



**Vivekanand Education Society's
College of Arts, Science and Commerce
(Autonomous)**

Sindhi Society, Chembur, Mumbai, Maharashtra – 400 071.

*Accredited by NAAC "A Grade" in 3rd Cycle - 2017
Best College Award – Urban Area, University of Mumbai (2012-13)
Recipient of FIST Grant (DST) and STAR College Grant (DBT)*

**Affiliated to the
University of Mumbai**

Syllabus for S.Y.B.Sc.

Program: B.Sc. (Biotechnology)

(Program code: VESUBT)

**As per Choice Based Credit System (CBCS)
with effect from Academic Year 2023 - 2024**

Program Outcomes (PO):

A learner completing B.Sc. (Biotechnology) will be able to:

- PO1 Demonstrate analytical skills in applying appropriate science principles and methodologies to solve a wide range of problems.
- PO2 Design, carry out experiments and analyze results by accounting uncertainties in different quantities measured using various scientific instruments.
- PO3 Acquire the ability to correlate and draw various inferences.
- PO4 Be able to apply the learnings in the academic course to an industrial setup

Program Specific Outcomes (PSO's)

On completion of B.Sc. (Biotechnology)

- PSO1 Apply the basics of biotechnology to build a strong foundation that will allow them to comprehend emerging and advanced engineering concepts in life sciences.
- PSO2 Acquire expertise in the field of biotechnology so that it may be used in industry and research.
- PSO3 By integrating disciplinary and interdisciplinary components of biotechnology, students will be able to gain technological knowledge.
- PSO4 Recognize the significance of bioethics, intellectual property rights, entrepreneurship, communication, and managerial skills in the development of the future generation of Indian industrialists.

SEMESTER III

Course code	Title	Credits	No. of Lectures /week
VESUBT301	Bioprocess Technology	2	3
VESUBT302	Medical Microbiology	2	3
VESUBT303	Applied Chemistry-1	2	3
VESUBT304	Fundamentals in Biophysics	2	3
VESUBT305	Immunology	2	3
VESUBT306	Molecular Biology-III	2	3
VESUBT307	Biosafety	2	3
VESUBTP301	Practicals of VESUBT301 & VESUBT302	2	3
VESUBTP302	Practicals of VESUBT303 & VESUBT304	2	3
VESUBTP303	Practicals of VESUBT305 & VESUBT306	2	3
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SEMESTER IV

Course code	Title	Credits	No. of Lectures /week
VESUBT401	Medical Biotechnology	2	3
VESUBT402	Cell Biology and Cytogenetics	2	3
VESUBT403	Applied Chemistry-2	2	3
VESUBT404	Biochemistry	2	3
VESUBT405	Molecular Diagnostics	2	3
VESUBT406	Bioinformatics and Biostatistics	2	3
VESUBT407	Research Methodology	2	3
VESUBTP401	Practical of VESUBT401 & VESUBT402	2	3
VESUBTP402	Practical of VESUBT403 & VESUBT404	2	3
VESUBTP403	Practical of VESUBT405 & VESUBT406	2	3
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V.E.S.

Since 1962

SEMESTER III

Course Code	Title	Credits	No of lectures
VESUBT301	Bioprocess Technology	02	
<p>Course Objectives: The objective of this course is to understand the basic skills applied in fermentation technology and build a foundation for more advanced studies in Bioprocess Technology.</p> <p>Learning outcomes: By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Develop an understanding of the various aspects of Bioprocess Technology. • Develop skills associated with the screening of Industrially Important Strains. • Understand principles underlying design of Fermentor and Fermentation Process. 			
<p>Unit I Fermentor Design, Media and Sterilization</p>	<p>Design of a Fermentor: Stirred Tank Fermentor; Parts of a Typical Industrial Fermentor. (2 lectures)</p> <p>Components; Design and Optimization. Aeration, Agitation, Baffles, pH, Temperature, Pressure, Oxygen, Basic Valves, Sampling/Inoculation ports. (3 lectures)</p> <p>Fermentation Media: Components-Carbon, Nitrogen sources, Buffers, Antifoams, Minerals, Chelators, Growth factors, Precursors, Oxygen requirements. (3 lectures)</p> <p>Types of Production Media: Saccharine-based (Molasses), Cellulose-based media, Nitrogen-based media (CSL) Sulphite liquor, Pharmamedia. (3 lectures)</p> <p>Sterilization: Sterilization of Fermentor and Fermentation Media. (3 lectures)</p>		15
<p>Unit II Screening, Isolation, Inoculum Development and Scale-up and Scale- down</p>	<p>Isolation of Industrially Important Organism Screening Primary screening, Secondary screening Types of organism examples (Bacteria, Fungi, Actinomycetes, Algae) (3 lectures)</p> <p>Storage and Preservation of Organism Dried culture, lyophilization, on agar slants, in dried form, in liquid Nitrogen (3 lectures)</p> <p>Inoculum Preparations (Pilot scale and large scale) Scale-up and Scale-down (4 lectures) Increasing product yield</p>		15

	Improvement of strains (5 lectures) Traditional and Modern strategies: Any 5		
Unit III Types of Fermentation and Fermentors	<p>Types of Fermentation: Surface and Submerged; Batch and Continuous; Aerobic and Anaerobic (3 lectures)</p> <p>Types of Fermentors (5 lectures)</p> <ol style="list-style-type: none"> 1. Continuous stirred tank fermentor 2. Airlift fermentor 3. Bubble column fermentor 4. Packed bed fermenter 5. Photobioreactor 6. Membrane bioreactor <p>Penicillin Production Characteristics of an ideal strain, structure, and properties, Types of Penicillin, Mode of Action, Production, Recovery Purification, Bioassay, Chemical assay (5 lectures)</p> <p>Kinetics of Fermentation (2 Lectures) Growth Kinetics, Primary and Secondary Metabolites, Bioequivalence, Chemical Assays and Chromatographic Techniques (in brief)</p>		15
References	<ol style="list-style-type: none"> 1. Principles of Fermentation Technology 2nd Edn. Stanbury Whitaker 2. Industrial microbiology AH Patel 2nd Edn. 3. Industrial Microbiology L.E.Casida 2nd Edn. 		

Course Code	Title	Credits	No of lectures
VESUBT 302	Medical Microbiology	02	

Course objectives: The objective of this course is to gain insight into Disease Factors and Processes and Diseases Caused by Microorganisms.

