University of Mumbai

No. AAMS_UGS/ICC/2022-23/ 105

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office circular No. UG/166 of 2016-17 dated 19th November, 2016 relating to the revised syllabus F.Y.B.Sc.(Chemistry) (Sem . I & II) (CBCS).

They are hereby informed that the recommendations made by the Board of Studies in **Chemistry** at its meeting held on 09th June, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 **vide** item No. 6.5 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 **vide** item No. 6.5 (R) and that in accordance therewith, the revised syllabus of F.Y.B.Sc.(Chemistry) (Sem . I & II) (CBCS). has been brought into force with effect from the academic year 2022-23. (The same is available on the University's website www.mu.ac.in).

(Dr. Shailendra Deolankar)
I/c Registrar

MUMBAI – 400 032
11th October, 2022

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.5(R)/11/07/2022

****

No. AAMS_UGS/ICC/ 2022-23/ 105

11th October, 2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies Chemistry,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

(Dr. Shailendra Deolankar)
I/c Registrar

Desktop/Circular Faculty of Science/priya

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC – 11/07/2022
ItemNo. 6.5 (R)

UNIVERSITYOF MUMBAI

Revised Syllabus for
F.Y.B.Sc.
(Chemistry)

Semester:I&II
(CBCS)

(Witheffectfrom the academic year 2022-23)

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	F.Y.B. Sc. (Chemistry)
2	Eligibility for Admission	**12th Science of all recognized Board**
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	
5	No. of Years /Semesters	Two
6	Level	UG
7	Pattern	Semester
8	Status	Revised
9	To be implemented from Academic Year	From Academic Year: 2022-2023

Date:

Dr Vishwanath Patil
Chairman BoS in Chemistry

Signature:

Dr. Anuradha Majumdar
Dean, Science and Technology

Proposed syllabus for CBCS

F. Y. B. Sc. Chemistry

For the subject of chemistry, there shall be two papers for 45 lectures each comprising of three units of 15 L each.

Semester-I

1. Paper-I / II (General Chemistry) Unit-I will be for PhysicalChemistry
2. Paper-I / II Unit-II will be for Inorganic Chemistry
3. Paper- I / II Unit-III will be for OrganicChemistry.

Semester-II

1. Paper-I /II (General Chemistry) Unit-I will be for PhysicalChemistry
2. Paper-I / II Unit-II will be for Inorganic Chemistry
3. Paper-I / II Unit-III will be for OrganicChemistry

Choice Based Credit System F.Y.B.Sc. Chemistry
Syllabus To be implemented from the
Academic year 2022-2023

SEMESTER I

Course Code	Unit	Topic	Credits	L/per week
USCH101	I	Chemical Thermodynamics	2	1
		Chemical calculations		
	II	Atomic structure		1
		Periodic Table and periodicity		
	III	Basics of Organic Chemistry:		1
		Bonding and Structure of organic compounds		
		Fundamentals of organic reaction Mechanism		
USCH102	I	Chemical Kinetics	2	1
		Liquid States		
	II	Comparative Chemistry of Main Group elements		1
	III	Stereochemistry I		1
USCHP1	Chemistry Practical		2	6

SEMESTER II

Course Code	Unit	Topic	Credits	L/per week
USCH201	I	Gaseous State	2	1
		Electrochemistry – I		
		Chemical Equilibria and Thermodynamic Parameters		
	II	Concept of Qualitative Analysis		1
		Acid Base Theories		
	III	Chemistry of Aliphatic Hydrocarbons		1
USCH202	I	Ionic Equilibria	2	1
		Photochemistry Molecular Spectroscopy		
	II	Chemical Bond and Reactivity		1
		Oxidation Reduction Chemistry		
	III	Stereochemistry II		1
		Aromatic Hydrocarbons		
USCHP2	Chemistry Practical		2	6

Programme Outcomes
B.Sc. Chemistry

The student graduating with the Degree B.Sc Chemistry should be able to acquire;

i) Core competency: Students will acquire core competency in the subject Chemistry, and in allied subject areas.

ii) A systematic and coherent understanding of the fundamental concepts in Physical chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry, and all other related allied chemistry subjects.

iii) Students will be able to use the evidence-based comparative chemistry approach to explain chemical synthesis and analysis.

iv) Students will be able to characterize, identify and separate components of organic or inorganic origin and will also be able to analyze them by making use of the modern instrumental methods learned.

v) Students will be able to understand the basic principle of equipmentand instruments used in the chemistry laboratory.

vi) Students will be able to demonstrate the experimental techniques and methods of their area of specialization in Chemistry

vii) The course curriculum also includes components that can be helpful to graduate students to develop critical thinking ability by way of solving problems/numerical using basic chemistry knowledge and concepts.

viii) Appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues, and key issues facing our society in terms of energy, health, and medicine.

ix) Lifelong learner: The course curriculum is designed to inculcate a habit of learning continuously through the use of advanced ICTtechniques and other available techniques/books/journals for personal academic growth as well as for increasing employability opportunity.

SEMESTER I
Paper I
UNIT I

1.1	**Chemical Thermodynamics (10 L)** **Thermodynamic terms;** System, surrounding, boundaries, types of system, Intensive and Extensive properties, State functions and path functions, Thermodynamic processes. **First law of thermodynamics:** Concept of heat (q), work (w), internal energy (U), enthalpy, heat capacity, relation between heat capacities, sign conventions, calculations of heat, work, internal energy and enthalpy (H). **Thermochemistry:** Heat of reactions, standard states, enthalpy of formation of molecules, enthalpy of combustion and its applications, calculations of bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equation (Numerical problems expected wherever necessary)
1.2	**Chemical Calculations: (5L)** Methods of expressing concentration of solutions: Normality, Molarity, Formality, Mole fractions, Weight ratio, Volume ratio, Weight to volume ratio, ppm, ppb, millimoles, milliequivalents, Preparation of solutions. (Numerical problems expected wherever necessary)
	UNIT II
2.1	**Atomic structure:(8 L)**
	Historical perspectives of the atomic structure; J. J. Thomson Model, Rutherford's Atomic Model- alpha particle scattering experiment, Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Structureof hydrogenatom. **Hydrogenicatoms:** 1. Simple principles of quantummechanics 2. Atomicorbitals i) Hydrogenic energylevels ii) Shells, subshells and orbitals iii) Electronspin iv) Radial shapes oforbitals v) Angular shapes oforbitals. Aufbauprinciple, Hund's rule of maximum multiplicity and Pauli exclusion principle
2.2	**Periodic Table and periodicity:(7 L)** **Long form of Periodic Table;** Classification for elements as main group, transition and inner transition elements. **Periodicity in the following properties:** Atomic and ionic size, electron gain enthalpy, ionization enthalpy, effective nuclear charge (Slater's rule), electronegativity, Pauling and Mulliken methods. (Numerical problemsexpected, wherever applicable.)
	Unit III
3	**Basics of Organic Chemistry**
3.1	**Classification and Nomenclature of Organic Compounds: (5L)** **Nomenclature of mono and bi-functional aliphatic compounds on the basis of priority order of the following classes of compounds**: Alkanes, alkenes, alkynes, haloalkanes, alcohols, ethers, aldehydes, ketones, carboxylic acids, carboxylic acid

	derivatives (acid halides, esters, anhydrides, amides), nitro compounds, nitriles and amines and their cyclic analogues.
3.2	**Bonding and Structure of organic compounds: (4L)** **Hybridization**: sp3, sp2, sp hybridization of carbon and nitrogen; sp3 and sp2 hybridizations of oxygen in Organic compounds (alcohol, ether, aldehyde, ketone, carboxylic acid, ester, cyanide, amine and amide) **Overlap of atomic orbitals:** Overlaps of atomic orbitals to form sigma and pi bonds, shapes of organic molecules. **Shapes of molecules;** Influence of hybridization on bond properties (as applicable to ethane, ethene, ethyne).
3.3	**Fundamentals of organic reaction mechanism: (6L)** **Electronic Effects:** Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications. Dipole moment**;** Organic acids and bases; their relative strengths. **Basic terms & concepts**:: Homolytic and Heterolytic fission with suitable examples. Electrophiles and Nucleophiles; Nucleophilicity and basicity, Electrophilicity and acidity. **Types (primary, secondary, tertiary, allyl, benzyl), shape and their relative stability of the following reactive intermediates**: i. Carbocations ii. Carbanions and iii. Free radicals **Introduction to types of organic reactions:** Addition, Elimination and Substitution reaction. (With one example of each)
	Semester- I **Paper – II** **Unit – I**
1.1	**Chemical Kinetics: (8L)** Rate of reaction, rate constant, measurement of reaction rates, order and molecularity of reaction, Integrated rate equation of first order and Second order reactions (with equal initial concentration of reactants) Determination of order of reaction by a) Integration method b) Graphical method c) Ostwald's isolation method d) Half time method, Effect of temperature on the rate of reaction, Concept of activation energy and its calculation from Arrhenius equation (derivation not expected). (Numerical problems expected wherever necessary).
1.2	**Liquid State: (7L)** **Surface tension:** Introduction, methods of determination of surface tension by drop number method **Viscosity:** Introduction, coefficient of viscosity, relative viscosity, specific viscosity, reduced viscosity, determination of viscosity by Ostwald viscometer **Refractive index**: Introduction, molar refraction and polarizability, determination of refractive index by Abbe's refractometer. **Liquid crystals**: Introduction, Classification and structure of thermotropic phases (Nematic, Smectic and Cholesteric phases), applications of liquid crystals. (Numerical problems expected wherever necessary).
	Unit II
2	**Comparative chemistry of MainGroupElements:(15L)**

	Metallic and non-metallic nature, oxidation states, electronegativity, anomalous behavior of second period elements, allotropy, catenation, diagonal relationship. Comparative chemistry of oxides and hydroxides of group I and group II elements. Some important compounds- **$NaHCO_3$, Na_2CO_3, CaO, $CaCO_3$**; oxides of carbon, oxides of Sulphur and Nitrogen with respect to environmental aspects like greenhouse effect, photochemical smog and acid rain.
	Unit III
3	**Stereochemistry I: (15L)** Projection formulae: Flying Wedge projection, Fischer Projection, Newman and Sawhorse Projection formulae (of erythro, threo isomers of tartaric acid and 2,3 - dichlorobutane) and their interconversions; **Geometrical isomerism in alkene and cycloalkanes**: cis–trans and syn-anti isomerism E/Z notations with C.I.P rules. **Optical Isomerism:** Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two similar and dissimilar chiral-centres, Diastereoisomers, meso structures, racemic mixture and resolution (methods of resolution not expected). **Relative and absolute configuration**: D/L and R/S designations. **Conformational analysis of alkanes** (ethane, propane and n-butane); Relative stability with energy diagrams

Semester II
Paper I
Unit I

1.1	**Gaseous State (6L)** Kinetic theory of gases, Maxwell-Boltzmann's distribution of velocities (Qualitative discussion), Ideal gas laws, Deviation from ideal gas laws, Ideal and real gases, Reasons for deviation from ideal gas laws, Compressibility factor, Boyle's temperature, van der Waals equation of state, Critical phenomena, Relation between critical constants and van der Waals constants. (Numerical problems expected wherever necessary)
1.2	**Electrochemistry - I (4 L)** Conductance, specific conductance, equivalent conductance, molar conductance, Variation of molar conductance with concentration of strong and weak electrolyte. Reversible electrodes, Electrode potential, standard electrode potential, Galvanic cells, Conventions to represent the galvanic cells, Concept of emf of cell. (Numerical problems expected wherever necessary)
1.3	**Chemical Equilibria and Thermodynamic Parameters (5L)** Second law of thermodynamics, concept of entropy, Physical significance of entropy, Concept of free energy, Helmholtz and Gibbs free energy, Variation of free energy with temperature and pressure, Spontaneity and Physical significance of free energy. Re Reversible and irreversible reactions, equilibrium constants (Kc and Kp), relationship between Kc and Kp. Thermodynamic derivation of equilibrium constant (Numerical problems expected wherever necessary)
	Unit II

2	**Concept of Qualitative Analysis:(8 L)**
2.1	Testing of Gaseous Evolutes, Role of Papers impregnated with Reagents in qualitative analysis (with reference to papers impregnated with starchiodide, potassium dichromate, lead acetate, dimethylglyoxime and oxinereagents).
	Precipitation equilibria,Formation of precipitates likeAgCl, AgBr, AgI and $BaSO_4$ effect of common ions, uncommon ions, oxidationstates, buffer action, complexing agents on precipitation of ionic compounds. (Balanced chemical equations)
2.2	**Acid Base Theories: (7L)**
	Arrhenius, Lowry- Bronsted, Lewis, Solvent – Solute concept of acids and bases, Usanovich concept, Hard and Soft acids and bases, Applications of HSAB.
	Unit III
3	**Chemistry of Aliphatic Hydrocarbons**
3.1	**Carbon - Carbon sigma bonds: (3L)** Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig reaction, free radical substitutions: Halogenation - relative reactivity and selectivity
3.2	**Carbon - Carbon pi bonds (12L):** **Formation of alkenes and alkynes by elimination reactions**: Mechanism of E1, E2, E1cb reaction. Saytzeff and Hofmann eliminations **Reactions of alkenes**: Electrophilic additions with mechanisms (Markownikoff / AntiMarkownikoff addition), Mechanism of oxymercuration - demercuration, hydroboration - oxidation, ozonolysis, reduction (catalytic and chemical), syn- and anti-dihydroxylation (oxidation), 1, 2- and 1, 4-addition reactions in conjugated dienes, Diels-Alder reaction. **Reaction of alkynes**: Acidity, Electrophilic and Nucleophilic additions with mechanisms. Hydration to form carbonyl compounds, Alkylation of terminal alkynes
	Semester II **Paper II** **Unit I**
1.1	**Ionic Equilibria: (7L)** Strong and weak electrolytes, degree of ionization, factors affecting degree of ionization,Ionization constant and ionic product of water, Ionization of weak acids and bases, Dissociation constants of mono-, di-, and tri-protic acids. pH scale, Buffer solutions, types of buffers, Derivation of Henderson equation for acidic and basic buffers, Buffer action, buffer capacity (Numerical problems expected, wherever necessary)
1.2	**Photochemistry (4L)** Laws of photochemistry, Quantum yield or efficiency, experimental determination of quantum yield, Reasons for low and high quantum yield, Primary and secondary processes. Photochemical reactions (with suitable examples), Photosensitizers and photosensitized reactions, Fluorescence, Phosphorescence and Chemiluminescence. (Numerical problems expected, wherever necessary)
1.3	**Molecular Spectroscopy: (4L)** Electromagnetic radiation, electromagnetic spectrum, Planck's equation, Interaction of electromagnetic radiation with matter; Absorption, Emission, Scattering, Electronic, Vibrational and Rotational transitions, Beer-Lamberts law.

