's Rule.

Unit–II:	No. of Lectures: 08 Hours	Marks: 12

Material Balances without reaction:

Law of conservation of mass, Material balance of unit operations such as Distillation, Mixing, Filtration, Evaporation, Liquid -Liquid Extraction and Solid Liquid Extraction.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

Material Balances with reaction:

Concept of limiting &excess reactants, conversion, yield and Selectivity . Material Balance of biochemical reactions. Material balance with recycle, by pass and purge stream of Bioprocesses.

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

Energy balances:

Basic Energy Concept ,Units, Enthalpy, General Energy Balance equation ,Enthalpy Change in Non reactive Processes: sensible heat change, heat capacity, specific heat, sensible heat change with constant Cp, Change of Phase : Enthalpy of Condensations, Heat of solution, study of steam table, energy balance calculations without reaction, enthalpy change due to reaction, heat of combustion, heat of reaction for process with biomass production, heat of reaction with oxygen as electron acceptor, heat of reaction with oxygen not the electron acceptor, energy balance equation for cell culture, fermentation energy balance.

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Humidity & Combustion

Humidity & saturation, Define Humid Volume, Humid Heat, Dry bulb temperature, Wet bulb temperature etc. Psychometric chart. Combustion: Introduction, fuels, calorific value of fuels, air requirements.

Text Books:

1. Bhatt & Vora ,Stoichiometry :Tata McGraw Hill.
2. Shekhar Pandharipande and Samir Mushrif, Process Calculations. Pune Vidyarthi Griha Prakashan, Pune.
3. K.A. Gavhane, Stoichiometry, Nirali Publications.

Reference Books:

1. Prasad Rao& DVS Murthy ,Process Calculations for Chemical Engineers:McMillanIndia, New Delhi.
2. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press an Imprint of Elsevier.
3. Hougen O.A, Watson K.M, & Ragatz R.A. Chemical Process Principles Part-I Asia Publishing House, Mumbai.
4. Himmelblau D.M. Basic principles and calculations in Chemical Engineering, Prentice Hall Publication.

Unit Operations

COURSE OUTLINE

Course Title:	*Unit Operations*	**Short Title:**	*UO*	**Course Code:**	

Course description:

Course Description: The goals of the course are to understand the basic principles of fluid mechanics and their applications in different areas. The subject needs to be studied by the biotechnology students to understand the characteristics and properties of fluids as regards to the processing of raw ingredients in the industry. The subject also includes solids handling and process characteristics for solids to process in industrial operations.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	14	42	04

Prerequisite course(s): --

Course objectives:

1. To study fluid properties and dynamics of fluid flow.
2. To make the students analyze the flow measurement principles and equipments.
3. To study and classify different types of pumps, blowers and compressors.
4. To make the student familiar with properties of solid.
5. To understand separation technique and to understand laws of crushing and grinding.
6. To study the industrial importance of mechanical operations.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand the following terms in relation to fluid mechanics: viscosity, density, specific gravity, and surface tension. Measure the properties listed above for any given fluids.
2. Apply their knowledge to minimize head losses and evaluate flow through a pipe system by using different types of flow meters.
3. Understand the principles of manometer to calculate pressure of the fluids.
4. Understand the handling of solid and size reduction of solid.
5. Identify the separation technique.

COURSE CONTENT			
Unit Operations		**Semester:**	*III*
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Properties of Fluid

Definition of fluid, mass density, specific weight, specific volume, specific gravity .viscosity concept, viscosity measurement: cone and plate viscometer, use of viscometer with fermentation broths, factor affecting broth viscosity, surface tension, capillarity. Types of fluid: ideal fluid, real fluid, Newtonian and non Newtonian, ideal plastic fluid etc.

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Dynamics of Fluid Flow:

Continuity equation, Euler's equation of motion, Bernoulli's equations for different conditions. pressure measurements: Hydrostatic law. Pascal law, principle and types of manometer, Major and minor losses in pipes .

Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**

Flow through Pipeline:

Flow measurement: Flow through Orifice meter, Nozzle meter, venturi meters, Rotameter and Pitot tube. Reynolds experiment.

Pumping of Fluids: Pumping equipments: working and construction of the Reciprocating pump, Centrifugal pumps, Peristaltic pump. Introduction to Compressors and Blowers.

Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**

Solids and Their Handling:

Properties of solids, Particle size, Specific surface area of the Mixture, Average particle size.
Laws of crushing, Types of Crushers such as Blake Jaw crushers, Gyratory crusher, Hammer mill , Ball mill , Ultra fine grinders , Open and Close circuit Grinding .

Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**

Screening: Screening equipments such as Grizzly, Gyratory screens, Trommels, Oscillating Screens, Calculation of screen Effectiveness.

Transportation of Solids: Operation of Conveyor Screw Conveyor, pneumatic Conveyor.

Mixing: Necessity of mixing ,Types of Impeller ,Radial and Axial Flow ,Different flow patterns in mixing **.**

Text Books:

1. Dr. R. K. Bansal, Fluid Mechanics: Laxmi Publications, New Delhi.

2. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press an Imprint of Elsevier.

3. R. S. Hiremath and A.P. Kulkarni , Unit operations of Chemical Engg. (Mechanical operations Vol.-I: Everest publication.

Reference Books:

1. I P. Chattopadhaya Unit operations of chemical engineering-volume I: Khanna Publication New Delhi, 2nd edition 1996.
2. V.P. Gupta, Alam Singh and Manish Gupta Fluid Mechanics, Fluid mechanics and hydrostatics: CBS publishers New Delhi.
3. J. M. Coulson and R.F. Richardson, Chemical Engg. Vol. I & II : Butter worth & Heinemann.
4. W.L. McCabe & J.C. Smith, Unit operations in Chemical Engineering: McGraw Hill Ltd.

Microbiology					
COURSE OUTLINE					
Course Title:	*Microbiology*	**Short Title:**	*MB*	**Course Code:**	

Course description:

This course is aimed at introducing the fundamentals of basic Microbiology to undergraduate students. The background expected includes a prior knowledge of Biology. The goals of the course are to understand the basic principles of life sciences and their applications in Engineering trade.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	14	42	04

Prerequisite course(s):---

Course objectives:

To build a necessary platform for analyzing the complex issues in microbiology, including the evolution and diversity of microbes; cell structure and function; metabolism; information flow and the role of microbes in ecosystems.

