Kavayitri Bahinabai Chaudhari

NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Second Year Engineering

(Biotechnology Engineering)

Faculty of Science and Technology

SYLLABUS

Semester – III & IV

W.E.F. 2019-20

NORTH MAHARASHTRA UNIVERSITY, JALGAON

STRUCTURE OF TEACHING & EVALUATION

S.E. (BIOTECHNOLOOGY Engineering) W.E.F.2019-20

Syllabus Structure for Second Year Engineering (Semester – III) (Biotechnology Engineering.) (w.e.f. 2019-20)

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) (Biotechnology Engineering) (w.e.f. 2019-20)

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	D	-	-	2	2	-	-	-	-	-	1
LAB Immunology	D	-	-	2	2	-	-	25	25 (PR)	50	1
LAB Biochemistry	D	-	-	2	2	-	-	25	25 (PR)	50	1
LAB- Environmental Biotechnology	D	1	-	2	3	-	-	25	25 (OR)	50	2
Environmental Science	H	-	-	-	-	-	60	40	-	100	
Internship – I*	H	-	-	-	-	-	-	-	-	-	-
		16	**1**	**8**	**25**	**200**	**300**	**75**	**75**	**650**	**21**

*Internship - I is a mandatory and non-credit course. It shall be during summer vacation after semester – IV. The satisfactory completion of Internship – I should be submitted to university at the end of semester VIII.

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

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NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Second Year Engineering

(Biotechnology Engineering)

Faculty of Science and Technology

SYLLABUS

Semester – III

W.E.F. 2019-20

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. To understand the structures and characteristics or functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
2. To learn the basic principles of inheritance at the molecular, cellular and Organism levels.
3. To test and deepen their mastery of genetics by applying this knowledge in a variety of problem-solving situations.
4. To explain the mechanism of plant and animal tissue culturing.
5. To demonstrate the mechanism of recombinant DNA technology and its application in the field of Biotechnology.

Course outcomes:

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

1. Describe the concepts of modern cell theories and identify the differences in eukaryotic and prokaryotic cells.
2. Explain the major groups of animal and plant kingdom.
3. Demonstrate the advanced techniques in plant and animal tissue culturing, and able to calculate the growth rate of cells through culturing.
4. Classify the microorganisms through different isolation techniques and illustrate microbial culture techniques.
5. Illustrate mechanism involved in rDNA technology and apply the different aspects of Biotechnology.

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: 09 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: 09 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.

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. David W. Mount, Bioinformatics: Sequence and Genome analysis, Cold Spring Harbour.
4. Bhojwani, S.S.and Rajdan, Plant Tissue Culture: Theory and Practice, Revised Edition, Elsevier.
5. V.K. Agrawal , Text book of Zoology , S. Chand Publication.
6. Dr. B.P. Pandey, Text book of Botany ,S. Chand Publication.
7. R.C. Dubey , Text book of Biotechnology, S. Chand Publications.

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 Bioreaction.
4. To understand the energy balance of physical operations.
5. To understand energy balance of Bioreaction.

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.

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: 09 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: 09 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: Mc Millan India, 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.
5. Narayanan & Lakshmikutty , Stoichiometry and Process Calculations, , PHI

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 developed proficiency in methods essentials for handling of fluid and solid.
2. To make the students analyze the flow measurement equipments.
3. To study and classify different types of pumps, blowers and compressors.
4. To make the student familiar with properties of fluids and solids.
5. To understand separation technique and to understand laws of crushing and grinding.

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: 09 Hours	Marks: 12

Flow through Pipeline:
Flow measurement: Flow through Orifice 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: 09 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. J. M. Coulson and R.F. Richardson, Chemical Engg. Vol. I & II : Butter worth & Heinemann.
3. W.L. McCabe & J.C. Smith, Unit operations in Chemical Engineering: McGraw Hill Ltd.
4. K. A. Gavhane ,Unit Operations, Fluid Flow & Mechanical Operation, Nirali Prakashan
5. Som & Biswas ,Introduction to Fluid Mechanics and Fluid Machines, , TMH

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:

1. To build a necessary platform for analyzing the complex issues in microbiology, cell structure and function; metabolism; information flow and the role of microbes in ecosystems.
2. To classify the types of microscopic techniques.
3. To understand the concept of sterilization and its types.
4. To describe the modes of cell division and microbial growth rate.
5. To explain the mode of action of antibiotics and therapeutic agents.