	(Numerical problems expected, wherever necessary)
	Unit II
2.1	**Chemical Bond and Reactivity:(10 L)** Types of chemical bond, comparison between ionic and covalent bonds, polarizability (Fajan's Rule), shapes of molecules, Lewis dot structure, Sidgwick Powell Theory, basic VSEPR theory for AB_n type molecules with and without lone pair of electrons, isoelectronic principles, applications and limitations of VSEPR theory.
2.2	**Oxidation Reduction Chemistry: (5L)** Reductionpotentials, **Redox potentials: half reactions**; balancing redoxequations. **Applications of redoxchemistry**; Redox reagents in Volumetric analysis; a) I_2 b)$KMnO_4$
	Unit III
3.1	**Stereochemistry II: (5L)** **Cycloalkanes and Conformational Analysis: (5L)** Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformational analysis of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagram.
3.2	**Aromatic Hydrocarbons: (10L)** **Aromaticity:** Hückel's rule, anti-aromaticity, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. **Electrophilic aromatic substitution:** halogenation, nitration, sulphonation and Friedel-Crafts alkylation/acylation with their mechanism, Directing effects of the groups

Reference Books:

Unit – I

1) Concise Graduate Chemistry – I, II, III & IV, University Text Book of Chemistry, University of Mumbai.
2)
3) Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University Press (2014).
4) Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
5) Keith J. Laidler& John H. Meiser, Physical Chemistry, 2nd Ed. (2004)
6) Puri B. R., Sharma L. R. &Pathania M. S. Principles of Physical Chemistry, Vishal Publishing Company, 2008
7) Ball, D. W. Physical Chemistry Thomson Press, India (2007).
8) Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
9) Engel, T. & Reid, P. *Physical Chemistry3rd Ed.*, Prentice-Hall (2012).
10) McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
11) Levine, I .N. *Physical Chemistry* 6th Ed.,Tata Mc Graw Hill (2010).

Unit II

1. Concise Graduate Chemistry – I, II, III & IV, University Text Book of Chemistry, University of Mumbai.
2. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
3. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry, Oxford, 1970
4. Atkins, P.W. & Paula, J. Physical Chemistry, 10^{th} Ed., Oxford University Press, 2014. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.
5. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India

Unit III

1. Concise Graduate Chemistry – I, II, III & IV, University Text Book of Chemistry, University of Mumbai.
2. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education).2012
3. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
4. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
5. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994
6. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
7. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013
8. Paula Y Bruice, Organic Chemistry, 7th Ed, Pearson education, Asia.2014
9. Graham Solomon, Fryhle, Dnyder, Organic Chemistry, Wiley publication. 12 th Ed,2016
10. Bahl and Bahl, Advanced Organic chemistry by S. Chand publication.2010
11. Peter Sykes. Guidebook to the mechanism in Organic chemistry ,6^{th}edition
12. D. Nasipuri.Stereochemistry of Organic Compounds,Principles and Applications, Second Edition

Chemistry lab.
Semester – I

Unit – I: Physical Chemistry

1) To prepare 0.1 N succinic acid and standardize the NaOH solution of different concentrations.
2) To determine the rate constant for the hydrolysis of ester using HCl as catalyst.
3) To determine enthalpy of dissolution of salt (KNO_3)
4) Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature (Any two solutions).

Unit II: Inorganic Chemistry

1) Commercial analysis of (anytwo)
    a) Mineralacid
    b) Organicacid
    c) Salt of weak acid and strongbase.
2) Titration using double indicator: analysis of solution of $Na_2CO_3$and$NaHCO_3$

3) Gravimetric analysis
   a) To determine the percent purity of sample of $BaSO_4$containingNH_4Cl
   b) To determine the percent purity of ZnO containing$ZnCO_3$.

Unit III Organic Chemistry

1. Purification of organic compounds by recrystallization selecting suitable solvent (minimum 2 organic compounds to be given)
   (Learners are expected to report a) Solvent for recrystallization. b) Percentage Yield and the melting points of the purified compound.)

2. Basic principles of Organic compound characterization (minimum 4 Solid organic compounds)
   (Learners should perform Preliminary Tests, Solubility Test, obtain melting point and recrystallize the compound with given solvent)

Minimum 80 percent of practical must be completed in each term

Chemistry lab:
Semester - II

Unit – I: Physical Chemistry

1) To determine the amount of strong acid in the given solution by titrating against strong base conductometrically.
2) To determine the dissociation constant of weak acid (Ka) using Henderson's equation and the method of incomplete titration pH metrically.
3) To verify Beer-Lamberts law using $KMnO_4$ solution by colorimetric method.
4) To standardize commercial sample of HCl using borax and to write material safety data of the chemicals involved.

Unit II Inorganic Chemistry

1) **Qualitative analysis: (5 mixtures to beanalyzed)**
   Semi-micro inorganic qualitative analysis of a sample containing two cations and two anions(from amongst):

   Cations (from amongst): Pb^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Cu^{2+}, Cd^{2+}, Fe^{2+}, Ni^{2+}, Mn^{2+}, Mg^{2+}, Al^{3+}, Cr^{3+}, K^+,NH_4^+

Anions (from amongst):CO_3^{2-}, S^{2-}, SO^{2-}, NO_2^-, NO_3^-, Cl^-, Br^-, I^-, SO_4^{2-}, PO_4
(Scheme of analysis should avoid use of sulphide ion in any form for precipitation/ separation of cations.)

2) **Redox Titration:** To determine the percentage of copper(II) present in agiven sample by titration against a standard aqueous solution of sodium thiosulfate (iodometrytitration)

Unit III Organic Chemistry

1) **Characterization of organic compounds** containing C, H, (O), N, S, X elements

(6 solid/liquid Organic compounds)
(Preliminary Tests, Solubility/Miscibility Test, Detection of Elements, Detection of Functional group and determination of Physical constant)
Minimum 80 percent of practicals must be completed in each term

Reference Books

Unit I:Physical Chemistry

1) Laboratory Experiments in Chemistry I & II, University Practical Book of Chemistry, University of Mumbai.
2) Athawale, V. D. & Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi (2001).
3) Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
4) Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry8th Ed.*; McGraw-Hill: New York (2003).
5) Halpern, A. M. &McBane, G. C. *Experimental Physical Chemistry3rd Ed.;* W.H. Freeman & Co.: New York (2003).

Unit II: Inorganic Chemistry

1) Laboratory Experiments in Chemistry I & II, University Practical Book of Chemistry, University of Mumbai.
2) Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6thEd.,* Pearson, 2009.

Unit III: Organic Chemistry

1) Laboratory Experiments in Chemistry I & II, University Practical Book of Chemistry, University of Mumbai.
2) Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
3) Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
4) Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

AC_11-5-2017

Item No._____

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	**Title of Course**	**S. Y. B. Sc. Chemistry**
2	**Eligibility for Admission**	F. Y. B. Sc. Passed from this university (or with ATKT in any two courses at the F. Y. B. Sc. Level) or equivalent qualification from other universities as may have been allowed by the relevant ordinances of this university
3	**Passing marks**	**40%**
4	**Ordinances/Regulations (if any)**	
5	**No. of Semesters**	**Two**
6	**Level**	**U.G.**
7	**Pattern**	**Semester**
8	**Status**	**New**
9	**To be implemented from Academic year**	**2017-2018**

Date : 05-5-2017 **Signature:**
BoS Chairperson: **Dr. Anil V. Karnik**
Convener: Dr. Ravindra G. Deshmukh

UNIVERSITY OF MUMBAI

Essentials Elements of The Syllabus

1	**Title of Course**	Syllabus for two semester S. Y. B. Sc. course in chemistry
2	**Couse Code**	USCH301, USCH302, USCH303 USCH401, USCH402, USCH404 USCHP1 to USCHP6
3	**Preamble**	Attached
4	**Objective**	• To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry. • To make the learner proficient in analysing the various observations and chemical phenomena presented to him during the course. • To make the learner capable of solving problems in the various units of this course • To give the learner an opportunity to get hands on experience of the various concepts and processes in the various branches of chemistry • To impart various skills of handling chemicals, reagents, apparatus, instruments and the care and safety aspects involved in such handling • To make the learner capable of analysing and interpreting results of the experiments he conducts or performs
5	**Eligibility**	Pass F. Y. B. Sc.
6	**Fee Structure**	As Per Guidelines issued from the University
7	**No. of Lectures**	9 lectures per week (three lectures per paper)
8	**No. of Practicals**	9 periods per week (three periods per paper)
9	**Duration of Course**	Two Semester

10	**Notional Hours**	72 hours per paper per semester Theory and 36 hours per paper per semester for laboratory sessions
11	**No of students per batch**	120 students per division (20 Students for laboratory sessions)
12	**Selection**	As per merit.
13	**Assessment**	**End of semester examination of 100 marks per paper for theory and 50 marks per paper for laboratory sessions**
14	**Syllabus Detail**	**Attached**
15	**Title of the Unit**	**As given in the Syllabus text**
16	**Title of the Sub-unit**	**As given in the syllabus text.**
17	**Semester wise Theory**	**As prescribed in the syllabus text**
18	**Semester wise Practicals**	**As prescribed in the syllabus text.**
19	**Question Paper Pattern**	**As prescribed by the Faculty of Science**
20	**Scheme of evaluation of Project**	**N.A.**
21	**List of suggested reading**	**As Attached**
22	**List of websites**	**As Attached**
23	**List of You Tube videos**	**As attached**
24	**List of MOOCs**	**As Attached**

REGULATIONS

1. **Preamble and objectives of the Course :**

In the first two semseters of the six semester graduation program of B. Sc.(Chemistry) the learner was introduced to some basic aspects in the various core branches of chemistry like Physical Chemistry, Organic chemistry and Inorganic chemistry. Concepts about the structure of atom, distribution of electrons, Thermodynamics, Formation of organic compounds and basic ideas in reactivity of molecules in general and organic compounds in particular were introduced to the learner. He was made inquisitive about why and how should atoms combine to give molecules or ions. The non-orbital approach to appreciating the shapes of polyatomic species in general and molecules in particular.

The story of chemistry is taken further in the coming two semesters of the second year of the B. Sc. (Chemistry) Program. However it is also realised that some students opting for the course on Chemistry may not continue with the subject subsequently as such the syllabus is designed to retain the interest of the serious learner of chemistry as well as be helpful to non-chemistry learners. With such students who would want to pursue other branches of science but would want to acquire a basic appreciation and experience of chemistry a separate paper (Paper-III) is designed. This paper along with the laboratory session unit that goes with it deals with the basics of chemical analysis, separating components from a given sample, basic concepts like pH, experimental techniques like Titrimetry, Gravimetry, using instruments to carry out analysis, the various techniques like chromatography, electrophoresis, Instrumentation in general is felt to be of interest to learners of various branches like physics, botany, zoology, and microbiology.

The major objectives of B.Sc. Chemistry course are

- To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry.

- To make the learner proficient in analysing the various observations and chemical phenomena presented to him during the course.
- To make the learner capable of solving problems in the various units of this course
- To give the learner an opportunity to get hands on experience of the various concepts and processes in the various branches of chemistry
- To impart various skills of handling chemicals, reagents, apparatus, instruments and the care and safety aspects involved in such handling
- To make the learner capable of analysing and interpreting results of the experiments he conducts or performs
- To make the learner capable of acquiring or pursuing a source of livelihood like jobs in chemical industry
- To arouse the interest to pursue higher levels of learning in chemistry,

2. Condition for Admission

A candidate who has passed the F.Y.B.Sc. of Mumbai University or an examination of some other university accepted by the syndicate as equivalent there to with Chemistry, Physics, Maths, Botany, Zoology or Life Science shall be eligible for admission into S.Y.B.Sc., course in Chemistry.

To

3. Duration of the Course: one year

4. Course of study:

Draft copy of the proposed revised syllabus for
Choice Based Credit System
S.Y.B.Sc. Chemistry
To be implemented from the Academic year 2017-2018

For the subject of chemistry there shall be three papers for 45 lectures each comprising of three units of 15 L each.

Semester-III

1. Paper-I (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
2. Paper-II (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
3. Paper III Basics of Analytical Chemistry

Semester-IV

1. Paper-I (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
2. Paper-II (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
   Basics of Analytical Chemistry
3. Paper III

Choice Based Credit System
S. Y. B. Sc.
Chemistry Syllabus
To be implemented from the Academic year 2017-2018

Course Content
Semester III

Course Code	Unit	Topics	Credits	L/Week
USCH301	I	Chemical Thermodynamics-II, Electrochemistry	2	1
	II	Chemical Bonding		1
	III	Reactions and reactivity of halogenated hydrocarbons, alcohols, phenols and epoxides		1
USCH302	I	Chemical Kinetics-II, Solutions	2	1
	II	Selected topics on p block elements		1
	III	Carbonyl Compounds		1
USCH303	I	Intorduction to Analytical Chemistry and Statistical Treatment of analytical data-I	2	1
	II	Classical Methods of Analysis.		1
	III	Instrumental Methods-I		1
USCHP1		Chemistry Practicals I	1	3
USCHP2		Chemistry Practicals II	1	3
USCHP3		Chemistry Practicals III	1	3

Semester IV

Course Code	Unit	Topics	Credits	L/Week
USCH401	I	Electrochemistry-II, Phase Equilibria	2	1
	II	Comparative Chemistry of the transition metals & Coordination Chemistry		1
	III	Carboxylic acids and their derivatives, Sulphonic acids		1
USCH402	I	Solid state, Catalysis	2	1
	II	Ions in aqeous medium & Uses and Environmental Chemistry of volatile Oxides and oxo-acids		1
	III	Amines, Diazonium salts, Heterocyclic compounds		1
USCH403	I	Separation Techniques in Analytical Chemistry	2	1
	II	Instrumental Methods-II		1
	III	Statistical Treatment of analytical data --II		1
USCHP4		Chemistry Practicals I	1	3
USCHP5		Chemistry Practicals II	1	3
USCHP6		Chemistry Practicals III	1	3

Semester III
Paper I
Theory: 45 Lectures

Unit I:Physical Chemistry

1.1 Chemical Thermodynamics-II(8L)

1.1.1 Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's
free energy with Pressure and Temperature.
1.1.2 Gibbs-Helmholtz equation, van't Hoff reaction isotherm and van't Hoff reaction isochore.
(Numericals expected).
1.1.3 Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature, Gibb's Duhem equation.
1.1.4 Concept of Fugacity and Activity

1.2 Electrochemistry: (7L)

1.2.1 Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes.
1.2.2 Kohlrausch law of independent migration of ions.
1.2.3 Applications of conductance measurements: determination of degree of ionization and ionization constant of weak electrolyte, solubility and solubility product of sparingly soluble salts, ionic product of water. (Numericals expected).
1.2.4 Transference number and its experimental determination using Moving boundary method. (Numericals expected). Factors affecting transference number.