Learning outcomes: By the end of the course the student will be able to:

- List the factors playing a role in causing disease.
- Discuss the various aspects of Systemic Infections including Causative Agents, Symptoms and Prophylaxis.
- Gain the technical capability of handling, isolating and identification of various Bacteria.

Unit I General Bacteriology and Bacteria as Human Pathogen, Host-parasite Interactions	<p>Host Parasite Relationship:</p> <p>The Role of Microorganisms in Disease Acquisition of infection; Koch's Postulates. (2 Lectures) Normal Flora;(2 Lectures) Factors Affecting the introduction (3 Lectures) Course of Infection and Disease. Mechanisms of Infection and Virulence Factors (3 Lectures) Microbial Growth Kinetics (brief introduction)</p>		15
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	<p>Infection: Patterns of Infection; Types of Infections; Signs and Symptoms (3 Lectures) Epidemiology and Markers (2 Lectures)</p>		
<p>Unit II Causative Organisms-1</p>	<p>Skin: <i>Staphylococcus aureus</i> Morphology, Resistance, Virulence factors, Diseases, Laboratory Diagnosis, Treatment in brief (3 Lectures)</p> <p><i>Streptococcus</i> Morphology, Classification, Virulence factors, Pathogenicity of skin and soft tissues, Laboratory diagnosis, Treatment in brief (3 Lectures)</p> <p>Respiratory Tract: <i>Mycobacterium tuberculosis</i> (3 Lectures) Morphology, Pathogenicity, Laboratory diagnosis, Vaccines, Treatment in brief</p> <p><i>Corynebacterium diphtheriae</i> Morphology, Antigenic Structure, Pathogenicity, Laboratory diagnosis, Vaccines, Treatment in brief (3 Lectures)</p> <p>Urinary Tract: <i>E coli</i> Morphology, Cultural Characteristics, Antigenic Structure, Virulence factors, Clinical infections, Laboratory Diagnosis of UTI (2 Lectures)</p> <p><i>Proteus</i> spp (1 Lecture) Morphology, Cultural Characteristics, Antigenic Structure, Virulence factors, Clinical infections, Laboratory Diagnosis of</p>		15
<p>Unit III Causative Organisms-2</p>	<p>GI Tract: <i>Salmonella</i> spp Morphology, Cultural Characteristics, Antigenic Structure, Pathogenicity, clinical course, complications, Carriers in Brief, Lab Diagnosis, Vaccines and Treatment (3 Lectures)</p> <p><i>Shigella</i> Morphology, Cultural Characteristics, biochemical reactions, Antigenic structure, Pathogenicity, Lab Diagnosis Treatment (3 Lectures)</p> <p>Sexually Transmitted diseases: <i>Treponema pallidum</i> Morphology, Cultivation, Antigenic structure, Pathogenicity, Syphilis, Lab diagnosis, treatment (3 Lectures)</p> <p><i>Neisseria gonorrhoeae</i> Morphology, Cultural Characteristics, biochemical reactions, Antigenic structure, Pathogenicity, Lab Diagnosis Treatment (3 Lectures)</p>		15

	Nosocomial infections: <i>Pseudomonas</i> Morphology, Cultural Characteristics, Pathogenicity, Lab diagnosis, Treatment. (3 Lectures)		
References	1. Microbiology Lansing Prescott 5th Ed 2. Foundations in microbiology Talaro 9th Ed 3. Microbiology Pelczar, Krieg & Chan 4. Textbook of Microbiology Ananthnarayan 10th Ed		

Course Code	Title	Credits	No of lectures
VESUBT 303	Applied Chemistry-1	02	

Course Objectives: To understand the basics of organic chemical reactions and synthesis of organic compounds

To introduce the basic principles of certain techniques used in chemistry and biochemistry such as Chromatography, Centrifugation and Spectroscopy

Learning Outcomes: By the end of the course the student will be able to:

- To differentiate between different organic reactions and delineate the steps of organic synthesis
- To be able to work with instruments such as Centrifuge, Spectrophotometer and be able to set up a chromatography experiment

Unit I Organic Chemistry	Introduction to Types of Organic Reactions: Addition Reaction, Elimination Reaction Substitution Reaction - SN1, SN2, Competitive, Electrophilic Substitution (6 Lectures) Essential and Nonessential Elements in Biological Systems. Role of Metal Ions in Biological Systems. (3 Lectures) Synthesis of Organic Compounds - Criteria for Ideal Synthesis; Selectivity and Yield; Linear and Convergent Synthesis and Multicomponent Reaction. (6 Lectures)		15
Unit II Chromatography and Centrifugation	Basic Principle of Chromatography: Planar Chromatography - Paper Chromatography, TLC (3 Lectures) Column Chromatography - Ion- Exchange, Size Exclusion, Affinity Chromatography, HPLC, Gas Chromatography (6 Lectures) Application of Chromatography (1 lecture) Centrifugation: Principle of Sedimentation, Types of Centrifugations, Type of Rotors, Differential Centrifugation, Density Gradient Centrifugation (5 Lectures)		15

Unit III Spectroscopy	Spectrophotometer: Principle, Instrumentation, and Applications. UV-Vis Spectrophotometer, Single and Dual Beam Spectrophotometer (6 Lectures) Fluorescence Spectroscopy (3 Lectures) CD Spectroscopy (3 Lectures) Light Scattering Spectroscopy (3 Lectures)		15
References	<ol style="list-style-type: none"> 1. Advanced Organic Chemistry - Reinhard Bruckner 2. Biochemistry - Satyanarayan 4th Edition, 3. Principle and Techniques of Biochemistry and Molecular Biology (Fifth Edition) Edited by Keith Wilson and John Walker 4. Principle and Techniques of Biochemistry and Molecular Biology (Seventh Edition) Edited by Keith Wilson and John Walker 		