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. Analyze and simplify the complex issues in microbiology.
4. Interpret the mode of action of antibiotics and therapeutic agents.
5. Describe the concepts of microbial growth kinetics and continuous cultures.

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: 09 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: 09 Hours	Marks: 12

Sterilization:
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:

1. To provide the basic knowledge of Bioprocess Industrial Economics and Management,
2. To explain the economics, profitability, various factors to be considered during industrial set up, marketability of product etc.
3. To understand the concept of profitability and cost of the industrial and management.
4. To describe the economical manufacturing process of bioproducts.
5. To use the techniques for isolation of industrial microbes for fermentation.

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: 09 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: 09 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**
Bioproducts Economics: Bioproducts 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:

1. To impart the fundamental knowledge of Unit operations
2. To develop their ability to apply the specific procedures to analyze the experimental results.
3. To identify the flow of fluids.
4. To handle the crushing equipments.
5. To identify the losses in pipes

Course outcomes:

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

1. Determine properties of Fluids and Solid .
2. Identify the problem and solve the problem .
3. Determine the coefficient of Venturi meter, Orifice meter.
4. Apply the knowledge to estimate minor losses in pipes.
5. Determine the friction factor for given pipe.

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 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:

1. To impart the fundamental knowledge of biology at the microscopic level to the students
2. To develop ability to apply the specific procedures to analyze the experimental results.
3. To familiar with the use of microorganisms as lab tools and various biological equipments
4. To isolate the microorganisms by streak plate method, pour plate method, serial dilution method etc.
5. To learn the different techniques for the maintenance and preservation of microorganisms.

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, haemo-cytometer and turbidity measurement.
5. Prepare the media and cultivate the microorganisms by different methods.

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:

1. To impart the fundamental knowledge of good manufacturing practices at the research level
2. To develop ability to apply and follow good practices in production.
3. To explain about the product quality
4. To describe the standard operating processes involved in GMP.
5. To use the different preservative techniques of Bioproducts.

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.
4. Demonstrate the packaging techniques of bioproducts
5. Explain the role and functions of various preservative components.

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)

1. 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.

Kavayitri Bahinabai Chaudhari

NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Second Year Engineering

(Biotechnology Engineering)

Faculty of Science and Technology

SYLLABUS

Semester – IV

W.E.F. 2019-20

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 and also learn various tests, for large sample and small sample.
3. Students will learn how to fit a curve to given data and also understand meaning of sampling.
4. Students will earn to test a hypothesis based on a sample.
5. Students will learn Experimental design and 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: 09 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: 09 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. Richard A. Johnson, Miller& Freund's Probability and Statistics for Engineers (Sixth Edition)
2. Jay L. Devore , Probability and Statistics for Engineers (India Edition)
3. Norman T .J .Bailey, Statistical methods in biology ,(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 modes of Heat Transfer.
2. To develop the relations for rate of heat transfer to achieve optimized operations.
3. To study the types of heat exchanger and their uses in different industrial operations.
4. To study the types of evaporator and their uses for various industrial processes and applications
5. To understand condensation and boiling operations with regards to the processing of bio chemicals.

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. Design a process , system and to conduct the experiments.
3. Demonstrate 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. 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: 09 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: 09 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
5. D.C.Sikdar ,Process Heat Transfer, , Khanna Publishing House
6. B.K. Dutta, Heat Transfer: Principles and Applications, , PHI

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): 12th STD

Course objectives:

1. 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.
2. To classify the types of antibodies.
3. To describe the mechanism of activation of cells involved in immune system.
4. To explain the types of antigen antibody interactions techniques.
5. To understand the role of immune system in medial field.