Unit-II
Chemical Bonding

2.1 Non-Directional Bonding (4L)

2.1.1 Ionic Bond: Conditions for the Formation of Ionic Bond.
2.1.2 Types of Ionic Crystals
2.1.3 Radius Ratio Rules
2.1.4 Lattice Energy, Borne-Lande Equation
2.1.5 Kapustinski Equation
2.1.6 Born-Haber Cycle and its Application

2.2. Directional Bonding: Orbital Approach. (6L)

2.2.1 Covalent Bonding The Valence Bond Theory- Introduction and basic tenets.

2.2.2 Interaction between two hydrogen atoms and the Potential energy diagram of the resultant system.

2.2.3 Corrections applied to the system of two hydrogen atoms- Formation of H_2

2.2.4 Homonuclear diatomic molecules from He_2 to Ne_2

2.2.5 Resonance and the concept of Formal Charge; Rules for Resonance or Canonical structures.

2.2.6 Bonding in Polyatomic Species: The role of Hybridization. And types of hybrid orbitals-*sp, sp^2, sp^3, sp^3d, $sp^2d^2$and sp^2d sp^3d^2*.

2.2.7 Equivalent and Non-Equivalent hybrid orbitals

2.2.8 Contribution of a given atomic orbital to the hybrid orbitals (with reference to sp^3 hybridisation as in CH_4, NH_3 and H_2O and series like NH_3, PH_3, AsH_3, BiH_3)

2.3 **Molecular Orbital Theory (5L)**

2.3.1. Comparing Atomic Orbitals and Molecular Orbitals.

2.3.2. Linear combination of atomic orbitals. to give molecular orbitals LCAO-MO approach for diatomic homonuclear molecules).

2.3.4. Wave mechanical treatment for molecular orbitals (H_2^+ and H_2)

2.3.4 Molecular orbital Theory and Bond Order and magnetic property: with reference to O_2,O_2^+ O_2^-,O_2^{2-}

(Problems and numerical problems expected wherever possible)

Unit III: Organic Chemistry

3.1.1. Reactions and reactivity of halogenated hydrocarbons: [4L]

3.1.1.**Alkyl halides:** Nucleophilic substitution reactions: S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and factors affecting nucleophilic substitution reactions-nature of substrate, solvent, nucleophilic reagent and leaving group.

3.1.2.**Aryl halides:** Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (S_NAr) addition-elimination mechanism and benzyne mechanism.

3.1.2.**Organomagnesium and organolithium compounds: [3L]**

Nomenclature, nature, type and reactivity of carbon-metal bond. Preparation using alkyl / aryl halide. Structure, stability and reactions with compounds containing acidic hydrogen, carbonyl compounds, CO2, cyanides and epoxides.

3.2 Alcohols, phenols and epoxides: [8L]

3.2.1. **Alcohols:** Nomenclature, Preparation: Hydration of alkenes, hydrolysis of alkyl halides, reduction of aldehydes and ketones, using Grignard reagent. Properties: Hydrogen bonding, types and effect of hydrogen bonding on different properties. Acidity of alcohols, Reactions of alcohols

3.2.2. **Phenols: Pr**eparation, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols.

3.2.3. **Epoxides:** Nomenclature, methods of preparation and reactions of epoxides: reactivity, ring opening reactions by nucleophiles (a) In acidic conditions: hydrolysis, reaction with halogen halide, alcohol, hydrogen cyanide. (b) In neutral or basic conditions: ammonia, amines, Grignard reagents, alkoxides.

Semester III
Paper II

Unit I: Physical Chemistry

1.1 Chemical Kinetics-II (7L)

1.1.1 Types of Complex Chemical reactions: Reversible or opposing, consecutive and parallel reactions (No derivations, only examples expected),

Thermal chain reactions: H. and Br. reaction. (only steps involved, no kinetic expression expected).

1.1.2 Effect of temperature on the rate of reaction, Arrhenius equation, Concept of energy of activation (Ea). (Numericals expected).

1.1.3 Theories of reaction rates: Collision theory and activated complex theory of bimolecular reactions. Comparison between the two theories

(Qualitative treatment only)

1.2 Solutions: (8 L)

1.2.1 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapour pressure-composition and temperature -composition curves of ideal and non-ideal solutions. Distillation of solutions.Lever rule.Azeotropes.

1.2.2 Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids with respect to Phenol-Water , Triethanolamine – Water and Nicotine – Water systems

1.2.3 Immiscibility of liquids- Principle of steam distillation.

1.2.4 Nernst distribution law and its applications, solvent extraction.

Unit-II

2. Selected topics on p block elements (15L)

2.1 Chemistry of Boron compounds

2.1.1 Electron deficient compounds – BH_3, BF_3, BCl_3 with respect to Lewis acidity and applications.
2.1.2 Preparation of simple boranes like diborane and tetraborane.
2.1.3 Structure and bonding in diborane and tetraborane (2e-3c bonds)
2.1.4 Synthesis of Borax.

2.2 Chemistry of Silicon and Germanium

2.2.1 Silicon compounds: Occurrence , Structure and inertness of SiO_2
2.2.2 Preparation of structure of $SiCl_4$
2.2.3 Occurrence and extraction of Germanium
2.2.4 Preparation of extra pure Silicon and Germanium

2.3 Chemistry of Nitrogen family

2.3.1 Trends in chemical reactivity - Formation of hydrides, halides, oxides with special reference to oxides of nitrogen.
2.3.2 Oxides of nitrogen with respect to preparation and structure of NO, NO_2, N_2O and N_2O_4.
2.3.3 Synthesis of ammonia by Bosch – Haber process.

Unit III: Organic Chemistry

Carbonyl Compounds: [15L]

3.1 Nomenclature of aliphatic, alicyclic and aromatic carbonyl compounds. Structure, reactivity of aldehydes and ketones and methods of preparation; Oxidation of primary and secondary alcohols using PCC, hydration of alkynes, action of Grignard reagent on esters, Rosenmund reduction, Gattermann – Koch formylation and Friedel Craft acylation of arenes

3.2 General mechanism of nucleophilic addition, and acid catalyzed nucleophilic addition reactions.

3.3 Reactions of aldehydes and ketones with $NaHSO_3$, HCN, RMgX, alcohol, amine, phenyl hydrazine, 2,4-Dinitrophenyl hydrazine, $LiAlH_4$ and $NaBH_4$.

3.4 Mechanisms of following reactions: Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt and Cannizzaro reaction.

3.5 Keto-enol tautomerism: Mechanism of acid and base catalysed enolization

3.6 Active methylene compounds: Acetylacetone, ethyl acetoacetate diethyl malonate, stabilised enols. Reactions of Acetylacetone and ethyl acetoacetate (alkylation, conversion to ketone, mono- and dicarboxylic acid)

Semester IV
Paper I

Unit I: Physical Chemistry

1.1Electrochemistry-II: (8 L)

1.1.1 Electrochemical conventions, Reversible and irreversible cells.

1.1.2 Nernst equation and its importance, Types of electrodes, Standard electrode potential, Electrochemical series (Numericals expected).

1.1.3 Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. (Numericals expected)

1.1.4 Calculation of equilibrium constant from EMF data. (Numericals expected)

1.1.5 Concentration cells with transference and without transference. Liquid junction potential and salt bridge.

1.1.6 pH determination using hydrogen electrode and quinhydrone electrode.(Numericals expected)

1.2 Phase Equilibria: (7L)

1.2.1 Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation.

1.2.2 Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. (numericals expected)

1.2.3 Phase diagrams of one-component systems (water and sulphur).

1.2.4 Two component systems involving eutectics, congruent and incongruent melting points (lead-silver system).

Unit-II

2.1 Comparative Chemistry of the transition metals (9 L)

2.1.1 Position in the periodic table; Natural occurrence principal ores and minerals;

2.1.2 Significance of special stability of d^0, d^5 and d^{10} leading to variable oxidation states; Unusual oxidation states and their stabilities in aqueous solutions (with special reference to vanadium, and chromium.)

2.1.3 Origin of colour for transition metals and their compounds: such as reflectivity, surface coatings, particle size, packing density for metals and nature of d-orbitals, number of electrons in the d-orbitals, geometry, and ability for charge transfer).

2.1.4 Magnetic properties of transition metal compounds: Origin of magnetism-spin and orbital motion of electrons; equation for spin only and spin-orbital magnetism in terms of Bohr magnetons (No derivation of relevant equations expected); Reasons for quenching of orbital moments.

2.1.5 Chemistry of Titanium and vanadium: properties of Oxides and chlorides; use in titrimetric analysis

2.1.6 Qualitative tests for transition metal ions: General considerations in devising tests (with reference to Chromium, Manganese, iron, Cobalt Nickel and Copper)

2.2 Coordination Chemistry : (6 L)

2.2.1 Introduction to Chemistry of Coordination Compounds

i. Historical perspectives: Early ideas on coordination compounds
ii. Basic terms and nomenclature.
iii. Types of ligands
iv. Isomerism :General Types with special reference to stereoisomerism of coordination compounds (C.N=6)
v. Evidence for the formation of coordination compounds,

2.2.2. Theories of coordination compounds

i. Werner's Theory of coordination compounds,
ii. Effective atomic number rule.
iii. Eighteen electron Rule

2.2.3. Nature of the Metal-Ligand Bond:

i. Valence Bond Theory; Hybridisation of the central metal orbitals-sp^3, sd^3/d^3s sp^3d^2/d^2sp^3, sp^2d,
ii. Inner and outer orbital complexes of .(suitable examples of Mn(II) Fe(II),Fe(III),Co(II)/Co(III),Ni(II), Cu(II) Zn(II) complexes with ligands like aqua, ammonia CN^- and halides may be used)
iii. Limitations of V.B.T

2.2.4. Application of coordination compounds.

Unit III: Organic Chemistry

3.1 Carboxylic Acids and their Derivatives :(11 Lectures)

3.1.1. Nomenclature, structure and physical properties, acidity of carboxylic acids, effects of substituents on acid strength of aliphatic and aromatic carboxylic acids.

3.1.2. Preparation of carboxylic acids: oxidation of alcohols and alkyl benzene, carbonation of Grignard and hydrolysis of nitriles.

3.1.3. Reactions: Acidity, salt formation, decarboxylation, Reduction of carboxylic acids with $LiAlH_4$, diborane, Hell-Volhard-Zelinsky reaction,Conversion of carboxylic acid to acid chlorides, esters, amides and acid anhydrides and their relative reactivity.

3.1.4. Mechanism of nucleophilic acyl substitution and acid-catalysed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acyl substitution.
3.1.5. Mechanism of Claisen condensation and Dieckmann condensation.

3.2 Sulphonic acids: [4L]

Nomenclature, preparation of aromatic sulphonic acids by sulphonation of benzene (with mechanism), toluene and naphthalene, Reactions: Acidity of arene sulfonic acid, Comparative acidity of carboxylic acid and sulfonic acids. Salt formation, desulphonation.Reaction with alcohol, phosphorous pentachloride, IPSO substitution.

Semester IV
Paper II

Unit I: Physical Chemistry

1.1 Solid State: (7L)

1.1.1 Recapitulation of laws of crystallography and types of crystals

1.1.2 Characteristics of simple cubic, face centered cubic and body centered cubic systems, interplanar distance in cubic lattice (only expression for ratio of interplanar distances are expected)

1.1.3 Use of X-rays in the study of crystal structure, Bragg's equation (derivation expected), X-rays diffraction method of studying crystal lattice structure, structure of NaCl and KCl. Determination of Avogadro's number (Numericals expected)

1.2 Catalysis: (8 L)

1.2.1 Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation

1.2.2 Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH.

1.2.3 Mechanisms and kinetics of enzyme catalyzed reactions (Michaelis-Menten equation)

1.2.4 Effect of particle size and efficiency of nanoparticles as catalyst.

Unit-II

2 Ions in aqeous medium

2.1. Acidity of Cations and Basicity of Anions

i. Hydration of Cations; Hydrolysis of Cations predicting degree of hydrolysis of Cations-effect of Charge and Radious.

ii. Latimer Equation. Relationship between pKa, acidity and z^2/r ratios of metal ions graphical Presentation

iii. Classification of cations on the basis of acidity category – Non acidic, Moderately acidic, strongly acidic, very strongly acidic with pKa values range and examples

iv. Hydration of Anions; Effect of Charge and Radius; Hydration of anions-concept, diagram classification on the basis of basicity

2.2. Uses and Environmental Chemistry of volatile Oxides and oxo-acids

i. Physical properties of concentrated oxo-acids like sulfuric, Nitric and Phosphoric acid

ii. Uses and environments aspects of these acids

Unit III: Organic Chemistry

Nitrogen containing compounds and heterocyclic compounds:

3.1 Amines: Nomenclature, effect of substituent on basicity of aliphatic and aromatic amines;

3.1.1. Preparation: Reduction ofaromaticnitro compounds using catalytic hydrogenation,chemical reduction using Fe-HCI, Sn-HCl, Zn-acetic acid, reduction of nitriles, ammonolysis of halides, reductive amination , Hofmann bromamide reaction.

3.1.2. Reactions- Salt Formation, N-acylation, N-alkylation, Hofmann's exhaustive methylation (HEM),Hofmann-elimination reaction, reaction with nitrous acid, carbylamine reaction, Electrophilic substitution in aromatic amines: bromination, nitration and sulphonation.

3.2 Diazonium Salts: **(7 Lectures)**

Preparation and their reactions/synthetic application - Sandmeyer reaction, Gattermann reaction, Gomberg reaction, Replacement of diazo group by -H,-OH. Azo coupling with phenols, naphthols and aromatic amines, reduction of diazonium salt to aryl hydrazine and hydroazobenzene

3.3 Heterocyclic Compounds: (8 Lectures)

3.3.1. Classification, nomenclature, electronic structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom;

3.3.2. Synthesis of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, and Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis),

3.3.3. Reactivity of furan, pyrrole and thiophene towards electrophilic substitution reactions on the basis of stability of intermediate and of pyridine on the basis of electron distribution. Reactivity of pyridine towards nucleophilic substitution on the basis of electron distribution.