Course Code	Title	Credits	No of lectures
VESUBT304	Fundamentals in Biophysics	02	
<p>Course Objectives: To develop an understanding of basic physics and its role in biology and biological research</p> <p>Learning Outcomes: By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • The student will be able to delineate the physics behind human physiology and outline the principle and working of instruments used in research and medicine 			
Unit I Optics and Light	<p>Introduction to Optics and Lasers:</p> <p>Optics: Properties of Light - Reflection, Refraction, Dispersion, Interference. (3 Lectures) Polarization of Light (1 Lecture)</p> <p>Lasers: Properties of Lasers, Stimulated Emissions, Laser Action; Applications of Laser. (3 Lectures)</p> <p>Electromagnetic Radiations: Introduction to Electromagnetic Radiation. (1 Lecture)</p> <p>Optics of Vision: Structure of the Eye, Accommodation, Lens System of the eye, Retina, Resolving Power of the eye, Vision and the Nervous System, Defects in Vision- Myopia, Presbyopia and Hyperopia (7 Lectures)</p>		15
Unit II Heat, Sound, Magnetism and Fluid dynamics	<p>Heat: Heat and Hotness, Kinetic theory of matter, Unit of heat, Specific heat, Latent heats, Transfer of heat: Conduction, Convection, Radiation, Diffusion (3 Lectures)</p> <p>Sound: Types of Sound Waves: Audible, Ultrasonic and Infrasonic Waves; Doppler Effect.</p>		15

	<p>Applications in biology - Hearing and the Ear, Performance of the ear, Bats and Echoes, Clinical uses of sound: The Stethoscope, Ultrasonic waves, Ultrasonic imaging, Echocardiography (5 Lectures)</p> <p>Magnetism: Nuclear Magnetism, The nucleus, magnetic resonance imaging, Nuclear magnetic resonance, Imaging with NMR (4 Lectures)</p> <p>Fluid Dynamics: Bernoulli's Equation, Viscosity and Poiseuille's Law, Turbulent flow, Circulation of the blood, Blood pressure (3 Lectures)</p> <p>Surface Tension: Definition - Surface tension and Surface energy; Capillary action; Angle of contact; Surfactants in biology (3 Lectures)</p>		
<p>Unit III Electrophoretic Techniques</p>	<p>Electrophoretic Techniques Migration of ions in an applied electric field Factors affecting electrophoretic mobility (3 Lectures)</p> <p>Moving Boundary Electrophoresis. Principle of Electrophoresis; Supporting Matrix (4 Lectures)</p> <p>Paper Electrophoresis; AGE; Native and SDS PAGE (reducing and non-reducing, continuous and discontinuous); IEF, 2D PAGE and PFGE (5 Lectures)</p> <p>Staining and Detection Methods; Gel-Documentation (in brief) Applications in Biology (3 Lectures)</p>		15
<p>References</p>	<ol style="list-style-type: none"> 1. A Textbook of Optics by N. Subrahmanyam, Brij Lal (23rd revised and enlarged edition, 2006) 2. Principle and Techniques of Biochemistry and Molecular Biology (Fifth Edition) Edited by Keith Wilson and John Walker 3. Physics in Biology and Medicine; Fifth Edition; Paul Dvidovits; H.C. Verma Concepts of Physics Volume 2 		

Course Code	Title	Credits	No of lectures
VESUBT305	Immunology	02	15
<p>Course objectives: The objective of this course is to familiarize students with the Immune Effector Mechanisms and various Immuno-techniques</p> <p>Learning outcomes: By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> Understand the role of different types of cells, Effector molecules, and Effector mechanisms in Immunology. Understand the principles underlying various Immuno-techniques. 			
<p>Unit I Cell and Organs of Immune System, the Complement system</p>	<p>Cell and Organs of Immune System Hematopoiesis: Cells of the Immune System (1 Lecture) Organs of the immune system (2 Lectures) Primary and Secondary lymphoid organs (4 Lectures) Complement System Classical, Alternate and Lectin (4 Lectures) Regulation and biological effects of Complement System (4 Lectures) Deficiencies of Complement System</p>		
<p>Unit II MHC and Antigen Presentation Pathways</p>	<p>MHC and Antigen Presentation Pathways MHC Classes: General organization and Inheritance; Structures and peptide interactions; Class I and II Diversity and Polymorphism (4 Lectures) Antigen Presentation: Endocytic and Exocytic Pathways; MHC Restriction (6 Lectures) TCR/BCR, T-cell and B-cell Activation B-cell Receptor: Structure, Maturation and Activation B-T Cell Interaction (B-T cell Cooperation) (3 Lectures) T-cell Receptor Complex: Structure and Activation (2 Lectures)</p>		
<p>Unit III Immuno-techniques</p>	<p>Immuno-techniques I. Immunoprecipitation (5 Lectures) 1. Immunoprecipitation reaction in solution 2. Immunoprecipitation reactions in gel Radial immunodiffusion, Ouchterlony double immunodiffusion 3. Immunoprecipitation using beads. II. Agglutination reactions (3 Lectures) 1. Coombs test 2. Passive, Reverse Passive, Agglutination Inhibition. Coomb's Test; Complement Fixation Tests 3. Immunoassay: Competitive and non-competitive immunoassay III. RIA, ELISA, ELISPOT, Immunofluorescence,</p>		

	Chemiluminescence, Immunoelectrophoresis, Classical, crossed, rocket and Immunofixation (3 Lectures)		
	Monoclonal antibodies Hybridoma technology (4 Lectures) <ol style="list-style-type: none"> 1. Co- Immunoprecipitation 2. Co-IP,ChIP,RIP 3. Alternatives to Antigen-Antibody Reactions 		
References	<ol style="list-style-type: none"> 1. Immunology - 5th edition by Goldsby, Kuby, Kindt and Osborne 2. Biophysics & Molecular Biology: Tools & Techniques by Pranav Kumar 		

