UNIVERSITY OF MUMBAI
No. UG/92 of 2018-19

CIRCULAR:-

Attention of the Principals of the affiliated Colleges and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/228 of 2009, dated 16th June 2009 relating to syllabus of the Bachelor of Science (B.Sc.) degree course.

They are hereby informed that the recommendations made by the Board of Studies in Biochemistry at its meeting held on 9th April, 2018 have been accepted by the Academic Council at its meeting held on 14th June, 2018 **vide** item No. 4.37 and that in accordance therewith, the revised syllabus as per the (CBCS) for the S.Y.B.Sc. in Biochemistry (Sem - III & IV) has been brought into force with effect from the academic year 2018-19, accordingly. (The same is available on the University's website www.mu.ac.in).

(Dr. Dinesh Kamble)
I/c REGISTRAR

MUMBAI – 400 032
2nd ~~July~~ August, 2018

To

The Principals of the affiliated Colleges & Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.37/14/06/2018

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No. UG/ 92 -A of 2018 MUMBAI-400 032 2nd August ~~July~~, 2018

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Biochemistry,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-Ordinator, University Computerization Centre,

(Dr. Dinesh Kamble)
I/c REGISTRAR

UNIVERSITY OF MUMBAI

Syllabus for the S.Y.B.Sc.
Program: B.Sc.
Course: Biochemistry

(Choice Based Credit System)

(To be implemented from the Academic year 2018-2019

S.Y.B.Sc. Bio-Chemistry Syllabus
Choice Based Credit System
To be implemented from the Academic year 2018-2019
Summary
SEMESTER III

Course Code & title	UNIT	TOPICS	Credits	L / Week
US BCH 301 Bio-organic chemistry & biophysical methods	I	Acids, bases, buffers and ionic equilibria	2	1
	II	Physicochemical principles		1
	III	Microscopy		1
US BCH 302 Fundamentals of Genetics and Physiology	I	Genetics I	2	1
	II	Blood and Body fluids		1
	III	Biological transport mechanisms		1
US BCH 303 Applied Biochemistry I	I	Introduction to microbiology and cell culture	2	1
	II	Fermentation and downstream processing		1
	III	Industrial biotechnology		1
US BCH P3	Practical's based on both courses in theory		3	9

SEMESTER IV

Course Code & Title	UNIT	TOPICS	Credits	L / Week
US BCH 401 Bio-organic chemistry & biophysical methods	I	Enzymology	2	1
	II	Plant growth regulators and endocrinology		1
	III	Approaches to biochemical investigations		1
US BCH 402 Fundamentals of Genetics and Physiology	I	Genetics II	2	1
	II	Movement and locomotion		1
	III	Neurophysiology		1
US BCH 403 Applied Biochemistry II	I	Trends in biotechnology	2	1
	II	Introduction to pharmacology		1
	III	Resource management		1
US BCH P4	Practical's based on both courses in theory		3	9

S.Y.B.Sc. Bio-Chemistry Syllabus
Choice Based Credit System
To be implemented from the Academic year 2018-2019

SEMESTER III

Course Code	Title	Credits
US BCH 301	**Bio-organic chemistry & biophysical methods**	**2 Credits (45 lectures)**
Unit I:	**Acids, bases, buffers and ionic equilibria**	**15 Lectures**
1.1	Definition – pH, pK, pKw, isoelectric pH, buffer, buffering capacity	
1.2	Derivations: Ionic product of water, Hendersen–Hasselbalch equation,	
1.3	Relation between pI, $pKa_1$and $pKa_2$for a neutral, acidic and basic amino acid	
1.3.1	Ionization and titration curves of glycine, lysine and aspartic acid; pKa, pHm, and pI values of these amino acids	
1.3.2	Sorensen's reaction and formol titration of amino acids	
1.4	Physiological buffers: Hb - HHb, carbonate-bicarbonate, phosphate and protein	
1.5	Numerical on above concepts.	
Unit II:	**Physicochemical principles**	**15 Lectures**
2.1	Diffusion and osmosis	
2.1.1	Ways of expressing solute concentration - mole, molal, normal, percent, activity & ionic strength.	
2.1.2	Diffusion & diffusion coefficient and factors affecting diffusion of solute in solution	
2.1.3	Osmosis - Vant Hoff's law of osmotic pressure law & mathematical expression (no derivation), mechanism of osmosis, role of osmosis in physiology.	
2.1.4	Renal dialysis: Principles and process	
2.2	Colloids and viscosity	
2.2.1	Colloidal state in relation to surface forces, surface area, electrical charge, precipitation and	