3.3.4. Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier-Haack reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction, Ring opening. Pyrrole: Acidity and basicity of pyrrole. Comparison of basicity of pyrrole and pyrrolidine.

3.3.5. Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and piperidine. Sulphonation of pyridine (with and without catalyst), reduction and action of sodamide (Chichibabin reaction).

Semester III
Chemistry Practicals:

Unit I: Physical Chemistry

1. To verify Ostwald's dilution law for weak acid conductometrically.
2. To determine dissociation constant of weak acid conductometrically.
3. To determine the critical solution temperature (CST) of phenol - Water System.
4. Determination of energy of activation of acid catalyzed hydrolysis of methyl acetate.
5. To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants
6. To determine solubility of sparingly soluble salts (anytwo) conductometrically.

Unit II: Inorganic Chemistry

1. Identification of cations in a given mixture and Analytically separating them [From a mixture containing not more than two of the following: Pb(II), Ba(II), Ca(II), Sr (II), Cu(II), Cd(II), Mg(II), Zn(II), Fe(II), Fe(III), Ni(II), Co(II) Al(III), Cr(III)]
2. Crystallisation of potassium iodate and to estimate its purity before and after the separation.
3. Estimation of total hardness
4. Investigation of the raction between Copper supfate and Sodium Hydroxide (Standard EDTA solution to be provided to the learner).

Unit III: Organic Chemistry

Short organic preparation and their purification: Use 0.5-1.0g of the organic compound. Purify the product by recrystallization. Report theoretical yield, percentage yield and melting point of the purified product.

Preparation of:

1. Cyclohexanone oxime from cyclohexanone.
2. Glucosazone from dextrose or fructose
3. Tribromoaniline from aniline.
4. β-Naphthylbenzoate
5. m-Dinitrobenzene from nitrobenzene

6. Phthalic anhydride from phthalic acid by sublimation
7. Acetanilide from aniline
8. p-Bromoacetanilide from acetanilide
9. Iodoform from acetone

(Any eight preparations)

Semester IV
Chemistry Practicals:

Unit I: Physical Chemistry

1. To determine standard EMF and the standard free energy change of Daniel cell potentiometrically .
2. To determine the amount of HCl in the given sample potentiometrically.
3. Compare the strengths of HCl and H_2SO_4 by studying kinetics of acid hydrolysis of methyl acetate.
6. Industrial visit report.

Unit II: Inorganic Chemistry

1. Inorganic preparation – Nickel dimethyl glyoxime using microscale method.
2. Complex cation – *Tris* (ethylene diamine) nickel (II) thiosulphate.
3. Complex anion – Sodium Hexanitrocobaltate (III) The aim of this experiment is to understand the preparation of a soluble cation (sodium)and a large anion hexanitrocobaltate(III) and its use to precipitate a large cation (potassium)
4. Inorganic salt – Calcium or magnesium oxalate using PFHS technique

Unit III: Organic Chemistry

Qualitative Analysis of bi-functional organic compounds on the basis of

1. **Prelimenary examination**
2. **Solubility profile**
3. **Detection of elements C, H, (O), N, S, X.**
4. **Detection of functional groups**
5. **Determination of physical constants (M.P/B.P)**

Solid or liquid Compounds containing not more than two functional groups from among the following classes may be given for analysisto be given: Carboxylic acids, phenol, carbohydrates, aldehydes, ketones, ester, amides, nitro, anilides, amines, alkyl and aryl halides.

Students are expected to write balanced chemical reactions wherever necessary. (Minimum 6 compounds to be analyzed)

Reference Books for Practicals:

Unit I:

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001)

Unit II:

1. *Practical Inorganic Chemistry* by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)

Unit III:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000). Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5^{th} Ed., Pearson (2012)
4. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996

Reference Books:

Unit I:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry CengageLearning India Pvt.Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).
6. K.L.Kapoor A textbook of Physical Chemistry3rd Ed. vol.1,2Macmillan Publishing Co., NewDelhi(2001)

Unit II:

1. *Practical Inorganic Chemistry* by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
2. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
3. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
4. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar
5. **References.**
6. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
7. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.
8. Chemistry of Transition Elements Pg.- 608 – 679 .
9. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359- 648.
10. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999) page 325-446.
11. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
12. CNR Rao edited, University General Chemistry, 513-578.
13. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity,
14. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry, page no. 435-463.
15. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
16. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt,. Ltd. (2002).
17. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry, page 416-628.
18. Bruce H. Mahan, University Chemistry, Narosa publishing house.
19. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.
20. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS
21. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999)
22. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
23. CNR Rao edited, University General Chemistry
24. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity,

25. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry
26. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
27. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt,. Ltd. (2002).
28. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry

Unit III:

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
6. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
7. Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek barton ,W. David Ollis.
8. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
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10. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005

Semester III
Paper III
Basics in analytical Chemistry
Theory: 45 Lectures

The Role of Analytical chemistry in various fields including non-chemistry fields such as Environmental Science, Pharmacy, Medicine, Life Sciences, Petrochemicals, Arts (like Painting) Forensic sciences and so on can never be underestimated. This course is expected to introduce the learner to this interesting field of Analytical Chemistry.

It is expected to provide the learner an overview of this very important branch of chemistry. After successful completion of this course the learner is expected to be familiar with the question of what is analysis, why it is required and the methods, techniques, procedures and protocols that may be used or required in the course of a given problem of analysis. The learner is also expected to appreciate the role of an Analytical Chemist and a Chemical Analyst.

Correctness or acceptability of the results of a given analysis and how to deal with wrong or erroneous results: when to reject them and when and how to retain them to be meaningful and/or acceptable are some other attributes expected as outcomes of learning this paper.

As such it is felt that this paper will be a subject of choice and interest for learners preferring a specialisation in Chemistry as well as to those who may have interests in other science fields as Physics, Botany, Zoology, Microbiology, Geochemistry and so on.

Goal:

To introduce the learner to an area of learning that is vital for the inherent nature of the subject itself but also is important and irreplaceable irrespective of the long term interest of specialisation or subject of interest of the learner.

Unit **I- Intorduction to Analytical Chemistry and Statistical Treatment of analytical data-I (15 L)**

Scope/ Objectives:

Learners should be able to

1. Select a method of analysis
2. Decide how to identify a sample and prepare it for analysis
3. Select a procedure for analysis
4. Identify sources of possible errors in the results obtained.

(Problems including numericals expected wherever necessary)

1.1. Role of Analytical Chemistry (9 L)

1.1.1. Language of analytical chemistry: important terms and their significance in Analytical Chemistry.

1.1.2. Purpose of Chemical Analysis; Analysis Based (i) On the nature of information required: (Proximate, Partial, Trace, Complete Analysis) and (ii) On the size of the sample used (Macro, semi-micro and micro analysis)

1.1.3. Classical and Non-Classical Methods of Analysis; their types and importance.

1.2. Significance of Sampling in Analytical Chemistry

1.2.1. Terms involved in Sampling

1.2.2. Types of Sampling

1.2.3. Sampling techniques

1.3. Results of Analysis. (6L)

1.3.1. Errors in Analysis and their types

1.3.2. Precision and Accuracy in Analysis

1.3.3. Corrections for Determinate Errors

(Problems including Numericals expected wherever required)

References:

1. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch

2. Instrumental methods of analysis by Willard, H.H.; Merritt, L.L. Jr.;
Dean, J.A.; Settle,7th Edition

3. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler,
S. R. Crouch

4. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education

Unit II- Classical Methods of Analysis(15 L)

Objectives:

The main objectives of this unit is to

- Introduce classical methods of chemical analysis.
- Appreciate the various terms and types of titrimetric analysis.
- Ability to select proper titrimetric method
- Appreciate the usefulness of the gravimetric method of analysis
- Identify a suitable gravimetric method
- Perform the required calculations involved in the analysis by titrimetry as well as gravimetry.

2. Classical Methods of Analysis. (04L)

2.1. Titrimetric Methods

2.1.1. Terms involved in Titrimetric methods of analysis. Comparing volumetry and Titrimetry

2.1.2. The Conditions suitable for titrimetry

2.1.3. Types of titrimetry – Neutralisation (Acidimetry, alkalimetry), Redox, (Iodometry, Iodimetry,) Precipitation and Complexometric titrations and indicators used in these titrations

2.1.4. Tools of Titrimetry: Graduated glasswares and Callibration

2.2. Standard solutions (Primary and Secondary standards in Titrimetry) and Calculations in Titrimetry.

2.3. Neutralisation Titrations (04L)

2.3.1. Concept of pH and its importance in Neutralisation Titrations

2.3.2. End point and Equivalence point of Neutralisation titrations

2.3.3. Determination of End point by using

i. Indicators causing colour change
ii. Change in potential, (by potentiometry)
iii. Change in conductance (by conductometry)

2.3.4. Construction of titration curve (on the basis of change in pH)of a titration of

i. Strong acid-weak base
ii. Strong base-weak acid

2.4. Gravimetric analysis (06 L)

2.4.1. General Introduction to Gravimetry.

2.4.2. Types of Gravimetric Methods –

2.4.3. Precipitation Gravimetry:

i. Steps involved in precipitation gravimetry analysis
ii. Conditions for precipitation
iii. Completion of precipitation,
iv. Role of Digestion, Filtration, Washing, Drying Ignition of precipitate.

v. Applications of Gravimetric Analysis: Determination of sulfur in organic compounds; Estimation of Nickel in Cu-Ni alloy using dimethyl glyoxime; Determination of Aluminum by converting it to its oxide.

References:

1) Skoog et al. “Fundamentals of Analytical chemistry" Cengage Learning, Eight Edition, chapter 13, 14 and 15
2) Day and Underwood, “Quantitative analysis" prentice hall 1991, chapter3
3) S.M. Khopkar, “ Basic Concepts of Analytical Chemistry”, IInd Edition NewAge International Publisher
4) Gary D. Christan,” Analytical Chemistry”, VIth Edition, Wiley Students Edition, Chapter No 8,9,10
5) Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch
6) Modern Analytical Chemistry , David Harvey (page numbers 232 -265)

Unit III: Instrumental Methods-I [15 L]

Objectives:

On completing the learning of this unit the learner is expected to

- Know the various instrumental methods of analysis
- Advantages of using instruments to make measurements
- The various observable properties of a given analyte and the stimulus best suited for its analysis
- Know about a generalized diagram of an analytical instrument
- Select a suitable instrumental method for analysis
- Appreciate the basic terms in spectrometry
- Use the relationship between absorbance (and its variations) and concentration of the analyte.
- Chose a suitable method foe photometric titrations.

3. Basic Concepts in Instrumental methods (03)

3.1. Relation between the Analyte, Stimulus and measurement of change in the observable property.

3.2. Block Diagram of an Analytical instrument.

3.3. Types of Analytical Instrumental methods based on

i. Optical interactions (eg. Spectrometry: uv-visible, Polarimetry)
ii. Electrochemical interactions (eg. Potentiometry, Conductometry,)
iii. Thermal interactions (eg. Thermogravimetry)

3.4. Spectrometry (07 L)

3.4.1. Interaction of electromagnetic radiation with matter: Absorption and Emission spectroscopy

3.4.2. Basic Terms: Radiant Power, Absorbance, Transmittance, Monochromatic

light, Polychromatic light, Wavelength of maximum absorbance, Absorptivity and Molar Absorbtivity

3.4.3. Statement of Beer's Law and Lambert's Law, Combined Mathematical Expression of Beer -Lambert's Law, Validity of Beer-Lambert's Law, Deviations from Beer-Lambert's Law ((Real deviations, Instrumental deviations and Chemical deviations)
(Numerical problems based on Beer-Lambert's Law)

3.4.4. Instrumentation for absorption spectroscopy: Colorimeters and Spectrophotometers

3.4.5. Block Diagrams for Single beam and Colorimeter, and Spectrophotometer (Principles, Construction and working-Details of Components expected i.e , source ,Sample holder , Filters/Monochromators, Detectors such as Photomultiplier tube)

3.4.6. Applications of UV-Visible Spectrophotometry **(02 L)**

(a) Qualitative analysis such as Identification of functional groups in Organic compounds ,Chromophores and Auxochrome,*cis* and *trans* isomers

(b) Quantitative analysis by Calibration curve method and

3.4.7. Photometric Titrations: Principle ,Instrumentation, Types of Photometric titration Curves with examples. **(03L)**

References:

1.Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal , Sham K.Anand pp 2.107-2.148

2.Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp 143-172.

3. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp 118-181.

Semester III
Chemistry Practicals:
Paper III
Basics in Analytical Chemistry

1. **Tools of Analytical Chemistry-I:**
   a) Analytical glass wares like burettes, pipettes, Standard flasks, Separating funnels.
   b) Weighing tools such as two pan balance and monopan balance, digital balances:
   c) Incineration devices: Burners, Electrical Incinerators, Muffle Furnace,
   d) Drying Devices: Hot Air Oven, Microwave Oven, Descicators, Vacuum descicators
   e) Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photoemissive cells, Photomultiplier tubes

(The learner should draw diagrams and write-ups providing uses, care and maintenance of the items mentioned in (a) and principle, construction and uses of items (b) to (e) in his journal.

2. Gravimetric estimation of Nickel (II) as Ni-DMG and calculation of % error.
   (The learner is expected to know the role of the various reagents/chemicals used In the estimation, various steps involved. They should write the complete and Balanced chemical reaction for the formation of the $Ni(DMG)_2$ complex.
3. Colorimetric Determination of Copper Ions in given Solution by using calibration curve method and calculation of % error.
   (The learner is expected to learn the relation between concentration and Absorbance, to draw a calibration curve, use the slope of the calibration curve and compare it with the calculated slope. They are also expected to state the error estimate of their results).
4. Determination of buffer capacity of acid buffer and basic buffer.
   (The learner is expected to learn the use pH meter, standardization of pH meter, use of Henderson's equation and calculation of buffer capacity)
5. Estimation of Aspirin
6. Gravimetric estimation of barium ions using K_2CrO_4 as precipitant calculation of % error.
   (The learner is expected to learn the skills of using the counterpoise technique used in this gravimetric estimation; Using counterpoise method whatman No.42 for filtration. In such a case no incineration or use of silica crucible is required. They are also expected to state the error estimate of their results)

Semester IV

Paper III Basics in Analytical Chemistry -II

Theory: 45 Lectures

Unit –I -Methods of separation (15 L)

Objectives:

The learner is expected to understand

- The importance of separation in sample treatment
- Various methods of separations
- How to select a method of separation of an analyte from the matrix
- How a solute gets distributed between two immiscible phases
- Principle of solvent extraction and various terms involved therein
- Effect of various parameters on solvent extraction of a solute
- Classification of Chromatographic methods
- Paper and thin layer chromatography and using them in practice.