Course Code	Title	Credits	No of lectures
VESUBT306	Molecular Biology-III	02	

<p>Course Objectives: The objective of this course is to have an insight into mechanism of Gene Expression and Regulation.</p> <p>Learning Outcomes: By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Discuss the mechanisms associated with Gene Expression at the level of Transcription and Translation. • Discuss the mechanisms associated with Regulation of Gene Expression in Prokaryotes and Eukaryotes 			
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Unit I Transcription	<p>Gene Expression- an Overview.</p> <p>Transcription Process in Prokaryotes: RNA Synthesis; Promoters and Enhancers; Initiation of Transcription at Promoters; Elongation and Termination of an RNA Chain (8 Lectures)</p> <p>Transcription in Eukaryotes: Eukaryotic RNA Polymerases; Eukaryotic Promoters; Transcription of Protein Coding Genes by RNA Polymerase; Eukaryotic mRNAs; Transcription of other genes; Spliceosomes; RNA editing (7 Lectures)</p>		15
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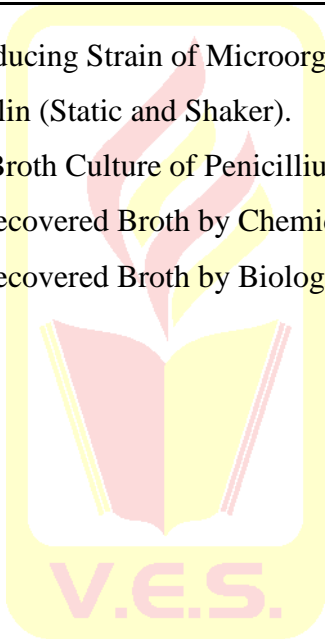
Unit II Translation	<p>Proteins: Chemical and Molecular structure of proteins Amino acid classification (3 Lectures) Nature of Genetic Code (1 Lecture) Wobble Hypothesis (1 Lecture)</p> <p>Translation: The Process of Protein Synthesis Structure of Transfer RNA Structure of Ribosomes (3 Lectures)</p> <p>Process of Protein Synthesis: Initiation, Elongation, Translocation, Termination (4 Lectures)</p> <p>Post Translation Modifications. Protein Sorting in the Cell (3 Lectures)</p>		15
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Unit III Regulation of gene expression	In Prokaryotes: In Bacteria: <i>Lac</i> operon of <i>E.coli</i> ; <i>Trp</i> operon of <i>E.coli</i> (5 Lectures) In Viruses: Lytic / Lysogenic Regulation Mechanism of repressor protein and <i>cro</i> protein (5 Lectures) In Eukaryotes: Operons in Eukaryotes; Control of Transcriptional Initiation; Gene Silencing and Genomic Imprinting; Post-Transcriptional Control; RNA Interference. (5 Lectures)		15
References	<ol style="list-style-type: none"> 1. iGenetics A Molecular Approach 3rd Edition Peter J. Russell-Pearson Education 2. Genetics, 5th Edition Peter J. Russell-Pearson Education 3. Genetics, (2006) Strickberger MW - (Prentice Hall, India) 4. Microbial Genetics- Freifelder –Narosa Publishing House 		

Course Code	Title	Credits	No of lectures
VESUBT307	Biosafety	02	
<p>Course Objectives: The main objective is to make the student aware of the risks involved in biological work</p> <p>Learning Outcomes: By the end of this course the students will be able to</p> <ul style="list-style-type: none"> • Identify the extent of risk involved in the experimental set up • Deal with accidents, if any in a biology laboratory • Be able to determine sterility of Pharma products 			
Unit I Introduction to Biosafety, GLP	General principles, Microbiological risk assessment, Basic laboratories – Biosafety Levels 1 and 2, The containment laboratory – Biosafety Level 3, The maximum containment laboratory – Biosafety Level 4 (7 Lectures) Concept GLP, Practicing and Guidelines, Documentation of Laboratory, Preparation of SOP, Calibration, Validation and Documentation, Audit and Audit reports (8 Lectures)		15
Unit II Biosafety in Diagnostics Labs	Administrative Aspects of the Microbiology Laboratory (3 lectures) Laboratory Safety, Biological Hazards (3 Lectures) Biosafety Cabinets (4 lectures) Cleaning Spills of Infectious Materials, Non-Biological Hazards and Classification of waste (4 Lectures)		15

Unit III Detection and Testing of Contaminants	Microbial Contamination in pharmaceutical products (4 Lectures) Sterile pharmaceutical products – Injections, non-injectable fluids, ophthalmic preparations (6 Lectures) Quality Control and quality assurance of sterile products (5 Lectures)		15
References	<ol style="list-style-type: none"> 1. Laboratory Biosafety Manual-WHO 2. WHO handbook of GLP 3. Koneman's Textbook of Diagnostic Microbiology 4. Microbiology Pharmaceutical Microbiology - Hugo, W.B, Russell, A.D 8th edition Oxford Black Scientific Publishers 		

Course Code	Title	Credits
VESUBTP301	Practicals' of Bioprocess Technology and Medical Microbiology	02
<ol style="list-style-type: none"> 1. Screening for an Antibiotic Producing Strain of Microorganism. 2. Lab Scale Production of Penicillin (Static and Shaker). 3. Purification of Penicillin from Broth Culture of Penicillium spp. by Solvent Extraction. 4. Estimation of Penicillin from Recovered Broth by Chemical (Iodometric) Method. 5. Estimation of Penicillin from Recovered Broth by Biological(Bioassay) Method. 6. Study of <i>S.aureus</i> 7. Study of <i>E.coli</i> 8. Study of <i>Salmonells spp</i> 9. Study of <i>Shigella spp</i> 10. Study of <i>Pseudomonas</i> 11. Study of <i>Proteus</i> 12. Study of <i>Corynebacterium diphtheriae</i> 		



Since 1962

Course Code	Title	Credits
VESUBTP302	Practicals' of Applied Chemistry-1 and Fundamentals in Biophysics	02
<ol style="list-style-type: none"> 1. Organic Estimation of Acetone and Amide 2. Base Catalyzed Aldol Condensation (Synthesis of Dibenzalpropanone). 3. Separation of plant pigments using Paper Chromatography 4. Separation of lipids using Thin Layer Chromatography 5. Estimate protein concentration using UV Visible spectrophotometer 6. Demonstration of the phenomenon of fluorescence using chlorophyll 7. Using Snellen's chart to estimate defects in vision 8. Demonstration of blind spot 9. Liposome Preparation 10. Study of Stethoscope and Blood Pressure Instrument 11. AGE 12. PAGE 		

Course Code	Title	Credits
VESUBTP303	Practicals' of Immunology and Molecular Biology-III	02
<ol style="list-style-type: none"> 1. Complement Fixation Test (CFT). 2. Passive Agglutination- RA Factor Test. 3. Immunoelectrophoresis. 4. ELISA (Kit-based) - HEPALISA 5. DOT-ELISA. 6. Coombs test 7. Immunodiffusion- Ouchterlony and Oudin's Test 8. Study of <i>E.coli</i> Diauxic Growth Curve- (Lactose and Glucose) 9. Study of lac Gene Expression using Blue-White Selection. 10. Expression of β-galactosidase and Measurement of Activity. 		