	flocculation.	
2.2.2	Surface tension and its measurement, factors affecting surface tension Eg. Role of bile in digestion	
2.2.3	Viscosity - definition, measurement; Donnan membrane equilibrium, relation between Donnan equilibrium and osmotic pressure.	
Unit III:	**Microscopy**	**15 Lectures**
3.1	History, Basic principles of microscopy, of light and colour.	
3.2	Dissection and compound microscope: Construction and parts of a microscope, function of each part, levels of magnification, concept of refractive index and role of oil in magnification	
3.3	Specialized microscopy I	
3.3.1	Differential interference contrast (DIC),	
3.3.2	Phase contrast,	
3.3.3	Dark Field	
3.4	Specialized Microscopy II	
3.4.1	Simple fluorescence microscopy	
3.4.2	Confocal microscopy	
3.4.3	Electron microscopy • Principle, applications and comparative study • Types - SEM and TEM	

Course Code	Title	Credits
USBCH302	**Fundamentals of Genetics and Physiology**	**2 Credits (45 lectures)**
Unit I:	**Genetics: I**	**15 lectures**
1.1	**History**: Contributions of Mendel, Bateson, Hardy-Weinberg, Garrod, Morgan, Griffith, Beadle and Tatum, Avery, Mac Leod, Mc Carthy, Lederberg, Tatum, Barbara Mclintock, Hershey & Chase, Watson &Crick.	
1.2	**Mendelian genetics**: Mendel's experiments - Monohybrid, Dihybrid crosses, Laws of inheritance	
1.3	Dominance, recessivity, co dominance, incomplete (semi) dominance, lethal genes	

1.4	Gene interaction -Epistasis, types of epistasis, multiple alleles, maternal effects	
1.5	Numerical on above concepts	
Unit II:	**Blood and Body Fluids**	**15 lectures**
2.1	**Fluid compartments of the body**–ICF and ECF	
2.2	**Blood**: Composition, characteristics and function; role of plasma proteins, Starlings hypothesis; blood clotting **and** factors involved	
2.3	**Bile**: Composition, characteristics and function; storage	
2.4	**Urine**: Composition–normal and abnormal constituents; formation of urine.	
2.5	**Lymph**: Composition, Formation and Circulation	
Unit III:	**Biological transport mechanisms**	**15 lectures**
3.1	**Transport in plants**: Role of xylem and phloem	
3.2	**Transport in blood:**	
3.2.1	Transport of gases CO_2 and O_2, Role of hemoglobin, O_2 dissociation curves, Bohr effect Chloride shift	
3.2.2	Transport of Metabolites: transport of lipids – lipoproteins and their types, role of plasma protein, albumin in transport of metabolites and drugs	
3.2.3	Transport of Ions: Fe -Ferritin and transferrin and calcium	
3.3	**Transport** a**cross cell membrane*s***	
3.3.1	Channel proteins and Carrier proteins	
3.3.2	Passive transport (simple and facilitated diffusion) with suitable examples; concept of symport, antiport, uniport, Endocytosis and Exocytosis – with one example each	
3.3.3	Active transport: primary–Na^+&K^+ pump, secondary Glucose-amino acid transport, types of glucose transporters (GLUT 1 to GLUT 4), aquaporins, ion channel inhibitors like gramicidin and valinomycin	