1. Separation Techniques in Analytical Chemistry (02 L)

1.1. An Introduction to Analytical Separations and its importance in analysis.

1.2. Estimation of an analyte without effecting separation.

1.3. Types of separation methods

1.3.1. Based on Solubilities (Precipitation, Filtration Crystallisation)

1.3.2. Based on Gravity- Centrifugation

1.3.3. Based on volatility-Distillation ;

1.3.4. Based on Electrical effects-Electrophoresis
1.3.5. Based on retention capacity of a Stationary Phase -Chromatography;
1.3.6. Based on distribution in two immiscible phases-Solvent Extraction;
1.3.7. Based on capacity to exchange with a resin-Ion Exchange;

1.4. **Electrophoresis:** Principles, Basic Instrumentation, Working and Application in separation of biomolecules like enzymes and DNA. (02L)

1.5. Solvent extraction (06 L)

1.5.1. Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient.
1.5.2. Conditions of extraction: Equilibration time, Solvent volumes, temperature, pH.
1.5.3. Single step and multi step extraction, Percentage extraction for single step and multistep extraction. Separation factor.
1.5.4. Batch and continuous extraction

1.6. Chromatography : **(05L)**

1.6.1. Introduction to Chromatography
1.6.2. Classification of chromatographic methods based on stationary and mobile phase
1.6.3. Paper Chromatography: Principle, techniques and applications of Paper Chromatography in separation of cations.
1.6.4. Thin layer Chromatography Principle, technique and Applications in determining the purity of a given solute; Following progress of a given reaction .

References :

1. D.A. Skoog, D.M. West, F.J. Holler and CX.R. Crouch – Fundamentals of Analytical chemistry, 8th edition
2. G.H. Morrison and H. Freiser , Solvent extraction in analytical chemistry
3. P. G. Swell and B. Clarke, Chromatographic separations , Analytical chemistry by open Learning , John Wiley and sons, 1987
4. Modern Analytical Chemistry , David Harvey (page numbers 596 -606)
5. Modern Analytical Chemistry , David Harvey (page numbers 215 -217)

Unit –II - Instrumental Methods-II (15 L)

Objectives
On completing this unit the learner is

- Expected to appreciate the nature of interaction between applied electrical potential and the concentration of the analyte.
- The nature of chemical reactions that influence potential of a given cell.
- Familiar with the various types of electrodes or half cells.
- Appreciate the nature, need and importance of pH
- Expected to know the applications of the various instrumental methods dealt with in this unit.

2. Instruments based on the electrochemical properties of the analytes

2.1. Potentiometry: **(05 L)**

2.1.1. Principle.
2.1.2. Role of Reference and indicator electrodes

2.1.3. Applications in Neutralisation reactions with reference to the titration of a Strong acid against a Strong Base (using quinhydrone electrode)

2.1.4. Graphical methods for detection of end points

2.2. pHmetry: **(04 L)**

2.2.1. Principle

2.2.2. Types of pH meters.

2.2.3. Principle, Construction Working and Care of Combined Glass electrode

2.2.4. Applications in Titrimetry (Strtong acid-Strong Base) biological and environmental analysis.

2.3. Conductometry: **(06 L)**

2.3.1. Principle

2.3.2. Conductivity cell its construction and care

2.3.3. Applications in Neutralisation Titrimetry with respect to

i. Strong Acid-Strong Base
ii. Strong Acid-Weak Base
iii. Strong Base-weak Acid
iv. Weak Acid- Weak Base**.**

2.3.4. Advantages & limitations of conductometric titrations.

References:

1) Principles of Instrumental analysis, D. A. Skoog, 3rd edition, Saunders college publishing. Chapters: 20, 23 Page nos: 600 - 605, 631, 704 - 711.
2) Vogel's Text book of quantitative inorganic analysis, 4th edition, ELBS/ Longman. Chapters: XIV, XV Page nos: 566 - 601, 615 – 625.
3) Instrumental methods of analysis, B. K. Sharma, Goel publishing house. Miscellaneous methods: Chapters: 1, 3, 4 Page nos: 1 - 14, 21 - 57.

Unit III- Statistical Treatment of analytical data --II (15 L)

Objectives:

On completing this unit the learner is expected to understand

i) The use of statistical methods in chemical analysis.
ii) The nature of indeterminate errors
iii) The randomness of such errors and its distribution around a correct or acceptable result
iv) Computation of Confidence limits and confidence interval
v) Test for rejection of doubtful result
vi) Method to draw best fitting straight line

3.1.**Nature of Indeterminate Errors: (03L)**

3.1.1. The true and acceptable value of a result of analysis

3.1.2. Measures of central tendency: mean, median. mode, average

3.1.3. Measures of dispersion: Absolute deviation, relative deviation, relative average deviation, standard deviation,(s,sigma) variance, coefficient of variation

3.2.**Distribution of random errors: (02L)**

3.2.1. Gaussian distribution curve.

3.2.2. Equation and salient features of Gaussian distribution curve

3.3.Concept of Confidence limits and confidence interval and its computation using (03 L)

(i) Population standard deviation

(ii) Student's *t* test

(iii) Range

3.4.Criteria for rejection of doubtful result (02 L)

(i) 2.5 d rule

(ii) 4.0 d rule

(iii) Q test

3.5.Test of Significance (02 L)

(i) Null hypothesis

(ii) F-test (variance ratio test)

3.6. Graphical representation of data and obtaining best fitting straight line (03 L)

(a) For line passing through origin

(b) For line not passing through origin

[Numerical problems wherever possible, expected]

References:

1. Modern Analytical Chemistry , David Harvey (page numbers 53 -84)
2. Fundamentals of analytical chemistry – Skoog and West

Semester IV
Chemistry Practicals:
Paper III Elective
(Basics in analytical Chemistry)

1. Tools of Analytical Chemistry-II

a. Filtration Flasks, Funnels, Separating Funnels, Distillation apparatus, Vacuum Distillation assembly, Centrifuge machine, Electrophoresis apparatus.

b. Development chamber for chromatography

c. Electrodes like Reference Electrodes and Indicator Electrodes (with respect to care and maintenance.)

d. Conductivity cell (with respect to care and maintenance.)

e. Combined Glass electrode (with respect to care and maintenance.)

f. Types of Salt Bridges and preparation of any one or use of salt bridge, its effect on the potential of a given electrode/cell

(The learner should draw diagrams and write-ups providing uses of the items mentioned in (a and b) and Principle, Construction care and Uses of items (c) to (f) in his journal.)

2. **Paper chromatography:** Separation of cations like Fe(III), Ni(II) and Cu(II) in a sample.

3. Separation of a solute between two immiscible solvents to determine the distribution ratio and/or extraction efficiency. (Solutes could be as their aqueous solutions and the organic solvent ethyl acetate) Suggested solute for the distribution study: Fe (III) in aqueous solutions.
   (The learner is expected to learn the technique of solvent extraction by using separating funnel, method to estimate the concentrations of the solute distributed in the two immiscible phases, determination of the extraction efficiency)
4. Conductometric titration: Estimation of given acid by conductometric titration with strong base and calculation of % error. (The learner is expected to learn the handling of the conductometer and the conductivity cell, determination of end point by plotting a graph. They are also expected to state the error estimate of their results).
5. Estimation of Fe(II) in the given solution by titrating against $K_2Cr_2O_7$ potentiometrically and calculation of % error. (The learner is expected to learn the handling of the potentiometer, use of Platinum electrode and reference electrode like SCE. They will learn to determine end point by plotting a graph. They are also expected to state the error estimate of their results).
6. Gravimetric estimation of Sulfate as $BaSO_4$ and calculation of % error. (The learner is expected to write a balanced chemical reaction, need for digestion of the precipitate and the skill required to carry out the incineration and to estimate the % error.)
   (The learner is expected to write a balanced chemical reaction, need for digestion of the precipitate and the skill required to carry out the incineration and to estimate the % error.)

REFERENCES:

***F*or paper III**

1. **D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp. 345-381.**
2. **A.I. Vogel. "Textbook of Quantitative Inorganic Analysis," Longman, London (1961).**
3. **R.V. Dilts. "Analytical Chemistry. Methods of Separation," van Nostrand, N.Y. (1974).**
4. **Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B.BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi**

UNIVERSITY OF MUMBAI
No. UG/ /156 of 2016-17

CIRCULAR:-

A reference is invited to the Syllabi relating to the B.Sc. degree course , **vide** this office Circular No. UG/98 of 2015-16, dated 13th October, 2016 and the Principals of affiliated Colleges in Science are hereby informed that the recommendation made by the Ad-hoc Board of Studies in Chemistry at its meeting held on 7th July, 2016 has been accepted by the Academic Council meeting held on 14th July, 2016 **vide** item No. 4.13 and that in accordance therewith, the revised syllabus as per the Choice Based Credit System for T.Y. B.Sc. programme in Chemistry (Sem. V & VI), which are available on the University's web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2016-17.

16/11/16

(Dr.M.A.Khan)
REGISTRAR

MUMBAI – 400 032
16 November, 2016

To,

The Principals of the affiliated Colleges in Science.

A.C/4.13/14.07.2016

****

No. UG/ /156A of 2016 MUMBAI-400 032 16 November, 2016

Copy forwarded with Compliments for information to:-

1) The Co-ordinator, Faculties of Science,
2) The Chairman, Board of Studies in Chemistry,
3) The Professor-cum-Director, Institute of Distance & Open Learning (IDOL)
4) The Director, Board of College and University Development,
5) The Co-Ordinator, University Computerization Centre,
6) The Controller of Examinations.

16/11/16

(Dr.M.A.Khan)
REGISTRAR

PTO..

UNIVERSITY OF MUMBAI

Syllabus for sem V & VI
Program: B.Sc.
Course: CHEMISTRY

(Credit Based Semester and Grading System with effect from the academic year 2016–2017)

T.Y.B.Sc.
CHEMISTRY
Credit Based Semester and Grading System
To be implemented from the Academic year 2016-2017

SEMESTER V
Theory

Course	UNIT	TOPICS	Credits	L / Week
USCH501	**I**	**1.1 Colligative Properties of Dilute Solutions (8L)** **1.1.1** Dilute solution, colligate properties, Raoult's law, relative lowering of vapour pressure. **1.1.2** Elevation in boiling point of a solution, thermodynamic derivation relating elevation in the boiling point of a solution and the molar mass of the non-volatile solute. **1.1.3** Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point of a solution and the molar mass of the non-volatile solute. **1.1.4** Osmotic pressure, van't Hoff's equation for osmotic pressure, (derivation is expected) and determination of molar mass of the solute. Abnormal molar masses of solutes and van't Hoff factor (calculation of Degree of Association and Degree of Dissociation.) **1.2 Phase Rule (7L)** **1.2.1** Gibb's phase rule and terms involved in the equation. **1.2.2** Application of phase rule to ONE component systems (i) water system, (ii) sulphur system **1.2.3** Application of phase rule to TWO component systems, condensed systems, condensed phase rule, eutectic systems (Lead-Silver system), desilverisation of lead. **1.2.4** Introduction to three component system, explanation of phase diagram for three liquids forming one immiscible pair.	**2.5**	**1**

	II	**2.1 Surface Chemistry & Catalysis (9L)** **2.1.1 Adsorption:** Physical and Chemical Adsorption, types of adsorption isotherms **.** Langmuir's adsorption isotherm (Postulates and derivation expected). B.E.T. equation for multilayer adsorption, (derivation not expected). significance of the terms involved in the equation is expected.),determination of surface area of an adsorbent using B.E.T. equation. Numericals on surface area determination are expected. **2.1.2 Catalysis:** Homogeneous and heterogeneous catalysis, catalytic activity and selectivity, promoters, inhibitors, catalyst poisoning and deactivation, **2.1.3 Acid-Base catalysis**, mechanism and kinetics of acid-base catalyzed reactions, effect of pH on acid-base catalyzed reactions. Mechanism and kinetics of enzyme catalyzed reaction (Michaelis-Menten equation). **2.2 Colloids (6L)** **2.2.1** Introduction to colloidal state of matter. **2.2.2** Origin of charge on colloidal particles. Concept of electrical double layer, zeta potential, Helmholtz and Stern model, Electro-kinetic phenomena:1.Electrophoresis, 2.Electrophoresis , 3. Streaming potential 4. Sedimentation potential . **2.2.3** Colloidal electrolytes. **2.2.4** Donnan Membrane Equilibrium. **2.2.5** Surfactants, micelle formation, applications of surfactants in detergents, food industry, in pesticide formulations.		
	III	**3.1 Electrochemistry – Electrochemical cells (15L)** **3.1.1** Lewis concept of Activity and Activity coefficient, Mean ionic activity and mean ionic activity coefficient γ_{+-} of an electrolyte, expression for activities of electrolytes of different valence type, ionic strength		