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.
5. Explain the role of applied immunology parameters.

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: 09 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: 09 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:

1. 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.
2. Explain the classes of proteins and amino acids and their application in the field of Biotechnology.
3. Describe the structure and functions of Lipids.

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: 09 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: 09 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.

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.
3. Lubert Stryer "Biochemistry", W.H. Freemen & Co. , New York.
4. Weil J.H. "General Biochemistry", New Age International (Pvt. Ltd.).

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:					
1. To provide the basic knowledge of IPR and Entrepreneurship, 2. To explain the concept of Intellectual property, trademarks, biosafety & bioethics and entrepreneurship. 3. To describe the phenomenon of SWOT. 4. To demonstrate the project management techniques. 5. To understand the concept of IPR and Trademark.					
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: 09 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: 09 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. David H. Holt, Entrepreneurship: New Venture Creation,.
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:

1. To provide necessary background of heat transfer to the students.
2. To impart the fundamental knowledge of Process heat transfer to the students.
3. To develop their ability to apply the specific procedures to analyze the experimental results.
4. To develop the proficiency in principals and methods used in various process industries.
5. To design heat exchange equipment.

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. Analyze and interpret the data of various processes.
4. Determine rate of heat transfer through various modes of heat transfer.
5. Design heat exchange equipment.

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):	**--**

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:

1. K.A.Gavhane, Nirali Prakashan. Nagpur 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.
4) To understand the immunological analytical techniques
5) To classify the various types of antigen and antibody reactions at in vitro conditions.

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.
3) Describe various types of antigen and antibody reactions at in vitro conditions.
4) Perform Immunoelectrophoresis.
5) Demonstrate the various immunodiffusion techniques.

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:

1. To impart the fundamental knowledge of chemical basis of biology at the research level.
2. To develop ability to apply the specific procedures to analyze the experimental results.
3. To 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
4. To understand the mechanism of isolation of nucleic acids.
5. To isolate and identify the biomolecules using various chromatographic techniques.

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)

1. 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.
11. Identification and estimation of an intermediate of EMP pathway.
12. Cell fractionation.
13. 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 ability to apply the various techniques for developing the new technology for waste management.
3. Design and execute new environmental science experiments.
4. To understand the mechanism of BOD and COD.
5. To explore the options for environmental biotechnology in higher study.

Course outcomes:

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

1. Communicate their understanding of environmental science to a lay audience.
2. 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.
3. Use the techniques, skill and modern engineering tools necessary for engineering practice.
4. Apply the knowledge of engineering principles to living entities for societal welfare.
5. Work in multidisciplinary stream.

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.

Environmental Studies					
COURSE OUTLINE					
Course Title:	Environmental Studies	**Short Title:**	EVS	**Course Code:**	**Non Credit**
Course description:					
The course aims to percolate the importance of environmental science and environmental studies.					
COURSE CONTENT					
Environmental Studies		**Semester:**	**IV**		
		Examination scheme			
		End Semester Exam (ESE):		**60 marks**	
		Duration of ESE:		**03 hours**	
		Internal Continuous Assessment (ICA):		**40 marks**	
Unit–I:	**No. of Lectures: 02 Hours**				
Multidisciplinary nature of environmental studies Definition, scope and importance Need for public awareness.					
Unit–II:	**No. of Lectures: 08 Hours**				
Natural Resources : **Renewable and non-renewable resources** Natural resources and associated problems. • Forest resources : Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. • Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. • Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies. • Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. • Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies. • Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual in conservation of natural resources. • Equitable use of resources for sustainable lifestyles.					
Unit–III:	**No. of Lectures: 06 Hours**				
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, characteristic 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)

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

Biodiversity and its conservation

- Introduction – Definition : genetic, species and ecosystem diversity.
- Biogeographic classification of India
- Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values
- Biodiversity at global, National and local levels.
- India as a mega-diversity nation
- Hot-sports 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.