Course Code	Title	Credits
USBCH 303	**Applied Biochemistry I**	**(45 lectures)**
Unit I:	**Microbiology in Human Health and Diseases**	**15 lectures**
1.1	Beneficial Microorganism: Lactobacillus, Normal flora of human gut, Probiotics, Yeast, Nitrogen fixing bacteria (Rhizobium and Azotobacter)	
1.2	Harmful microorganisms:	
1.2.1	Air borne- *Mycobacterium tuberculae*(Tuberculosis), *Corynebacterium diptheriae*(Diptheria), *Candida* sp., *Haemophilus influenza*e (Influenza), morbillivirus (measles)	
1.2.2	Water borne- *Shigella sp.* (Dysentery), *Vibrio cholerae* (Cholera), *Salmonella sp.* (Enteric fever), *Hepatitis virus*	
1.2.3	Food borne- *Staphylococcus aureus, Clostridium botulinum (Botulism)*	
1.2.4	Soil borne- *Clostridium tetani*	
1.3	Virology- General structure of a typical virus, classification of viruses based on genome (DNA, RNA); symmetry (helical, icosahedral, complex), host (bacteria, plant, animal, insect); Lytic and Lysogenic cycle	
Unit II:	**Cell and Tissue Culture**	**15 lectures**
2.1	Plant Tissue Culture:	
2.1.1	History, Introduction or definition (explants, callus, dedifferentiation, re-differentiation) concept of totipotency	
2.1.2	Culture techniques; Types of culture (Callus culture, Organ culture, protoplast culture, cell culture)	
2.1.3	Applications: secondary metabolites in plant culture, Micropropagation	
2.2	Animal Cell Culture:	
2.2.1	History, Introduction to Primary cell culture, Cell lines (Finite and continuous)	
2.2.2	Culture techniques used for primary culture,	
2.2.3	Stem cell culture, Animal Organ Culture, Whole embryo culture	
2.2.4	Applications: hybridoma (monoclonal antibody), production of Vaccines	

Unit III:	**Industrial Biochemistry**	**15 lectures**
3.1	Basics of fermentation	
3.1.1	Typical Fermenter, Types of Fermenters (CSTF, Bubble cap, Airlift, Fluidized Bed reactor)	
3.1.2	Industrial production of wine, penicillin	
3.2	Immobilized Enzyme: Introduction, Methods of immobilization (entrapment, adsorption, covalent binding, microencapsulation, cross linking)	
3.2.1	Stabilization of soluble enzyme (solvent and substrate stabilization, enzyme stabilization by polymer. Salts and chemical modification)	
3.3.2	Applications	
3.3	Biosensors: Features of Biosensors, classification based on transducers, applications	
3.4	Single Cell proteins and their applications	

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Semester III

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4. J. L. Jain, Fundamentals of Biochemistry, S. Chand & company, 2005 edition
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6. U. Satyanarayan, Biochemistry, Books & allied (P) Ltd., Kolkata, 3rd edition
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8. J.B.Russel, Genetics
9. Benjamin Lewin, Gene VII, Oxford University Press
10. M.W. Strickberger, Genetics
11. William & Wilson
12. Michael J. Pelczar, Jr; E.C.S. Chan; Noel R. Krieg; Microbiology Tata McGraw Hill
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14. U. Satyanarayan; Biotechnology
15. Jogdand, Advances in biotechnology
16. Willium Frazier, Dennis C. Westhoff; Food Microbiology; The McGraw hill Companies
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18. David Freifelder, Microbial genetics
19. Gardner E J, Simmons M J, Snustad P D; Principles of Genetics, Wiley
20. Harvey Lodish , Arnold Berk ,Paul Matsudaira, Chris A., Kaiser, Monty Krieger , Matthew P. Scott , Lawrence Zipursky, James **Darnell,** Molecular Cell Biology, Wiley
21. S.K. Verma and Mohit Verma; Plant physiology, Biochemistry and Biotechnology

SY.B.Sc BIOCHEMISTRY
Practical Syllabus P3

P3 (301)

1) a] Preparation of beta Amylase/Urease/Invertase extract demonstration of the activity Qualitatively.

   b] Determination of the Achromic point of Salivary Amylase.

2) Preparation of Buffers and measurement of pH using pH papers and pH meter.