		3.1.2 Classification of cells: 1.chemical cells without transference 2.Concentration cells with and without transference (derivations of expression for concentration cell EMF are expected) Origin of liquid-liquid junction potential and its elimination using a salt bridge. **3.1.3** Applications of EMF .measurements in the determination of **1.** pH of a solution using quinhydrone and glass electrode. **2** solubility and solubility product of sparingly soluble salts using chemical cell and concentration cell method **3**. determination of liquid-liquid junction potential .		
	IV	**4.1 Introduction to Polymers (8L)** **4.1.1 Basic terms** : macromolecule, monomer, repeat unit, degree of polymerization. **4.1.2. Classification of polymers** based on (i) source, (ii) structure, (iii) thermal response, (iv) physical properties. **4.1.3. Molar masses of polymers**: 1. Number average molar mass, 2.Weight average molar mass, 3. Viscosity average molar mass, monodispersity, polydispersity. **4.1.4. Methods of determining molar masses of polymers** : 1. Ultrcentrifuge method (Limiting velocity method only). Viscosity method (Mark-Houwink equation). **4.1.5. Introduction to light emmiting polymers** (characteristics, method of preparation and it's application are expected). **4.2 Crystalline State (7L)** **4.2.1. Laws of Crystallography** **4.2.2**. Characteristics of simple cubic, face centered and body centered cubic system, inter planar distance in cubic lattices (only expressions for ratios of inter planar distances are expected). **4.2.3.** Use of X- rays in the study of crystal structure, Bragg's equation (derivation expected), X- ray diffraction method of studying crystal lattices, structure of NaCl and KCl,		**1**

		determination of Avagadro number. **4.2.4.** Elementary idea of defects in crystals- Frenkel defect and Schottky defect.		
USCH502	**I**	**1. Chemical Bonding And Solid State Chemistry (15L)** **1.1 Molecular Symmetry (7L)** **1.1.1** Introduction and Importance. **1.1.2** Symmetry elements and symmetry operations. **1.1.3** Concept of a Point Group with illustrations using the following point gro ups: (i) $C_{\alpha v}$ (HCl), (ii) $D_{\alpha h}$ (H_2), (iii) C2v (H_2O), (iv) C_{3v} (NH_3), (v) C_{2h} (trans – trichloroethylene), and (vi) D_{3h} (BCl_3). **1.2 Molecular Orbital Theory for Polyatomic Species (5L)** **1.2.1** Simple triatomic species: H_3^+ and H_3 (correlation between bond angle and Molecular orbitals). Term such as Walsh correlation diagram, Symmetry Adapted Linear Combinations (SALCs), Ligand Group orbitals (LGOs), transformation of atomic orbitals into appropriate symmetry types, expected to be discussed **1.3 (3L)** Other molecules (considering only σ-bonding): i) BeH_2, ii) H_2O, Explanation of terms viz.crystal lattice, lattice points, unit cells and lattice constants.	**2.5**	**1**

	II	**2. Solid Materials (15L)** **2.1 Structures of Solids (10L)** **2.1.1** Importance of solid state chemistry. **2.1.2** Classification of solids on the basis of bonding. **2.1.3** Closest packing of rigid spheres (hcp, ccp), packing density in simple cubic, bcc, fcc and hcp lattices (numerical problems expected). Point defects with respect to Frenkel and Schottky defects expected. **2.1.4** Structure metallic solids. **2.1.5** Tetrahedral and octahedral interstitial voids in ccp lattice, tetrahedral holes,limiting radius ratios for different coordination numbers and their significance, calculation of limiting radius ratio for coordination number 4. **2.1.7** Structures of sodium chloride and cesium chloride. **2.2 Superconductivity (05L)** **2.2.1** Superconductivity, Meissner effect. **2.2.2** Different superconducting materials viz,convential superconductors, organic superconductors, alkali metal fullerides (A_3C_{60}) and high temperature Superconductors. **2.2.3** Applications of superconducting materials.		**1**
	III	**3. Chemistry of elements (15L)** **3.1 Inner transition elements (3L)** **3.1.1** Introduction: position of f-block elements and comparison between lanthanides and actinides **3.1.2** The shapes of *f*-orbitals. **3.1 Lanthanides Series (10L)** **3.2.1** Chemistry of lanthanides with reference to (i) lanthanide contraction, (ii) Oxidation states (iii) magnetic and spectral properties, **3.2.2** Occurrence, extraction and separation of lanthanides by Solvent extraction. **3.2.3** Applications of lanthanides.		**1**

		3.3 Actinides Series (2L) **3.3.1 Chemistry** of Uranium and with reference to occurrence, extraction (solvent extraction method), **3.3.2** Properties and applications.		
	IV	**4. Solution Chemistry** **4.1 Acid-base Chemistry in Aqueous Medium (8L)** **4.1.1 Acidity** of mono- and polyatomic cations. **4.1.2** Basicity of mono- and polyatomic anions (discussion for 4.1.1 as well as 4.1.2 to Include Latimer equation and predominance diagrams). **4.2 Chemistry in Non-aqueous Solvents (7L)** **4.2.1** Classification of solvents and importance of non-aqueous solvents. **4.2.2** Characteristics and study of liquid ammonia, dinitrogen tetraoxide and acetic acid as non-aqueous solvents with respect to (i) acid-base reactions and (ii) redox reactions.		**1**
USCH503	**I**	**1.1. Mechanism of Organic Reactions (15L)** 1.1.1 Thermodynamic and Kinetic control of organic reactions: Concept with mechanisms of the following reactions: addition of HX to butadiene; sulfonation of naphthalene. Nucleophilicity/ electrophilicity vs Basicity/acidity. 1.1.2 Mechanism of elimination reactions, with stereochemistry: E1 and E2 reactions: regioselectivity (Saytzeff and Hofmann rules). 1.1.3 Mechanism of reactions of carbonyl compounds with nucleophiles: 1.1.3.1 Formation of acetals/ketals from aldehydes and ketones. 1.1.3.2 Reaction of aldehydes and ketones with primary and secondary amines. 1.1.3.3 Acyl nucleophilic substitution (tetrahedral mechanism): Acid catalysed esterification of Carboxylic acids and base promoted hydrolysis of esters. 1.1.4 Mechanism of rearrangements with examples and stereochemistry wherever applicable. 1.1.4.1 Migration to electron deficient carbon: Pinacol,	**2.5**	**1**

		Benzylic acid. 1.1.4.2 Migration to electron deficient nitrogen: Beckmann, Hofmann. 1.1.5 Mechanism of the following reactons with synthetic application: Claisen condensation, Michael addition.		
	II	**2. Stereochemistry (15L)** 2.1.1 Molecular chirality and element of symmetry: Mirror Plane symmetry (inversion centre), rotation-reflection (alternating) axis, Chirality of compounds without stereogenic centre: cummulenes, spirans and biphenyls. 2.1.2 Stability ofcycloalkanes: Strains in cycloalkanes-angle,eclipising, transannular (3 to 8 membered). Conformations of cyclohexane, mono- and di- alkyl cyclohexanes and their relative stabilities. 2.1.3 Stereo selectivity and Stereo specificity: Idea of enantioselectivity (ee) and diastereoselectivity (de).Topicity-enantiotopic and diastereotopic atoms, groups and faces. **Stereochemistry of-** (1) Substitution reactions- S_N1, S_N2, S_Ni (reaction of alcohol with thionyl chloride). (2) E_2-anti-elimination-Base induced dehydrohalogenation of 1-bromo-1,2- diphenylpropane. (3) Addition reactions to olefins-i) catalytic hydrogenation ii) bromination (electrophilic anti addition) (iii)syn-hydroxylation (molecular addition) with OsO_4 and $KMnO_4$.		**1**
	III	**3.1 Carbohydrates (10L)** 3.1.1 Introduction: Classification, Sources, Reducing and non-reducing sugars DL notation. 3.1.2 Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides and Haworth formula-Furanose and pyranose forms of pentoses and hexoses. Interconversion :open and Haworth forms of monosaccharides with 5 and 6 carbons. Chair conformation with stereochemistry of D-glucose and D-fructose. Stability of chair forms of D-		**1**

		glucose. 3.1.3 Determination of open chain configuration- of D-glucose assuming the configuration of D-arabinose; and of D-fructose assuming the configuration of D-glucose. 3.1.4 Anomers and epimers of monosaccharides. Enantiomers and diastereomers of glucose. Mutarotation (with mechanism) in D-glucose. 3.1.5 Chain lengthening and shortening reaction: Modified kiliani-fischer synthesis. Wohl method. 3.1.6 Reactions of D-glucose and D-fructose: (a) osazone formation (b) reduction- H_2/Ni, $NaBH_4$ c)oxidation- bromine water, HNO_3, HIO_4. D) interconversion of D-glucose and D-fructose e) acetylation f) methylation [e and f with cyclic pyranose form]. 3.1.7 Commercial importance of carbohydrates in pharmaceutical, paper,food and Textile industries. **3.2. IUPAC Nomenclature (5L)** IUPAC systematic and accepted trivial nomenclature of the following classes of compounds, including substituted ones (up to 2 substituents/ functional groups): **3.2.1** (a)Bicyclic compounds- spiro-,fused, and bridged (upto 11carbon atoms)-saturated and unsaturated compounds. **3.2.2** (b) Biphenyls. **3.2.3** (c) Cummulenes upto 3 double bonds (d) Monocyclic (5 and 6 membered) aromatic and non-aromatic heterocyclic compounds containing a maximum of two hetero atoms among N,O,S. **3.1.1**Introduction:Classification, Sources, Reducing and non-reducing sugars DL notation. **3.1.2** Structures of monosaccharides: Fischer projection (4- 6 carbon monosaccharides and Haworth formula-Furanose and pyranose forms of pentoses and hexoses. Interconversion :open and Haworth forms of monosaccharides with 5 and 6 carbons. Chair conformation with		

		stereochemistry of D-glucose and D-fructose. Stability of chair forms of D-glucose. **3.1.3** Determination of open chain configuration- of D-glucose assuming the configuration of D-arabinose; and of D-fructose assuming the configuration of D-glucose. **3.1.4** Anomers and epimers of monosaccharides. Enantiomers and diastereomers glucose. Mutarotation (with mechanism) in D-glucose. **3.1.5** Chain lengthening and shortening reaction: Modified kiliani-fischer synthesis. Wohl method. **3.1.6** Reactions of D-glucose and D-fructose: (a) osazone formation (b) reduction- H_2/Ni, $NaBH_4$ c)oxidation-bromine water, HNO_3, HIO_4. D) interconversion of D-glucose and D-fructose e) acetylation f) methylation [e and f with cyclic pyranose form]. **3.2. IUPAC Nomenclature (5L)** IUPAC systematic and accepted trivial nomenclature of the following classes of compounds, including substituted ones (up to 2 substituents/functional groups): **3.2.1** (a)Bicyclic compounds- spiro-,fused, and bridged (upto 11carbon atoms)-saturated and unsaturated compounds. **3.2.2** (b) Biphenyls. **3.2.3** (c) Cummulenes upto 3 double bonds (d) Monocyclic (5 and 6 membered) aromatic and non-aromatic heterocyclic compounds containing a maximum of two hetero atoms among N,O,S.		
	IV	**4.1. Heterocyclic Chemistry (8L)** **4.1.1** Introduction: Electronic structure and aromaticity of furan, pyrrole,thiophene and pyridine. **4.1.2** Synthesis: Synthesis of furans, pyrroles, and thiophenes by Paal-Knor synthesis. Pyridines by Hantzsch synthesis and from 1,5-diketones. **4.1.3** Reactivity: Reactivity towards electrophilic substitution reactions- of furan, pyrrole and thiophene on basis		**1**

		of stability of intermediate; and of pyridine on the basis of electron distribution.Nucleophilic substitution reaction of pyridine on the basis of electron distribution. **4.1.4** Reactions of heterocycles: The following reactions of furan, pyrrole and thiophene: Halogenation , Nitration, Sulphonation, Vilsmeir formylation reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction. Ring opening of furan. Pyrrole: Acidity and basicity of pyrrole -Comparison of basicity of pyrrole and pyrrolidine, Acid catalyzed polymerization of pyrrole. Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and piperidine. Sulphonation of pyridine, with and without catalyst. Reduction.Oxidation of alkyl pyridines and action of sodamide (Chichibabin reaction).N-methylation of pyridine. Quaternization of piperdine, pyrrolidine and Hofmann elimination of the quaternary salts. **4.2. Organic Synthesis (7L)** **4.2.1** Introduction: Criteria for ideal organic synthesis. Yield and selectivity. Multi- component synthesis – with examples, Mannich reaction, Hanztsch synthesis of pyridines (without mechanism). **4.2.2** Illustrative synthesis of industrially important compounds: Ibuprofen (chiral synthesis), paracetamol (green synthesis), L-ascorbic acid (from D-glucose), norfloxacin, thyroxine, vanillin, methyl dihydrojasmonate (Hedione), Bifenox-I, pigment red 242, indigo, 2-hydroxy-3-amino-5-nitrobenzene sulphonic acid. **4.2.3** Newer methods of organic synthesis: Introduction to the use of the following in organic synthesis: Ultrasound, microwaves, PTC. **4.1.1** Introduction: aromaticity of furan,pyrrole,thiophene and pyridine. **4.1.2** Synthesis: Synthesis of furans, pyrroles, and thiophenes by Paal-Knor synthesis. Pyridines by Hantzsch		

		synthesis and from 1,5-diketones. **4.1.3** Reactivity: Reactivity towards electrophilic substitution reactions- of furan, pyrrole and thiophene on basis of stability of intermediate; and of pyridine on the basis of electron distribution. Nucleophilic substitution reaction of pyridine on the basis of electron distribution. **4.1.4** Reactions of heterocycles: The following reactions of furan, pyrrole and thiophene: Vilsmeir formylation reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction. Ring opening of furan. Pyrrole: Acidity and basicity of pyrrole-Comparison of basicity of pyrrole and pyrrolidine, Acid catalyzed polymerization of pyrrole. Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and piperidine. Sulphonation of pyridine, with and without catalyst. Reduction.Oxidation of alkyl pyridines and action of sodamide (Chichibabin reaction). N-methylation of pyridine.Quaternization of piperdine, pyrrolidine and Hofmann elimination of the quaternary salts. **4.2. Organic Synthesis (7L)** **4.2.1** Introduction: Criteria for ideal organic synthesis. Yield and selectivity. Multi- component synthesis – with examples, Mannich reaction, Hanztsch synthesis of pyridines (without mechanism). **4.2.2** Illustrative synthesis of industrially important compounds: Ibuprofen (chiral synthesis), paracetamol (green synthesis), L-ascorbic acid (from D-glucose), norfloxacin, nalidixic acid, vanillin, methyl dihydrojasmonate (Hedione), Bifenox-I, pigment red 242, 2-hydroxy-3-amino-5-nitrobenzene sulphonic acid. **4.2.3** Newer methods of organic synthesis: Introduction to the use of the following in organic synthesis: Ultrasound, microwaves, PTC.		