SEMESTER IV

Course Code	Title	Credits	No of lectures
VESUBT401	Medical Biotechnology	02	45
<p>Course Objectives: The objective of this course is to gain insight into Disease Factors and Processes and Diseases Caused by Microorganisms.</p> <p>Learning Outcomes: By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • List the factors playing a role in causing disease. • Discuss the various aspects of Systemic Infections including Causative Agents, Symptoms and Prophylaxis. • Gain the technical capability of handling, isolating and identification of various Bacteria. 			
Unit I	<p>The Position of Viruses in the Biological Spectrum The General Structure of Viruses (1 lecture) General structure of viruses Baltimore Classification and Taxonomy(ICTV) (1 lecture)</p> <p>General Properties of Viruses (3 lectures) The Cultivation of Viruses Virus Purification Virus Assays</p> <p>Animal Viruses (3 lectures) Classification of animal viruses Reproduction of animal viruses Adsorption of virions Penetration and Uncoating Replication and transcription in DNA viruses replication and transcription in RNA viruses synthesis and assembly of virus capsids Virion release Cytocidal infections and cell damage</p> <p>Plant Viruses (2 lectures) Virion morphology Plant virus taxonomy Plant virus reproduction Transmission of plant viruses</p> <p>Viruses of Fungi and Algae (2 lectures) Insect viruses Viroids and prions</p> <p>Classification of Bacteriophages (2 lectures) Lytic cycle Lysogeny Role of viruses in cancer (1 lecture)</p> <p>CASE STUDY: Combating the worst epidemic of Ebola virus disease in human history (Self learning)</p>		15

<p>Unit II</p>	<p>Discovery and design of antimicrobial agents (1 lecture;</p> <p>Classification of antibacterial agents, selective toxicity, MIC, MLC (2 lectures)</p> <p>Inhibition of cell wall synthesis (Mode of action for): Beta-lactam antibiotics: Penicillin, Cephalosporins; Glycopeptides: Vancomycin; Polypeptides: Bacitracin (2 lectures)</p> <p>Injury to the plasma membrane: Polymyxin (1 lecture)</p> <p>Inhibition of protein synthesis Aminoglycosides, Tetracyclines Chloramphenicol, Macrolides, Erythromycin (2 lectures)</p> <p>Inhibition of Nucleic acid synthesis: Quinolones, Rifampicin, Metronidazole (2 lectures)</p> <p>Antimetabolites: Sulphonamides, Trimethoprim (1 lecture)</p> <p>Drug Resistance: Mechanism, Origin and transmission of drug resistance (1 lecture)</p> <p>Use and misuse of antimicrobial agents (1 lecture)</p> <p>Antifungal drugs, Antiviral drugs (2 lectures)</p>		<p>15</p>
<p>Unit III</p>	<p>General Aspects characteristics of fungi Classification Laboratory diagnosis Treatment -(2 lectures) Fungal Diseases (5 lectures) Introduction Superficial mycoses Cutaneous mycoses Subcutaneous mycoses Systemic mycoses Opportunistic mycoses Protozoan Diseases (8 lectures) Introduction Amebiasis Cryptosporidiosis Freshwater Amoeba diseases Giardiasis Malaria Hemoflagellate diseases Toxoplasmosis Trichomoniasis</p>		<p>15</p>
<p>References</p>	<ol style="list-style-type: none"> 1. Microbiology - by Talaro 4th Ed 2. Understanding Viruses by Teri Shors.pdf 3rd ED 3. Prescott's Microbiology 5th Edition 4. Mim's Med Micro 5th ed 5. Jawetz 22nd ed 6. Murray 5th Ed 		

Course Code	Title	Credits	No of lectures
VESUBT402	Cell Biology and Cytogenetics	02	45
<p>Course Objectives: The objective of this course is to have a firm foundation in the fundamentals of Cell Biology and Cytogenetics.</p> <p>Learning Outcomes: By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Develop an understanding of the Cytoskeleton and Cell Membrane. • Discuss the structure of Chromosomes and types of Chromosomal Aberrations. • Discuss the principles underlying Sex Determination, Linkage and Mapping. 			
Unit I	<p>Cytoskeleton Overview of the major functions of cytoskeleton. (1 lecture)</p> <p>Microtubules: Structure and Composition. (1 lecture) MAPs: Functions- Role in Mitosis, Structural support and cytoskeleton intracellular motility (3 lectures)</p> <p>Motor proteins: Kinesins, Dynein; MTOCs. Dynamic properties of microtubules. Microtubules in cilia and flagella. (3 lectures)</p> <p>Microfilaments: Structure, Composition, Assembly and disassembly. (2 lectures) Motor protein: Myosin. (1 lecture)</p> <p>Muscle contractility: Sliding filament model. Actin binding proteins: Examples of Non-muscle motility. (2 lectures)</p> <p>Intermediate Filaments: Structure and composition; Assembly and disassembly; Types and functions. (2 lectures)</p>		15
Unit II	<p>Cell Membrane An overview of membrane functions (1 lecture)</p> <p>Cell membrane structure & composition (3 lectures)</p> <p>Principles of membrane transport (3 lectures)</p> <p>Cell Junctions; Cell adhesion and extracellular material Microvilli; Tight junctions, Gap junctions; (5 lectures)</p> <p>Cell coat and cell recognition. Cellular interactions. (3 lectures)</p>		15
Unit III-	<p>Cytogenetics Chromosome Theory of Inheritance (3 lectures) Genetic linkage- Morgan's experiments with <i>Drosophila</i> Sex chromosomes, sex linkage, non-disjunction Variation in Chromosomal Structure and Number: (2 lectures)</p>		15

	<p>Deletion, Duplication, Inversion, Translocation, Aneuploidy, Euploidy and Polyploidy and Syndromes- Klinefelter, Turner, Cri-du-Chat, Trisomy -21, Trisomy 18 and Trisomy 13.</p> <p>Sex Determination (2 lecture) Mechanisms of Sex Determination (XX-XY, ZZ-ZW, XX-XO) Dosage Compensation and Barr Body.</p> <p>Pedigree Analysis (4 lectures) Analysis of autosome linked traits in humans Analysis of sex-linked traits in humans Pedigree problems including probability</p> <p>Chromosomal Mapping (4 lectures) Two-point cross; Three-point cross</p>		
References	<ol style="list-style-type: none"> 1. Cell and Molecular biology by Karp 2. Essential Cell biology 4th ed Bruce Alberts 3. Cell and Molecular Biology DeRobertis 8th ed 4. Russell, P. J., & Gordey, K. (2002). IGenetics , San Francisco: Benjamin Cummings. 5. Russell, P. J. (2000). Fundamentals of genetics. Longman Publishing Group. 		