Course outcomes:

After successful completion of this course the student will be able to:

1. Apply their knowledge in research related to the use of microbes for human welfare like food production, pigment production, pharmaceutical products etc.
2. Communicate the fundamental concepts of microbiology, both in written and in oral format;
3. Should be able to analyze and simplify the complex issues in microbiology.

COURSE CONTENT

Microbiology		**Semester:**	*III*
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Introduction of Microbiology:

Microbiology and its Scope; History of Microbiology: Contribution of Various Scientists in the Development of Microbiology, Incidences of Microorganisms in Environment, Classification of Microorganisms: Prokaryotes and Eukaryotes (Cell Structure), Morphology and Physiology of Bacteria, Yeast, Molds, Algae and Viruses, Identification of Microorganisms

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Microscopy, nutritional requirements of microorganisms and microbial culture media, isolation,

identification and maintenance of cultures (preservation), characteristics of pure culture, enumeration techniques.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

Basic terms: sterilization, disinfection, antiseptic, sanitizer, germicide, microbiostasis, antimicrobial agents, preservatives, factors influencing antimicrobial activity, mechanisms of cell injury, physical and chemical methods of control of microorganisms with principle, temperature, desiccation, osmotic pressure, surface tension, radiations, filtration, antiseptics and disinfectants, halogens, heavy metals, detergents, dyes.

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

Microbial Growth

Modes of Cell Division, Microbial Growth Kinetics: Growth Rate & Generation, Mathematical expression for Growth, Growth Curve, Diauxic Growth Curve, Continuous Culture: Chemostat and Turbidostat, Synchronous Culture: Selection by Size and Age, Selection by induction techniques.

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Antibiotics & Other Chemotherapeutic Agents

Characteristics of Chemotherapeutic Agents, Antibiotics and their Mode of Action, Antifungal Antibiotics.

Text Books:

1. Powar and Daginawala, General Microbiology, Vol I and vol II , Himalaya Publishing House.
2. R.C.Dubey & D.K.Maheshwari, A Textbook of Microbiology, S. Chand Publications.
3. Stainer R.Y., Ingraharn J.L., Whoolis M.L. and Painter P.R. General Microbiology. The McMillan Press Ltd

Reference Books:

1. M.J. Pelzer, Jr. E.C.S. Chan and N.R. Krieg, Microbiology 5 Ed. , TMH Book Company.
2. Industrial Microbiology by Casida

Bioprocess Industrial Economics & Management					
COURSE OUTLINE					
Course Title:	*Bioprocess Industrial Economics & Management*	**Short Title:**	*BIEM*	**Course Code:**	

Course description:

This course is introduced for learning the basic fundamentals of Bioprocess Industrial Economics and Management to undergraduate students. The goals of the course are to understand the basic knowledge of economics, various factors to be considered during industrial set up, marketability of product etc.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s): ---

Course objectives:

The objective of the course is to provide the basic knowledge of Bioprocess Industrial Economics and Management, economics, profitability, various factors to be considered during industrial set up, marketability of product etc.

Course outcomes:

After successful completion of this course the student will be able to:

1. Apply the basic knowledge of economics in order to design the bioprocesses at low cost
2. Apply knowledge of marketability to communicate effectively about various bioprocesses of products.
3. Apply the knowledge to set up a bioprocess Industry in all respect
4. Estimate the cost of final product
5. Calculate the profitability and losses during the product formation.

COURSE CONTENT

Bioprocess Industrial Economics & Management		**Semester:**	III	
Teaching Scheme:		**Examination scheme**		
Lectures:	**3 hours/week**	**End semester exam (ESE):**		**60 marks**
		Duration of ESE:		**03 hours**
		Internal Sessional Exams (ISE):		**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Bio process Design Considerations:

Technical feasibility survey, process development, flow diagram, equipment design and specifications, marketability of product, availability of technology, raw materials, equipments, human resources, land and utilities, site characteristics, waste disposal, government regulations and other legal restrictions, community factors and other factors affecting investment and production cost, Indian Bioprocess Industry - Current Status and Trends.

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Cost Estimation: Factors affecting investment and production cost, capital investment, fixed investment and working capital, estimating equipment cost by 6/10 factor rule, method of estimating capital investment, Different costs involved in total product cost, computer automization in costing.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12
Investment Cost and Profitability: Interest and investment cost, type of interest, types of taxes and tax returns, types of insurance and legal responsibility, depreciation, types of depreciation, and methods of determining depreciation. Profitability, mathematical methods of profitability evaluation, cash flow diagram, break even analysis, balance sheet, pricingissue method and income statement.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Fermentation Economics: Introduction, isolation of microorganisms of potential industrial interest, strain improvement, market potential, effects of legislation on production of antibiotics and recombinant proteins, plant and equipment, media, air sterilization, heating and cooling, aeration and agitation, batch process cycle times, continuous culture, recovery costs, water usage and recycling, effluent treatment.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Bioproduct Economics: Bioproduct regulation, Fermentation process economics: A complete example, Economic consideration of commercial Bioproduct: Enzymes, Proteins via rDNA, Antibiotics, Vitamins, Alkaloids, Nucleosides, Steroids, Monoclonal antibodies, Brewing and wine making, Fuel Alcohol Production, Organic and Amino acid manufacture, Single cell protein, Anaerobic methane production.		
Text Books:		
1.Peter M.S. Timmerhaus K.D. Plant Design and Economics for Chemical Engineers. McGraw Hill. 2. Vilbrandt F.C. and C.E. Dryden, Chemical Plant Design. McGraw Hill		
Reference Books:		
1. O.P.Khanna Industrial Engineering and Management, Dhanpat Rai Publications Pvt. Ltd. New Delhi. 2. Dewett and Varma, Elementary Economic Theory, S Chand and Company Ltd New Delhi 3. James E. Bailey, David F. Ollis, Biochemical Engineering Fundamentals, Mc Graw-Hill Book Company. 4. P. F. Stanbury, A. Whitaker and S. J. Hall, Principles of Fermentation Technology, Aditya Book PrivateLimited. 5. T.R. Banga and S.C.Sharma, Industrial Organization and Engineering Economics, Khanna Publications, New Delhi.		