USCH504	**I**	**1. Treatment of analytical data-I and sampling (15 L)** **1.1 Treatment of Analytical Data (7L)** Types of errors, determinate and indeterminate errors, minimization of errors, constant and proportionate errors, accuracy and precision, measures of dispersion and central tendency: mean, median, average deviation, relative average deviation, standard deviation, variance, coefficient of variation.[Numerical problems expected] **1.2 Sampling (8L)** Terms involved, importance of sampling, sampling techniques, sampling of gases, ambient and stack sampling, equipment used, sampling of homogeneous and heterogeneous liquids, sampling of static and flowing liquids, methods and equipments used, sampling of solids, importance of particle size and sample size, samples used, need for the reduction in the sample size, methods of reduction in sample size, collection, preservation and dissolution of the sample.	**2.5**	**1**
	II	**2. Titrimetric analysis-I and UV-Visible spectroscopy. (15L)** **2.1 Acid-base Titrations (5L)** Construction of titration curves and choice of indicators in the titration of [1] strong acid and strong base, [2] strong acid and weak base, [3] weak acid and strong base, [4] weak acid and weak base. **2.2 Precipitation titrations (4L)** Argentimetric titrations, construction of the titration curve, Volhard's method, Mohr's method, adsorption indicators, theory and applications**.** **2.3 U.V. Visible Spectroscopy (4L)** Photometers and spectrophotometers, Instrumentation in the case of single and double beam spectrophotometers, Qualitative and quantitative analysis, calibration cure method.		**1**

	III	**3. Methods of separation-I (15L)** **3.1 Solvent Extraction (8L)** Partition coefficient and distribution ratio, extraction efficiency, separation factor, role of complexing agents in solvent extraction, chelation, ion pair formation, solvation, types of solvent extraction: batch, continuous. [Numerical problems expected] **3.2 Chromatography (2L)** Introduction to chromatographic techniques, classification of chromatographic techniques. **3.3 Planar Chromatography (5L)** Principle, techniques and applications of [1] Paper chromatography [2] Thin layer chromatography		**1**
	IV	**4. Optical methods (15L)** **4.1 Atomic Spectroscopy (7L)** Absorption and emission spectra, energy level diagrams, process involved in atomization, flame photometry, flame atomizer, types of burners, monochromators and detectors, atomic absorption spectroscopy; flame and electrothermal atomizer, sources, instrumentation, quantitative applications of atomic absorption and flame photometry, calibration curve method, standard addition and internal standard method. **4.2 Molecular Fluorescence and Phosphorescence Spectroscopy (4L)** Theory, instrumentation and applications **4.3 Turbidimetry and Nephelometry (4L)** Scattering of light, effect of concentration, particle size and wavelength on light scattering, instrumentation and applications.		**1**

Practicals

USCHP05	**Practicals of Course USCH501** **<u>Physical Practicals</u>** **Chemical Kinetics –** To determine the order between $K_2S_2O_8$ & KI by fractional change method. **Viscosity** – To determine the molecular weight of high polymer polyvinyl alcohol (PVA) by viscosity measurement. **OR** To determine the radius of a glycerol molecule by viscosity measurement. **Potentiometry** – 1. To determine the amount of Fe(II) in the given solution by titration with a standard $K_2Cr_2O_7$ solution and hence to find the formal redox potential of Fe^{3+}/Fe^{2+} 2. To determine the solubility product and solubility of AgCl potentiometrically using chemical cell. **OR** 3. To determine the solubility product and solubility of AgCl potentiometrically using concentration cell. **Colorimetry –** To determine the amount of Fe(III) present in the given solution by using salicylic acid by colorimetric titration.(static method) (=525 nm) **pH –Metry –** To determine acidic and basic dissociation constants of amino acid hence to calculate isoelectric point. **Course USCH502** **<u>Inorganic Practicals</u>** **Inorganic preparations** 1. Potassium diaquo bis-(oxalate)cuprate (II)$K_2[Cu(C_2O_4)_2.(H_2O]$	**3**	**8**

	2. CuCl2-2DMSO 3. Bis(ethylene diamine)iron(II)sulphate[$C_2H_4(NH_2)_2FeSO_4.4H_2O$]. 4. Skill based Qualitative preparation of Chromium (II)acetate $Cr(OAc)_2$ so that the following outcomes are achieved: • Setting up reactor for Cr(II) ions • Identification of oxidation states of Chromium • Preparation of chromium(II)acetate • Isolation of the product		

	Volumetric analysis 1. Determination of magnesium from the supplied commercial sample of Milk of magnesia tablet 2. Estimation of Nickel(II)complexometrically using murexide indicator (Students are expected to standardize supplied EDTA solution using $ZnSO_4.7H_20$)		
USCHP06	**Practicals of Course USCH503** **Organic Practicals** i. Separation of binary (solid-slid) mixture.(Weights and physical constant of both crude components of the mixture are to be reported. (Minimum 4 mixtures) ii. Identification of an organic compound of known chemical type. (Minimum 4 mixtures) Syllabus for Organic Chemistry Sem-VI **Organic preparations** i. Acetylation of hydroquinone. ii. Nitration of nitrobenzene. iii. Hydrolysis of ethyl benzoate. iv. Bromination of acetanilide. **Course USCH504** **Analytical Practicals** 1. Estimation of persulphate in the given sample by the method of back titration. 2. Determination of the calcium and the magnesium content of a dolomite sample. 3. Determination of glucose content of a honey sample by Wilstater's method. 4. Determination of the amount of fluoride in the given solution colorimetrically. 5. Determination of Vitamin C content of a given tablet by titration with sodium hydroxide pH metrically	**3**	**8**

T.Y.B.Sc.
Chemistry
Credit Based Semester and Grading System
To be implemented from the Academic year 2016-2017

SEMESTER VI
Theory

Course	UNIT		Credits	L / Week
USCH601	I	**1.1 Molecular Spectroscopy –I (15L)** **1.1.1** Dipole moment: Dipole moment, polarization of a bond, bond moment, dipole moment and molecular structure. **1.1.2 Rotational Spectrum:** Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, conditions for obtaining pure rotational spectrum, selection rule, nature of spectrum, determination of inter nuclear distance and isotopic shift. **1.1.3 Vibration (IR) spectrum:** Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero point energy, conditions for obtaining vibrational spectrum, selection rule, nature of spectrum. **1.1.4 Vibration-Rotation spectrum of diatomic molecule v**ibrating rotor, energy levels, selection rule, nature of spectrum, R and P branches, anharmonic oscillator : energy levels, selection rule, fundamental band, overtones . Application of vibration-rotation spectrum in determining Force constant, determination and significance. Introduction to infrared spectra of simple molecules like H_2O and CO_2 **1.1.5 Raman Spectroscopy :** Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum , Stoke's lines,anti-Stoke's lines, Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion.(example of CO_2molecule).	**2.5**	**1**
	II	**2.1 Basics of Quantum Chemistry (10L)** **2.1.1** Classical mechanics, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect. **2.1.2** Introduction to quantum mechanics,		**1**

		Planck's theory of quantization, wave particle duality, de-Broglie equation, Heisenberg's uncertainty principle. **2.1.3** Progressive and standing waves, boundary conditions, Schrodinger's time independent wave equation(derivation not expected)., interpretation and properties of wave function. **2.1.4** Postulates of quantum mechanics (following are to be considered),1. state function and it's significance2. Concept of operators : definition, addition, subtraction and multiplication of operators, commutative and non- commutative operators, linear operator, Hamiltonian operator, 3. Eigen function and eigen value, eigen value equation. **2.2 Applied Electrochemistry (5L)** **2.2.1** Polarization, concentration polarization and it's elimination **2.2.2** Decomposition potential, experimental determination of decomposition potential, factors affecting decomposition potential (nature of electrolyte, nature of electrodes and temperature) Tafel's equation for hydrogen overvoltage, Overvoltage, experimental determination of over-voltage, **2.2.3** Electroplating ---objectives and procedures		
	III	**3.1 Renewable Energy Sources (5L)** **3.1.1.** Lithium ion cell. **3.1.2**. Fuel cells; Choice of fuel and oxidant, Bacon's H_2 and O_2 fuel cell. **3.1.3**. Solar cells, solar energy, photovoltaic effect, semiconductors as solar energy converters, silicon solar cell **3.1.4**. Hydrogen : Fuel of the future, production of hydrogen by direct electrolysis of water, advantages of hydrogen as a universal energy medium. **3.2 Nuclear Magnetic Resonance Spectroscopy (6L)** **3.2.1**. Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession, Relaxation processes in n.m.r. (spin-spin relaxation and spin-lattice relaxation). **3.2.2**. NMR Spectrometer, chemical shift, shielding and deshielding of protons, low resolution n.m.r. spectrum of methanol and ethanol.		**1**

		3.3 Chemical Kinetics (4 L) **3.3.1** Collision theory of reaction rates, application of collision theory to 1. uni-molecular reaction and 2. bimolecular reaction (Lindemann theory, derivation expected). Merits and drawbacks of collision theory. **3.3.2** Classification of reactions as slow, fast and ultra-fast. study of kinetics of fast reactions by Stop flow method.		
	IV	**4.1 Nuclear Chemistry** **4.1.1** Types of nuclear radiations and their characteristics, behaviour of ion pairs in electric field, detecton and measurement of nuclear radiations using G. M. Counter and Scintillation Counter. **4.1.2** Kinetics of radioactive decay, units of radioactivity (Curie, Bequerel, Rutherford) **4.1.3** Radioactive equilibrium (secular and transient), determination of radioactive constants for radio-elements having 1. moderate half life, 2. long half life 3.extremely long or short half life. **4.1.4** Use of radioisotpes as tracers in 1. chemical investigations- reaction mechanism, 2. age determination- dating by carbon-14 **4.1.5** Nuclear reactions – nuclear transmutation, artificial radioactivity Q-value of nuclear reaction, threshold energy. **4.1.6** Fissile and fertile material, nuclear fission, chain reaction, factor controlling fission process. (multiplication factor and critical size or mass of fissionable material)., nuclear power reactor and breeder reactor.		**1**
USCH602	**I**	**Coordination Chemistry (15L)** **1.1 Crystal Field Theory (CFT)** **1.1.1** Basic tenets of Crystal field theory and effect of crystal field on central metal valence orbitals. **1.1.2** Splitting of *d* orbitals in octahedral, tetrahedral and square planar complexes. **1.1.3** Crystal field splitting energy ($10Dq$ or Δ_o) for octahedral complexes and factors affecting the magnitude of Δ_o. **1.1.4** Crystal field stabilization energy (CFSE), calculation of CFSE, for octahedral and tetrahedral complexes with	**2.5**	**1**

		d^1 to d^{10} metal ion configurations. **1.1.5** Effect of crystal field splitting on i) Ionic radius and ii) Lattice energy. **1.1.6** Theoretical failure of the CFT model. **1.1.7** Experimental evidence for co-valence in co-ordination compounds.(i) ESR spectrum of $[IrCl_6]^{2-}$ (ii) NMR spectrum of tris (acetyl acetanato) vanadium complex, (iii) Intensities of *d-d* transitions, and (iv) Nephelauxetic effect. Consequences of crystal field splitting on various properties such as ionic radii, hydration energy, lattice energy, enthalpies of formation, colour and magnetic properties. **1.2 Molecular Orbital Theory (MOT) of Coordination Complexes** **1.2.1** Application to octahedral complexes in case of (i) $[Ti(H_2O)]^{3+}$, (ii) Fluoro complexes of Fe(II) and Fe (III) and (iii) Cyano complexes of Fe(II) and Fe (III). **1.2.2** Effect of pi-bonding an ligand field splitting parameter in M→L and L→M interactions. **1.3 Electronic States and Terms for Polyelectronic Atoms** **1.3.1** Introduction: electronic configuration and electronic states, Term symbols, coupling of spin momenta (M_S),orbital momenta (M_l)and spin- orbit coupling or Russell-Saunders coupling. **1.3.2** Determination of Terms for p^2 electronic configuration (as in a carbon atom). **1.3.3** Terms and micro-states for transition metal atoms/ions.		
	II	**2. Properties of Coordination compounds (15L)** **2.1 Stability of Complexes (5L)** **2.1.1** Thermodynamic stability and kinetic stability of complexes with examples. **2.1.2** Stability constants: Stepwise and overall constants and their inter-relationship. **2.1.3** Factors affecting thermodynamic stability. **2.1.4** Potentiometric method of determination of stability constants with example of silver-ammonia complex. **2.2 Substitution Reactions in Octahedral Complexes (5L)**		**1**

2.2.1 Introduction, types of reactions in complexes.
2.2.2 Ligand substitution reactions: basic mechanisms.
2.2.3 Inert and labile complexes and

		electronic configurations and lability of complexes. **2.2.4** Acid hydrolysis, base hydrolysis and anation reactions. **2.3 Electronic Spectra (5L)** **2.3.1** Types of electronic transitions like intra –ligand transitions, charge transfer transitions and intra-metal transitions and (*d-d* or ligand field transitions for transition metals). **2.3.2** Rules for electronic transitions: Spin and Orbital or Laporte selection rules. Orgel Diagrams for D Terms (i.e, d^1 , d^4 and d^6 .d^9 electronic configurations) and its use in interpretation of visible electronic absorption spectra of these configurations.		
	III	**Organometallic Chemistry (15L)** **3.1 Organometallic Compounds of main group metals (6L)** **3.1.1** Introduction: General synthetic methods: (i) Oxidative addition, (ii) Metal-Metal exchange (Transmetallation), (iii) Carbanion-Halide exchange, (iv) Metal Hydrogen exchange and (v) Methylene insertion reactions. **3.1.2** Chemical rections: (i) Reactions with oxygen, (ii) Alkylation and arylation reactions (iii) Reactions with protic reagents and (iv) Complex formation reactions. **3.2 Organometallic compounds of transition metals (9L)** **3.2.1** Synthesis , structure, reactions and of ferrocene. **3.2.2** Bonding in ferrocene on the basis of VBT. **3.2.3** Bonding in Re and Mo halide complexes.		**1**
	IV	**Some Selected Topics (15L)** **4.1 Inorganic Polymers (3L)** 4.1.1Various methods of classification with examples. **4.1.2** Chemistry of borazine with reference to preparation , properties, structures, bonding and applications. **4.2 Characteristics and Treatment**		**1**