3) Acid – Base titration of a polyprotic acid [H_2CO_3/H_3PO_4/Glycine hydrochloride]

4) a] A study of some methods of cell rupture: effect of hypo, hyper and isotonic solutions on cells of the onion peel /plant cell (Hydrilla/ Vallisneria/ Spirogyra)

   b] Effect of organic solvents on cell rupture

5) Determination of the Viscosity of sucrose solution using Ostwald's Viscometer.

6) Demonstration of Osmosis through a semi permeable membrane. Potato Osmometer

P3 (302)

1) Mendel's Laws:

   a] Problems based on the laws

   b] case studies based on the laws

2) A study of Human Karyotypes.

3) Isoelectric precipitation of Casein using an indicator.

4) Field visit /Assignment on vermiculture, organic farming, composting, biogas plant followed by a detailed report of at least one [the visit is recommended with the report, but in case it is not possible an assignment is mandatory]

P3 (303)

1) Demonstration of the working of an autoclave and a hot air oven.

2) Optimization of curd – a demonstration.

3) Sterility testing of air by plate exposure technique. [in sterile zone, in lab] and of tap water.

4) A study of various culture inoculation methods. (streak plate, pour plate and spread plate methods).

5) Cell count in a culture medium using optical density

6) Determination of the zone of inhibition of microorganisms using the agar well method and disc method.

7) Flow sheet diagrams of industrial preparation of: a vitamin, an antibiotic, a food item, an enzyme and an alcohol.

Semester IV

Course Code	Title	Credits
USBCH 401	**Bio-organic chemistry & biophysical methods**	**2 Credits 45 lectures**
Unit I:	**Enzymology**	15 lectures
1.1	Definition – Enzyme, coenzyme, cofactor, apoenzyme, holoenzyme, prosthetic group, active site , enzyme specificity, Turnover number, specific activity, Katal, IU.	
1.2	IUB / EC classification upto one digit. Enzyme specificity :Fischers lock & key and Koshlands induced fit theories	
1.3	Activation energy, mechanism of enzyme action (concept of active site, single and bi- substrate reaction), factors affecting enzyme activity – substrate concentration, pH, temperature	
1.4	Enzyme kinetics – Derivation of Michaelis - Menten equation and Lineweaver Burk plot for mono-substrate reactions and numerical problems based on them.	
1.5	Enzyme inhibition – Reversible and Irreversible; competitive and non competitive, (one example of each) Numerical problems on above.	
Unit II:	**Plant growth regulators and endocrinology**	15 lectures
2.1	Plant growth regulators- Structure and function of- auxins, gibberellins, cytokinins, ethylene and abscisic acid.	
2.2	Definition of hormones, hormone receptor, endocrine & exocrine glands	
2.3	Classification of hormones on the basis of:	
2.3.1	Distance of target tissue - autocrine, paracrine, endocrine. Hierarchal organization of the mammalian endocrine system	
2.3.2	Chemistry - One example for each sub class.	
2.4	Chemistry & physiological role of thyroxine, oxytocin & vasopressin, Physiological role of glucocorticoids, FSH, LH, Estrogen, Progesterone (Reproductive cycle) Mode of action of steroid hormones and epinephrine. (amplification cascade Only till the level of protein kinase A) G protein not to be covered.	
Unit III:	**Approaches to Biochemical investigations**	15 lectures
3.1	Whole animal and plant studies - the advantages and	

	disadvantages of any four model systems for biochemical investigation (e.g. *E.coli*, yeast, *Dictyostelium*, *C. elegans*, Drosophila, *Arabidopsis)*	
3.2	Organ & tissue studies	
3.3	Isolated and cultured tissue and cell techniques: isolation, culture and counting of cells.	
3.4	*Cell Fractionation*	
3.4.1	Cell rupture – solid shear, liquid shear, high pressure, ultrasound, osmotic shock, chemical treatment (enzyme, organic solvent), temperature.	
3.4.2	Choice of suspension medium (isotonic & hypotonic solution, PBS) and separation methods.	