Lab Unit Operations					
LAB COURSE OUTLINE					
Course Title:	*Lab Unit Operations*	**Short Title:**	*Lab UO*	**Course Code:**	

Course description:

This course is intended to provide engineering students with a background in important concepts and principles of Unit operations.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	14	28	1

End Semester Exam (ESE) Pattern:	**Oral (OR)**

Prerequisite course(s):---

Course objectives:

The objective of the laboratory is to impart the fundamental knowledge of Unit operations to the students and develop their ability to apply the specific procedures to analyze the experimental results.

Course outcomes:

After successful completion of lab Course, student will be able to:

1. Determine properties of Fluids .
2. Analyze the characteristics curves of Centrifugal Pump.
3. Determine the coefficient of Venturi meter, Orifice meter.
4. Identify the fluids flow laminar , turbulent by Reynolds Experiment.
5. Estimate to minor losses in pipes.
6. Determine the fanning friction factor for given pipe.
7. Determine the effectiveness of the Vibrating screen.
8. Determine power requirement for crushing

LAB COURSE CONTENT			
Lab Unit Operations		**Semester:**	III
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	***25 marks***
		Internal Continuous Assessment (ICA):	***25 marks***

List of the Experiments (Note: Minimum Eight Experiments from the following)

1. Determination of Viscosity.
2. Study of Manometers
3. Verification of Bernoulli's theorem.
4. To determine the coefficient of Venturi meter, Orifice meter.
5. Reynolds Experiment.
6. Minor losses in pipe.
7. To determine the fanning friction factor for given pipe.
8. To study the characteristics curves of Centrifugal Pump.
9. To study of the different types of Fans, Blowers & Compressors
10. Jaw Crusher : To verify the laws of crushing & grinding
11. Ball Mill :To verify the laws of crushing & grinding
12. Vibrating Screen : To find out the effectiveness of the Vibrating Screen

Text Books:

1. Dr. R. K. Bansal, Fluid Mechanics: Laxmi Publications, New Delhi.
2. R. S. Hiremath and A.P. Kulkarni , Unit operations of Chemical Engg. (Mechanical operations Vol.-I: Everest publication.

Reference Books:

1. I P. Chattopadhaya Unit operations of chemical engineering-volume I: Khanna Publication New Delhi, 2nd edition 1996.
2. V.P. Gupta, Alam Singh and Manish Gupta Fluid Mechanics, Fluid mechanics and hydrostatics: CBS publishers New Delhi.
3. J. M. Coulson and R.F. Richardson, Chemical Engg. Vol. I & II : Butter worth & Heinemann.
4. W.L. McCabe & J.C. Smith, Unit operations in chemical engineering: McGraw Hill Ltd.

Guide lines for ICA:
Students must submit ICA in the form of journal. Each practical should be well documented. Faculty in charge will assess the practical continuously and grade or mark each practical on completion date declared for each practical.
Guidelines for ESE:
ESE will be based on the oral examination of laboratory experiments submitted by the students in the form of journal.

Lab Microbiology					
LAB COURSE OUTLINE					
Course Title:	*Lab Microbiology*	**Short Title:**	*Lab MB*	**Course Code:**	

Course description:

In this laboratory, course emphasis is on the understanding of basics of identification, isolation, cultivation of microorganisms from the enormous diversity found in environment and its application for the human welfare. The learner here can use this knowledge and apply in allied branches of Biotechnology as required.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	02	14	28	01

End Semester Exam (ESE) Pattern:	**Practical (PR)**

Prerequisite course(s):---

Course objectives:

The objective of the laboratory is to impart the fundamental knowledge of biology at the microscopic level to the students and develop their ability to apply the specific procedures to analyze the experimental results.

In this lab, students will be familiar with the use of microorganisms as lab tools and various biological equipments which they can apply in research and Development in the field of Biotechnology

Course outcomes:

After successful completion of lab Course, student will be able to:

1. Use the microscope effectively and observe and identify the characteristics of microorganisms.
2. Stain the microbes for better visualization and characterization of cells and cell organelles
3. Identify and examine the microorganisms from the food sample and environment.
4. Enumerate the microbes by various methods including viable cell count, haemocytometer and turbidity measurement.
5. Prepare the media and cultivate the microorganisms by different methods.
6. Isolate the microorganisms by streak plate method, pour plate method, serial dilution method etc.
7. Different techniques for the maintenance and preservation of microorganisms.
9. Study the effect of antimicrobial agent , UV radiation & heat on microbial growth.
10. Examine the water samples microbiologically.

LAB COURSE CONTENT			
Lab Microbiology		**Semester:**	III
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	***25 marks***
		Internal Continuous Assessment (ICA):	***25 marks***

List of Experiments (Note: Minimum Eight Experiments from the following)

1. Study and use of microscope
    a. Examination of prepared slides
2. Preparation of laboratory media:
    a. Autoclaving,
    b. Preparation of agar slants and agar plates.
    c. Preparation of liquid media.
3. Isolation & Cultivation of microorganisms (Bacteria & Fungi) on solid and liquid media and observation of cells
    a. By streak plate method
    b. By pour plate method.
    c. By spreading
    d. Observation of cells:
        i. Cultural characteristics,
        ii. Biochemical characteristics
4. Staining techniques:
    a. Simple staining,
    b. Gram staining,
    c. Lactophenol cotton blue mounting of fungi.
5. Isolation by serial dilution method, maintenance & preservation.
6. Influence of antimicrobial agent,
7. UV radiation & heat on microbial growth.
8. Study of bacterial growth curve. (Turbidity measurement as direct expression of growth)

Text Books:

1. H.W. Seeley Jr. and Paul J.Van Demark, “Microbes in action”. A laboratory manual of Microbiology.D.B. Taraporevala Sons & Co. Pvt. Ltd.
2. Ed. J.R. Norris and D.W. Ribbons, “Methods in Microbiology”, Vol. 3 A, Academic Press, London & New York.