Course Code	Title	Credits	No of lectures
VESUBT403	Applied Chemistry-2	02	45
<p>Course Objectives: The objective of this course is to have a firm foundation of the fundamentals and applications of current Chemical Theories for the Physical World.</p> <p>Learning Outcomes: By the end of the course the student will:</p> <ul style="list-style-type: none"> • Develop an understanding of the different aspects of Analytical Chemistry. • Gain knowledge of Natural Product Chemistry and related acquired skills. • Gain an understanding of basic concepts in Nanotechnology. 			
Unit I	<p>Synthesis of Organic Compounds Introduction to synthesis reactions (2 lectures) Criteria for ideal synthesis (1 lecture) Microwave assisted organic synthesis (2 lectures) Ultrasound in synthesis and polymer supported synthesis (5 lectures) Retrosynthesis (5 lectures)</p>		15
Unit II	<p>Natural Product Chemistry : Primary and secondary metabolites. (1 Lecture) Classification of natural products based on Structure- Alkaloids, phenolics, essential oils and Steroids. (2 lecture) Commercial synthesis of natural products. (2 lectures) Chromatographic separation of natural products : (5 lectures) Gas chromatography and its applications.</p>		15

	<p>Liquid chromatography : HPLC and its applications.</p> <p>HPTLC for Separation and analysis of natural products.</p> <p>Green Chemistry and Synthesis: (5 lectures)</p> <p>Introduction to Green chemistry; need and Relevance of Green chemistry; principles of Green chemistry.</p>		
Unit III	<p>Nanotechnology</p> <p>Nanomaterials: (1 lecture)</p> <p>Introduction to nanomaterials</p> <p>Forms of Nanomaterials: (1 lecture)</p> <p>Nanoparticles, nanofilms and nanotubes</p> <p>Synthesis of Nanomaterial: (4 lecture)</p> <p>Physical, chemical and biological method</p> <p>Characterization of Nanomaterial:(9 lecture)</p> <p>Microscopic (TEM, SEM, AFM, STM), Spectroscopic (UV, IR, XPS), X-Ray Diffraction, Magnetic measurement and applications of nanomaterials</p>		15
References	<ol style="list-style-type: none"> 1. College Organic Chemistry for T.Y.B.Sc. (Himalaya Publishing House) 2. Organic Synthesis (Special Techniques)- V. Ahluwalia 3. Textbook of Organic Chemistry for T.Y.B.Sc. (Himalaya Publishing House) - Revised Syllabus 4. Nanomaterials: B. Vishwanathan 		

Course Code	Title	Credits	No of lectures
VESUBT404	Biochemistry	02	45
<p>Course Objectives: The objective of this course is to gain insight into the metabolic processes associated with the catabolism of carbohydrates, amino acids, lipids and nucleotides.</p> <p>Learning Outcomes: By the end of the course the student will be able to</p> <ul style="list-style-type: none"> • Discuss the metabolic pathways of carbohydrates, amino acids, lipids and nucleotides. • Explain the role of energy-rich molecules in metabolism. 			
Unit I	<p>Carbohydrate Metabolism:</p> <p>Glycolytic pathway and its regulation (2 lectures)</p> <p>Homolactic fermentation; alcoholic fermentation; energetics of fermentation (1 lecture)</p> <p>Citric acid cycle and its regulation (3 lectures);</p> <p>Gluconeogenesis (1 lectures)</p> <p>Pentose phosphate pathway (1 lectures)</p> <p>Glyoxylate pathway (1 lectures)</p> <p>Reductive TCA:Sequence of Reactions, Regulation, Energy, Yield and Metabolic Disorders of the above pathways (1 lectures)</p> <p>Electron Transport System: (3 lectures)</p> <p>Electron transport and oxidative phosphorylation. Inhibitors of ETS</p> <p>Energy Rich Compounds: (2 lectures)</p>		15

	ATP as energy currency, structure of ATP, hydrolysis, other energy rich compounds other than ATP like PEP, creatine phosphate, etc.		
Unit II	Amino Acid Breakdown: Deamination and Transamination (3 lectures) Urea cycle (1 lecture) Breakdown of glucogenic and ketogenic amino acids (4 lectures) Amino Acids as Biosynthetic Precursors: (7 lectures) Biosynthesis of epinephrine, Dopamine, Serotonin, GABA, Histamine, Glutathione. (Sequence of reactions, regulation and metabolic disorders of the above pathways)		15
Unit III	Lipid Metabolism (10 lectures) Mobilization, transport of fatty acids. Beta, Alpha and Omega oxidation of saturated fatty acids Oxidation of unsaturated fatty acids Oxidation of odd chain fatty acids Energy yield, ketone body breakdown to yield energy (Sequence of reactions, regulation, energy yield and metabolic disorders of the above pathways) Nucleotide Metabolism (5 lectures) Degradation of purines and pyrimidines		15
References	<ol style="list-style-type: none"> 1. Lehninger's Principles of Biochemistry, 4th edition, Nelson and Cox 2. General Microbiology, 5th edition, Stanier 3. Biochemistry by Stryer. Fifth edition. 		

Course Code	Title	Credits	No of lectures
VESUBT405	Molecular Diagnostics	02	45

Course Objectives: The objective of this course is to learn and understand molecular techniques and utilize these techniques in diagnosis.

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Learning Outcomes: By the end of the course the student will be able to:

- Gain an understanding of the basic principles used in molecular diagnosis.
- Gain critical thinking and analytical skills to understand new diagnostic methods.
- Apply the knowledge and skills gained in the course should be useful in developing new diagnostic kits.