Course Code	Title	Credits
USBCH402	**Fundamentals of Genetics and Physiology**	**2Credits 45 lectures**
Unit I:	**Genetics: II**	15 lectures
1.1	**Genome organization**	
1.1.1	Prokaryotic Genome: Nucleoid structure	
1.1.2	Eukaryotic chromosomes: Packaging of DNA(upto Solenoid structure), DNA supercoiling, Topoisomerase, Chromatin structure -Euchromatin, Heterochromatin, structure of condensed chromatin, Centromere, kinetochore, telomere, Comparison of chromosomal structure in prokaryotes and Eukaryotes	
1.2	**Recombination in prokaryotes**	
1.2.1	Transformation: Transformation in *S. pneumoniae*	
1.2.2	Transduction: General features with one example	
1.2.3	Conjugation: Mechanism F+, F- and Hfr strain	
Unit II:	**Movement and locomotion**	15 lectures
2.1	**Movement in plants**	
2.1.1	Movements of Locomotion Spontaneous: Ciliary, Amoeboid, Cyclosis (Rotation, Circulation) Induced: Chemotaxis, Phototaxis, Thermotaxis	
2.1.2	Movements of Curvature: Mechanical: hygroscopic movements Vital:i)Spontaneous-movements of growth(nutation, circumutation, Hyponasty, epinasty); movements of variation ii)Induced–Tropic-hapto/geo/hydrotropism; Nastic–seismonasty, Nyctynasty	
2.2	**Muscle contraction**	
2.2.1	Structural organization of a muscle fibre, myofibril	
2.2.2	Contraction and Relaxation of Muscles; -mechanisms, Other types of contractions–e.g. twitch, tetanus, Isotonic, Isometric regulation of Muscle contraction	
Unit III:	**Neurophysiology**	15 lectures
3.1	**Nervous System Classification:** CNS,PNS; Components: Neurons (3types) and Neuroglia(6types)–structure and function, Axonal transport	

3.2	**Nerve impulse transmission:** Resting Membrane Potential, ion channels [voltage and ligand gated], Action Potential (depolarization, polarization and refraction period), propagation of action potential (salutatory & continuous conduction)	
3.3	**Synaptic transmission**: Physiological anatomy of a synapse;– Electrical & Chemical synapses, Excitatory & inhibitory postsynaptic potentials, Agonists & Antagonists, inactivation of Neurotransmitter	
3.4	**Neurotransmitters**: Structure and function of acetylcholine, catecholamines, GABA, glutamate, glycine	

Course Code	Title	Credits
USBCH 403	**Applied Biochemistry II**	**2 Credits 45 lectures**
Unit I:	**Trends in Biotechnology:**	**15 lectures**
1.1	*Bioremediation:*	
1.1.1	Introduction to terms – Bioremediation, Biotransformation, Xenobiotics, Recalcitrant xenobiotics, Biomagnification, Factors affecting bioremediation	
1.1.2	Types of Bioremediation (*Insitu*, *Exsitu)*; Types of reactions (Aerobic, anaerobic, sequential)	
1.1.3	Applications of Biodegradation - hydrocarbons, (Oil spills) Pesticides and herbicides,Heavy metals (Uranium) contaminated soil and waste land, Ground Water; Genetically Engineered Microbes in bioremediation.	
1.2	Biopesticides:	
1.2.1	Introduction; Types of Biological Control (Classical, inoculation, Inundation);	
1.2.2	Examples each of Bacterial, Viral, Fungal and Protozoal biopesticide .	
1.3	Biofungicide: Examples and applications	
1.4	Biofertilizers: Examples and applications	
Unit II:	**Introduction to Pharmacology**	**15 lectures**
2.1	Scope of pharmacology	
2.2	Sources, Classification, Chemical & physical properties of drug and Nomenclature of drugs	
2.3	Dosage forms and routes of drug administration; Factors affecting dosage and drug delivery	
2.4	Pharmacokinetics: LD 50, ED 50 Half Life, Loading dose, Maintenance dose (Explanation of terms only); Therapeutic index	
2.5	Novel Drug delivery system (NDDS):	
2.5.1	2.5.1 Transdermal and oral modes	
2.5.2	2.5.2 Liposomes and nanoparticles	
Unit III:	**Resource management**	**15 lectures**
3.1	Solid waste: Types of waste, treatment, recycling	