3. Ronald M. Adas, Alfred E. Brown, Kenneth W. Dobra and Llnas Miller (1986). Basic Experimental Microbiology. Prentice Hall.

Reference Books:

1. Aneja K.R.(2nd Edn., 1996). Experiments in Microbiology, Plant pathology, Tissue Culture and Mushroom Cultivation. Wishwa Prakashan, New Age International (P) Ltd.
2. S. Harisha. An Introduction to Practical Biotechnology. Laxmi Publications (P) Ltd. New Delhi.

Guide lines for ICA:

Students must submit ICA in the form of journal. Each practical should be well documented. Faculty in charge will assess the practical continuously and grade or mark each practical on completion date declared for each practical.

Guidelines for ESE:

ESE will be based on the practical examination of laboratory experiments submitted by the students in the form of journal.

Lab Good Manufacturing Practices

LAB COURSE OUTLINE

Course Title:	*Lab Good Manufacturing Practices*	**Short Title:**	*Lab GMP*	**Course Code:**	

Course description:

This course provides an overview of the quality system of management controls for research laboratories and organizations. To ensure the uniformity, consistency, reliability, reproducibility, quality, and integrity of the final product. This lab course is introduced to understand basic good manufacturing practice to maintain the product quality.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
Theory	01	14	14	03
Laboratory	02	14	28	

End Semester Exam (ESE) Pattern:	**Oral (OR)**

Prerequisite course(s):

11^{th}, 12^{th} Science.

Course objectives:

The objective of the laboratory is to impart the fundamental knowledge of good manufacturing practices at the research level to the students and to develop their ability to apply and follow good practices in production.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

1. Follow fundamental compliance requirements for current GMP.
2. Apply compliance protocols in all efforts aimed at generating regulated data for evaluation by the US FDA and regulatory agencies overseas.
3. Demonstrate their understanding good practices in production.

LAB COURSE CONTENT

Lab Good Manufacturing Practices		**Semester:**	III
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	***25 marks***
		Internal Continuous Assessment (ICA):	***25 marks***

List of Experiments (Note: Minimum Eight Experiments from the following)

Introduction to GMP.

2. Product quality review.

3. Starting materials for various industries.

4. Packaging materials.

5. Waste materials management.

6. Prevention of cross-contamination and bacterial contamination during production.

7. Personal hygiene.

8. Labeling.

9. Drafting the device master record.

10. Obtaining information on GMP requirements.

Text Books:

1. M.K. Satish, Biosafety and Bioethics, I.K. International publishing house.
2. Mindy J. Allport-Settle,Good Manufacturing Practice (GMP) Guidelines: The Rules Governing Medicinal Products in the European Union, EudraLex Volume 4 Concise Reference PharmaLogica, Inc.

Reference Books:

1. Joseph D. Nally Good Manufacturing Practices for Pharmaceuticals, Sixth Edition (Drugs and the Pharmaceutical Sciences), edited, CRC Press.
2. Mindy J. Allport-Settle, Current Good Manufacturing Practices: Pharmaceutical, Biologics, and Medical Device Regulations and Guidance Documents Concise Reference Create Space Independent Publishing Platform.

Guide lines for ICA:

Students must submit ICA in the form of journal. Each practical should be well documented. Faculty in charge will assess the practical continuously and grade or mark each practical on completion date declared for each practical.

Guidelines for ESE:

ESE will be based on the oral examination of laboratory experiments submitted by the students in the form of journal.

NORTH MAHARASHTRA UNIVERSITY,

JALGAON (M.S.)

Second Year Engineering

(Biotechnology Engineering)

Semester - IV

Faculty of Science and Technology

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

COURSE OUTLINE

W.E.F. 2018 – 19

Biostatistics

COURSE OUTLINE

Course Title:	*Biostatistics*	**Short Title:**	*BST*	**Course Code:**	

Course description:

This course is a combination of both elementary probability and basic statistics with a strong emphasis on Biotechnology applications. The course coverage explores the probability; probability distributions; probability densities; curve fitting; correlation and regression; sampling distributions; inferences concerning means; inferences concerning variances; inferences concerning proportions; analysis of variance; factorial experimentation.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	14	42	04
Tutorial	01	14	14	

Prerequisite course(s):----

Course objectives:

1. Students will understand the Probability distribution. Namely, Binomial, Poisson and Normal distribution are discussed which will allow them to apply to engineering problems.
2. Students will understand what is meaning of bi-variate data and correlation between them.
3. Students will learn how to fit a curve to given data.
4. Students will also understand meaning of sampling.
5. Students will earn to test a hypothesis based on a sample.
6. Students will also learn various tests, for large sample and small sample.
7. Students will learn Experimental design.
8. Students will learn 2^2,2^3designs

Course outcomes:

After successful completion of this course the student will be able to:

1. Will be able to use Probability distributions effectively. Also will be able to know a given set of data will follow which distribution.
2. Will be able to calculate the mean and variance of a probability distribution.
3. Can use sampling for performing any real experiment which is otherwise very expensive
4. Will be able to use t-test, F-test and chi square test etc. for Goodness of fit to test hypothesis.
5. Able to apply Randomization to avoid confounding the variable under investigation with other uncontrollable variables.

COURSE CONTENT			
Biostatistics		**Semester:**	IV
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Probability Distributions

Random variables, The mean and variance of a Probability distribution, The Binomial and Poisson distributions, The Poisson's approximation to the Binomial Distribution. Continuous random variable, and Normal Distribution, Normal approximation to the Binomial Distribution.

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Curve Fitting , Correlation and Regression

The method of Least Square, Curvilinear regression (quadratic, exponential), Correlation coefficient and its properties .Regression coefficient, line of regression.

Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**

Sampling

Definitions of (population, sample, statistic, parameter, hypothesis, null hypothesis, alternative hypothesis, critical region, level of significance),Interval estimation, Confidence interval, confidence limit, Sampling, types of sampling, type-I error, type-II error. Test of sampling for single mean, two means. Hypothesis concerning one proportion, Hypothesis concerning two proportions.

Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**

Small sample test and Chi-square test

Small sample test(1.Student t-test for an assumed mean and equality of means of two populations when sample observations are independent, 2.F-test for comparison of variances of two populations,)Chi-square test for independence of attributes, Goodness of fit and homogeneity of samples.

Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**

Experimental Designs

Principles of experimental designs, Completely randomized, Randomized block and Latin square designs, Simple factorial experiments of 2^2,2^3,2^4,Confounding in factorial experiments (mathematical derivations not required);Analysis of variance(ANOVA)and it' s use in the analysis of RBD.

Text Books:

1. A Text Book of Engineering Mathematics, by N.P. Bali and Manish Goyal.
2. Gupta S. C. Fundamentals of Statistics. Himalaya Publishing House, NewDelhi
3. Khan. Biostatistics. Tata Mc Graw Hill Publishers.

Reference Books:

1. Miller& Freund's Probability and Statistics for Engineers (Sixth Edition),by Richard A. Johnson.
2. Probability and Statistics for Engineers (India Edition),by Jay L. Devore
3. Statistical methods in biology by Norman T .J .Bailey (3rdEdition), Cambridge University Press (1995).
4. Daniel W.W.(9th Edn. 2009).Biostatistics: A Foundation for Analysis in the Health Sciences.

Process Heat Transfer					
COURSE OUTLINE					
Course Title:	*Process Heat Transfer*	**Short Title:**	*PHT*	**Course Code:**	

Course description:

This course introduces students to key concepts and principles required to analyze problems involving heat exchange and energy conversion. Objective of the course is to study modes of heat transfer and development of relations to calculate hear transfer rate

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	14	42	04

Prerequisite course(s):----

Course objectives:

1. To make the student familiar with conduction, convection and radiation phenomenon.
2. To understand condensation and boiling operations with regards to the processing of bio chemicals.
3. To develop the relations for rate of heat transfer to achieve optimized operations.
4. To study the types of heat exchanger and their uses in different industrial operations.
5. To study the types of evaporator and their uses for various industrial processes and applications.

Course outcomes:

After successful completion of this course the student will be able to:

1.Demonstrate general applications of heat transfer modes as conduction, convection and radiation in biochemical process industry.
2. Control the different parameters which are required for various biochemical processes.
3. Know the working and principle of all types of evaporators which are used in industries.
4. Know working and principles of all types of Heat Exchanger equipments which are widely used in biochemical, fermentation and pharmaceutical industries.
5. Apply their knowledge to condensate and boiling the various types of biochemicals and other fluids used in industries.
6. Design of heat exchange equipments.

COURSE CONTENT

Process Heat Transfer		**Semester:**	IV
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Conduction in solids

Fourier's law of heat conduction, steady state heat conduction through walls (single and multilayer), heat flow through cylinder, sphere, unsteady state heat conduction, Thermal insulation, Optimum thickness of Insulation, Critical radius of insulation.

Unit–II:	No. of Lectures: 08 Hours	Marks: 12
Convection Classification of convection(natural convection and force convection), individual and over all Heat transfer coefficients, Fouling factor, Flow arrangement in heat exchanger, Log mean temperature difference (LMTD), Wilson Plot, Extended surfaces-fins, classification of extended surfaces, Effectiveness of fin.		
Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**
Radiation heat transfer Fundamental of radiation, black body radiation, Kirchhoff's law, radiant heat exchange between nonblack surfaces, Laws of black body radiation, Radiation shield.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Heat exchange equipments: Heat exchangers (Double pipe , Shell and tube ,Kettle type ,plate type Heat Exchangers). Effectiveness factor, capacity and NTU.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Evaporation: Types of evaporator (Jacketed pan evaporator, Calendria type evaporator, single effect evaporator. Forced circulation evaporator, Multiple effect evaporator. **Boiling and condensation**: Heat transfer to boiling liquids**:** Pool boiling of saturated liquid, Boiling point curve. Condensation, Film wise and drop wise condensation.		
Text Books:		
1. Dawande S.D. Principals of Heat Transfer and Mass Transfer. Central Techno Publications, Nagpur. 2. K.A.Gavhane, Heat Transfer ,Nirali Prakashan.		
Reference Books:		
1. W.L.Mc Cabe and J.C.Smith , Unit operations in chemical engineering. McGraw Hill Ltd 2. Coulson & Richardson , Chemical engineering. – Volume. I, Pergamon Press 3. Kern D.Q. Process Heat Transfer, McGraw Hill Book 1NC New York, 1950 4. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press an Imprint of Elsevier		

Immunology					
COURSE OUTLINE					
Course Title:	*Immunology*	**Short Title:**	*IMM*	**Course Code:**	

Course description:

This course is introduced for learning the basic fundamentals of the defense mechanism of human body. The prospectus includes a prior knowledge about the immunity, mechanisms and the therapy or treatment for curing the diseases.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	14	42	04

Prerequisite course(s):---

Course objectives:

To build a necessary platform for analyzing the chemical basis of immune system, including the introduction to immune organs and their role in biological systems, antibodies, and other immune molecules, fundamentals of techniques used in immunology.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand the basic principles of modern immunology and an introduction to methods used in immunological research.
2. Describe the cells, molecules and pathways involved in the induction and regulation of innate and adaptive immune responses and how regulatory responses can be exploited therapeutically.
3. Demonstrate an understanding of how vaccines work and of the requirements for developing new safe and effective injectibles and mucosal vaccines.
4. Integrate information on the role of the immune system in asthma and chronic obstructive pulmonary disease and the use of this information to develop new therapies for these conditions.

COURSE CONTENT

Immunology		**Semester:**	IV
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Introduction to Immunology

Properties of immune response, Innate and acquired Immunity, active and passive immunity.
Cells & Tissues of Immune System: Lymphocytes, Classes of lymphocytes, antigen presenting cells, NK Cells, Mast Cells, Dendritic Cell, LPT cells, Organs of the Immune System, Bone marrow, Thymus, Lymph node, Spleen, MALT.