Unit I	Basics of molecular diagnostics Introduction to Molecular Diagnostics (5 Lectures) Overview of molecular diagnostics, history of molecular diagnostic, future prospects- commercializing molecular diagnostics, personalized medicine and therapy Characterisation and analysis of nucleic acid and proteins (5 lectures) Extraction, isolation and detection of DNA, RNA and proteins, restriction endonucleases and restriction enzyme mapping Hybridisation techniques (5 lecture)		15
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	Southern, Northern, Western and FISH; markers, probes and its clinical applications.		
Unit II	<p>Nucleic acid amplification methods</p> <p>Target Amplification (5 lecture) PCR - General principle; components of a typical PCR reaction; experimental design; primer designing; controls of PCR contamination and mispriming; PCR product clean-up and detection.</p> <p>PCR Types (5 lecture) Reverse transcriptase and real time PCR.</p> <p>Probe amplification (5 lecture) Ligase chain reaction Strand displacement amplification</p>		15
Unit III	<p>Molecular biology related diagnostics (4 lecture)</p> <p>DNA Polymorphism and Identification RFLP and Parentage testing RFLP and Sickle cell anemia</p> <p>Molecular diagnostics for infectious diseases (3 lecture) Molecular testing for Neisseria, Molecular diagnosis for HIV</p> <p>Genetic counseling and Molecular diagnosis (5 lecture) Genetic testing -need and uses, genetic counseling Case studies- Diagnostic testing for cystic fibrosis, Fragile X diagnostics and carrier testing</p> <p>Ethical , Social and Legal issues to molecular genetic testing (3 lecture)</p>		15
References	<ol style="list-style-type: none"> 1. Molecular diagnostics George patrinis Wilhelm Ansoerge 2. Molecular Diagnostics: fundamentals, Methods and Clinical Applications By Lela Buckingham & Maribeth Flaws 2007 		

Course Code	Title	Credits	No of lectures
VESUBT406	Bioinformatics and Biostatistics	02	45

Course Objectives: The objective of this course is learning and understanding basic concepts of Bioinformatics and Biostatistics.

Learning Outcomes: By the end of the course the student will be able to:

- Gain an understanding of the basic concepts of Bioinformatics and Biostatistics.
- Understand the tools used in Bioinformatics.
- Apply the various Statistical Tools for Analysis of Biological Data.

Unit I-	<p>Basics of Bioinformatics</p> <p>Introduction to bioinformatics, the scope of bioinformatics, bioinformatics and the internet (3 lectures)</p> <p>Biological Databases (3 lectures) Classification of Databases - Raw and Processed Databases; Primary (NCBI), Secondary (PIR) and Tertiary or Composite (KEGG) Databases; Structure and Sequence Databases.</p>		15
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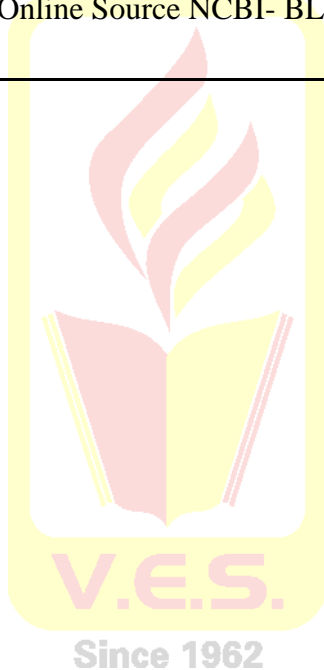
	<p>Specialized Databases (3 lectures) Protein Pattern Databases; Protein Structure and Classification Databases (CATH/SCOP)</p> <p>Genome Information Resources (3 lectures) DNA Sequence Databases Specialized Genomic Resources. Protein Databases based on Composition, Motifs and Patterns.</p> <p>Protein Structure Visualization Software: RASMOL (3 lectures)</p>		
Unit II-	<p>BLAST and Sequence Alignment</p> <p>BLAST and its Types (4 lectures) Retrieving Sequence using BLAST.</p> <p>Pairwise Alignment (3 lectures) Identity and Similarity; Global and Local Alignment; Pairwise Database Searching</p> <p>Multiple Sequence Alignment (8 lectures) Goal of Multiple Sequence Alignment; Computational Complexity; Manual Methods; Simultaneous Methods; Progressive Methods; Databases of Multiple Alignment; Secondary Database Searching; Analysis Packages; MSA and Phylogenetic Trees.</p>		15
Unit III-	<p>Biostatistics Theory and problems based on- coefficient of correlation and regression analysis (4 lectures) Steps in testing statistical hypothesis (3 lectures) Parametric Tests: Z Test – Single Mean and Two Means (3 lectures) t-Test – Single Mean, Paired and Unpaired; (2 lectures) Chi-Square test (3 lectures)</p>		15
References	<ol style="list-style-type: none"> 1. Concept on Bioinformatics by- Rajendra Prasad Pangen 2. Bioinformatics methods and applications- S.C. Rastogi 3. Biostatistics by Arora and Malhan 		

Course Code	Title	Credits	No of lectures
VESUBT407	Research Methodology	02	45
<p>Course Objectives: The objective of this course is to develop research aptitude, logical thinking and reasoning.</p> <p>Learning Outcomes: By the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Understand basic principles of research methodology and identify a research problem. • Understand a general definition of research design. • Identify the overall process of designing a research study from its inception to its report. 			
Unit I	<p>Introduction to Research Methodology and Research Problem</p> <p>Meaning of Research; Objectives of Research (1 lecture)</p> <p>Motivation in Research; Types of Research (2 lectures)</p> <p>Research Approaches; Significance of Research (2 lectures)</p> <p>Research Methods versus Methodology (2 lectures)</p> <p>Research Process; Criteria of Good Research (2 lectures)</p> <p>Problems Encountered by Researchers in India (2 lectures)</p> <p>What is a Research Problem? Selecting the Problem (1 lecture)</p> <p>Necessity of Defining the Problem (2 lectures)</p> <p>Technique Involved in Defining a Problem (1 lecture)</p>		15
Unit II	<p>Research Design, Data Collection and Processing (7 lectures)</p> <p>Meaning of research design; need for research design; features of a good design; important concepts relating to research design; different research designs; basic principles of experimental designs</p> <p>Developing a Research Plan (8 lectures)</p> <p>Collection of primary data; observation method; interview method; collection of data through questionnaires; collection of data through schedules; other methods of data collection, collection of secondary data, selection of appropriate method for data collection, case study method</p>		15
Unit III	<p>Interpretation and Report Writing</p> <p>Meaning of interpretation, why interpretation? (1 lecture)</p> <p>Technique of interpretation, precautions in interpretation (2 lecture)</p> <p>Significance of report writing, different steps in writing a report, the layout of research report, types of reports, oral presentation, mechanics of writing a research report, and precautions for writing research reports (12 lecture)</p>		15
References	1. Research Methodology by C.R .Kothari		