3.2	Waste water- sewage-	
3.2.1	Composition of sewage, types of sewage, detection of pathogenic organism of sewage; preliminary treatment, primary treatment	
3.2.2	Secondary treatment; tertiary treatment, disinfectant	
3.2.3	Sludge treatment and disposal; waste water collection vs sewage treatment in developing countries	
3.3	Biomass and Bio energy production	
3.3.1	Biofuel and Biomass: Fossil fuel; Energy rich crops (sugar and starch; wood-rich; petroleum plants); Animal energy; Sources of biofuel, its cultivation and extraction process	
3.3.2	Biogas: Production, Composition, Applications. Gobar gas. [MSW and LFG, Renewable natural gas, NG vehicle]	

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Semester IV

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3 David Freifelder, Microbial genetics
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17 Harvey Lodish , Arnold Berk ,Paul Matsudaira, Chris A., Kaiser, Monty Krieger , Matthew P. Scott , Lawrence Zipursky, James Darnell**,** Molecular Cell Biology, Wiley
18 S.K.Verma and Mohit Verma, Plant physiology, Biochemistry and Biotechnology

S.Y.B.Sc. BIOCHEMISTRY

Practical Syllabus P4

P4 (401)

1) Parts and maintenance of a microscope.
2) A study of electron micrographs of cell organelles.
3) Permanent slides of Muscle tissue
4) Recrystallization of Benzoic acid and determination of its yield.
5) Ammonium sulphate fractionation of protein and its estimation by a suitable method.
6) Field visit/ assignment on any topic from the syllabus.

P4 (402)

1) Blood experiments:
   i] Determination of total RBC count
   ii] Determination of total WBC count
2) Urine analysis :
   i] Normal constituents - Urea, Uric acid, Chloride
   ii] Abnormal constituents – Glucose, Protein Ketone bodies, bile salts and bile pigments.
   iii] Titratable acidity [using neutral red or phenol red]
3) Bile :
   i] Detection of Bilirubin [Iodine test / Gmelin's Nitric acid test / Fouchet's test]
   ii] Detection of Bile salt [Pettenkofer's test. Hays sulphur test]
4) A demonstration of online muscle twitch.
5) Demonstration of plant movement. [A project to be handled in a group. Each group to plan and execute the experiment in any way they choose. Results to be presented to the class during a practical turn.]

P4 (403)

1) Isolation of DNA from Onions and confirmation by DPA test
2) Determination of the Minimum Inhibitory Concentration of any one disinfectant.
3) Determination of the potability of water by conducting a coliform count. [MPN]
4) Gram stain of sewage.
5) Determination of the Chemical Oxygen demand of an effluent / sewage.
6) Preparation of immobilized yeast/ amylase and determination of enzyme activity.

SEMESTER END THEORY ASSESSMENT (100 marks) Duration of the examination shall be of **3 hours**. The theory question paper pattern suggested is as follows:

1. There shall be four questions of 25 marks each.
2. On each unit there will be one question and fourth question will be based on all the units.
3. All questions shall be compulsory with internal choice within the questions.
4. The questions may be subdivided into sub questions as A, B, C etc.

THEORY:

Q1, Q2, Q3 to be based on Unit I, Unit II and Unit III of **25 marks** each and Q4 to be subdivided into A and B of 10 and 15 marks respectively based on Unit I, Unit II and Unit III. **Total 25 marks.**

Options available: (**For Q1, Q2, Q3**) **25 marks each.**

A. Objective: (No Internal options) **04 marks**
Match the following / Answer in one sentence /Define / Give an example / Name the following/ True or false.: Attempt 4 out of 6

B. Answer the following: Attempt 3 out of 6, each of 3 marks, **09 marks**

C. Attempt 2 out of 4, each of 6 marks **12 marks**

Q4 to be subdivided into 2 parts A and B based on Unit I, Unit II and Unit III **Total 25 marks**

A. Define/ Explain the term: Attempt 5 out of 7, each of 2 marks. **10 marks**

B. Attempt 3 out of 6, each of 5 mark with two questions from each unit. **15 marks**

PRACTICAL:

Term End Exam: Practical **40 marks +** Journal **05 marks +** Viva **05 marks= Total 50 marks**