Unit–II:	No. of Lectures: 08 Hours	Marks: 12

Molecular Immunology

Molecular structure of antibody, Classification, Isotypes, Synthesis assembly and expression of immunoglobulin molecules, Nature of antigens, function and diversity, Generation of anti-body diversity, Antigens: Different characteristics of antigens, mitogens, Hapten, Adjuvants.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

MHC Molecule & Immune Mechanism

Discovery of MHC complex, Role of MHC, Structure of MHC molecule, Binding of peptides to MHC molecules, MHC restriction.
Mechanism of Immune Response: Cytokines, T- cell receptors, B cell activation cell complement system, antigen processing and presentation, regulation of immune response.

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

Immunological Techniques

Antigen- antibody reactions, Immunodiffusion, immuno - electrophoresis, ELISA: Direct ELISA, Indirect ELISA, Dot ELISA, Sandwich ELISA, RIA, Rocket immuno - electrophoresis, Agglutination reaction, Precipitation reaction, Flow cytometry, Ouchterlony diffusion.

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Applied Immunology

Immune system in health and disease, autoimmunity, hypersensitivity, Immunology of graft rejection methods and precautions, GVHD, Hybridoma technology: - Fusion of myeloma cells with lymphocytes, production of monoclonal antibodies and their application.

Text Books:

1. C.V. Rao " A Textbook of Immunology" Narosa Publishing House.
2. Kuby " A Textbook of Immunology" Freeman Publication.

Reference Books:

1. Roitt I.M. (1998) Essentials of Immunology. ELBS, Blackwell Scientific Publishers, London.
2. Ivan Riot- Essentials of Immunology (6th Edition), Blakswell Scientific Publications, Oxford, 1988.
3. Benjamin E and Leskowitz S, IMMUNOLOGY A short course wiley liss, ny 1991Immunotechnology.

Biochemistry					
COURSE OUTLINE					
Course Title:	*Biochemistry*	**Short Title:**	*BCH*	**Course Code:**	

Course description:

This course is aimed at introducing the fundamentals of basic Biological chemistry to undergraduate students. The background expected includes a prior knowledge of Biology and chemistry from HSC (science) and first year engineering knowledge. The goals of the course are to understand the basic principles of life sciences and their applications in engineering trade.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	14	42	3

Prerequisite course(s): Biology

Course objectives:

To build a necessary platform for analyzing the chemical basis of biological phenomenon, including the introduction to biomolecules and their role in biological systems, fundamentals of techniques used in biochemistry.

Course outcomes:

After successful completion of this course the student will be able to:

1. Identify the classes of biomolecules and their role in the biological system.
2. Explain the functions and properties of biomolecules
3. Explain the synthesis of biomolecules in biological system and how it directly relate the energy generation in body.
4. Separate biomolecules from the source by biochemical techniques and its application for human welfare

COURSE CONTENT

Biochemistry		**Semester:**	IV
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Carbohydrates & their Metabolism

Structure, Classification & Functions of Carbohydrates: Monosaccharides, Oligosaccharides, Polysaccharides. Metabolism: Glycolysis, Gluconeogenesis. TCA cycle, Pentose phosphate pathway , Glyoxylate cycle & Electron Transport Cycle (Brief), Regulation of glycolysis & TCA.

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Proteins & Amino Acids

Structure, Classification &Functions of Amino acids & Proteins. Metabolism: Amino acid degradation: Summary of amino acid catabolism, amino acid degradation to pyruvate, Acetyl

COA, & α- ketoglutarate, Urea cycle. Biosynthesis: Amino acid synthesis overview, six essential amino acid synthesis, synthesis of glutamate, glutamine, proline & arginine.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

Lipids & their Metabolism

Structure & Functions of lipids: Triacyglycerols, Glycerophospholipids, sphingolipids, Cholesterol, phosphatidylinositols, eicosanoids. Oxidation of fatty acids. Biosynthesis: Fatty acids, Triacylglycerols, & Cholesterol, Glyceroneogenesis

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

Nucleotides & Vitamins

Vitamins: Introduction, Classification, Biochemical Functions, RDA, Dietary Sources, Deficiency. Structure & Functions of nucleotides. Biosynthesis of nucleotides: denovo synthesis of purine & pyrimidine synthesis and its regulation, salvage pathway.

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Enzymes & Membrane transport

Enzymes: Introduction, Classification, mechanism of enzyme action, factors affecting enzyme activity (concentration of enzyme, substrate, temperature, pH), units of enzyme activity. Membrane transport: Architecture of membranes: Fluid mosaic model. Passive transport: Solutes, glucose, chloride-bicarbonate exchanger, Active transport: Na+. K+ ATPase, F-type ATPase, P-type ATPase.

Text Books:

1. U Satyanarayana & U. Chakrapani, Biochemistry.
2. Donald Voet, Judith G. Voet, Charlotte W. Pratt, Principles of Biochemistry, International Student version
3. Lehninger A.L., Neston D.L., N.M. Cox "Principles of Biochemistry", CBS Publishers & Distributors.
4. Lubert Stryer "Biochemistry", W.H. Freemen & Co. , New York.
5. Weil J.H. "General Biochemistry", New Age International (Pvt. Ltd.).

Reference Books:

1. Veoet O, voet G,Biochemistry, Second Edition, John Wiley and Sor1s,1994.
2. Murray R.K. and others (Eds). Harper's Biochemistry, 25 Edn. Appleton and Lange Stanford

Intellectual Property Rights & Entrepreneurship					
COURSE OUTLINE					
Course Title:	*Intellectual Property Rights & Entrepreneurship*	**Short Title:**	*IPR&E*	**Course Code:**	
Course description:					
This course is introduced for learning the basic fundamentals of Intellectual property rights and Entrepreneurship to undergraduate students. The goals of the course are to understand the basic knowledge of Intellectual property rights, trademarks, and entrepreneurship.					

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):

Course objectives:

The objective of the course is to provide the basic knowledge of IPR and Entrepreneurship, Intellectual property, trademarks, biosafety & bioethics and entrepreneurship.