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

Environmental Pollution

Definition

- Cause, effects and control measures of :-

a. Air pollution
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

- Solid waste Management : Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution.
- Pollution case studies.
- Disaster management : floods, earthquake, cyclone and landslides.

Unit–VI:	**No. of Lectures: 07 Hours**	

Social Issues and the Environment

- From Unsustainable to Sustainable development
- Urban problems related to energy
- Water conservation, rain water harvesting, watershed management
- Resettlement and rehabilitation of people; its problems and concerns. Case Studies
- Environmental ethics : Issues and possible solutions.
- Climate change, global warming, acid rain, ozone layer depletion, nuclear

- accidents and holocaust. Case Studies.
- Wasteland reclamation.
- Consumerism and waste products.
- Environment Protection Act.
- Air (Prevention and Control of Pollution) Act.
- Water (Prevention and control of Pollution) Act
- Wildlife Protection Act
- Forest Conservation Act
- Issues involved in enforcement of environmental legislation.
- Public awareness.

Unit–VII:	**No. of Lectures: 06 Hours**	

Human Population and the Environment

- Population growth, variation among nations.
- Population explosion – Family Welfare Program
- Environment and human health.
- Human Rights.
- Value Education.
- HIV/AIDS.
- Women and Child Welfare.
- Role of Information Technology in Environment and human health.
- Case Studies.

Unit–VIII:	**No. of Lectures:**	

Field work

- Visit to a local area to document environmental assets, river / forest / grassland / hill / mountain
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
- Study of common plants, insects, birds.
- Study of simple ecosystems-pond, river, hill slopes, etc. (Field work Equal to 5 lecture hours)

Guide lines for ICA:

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

Reference Books:

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
4. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
6. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
7. Down to Earth, Centre for Science and Environment (R)
8. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment &

Security. Stockholm Env. Institute Oxford Univ. Press. 473p
9. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
10. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
11. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p.
12. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p.
13. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
14. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
15. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
16. Rao M N. & Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345p.
17. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut
18. Survey of the Environment, The Hindu (M)
19. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)

Internship –I

Internship is a mandatory and non-credit course. It is mandatory for all admitted students to undergo Internship during the degree course. The course Internship – I shall be during summer vacation after Semester - IV of THREE weeks duration.

Following are the intended objectives of internship training:

- Will expose Technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
- Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.
- Exposure to the current technological developments relevant to the subject area of training.
- Experience gained from the 'Industrial Internship' in classroom will be used in classroom discussions.
- Create conditions conducive to quest for knowledge and its applicability on the job.

Students shall choose to undergo Internship / Innovation / Entrepreneurship related activities for Internship. Students shall choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/ NGO's/ Government organizations / Micro / Small / Medium enterprises / academic institutions / research institutions. In case student want to pursue their family business and don't want to undergo internship, a declaration by a parent may be submitted directly to the Department Head / TPO.
During the last year of FOUR year Bachelor of Engineering course the student should take project work, as specified in the curriculum, based on the knowledge acquired by the student during the degree course and during Internship. The project work provides an opportunity to build a system based on area where the student likes to acquire specialized skills. The work may also be on specified task or project assigned to the student during Internship.
The internship activities and list of sub-activities for Internship – I are as under.

- Inter/ Intra Institutional Activities
- Training with higher Institutions;
- Soft skill training organized by Training and Placement Cell of the respective institutions;
- Participation in conferences/ workshops/ competitions etc.;
- Learning at Departmental Lab/ Institutional workshop;
- Working for consultancy/ research project within the institutes;
- Participation in all the activities for eg. Leadership Talks / Technical Expos etc.

Internship:

- Internship with Industry/Govt. / NGO/ Any Micro/ Small/ Medium enterprise/ academic institutions / research institutions

The evolution of internship – I will be in semester - V and done by expert committee constituted by the concerned department including Department Head/ TPO/ faculty mentor or guide. It should be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary.
- Adequacy & quality of information recorded.
- Originality.
- Adequacy and purposeful write-up.
- Practical applications, relationships with basic theory and concepts taught in the course.
- Skill / knowledge acquired