Course Code	Title	Credits
VESUBTP401	Practical of VESUBT401 & VESUBT402	02
<ol style="list-style-type: none"> 1. Study of Chromosomal Aberrations- Deletion, Duplication, Inversion, Translocation 2. Karyotype Analysis and Syndromes Characteristics- Trisomy 21 Trisomy 13 Trisomy 18, Klinefelter, Turner and Cri-du-Chat. 3. Mapping based on Two point and Three Point Cross. 4. Pedigree Analysis- Autosomal and Sex-Linked. 5. Chick embryo 6. Phage assay 7. Synergism 8. Disc diffusion 9. Agar cup 10. Ditch plate 11. Identification of <i>Candida</i> species using the germ tube test and growth on Chrom agar. 12. Demonstration of malarial parasites in blood films. 		

Course Code	Title	Credits
VESUBTP402	Practical of VESUBT403 & VESUBT404	02
<ol style="list-style-type: none"> 1. Determination of Lactate Dehydrogenase (LDH) Activity in Blood Serum 2. Determination of Total, and HDL Cholesterol in serum 3. Liver Function Tests: SGOT, SGPT 4. Kidney Function Test: Serum Urea 5. Urinalysis: Estimation of Uric Acid and Creatinine in Urine 6. Qualitative Detection of Ketone Body in Urine 7. Isolation of Mitochondria and Demonstration of ETC using a Marker enzyme 8. Separation and Identification of Organic Compounds from a solid-solid binary mixture 9. Report on Industrial Visit to observe the working HPLC, GC and HPTLC 10. Chemical and Biological Synthesis of Silver Nanoparticles and its characterization by UV-Vis Spectrophotometer 		

Course Code	Title	Credits
VESUBTP403	Practical of VESUBT405 & VESUBT406	02
<ol style="list-style-type: none"> 1. Familiarization with NCBI, EMBL, DDBJ, PIR, KEGG Databases. 2. Use of NCBI BLAST Tool. 3. Pairwise and Multiple Sequence Alignment and Phylogeny. 4. Classification of Proteins using CATH/SCOP. 5. Visualization PDB Molecules using Rasmol/Raswin. 6. Handling and Calibration of Micropipette. 7. Isolation, Quantitative Analysis and AGE of Genomic DNA from Bacteria and Yeast. 8. Isolation and Detection of RNA from Bacteria and Yeast. 9. Restriction Enzyme Digestion. 10. RFLP- Kit Based. 11. Primer Designing through Open Online Source NCBI- BLAST. 12. DNA Amplification – PCR. 		



Modality of assessment

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 25% marks in the first part & by conducting the Semester End Examinations with 75% marks in the second part. Practical Examination will consist of End Sem examination.

Student will have to score 40% of marks in Internal assessment as well as End Sem examination to pass the course.

The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:

Internal Assessment: It is defined as the assessment of the learners based on internal evaluation as envisaged in the Credit & Choice based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

Semester End Assessment: It is defined as the assessment of the learners based on Performance in the semester end Theory/ written/ Practical examination.

A. Theory - Internal assessment 25%

25 marks

Sr No	Evaluation type	Marks
1.	<ul style="list-style-type: none">- Tests, Assignments,- Project based learning activities (Group Research/ Case studies/ Reports / Assignments / Presentations / Skit / Poster / etc.),- Class Test (multiple choice questions / objective)- Best of two evaluations	20
2.	<ul style="list-style-type: none">- Active participation in routine class activity- Overall conduct as a responsible student, with respect to good behavior, leadership qualities, interpersonal skills etc.- Activities/Attendance	05

B. Theory - External examination - 75%

Since 1962

75 marks

Semester End Theory Assessment

Duration - Each paper shall be of 2.5 hour duration.

1. Theory question paper pattern:

- i. There shall be three compulsory questions, one based on each unit and one from all units
- ii. Each question shall carry 25 marks each.
- iii. Each question shall be subdivided into three sub questions a and b with internal choice in each
 - a) Sub-question 'a' shall consist of 4 questions of 5 marks each
 - b) Sub-question 'b' shall consist of 5 questions of 2 marks each
 - c) Sub-question 'c' shall consist of 5 questions of 1 mark each

Question no.	Details	Marks
Q1.	Based on Unit 1	25
	a. Attempt the following (Any two of four)	10
	b. Attempt the following (any five out of seven)	10
	c. Attempt the following (any five out of seven)	5
Q2.	Based on Unit 2	25
	a. Attempt the following (Any two of four)	10
	b. Attempt the following (any five out of seven)	10
	c. Attempt the following (any five out of seven)	5
Q3.	Based on Unit 3	25
	a. Attempt the following (Any two of four)	10
	b. Attempt the following (any five out of seven)	10
	c. Attempt the following (any five out of seven)	5

C. Semester End Practical Assessment

100 marks

	Section 1 Based on Paper 1	50 Marks
A	Technique 1	20
B	Technique 2	10
C	Spots/Quiz	10
D	Viva	05
E	Journal	05
	Section 2 Based on Paper 2	50 Marks
A	Technique 1	20
B	Technique 2	10
C	Spots/Quiz	10
D	Viva	05
E	Journal	05

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Coordinator / In-charge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

SEMESTER III

Course	Marks	
VESUBT301	100	Theory 700
VESUBT302	100	
VESUBT303	100	
VESUBT304	100	
VESUBT305	100	
VESUBT306	100	
VESUBT307	100	
VESUBTP301	100	Practical 300
VESUBTP302	100	
VESUBTP303	100	
Total		1000

SEMESTER IV

Course	Marks	
VESUBT401	100	Theory 700
VESUBT402	100	
VESUBT403	100	
VESUBT404	100	
VESUBT405	100	
VESUBT406	100	
VESUBT407	100	
VESUBTP401	100	Practical 300
VESUBTP402	100	
VESUBTP403	100	
Total		1000