Course outcomes:

After successful completion of this course the student will be able to:

1. Choose which type of IPR they should apply for.
2. Adopt environment friendly approach industrially.
3. Understand entrepreneurial aspects.
4. Understand the basics of marketing management.
5. Apply project Management Techniques to real life industrial problems

COURSE CONTENT

IPR & Entrepreneurship		**Semester:**	IV
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Entrepreneurship:

Concept, knowledge and skills requirement; characteristic of successful entrepreneurs; role of entrepreneurship in economic development, From Business Idea to Business Model: Innovative Business Idea, Benefit to the customer, Unique Selling Proposition (USP), Market and competitors, Profitability scenario, Protecting your idea, Formal presentation of the business idea

Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Business Plan:

Introduction: Management team, Implementation of Plan, Finance and Financial Planning, Opportunities & Risks, business ethics, performance appraisal, and (SWOT) analysis.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12
Marketing and Distribution: Elements of Marketing and Sales Management, Analysis of the market; Customers and competition, Marketing Plan, Marketing tools, Pricing techniques. **Project Management Techniques:** Critical Path Method (CPM) and Project Evaluation Review Techniques (PERT)		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
IPR, Patents and copyright General Overview of Intellectual Property Rights, WIPO, WTO, Trade Related Intellectual Property Rights. Patent- Basic requirements of Patentability, Patentable Subject Matter, Procedure for Obtaining Patent, Provisional and Complete Specification. Copyright-Objectives of copyright, Rights conferred by registration of copyright, Infringement of copyright.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Trademarks, GI and other types of IPR Trademarks-Basic Principles of Trademark, Rights conferred by Registration of Trademark, Infringement of Trademark. Geographical Indications-Objectives of Geographical Indications, Rights conferred, Infringement of Geographical Indications, International Position, Indian Position, Bioprespecting and Biopiracy. GATT Farmers rights, plant breeders right.		
Text Books:		
1. Entrepreneurship: New Venture Creation, David H. Holt. 2. Patterns of Entrepreneurship: Jack M. Kaplan.		
Reference Books:		
1. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka,Sultan Chand.		

Lab Process Heat Transfer					
LAB COURSE OUTLINE					
Course Title:	*Lab Process Heat Transfer*	**Short Title:**	*Lab PHT*	**Course Code:**	

Course description:

In this laboratory course emphasis is on the understanding of basics of Process heat transfer

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	02	14	28	01

End Semester Exam (ESE) Pattern: ---

Prerequisite course(s):

Engineering Physics, Chemistry and Mathematics.

Course objectives:

The objective of the laboratory is to impart the fundamental knowledge of Process heat transfer to the students and develop their ability to apply the specific procedures to analyze the experimental results.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

1. Demonstrate general applications and use of heat exchange equipments in industries.
2. Control the different parameters which are required for various processes industries .
3. Apply their knowledge to condensate and boiling the various types of fluids used in industries.
4. Determine emissivity of test plate.
5. Determine thermal conductivity of metals and insulators.

LAB COURSE CONTENT

Lab Process Heat Transfer		**Semester:**	IV
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	--
		Internal Continuous Assessment (ICA):	***25 marks***

***List of Experiments*(Note: Minimum Eight Experiments from the following)**

1. Conductivity of metals and / or insulator.
2. Experiment on Pin fins.
3. Experiment on forced convection apparatus.
4. Experiment on natural convection apparatus.
5. Determination of emissivity of test plate.
6. Stefan Boltzmann apparatus .

7. Parallel / counter flow heat exchanger.
8. Study of pool boiling phenomenon and critical heat flux.
9. Study of heat transfer in evaporator .
10. Temperature profile in a rod .
11. Study of evaporators .
12. Drop wise and film wise condensation .

Text Books:

2. K.A.Gavhane, Nirali Prakashan. Nagpur
3. Dawande S.D. Principals of Heat Transfer and Mass Transfer. Central Techno Publications, Nagpur.

Reference Books:

1. W.L.Mc Cabe and J.C.Smith , Unit operations in chemical engineering. McGraw Hill Ltd.
2. Coulson & Richardson , Chemical engineering. – Volume. I, Pergamon Press
3. Kern D.Q. Process Heat Transfer, McGraw Hill Book 1NC New York, 1950
4. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press an Imprint of Elsevier

Guide lines for ICA:

Students must submit ICA in the form of journal. Each practical should be well documented. Faculty in charge will assess the practical continuously and grade or mark each practical on completion date declared for each practical.

Guidelines for ESE: ESE will be based on the oral examination of Laboratory experiments submitted by the students in the form of journal.

Lab Immunology					
LAB COURSE OUTLINE					
Course Title:	*Lab Immunology*	**Short Title:**	*Lab IMM*	**Course Code:**	

Course description:

Course emphasis is on the understanding of basic concepts in immunology. The learner here can use this knowledge and apply in allied branches of Biotechnology as required. The course is also helps for the study of antigen antibody interaction.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	02	14	28	01

End Semester Exam (ESE) Pattern:	**Practical (PR)**

Prerequisite course(s):

12th STD Zoology

Course objectives:

1) To study the antigen antibody interaction.
2) To study the analytical techniques such as ELISA, Ouchterlony diffusion.
3) To study the advanced techniques of the antigen antibody interactions such as Precipitin reaction, Antibody titer test, Agglutination reaction.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

1) Apply the basic fundamentals in antigen antibody reaction for designing the experiment.
2) Perform the analytical techniques in immunology in the industry.

LAB COURSE CONTENT

Lab Immunology		**Semester:**	IV
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	***25 marks***
		Internal Continuous Assessment (ICA):	***25 marks***

List of Experiments(Note: Minimum Eight Experiments from the following)

1. Immunoelectrophoresis.
2. Radial immunodiffusion.
3. Antigen –Antibody interaction: The Ouchterlony procedure
4. Introduction to ELISA reactions
5. Western Blot Analysis – demo.
6. Immunology of pregnancy test – demo.
7. Latex agglutination test

8. Precipitin reaction

9. Antibody titer test

10. Agglutination reaction.

Text Books:

1. Harlow and David Lane Antibodies A laboratory Manual: (1988), Cold spring harbor laboratory.
2. Talwar G.R. and Gupta S.K. (Eds.). A Handbook of Practical and Clinical Immunology, Vol. 1 and 2 (2nd Edn.). CBS Publishers and Distributors.

Guide lines for ICA:

Students must submit ICA in the form of journal. Each practical should be well documented. Faculty in charge will assess the practical continuously and grade or mark each practical on completion date declared for each practical.

Guidelines for ESE:

ESE will be based on the practical examination of laboratory experiments submitted by the students in the form of journal.

Lab Biochemistry					
LAB COURSE OUTLINE					
Course Title:	*Lab Biochemistry*	**Short Title:**	*Lab BCH*	**Course Code:**	

Course description:

In this laboratory course emphasis is on the understanding of basics of qualitative and quantitative identification and estimation of biomolecules from the enormous diversity of source in environment. The learner here can use this knowledge and apply in allied branches of Biotechnology as required.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	02	14	28	01

End Semester Exam (ESE) Pattern:	***Practical (PR)***

Prerequisite course(s):

Biology

Course objectives:

The objective of the laboratory is to impart the fundamental knowledge of chemical basis of biology at the research level to the students and develop their ability to apply the specific procedures to analyze the experimental results.

In this lab, students will be familiar with the use and application of biomolecules in laboratory and various equipments which they can apply in research and Development in the field of Biotechnology

Course outcomes:

Upon successful completion of lab Course, student will be able to:

1. Estimate the amount of different biomolecules like carbohydrates, proteins, nucleic acids from various sources.
2. Understand the basic principle of isoelectric precipitation.
3. Apply the basic properties of biomolecules for their separation from mixture.
4. Extract the lipids from various biological sources.
5. Understand the basic principles of thin layer chromatography and gel electrophoresis.

LAB COURSE CONTENT

Lab Biochemistry		**Semester:**	IV
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	***25 marks***
		Internal Continuous Assessment (ICA):	***25 marks***

List of Experiments (Note: Minimum Eight Experiments from the following)

Estimation of carbohydrates.

a. Estimation of reducing sugars by Dinitrosalicylic acid method.

2. Estimation of proteins.

a. Estimation of proteins by Lowry method.

3. Estimation of nucleic acids:

4. Isoelectric precipitation.

5. Separation of amino acids by paper chromatography.

6. Separation of sugars by paper chromatography.

7. Extraction of Lipids.

8. Thin layer Chromatography.

9. Gel Electrophoresis.

10. Assay of enzyme activity
11. Assay of enzyme kinetics.

12. Identification and estimation of an intermediate of EMP pathway.

13. Cell fractionation.

14. Vitamin Assay.

Text Books:

1. Plummer David T. "An Introduction to Practical Biochemistry", Tata McGraw-Hill Pubblishing Co. Ltd., New Delhi.
2. Jayraman J. A Laboratory Manual in Biochemistry. New Age International Publishers.
3. Sadasivan S. and Manikam K. Methods in Agricultural Biochemistry. Wiley Eastern Ltd., New Delhi.
4. S. Harisha. An Introduction to Practical Biotechnology. Laxmi Publications (P) Ltd. New Delhi.

Guide lines for ICA:

Students must submit ICA in the form of journal. Each practical should be well documented. Faculty in charge will assess the practical continuously and grade or mark each practical on completion date declared for each practical.

Guidelines for ESE:

ESE will be based on the practical examination of laboratory experiments submitted by the students in the form of journal.

Lab Environmental Biotechnology					
LAB COURSE OUTLINE					
Course Title:	*Lab Environmental Biotechnology*	**Short Title:**	*Lab EBT*	**Course Code:**	

Course description:

In this laboratory, course emphasis is on the understanding of basics environmental engineering. The learner can use this knowledge and apply in allied branches of Biotechnology as required.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	14	28	2

End Semester Exam (ESE) Pattern:	***Oral (OR)***

Prerequisite course(s):

Biochemistry and Microbiology

Course objectives:

1. The objective of the laboratory is to impart the fundamental knowledge of environmental engineering at the research level to the students
2. To develop their ability to apply the various techniques for developing the new technology for waste management.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

1. Design and execute new environmental science experiments.
2. Communicate their understanding of environmental science to a lay audience.
3. Demonstrate through presentation an understanding of the global character of environmental problems and ways of solving them, including collaborative efforts spanning local to global scale.
4. Use the techniques, skill and modern engineering tools necessary for engineering practice.
5. Apply the knowledge of engineering principles to living entities for societal welfare.
6. Work in multidisciplinary stream.
7. Explore the options for environmental biotechnology in higher study.

LAB COURSE CONTENT

Lab Environmental Biotechnology		**Semester:**	IV
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	***25 marks***
		Internal Continuous Assessment (ICA):	***25 marks***

List of Experiments (Note: Minimum Eight Experiments from the following)

1. Analysis of water for colour, turbidity, solids, hardness, alkalinity, acidity, iron, sulphate, chloride, fluoride, nitrate etc.
2. Physical analysis of wastewater sample
3. Analysis of samples for DO.
4. Analysis of samples for BOD of waste water.
5. To determine the COD of waste water.
6. To determine the nitrogen contents of waste water.
7. Biological examination of water: Algae, bacteria and Protozoa
8. Bacterial water quality: Measuring quality of water by using coli form organisms (MPN method and membrane filter).
9. Biochemical activities of bacteria: hydrolysis of polysaccharides, Bacteria in waste water.
10. Determination of Biodiversity index.

Text Books:

1. Mathur: Water and Wastewater Testing.
2. Sawyer, Mc Carty & Parkin Chemistry for Environmental Engg. Standard Methods P.A, H.A New York.
3. Sirockin and Cullimore: Practical Microbiology.

Guide lines for ICA:

Students must submit ICA in the form of journal. Each practical should be well documented. Faculty in charge will assess the practical continuously and grade or mark each practical on completion date declared for each practical.

Guidelines for ESE:

ESE will be based on the oral examination of laboratory experiments submitted by the students in the form of journal.