		of Liquid Effluent (06L) **4.2.2** Characterization of waste: biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), aerobic and anaerobic processes. **4.2.3** Removing of solid contaminants, physical and chemical principles such as coagulation, flocculation and sedimentation. **4.2.4** Primary,secondary and tertiary of liquid effluents. **4.3 Nanomaterials(04L)** **4.3.2** Introduction and importance of nanomaterials. **4.3.3** Properties (Comparison between bulk and nanomaterials): (i) Optical properties, (ii) Electrical conductivity, and (iii) Mechanical properties. **4.3.4** Forms of nanomaterials: nanofilms, nanolayers, nanotubes, nanowires, and nanoparticles. **4.3.5** Chemical methods of preparation: (i) Colloidal route, and (ii) Sol-gel method. **4.5 Inorganic Pharmaceuticals (2L)** **4.4.2** Gastrointestinal agents viz., (i) antacids (aluminium hydroxide, milk of magnesia, sodium bicarbonate and (ii) cathartics (magnesium sulphate and sodium phosphate). Topical agents viz., (i) protectives and adsorbents (talc, calamine), (ii) antimicrobial agents (potassium permanganate, tincture iodine, boric acid) and astringents (alum).		
USCH603	**I**	**1.1 Spectroscopy** (15L) 1.1.1 Introduction : Electromagnetic spectrum, units of wavelength and frequency. 1.1.2 UV- Visible Spectroscopy: Basic theory, solvents, nature of UV-VIS spectrum, concept of Chromophore, auxochrome,bathochromic shift,Hypsochromic shift hyperchromic	**2.5**	**1**

		effect and chromophore-auxochrome interactions. 1.1.3 IR Spectrocopy: Basic theory, nature of IR spectrum, selection rule , fingerprint region. 1.1.4 PMR Spectroscopy: Basic theory of NMR, nature of PMR spectrum, chemical shift (∂ unit), standard for PMR, solvents used. Factors affecting chemical shift: (1) inductive effect (2) anisotropic effect (with reference to C=C, CΞC, C=O and benzene ring). Spin- spin coupling and coupling constant. Proton exchange-application of deuterium exchange ,Application of PMR in structure determination. 1.1.5 Spectral characteristics of following classes of organic compounds, including benzene and monosubstituted benzenes, with respect to UV-VIS, IR,PMR: (1)alkanes (2)alkenes and polyenes (3) alkynes (4) haloalkanes (5) alcohols (6) carbonyl compounds (7) ethers (8) carboxylic acids (9) esters (10)amines (11) amides (broad regions characteristic of different groups are expected). 1.1.6 Mass Spectrometry: Basic theory.Nature of mass spectrum. General rules of fragmentation. Importance of - molecular ion peak, isotopic peaks, basepeak, Nitrogen rule.Illustrative fragmentation of alkanes and aliphatic carbonyl compounds (No Mclafferty rearrangement). 1.1.7 Problems of structure elucidation of simple organic compounds using individual or combined use of the above spectroscopic technique are expected.(index of hydrogen deficiency should be the first step in solving the problems).		
	II	**2.1 Polymers (11L)** 2.1.1 Introduction: General idea of monomers, polymers, and polymerization, natural and synthetic polymers. Homoplymers and copolymers. Classification of polymers- Plastic, fibres, resins, elastomers. Thermoplastics and thermosets. Copolymers-alternating, block, random, graft. 2.1.2 Mechanism of free radical addition		**1**

		polymerization. 2.1.3 Elastomers: Natural and synthetic rubbers. Diene polymerization: 1,2- and 1,4- addition (cis and trans) polymerization of isoprene. 1,3-Butadiene-styrene copolymer. 2.1.4 Stereochemistry of polymers: Tacticity. Role of Ziegler-Natta catalyst (co- ordination polymerization) in directing the tacticity in polypropylene (no mechanism). 2.1.5 Preparation & use of polymers: (1) Addition polymers: (a) polyethylene (b)polypropylene (c) PVC (d) polystyrene (e) polyacrylonitrile (f) polyvinylalcohol (g) Teflon. (2) Condensation Polymers: (a) Polyesters (b) polyamides (c) polyurethans (d)phenol-formaldehyde resin (e) epoxy resin (f) polycarbonates. 2.1.6 Recyclable polymers. Biodegradable polymers and their uses. Biomedical use of polymers. 2.1.7 Additives to polymers: Plasticizers ,stabilizers and fillers.(The students are expected to identify monomers in a given polymer and draw the structure of a polymer from a given set of monomers). **2.2 Photochemistry** 2.2.1 Introduction: Difference between thermal and photochemical reactions. Jablonski diagram, singlet and triple states, allowed and forbidden transitions, fate of excited molecules, photosensitization. 2.2.2 Photochemical reactions of olefins: photoisomerisation, photochemical rearrangement of 1,4-dienes (di π methane) 2.2.3 Photochemistry of carbonyl compounds: Norrish I, Norrish II cleavages, Photo reduction (e.g. benzophenone to benzpinacol).		
	III	**3.1 Catalysts and Reagents (5L)** Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism). 3.1.1 **Catalysts** : Catalysts for **1** hydrogenation: Raney Ni,Pt and PtO_2: C=C, CN, NO_2, aromatic ring; Pd/C: C=C, COCl→CHO (Rosenmund); Lindlar catalyst: alkynes; Wilkinson's catalyst for		

		stereo selective reduction of olefins. 3.1.2 **Reagents**: (1)$LiAlH_4$ and Red-Al: reduction of CO,COOR, CN, NO_2. (2) $NaBH_4$: reduction of CO (3) SeO_2: hydroxylation of allylic and benzylic positions,oxidation of CH_2, alpha to CO to CO.(5)mCPBA and R-OOH/H_2O_2 for epoxidation of C=C. (6) NBS: allylic and benzylic bromination of position alpha to CO. **3.2 Natural Products (10L)** 3.2.1 Introduction: Primary and secondary metabolites. Introduction to the following natural products with respect to the sources and classes. (Structures of the compounds specified below are expected). (a) Terpene: Isoprene and special isoprene rule.α-terpeniol, citral,camphor, α-pinene. (b) Alkaloids: nicotine,atropine. (c) Vitamins: Vitamins A and C. (d) Hormones: adrenaline, thyroxine. (e) Steroids: cholesterol, progesterone. 3.2.2 Structure determination of natural products: 3.2.2.1 Ozonolysis in terpenoids-Examples of open chain and monocyclic monoterpenes. 3.2.2.2 Hofmann exhaustive methylation and degradation in alkaloids – simple open chain and monocyclic amines.3.2.2.3 Structure determination of citral and nicotine through degradation studies. Total synthesis of degradation studies. Total synthesis of (i) Citral from 3-methylbutan-1-ol (ii) Nicotine from nicotinic acid. 3.2.4 Commercial importance of terpenoids and alkaloids: Synthesis of camphor from α-pinene, α and β ionones, geraniol and nerol from citral. 3.2.5		
	IV	**4.1 Organometallic Chemistry (5L)** 4.1.1 Intoduction: Carbon-metal bond-Nature, types reactivity. 4.1.2 **Organo magnesium Compounds**: Grignard reagent :Preparation, structure, and stability, Reaction with compounds containing acidic hydrogen,carbonyl compounds, cyanides and CO_2. 4.1.3 **Organolithium Compounds** : Preparation using alkyl/aryl halides. Reactions with compounds containing		**1**

		acidic hydrogen, alkyl halides, carbonyl compounds, cyanides and CO_2. Lithium dialkyl cuprates: Preparation and reactions with aliphatic /aromatic/vinylic halides. 4.1.4 **Organozinc compounds**: Preparation of dialkyl zinc. Reaction with water, acid chlorides and alkyl halides. Reformatsky reaction (with mechanism). **4.2 Chemistry of some Important Biomolecules: (10L)** 4.2.1 α-Amino acids: Structure,configuration,Essential amino acids and their abbreviations, classification, Properties: pH dependency of ionic structure and isoelectric point. Methods of preparations: Strecker synthesis, amidomalonate synthesis, Erlenmeyer azalactone synthesis. 4.2.2 Polypeptides and Proteins: Polypeptides: Peptide bond. Nomenclature and representation of polypeptides. Merrifields solid phase peptide synthesis (example of di- and tri- peptides for nomenclature and synthesis). Proteins: Sources, types,functions,colloidal nature, separation based on isoelectric point, denaturation and functions. Partial and total hydrolysis. General idea of primary, secondary, tertiary and quartenary structures. 4.2.3 Nucleic acids: Selective hydrolysis of nucleic acids.Sugars and bases in nucleic acids. Stuctures of nucleosides an nucleotides in DNA and RNA. Structure of nucleic acids (DNA and RNA): Base pairing in nucleic acids. Importance of nucleic acids-self duplication, protein synthesis.		
USCH604	**I**	**Electroanalytical methods. (15L)** **1.1** D.C. Polaroghraphy (11L): Polarizable and nonpolarizable electrodes, basic principles, residual current, diffusion current, limiting current, dropping mercury electrode, supporting electrolyte half wave potential, derivation of the polarographic wave equation for a reversible reaction. Ilkovic equation, oxygen interference and its removal, maxima and maxima suppressors, polarographic cell, qualitative	**2.5**	**1**

		and quantitativeanalysis, calibration curve and standard addition method, applications. [Numerical problems expected] **1.2** Amperometric Titrations: Basic principles, rotating platinum electrode and nature of the titration curves, applications, advantages and limitations.		
	II	**Methods of separation-II (15L)** **2.1** Gas chromatography (6L): Gas liquid chromatography, basic principles retention time, retention volume, resolution, peak width theoretical plates. HETP, instrumentation, columns, detectors, applications. **2.2** High Performance Liquid Chromatography (4L): Instrumentation, types of elution, U.V. and I.R. detector and applications **2.3** Ion Exchange Chromatography (5L): Types of ion exchangers, mechanism of ion exchange, selectivity coefficients and separation factors, capacity and its determination, factors affecting the separation of ions, applications.		**1**
	III	**Treatment of analytical data-II and Titrimetric analysis-II (15L)** **3.1** Treatment of Analytical Data (6L): Distribution of random errors, Gaussian curve, students' t, confidence limits and confidence interval, criteria for rejection of result: 2.5d rule,4.0 rule and Q test, F teset, testing for significance, null hypothesis, method of averages, least squares method. Numerical problems expected] **3.2** Complexometric Titrations (5L): General introduction, EDTA titrations, advantages and limitations of EDTA as the titrant, absolute and conditional formation constants of metal EDTA complexes, construction of titration curves, types of EDTA titrations,methods of increasing the selectivity of EDTA as a titrant, metallochromic indicators, theory and applications. **3.3** Redox Titrations (4L): General introduction, theory of redox indicators, criterion for choosing an indicator for a redox titration, construction of the titration curves in the case of (1) Fe (II) Vs. Ce(IV)		**1**

		(2) Fe (II) Vs. dichromate, use of diphenyl amine and ferroin as redox indicators.		
	IV	**Concepts in Quality and miscellaneous methods (15L)** **4.1** Total quality management (5L) : concept of quality, quality control, quality assurance total quality management, ISO series, Good laboratory practices **4.2** Mass Spectrometry (2L): Basic principles, introduction of components only **4.3** Thermal Methods (5L): Classification of thermal methods, thermogravimetric analysis,basic principles, instrumentation factors affecting the TG curve, applications **4.4** Introduction to Radio Analytical Techniques (3L): Classification of the techniques, introduction to neutron activation analysis and its applications.		**1**

Practicals

USCHP07	**Practicals of Course USCH601** **<u>Physical Practicals</u>** **Chemical Kinetics –** To determine the energy of activation for the acid catalysed hydrolysis of methyl acetate. **Partition coefficient** To determine the equilibrium constant for the reaction$KI + I_2 \rightleftharpoons KI_3$ by partition method. (Partion coefficient of I_2 between CCl_4 and water is to be given) **Potentiometry –** 1. To determine the strength of the given strong acid (HCl) by potentiometric titration using quinhydrone electrode (Calculation of pH from E_{cell} and the plot of (a) $\frac{\Delta E}{\Delta V}$ against V (b) pH against V graphs are expected). **OR** To determine pKa value of the given weak monobasic acid (CH_3COOH) by e.m.f. measurements. 2. To determine E_{cal} at room temperature	**3**	**8**

	and using this value, determine standard reduction potential of Ag/Ag^+ electrode at room temperature. **Conductometry –** To determine the amount of dibasic acid (Oxalic acid) by conductometric titration against strong base. **OR** To determine the relative strength of monochloroacetic acid and acetic acid conductometrically. **Course USCH602** **<u>Inorganic Practicals</u>** **Inorganic preparations** 1. Mercury tetrathiocyanato Cobaltate (II) $Hg[Co(SCN)_4]$ 2. Magnesium oxinate$[Mg(Ox)_2]$ 3. Tris-acetyl acetonato iron(III) $[Fe(AcAc)_3]$ 4. Tetrammine copper(II) sulphate. $[Cu(NH_3)_4]SO_4.H_2O$ **Inorganic estimations/ Analysis** 1. Estimation of copper iodometrically using sodium thiosulphate. (Students are expected to standardize supplied sodium thiosulphate solution using potassium dichromate) 2. Estimation of lead by complexomety using EDTA solution. (Students are expected to standardize the supplied EDTA solution. Suggested standard for standardization: $ZnSO_4.7H_2O$)		
USCHP08	**Practicals of Course USCH603** **<u>Organic Practicals</u>** **Binary Mixture Separation** Seperation of mixture containing (VL + NVL) & (S + VL) components. **Organic Preparations** 1. Aniline/p-toluidine → N-Acetyl derivative 2. Salicylic acid/nitrobenzene/ Acetanilide → Nitro derivative	**3**	**8**

	3. β- naphthol → Methyl Ether derivative (Using dimethyl sulphate) 4. Acetanilide → p-bromoacetanilide derivative 5. Aniline/ p-toluidine → Schiff base with benzaldehyde 6. Hydroquinone/beta naphthol → Acetyl derivative 7. Methyl salicylate/ethyl benzoate → Acid derivative (Hydrolysis) 8. Benzaldehyde/p-nitrobenzaldehyde → Acid (Oxidation) **Course USCH604** **<u>Analytical Practicals</u>** 1. Determination of chemical oxygen demand of a water sample. 2. Determination of percentage purity of a sample of common salt using a cation exchanger. 3. Determination of potassium content of a commercial salt sample by flame photometry. 4. Determination of acetic acid content of a vinegar sample by potentiometric titration with sodium hydroxide using quinhydrone. **5.** Determination of Cr (VI) in the given solution as dichromate by the method of least squares, spectrophotometrically		

Reference List for Paper-I (Physical Chemistry)

1. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co.Ltd.
2. Physical Chemistry, P.C. Rakshit, 6th Edition, 2001, Sarat Book Distributors, Kolkota.
3. Physical Chemistry, R.J. Silbey, & R.A. Alberty, 3rd edition , John Wiley & Sons, Inc [part 1]
4. Physical Chemistry, G. Castellan, 3rd edition, 5th Reprint, 1995 Narosa Publishing House.
5. Modern Electrochemistry, J.O.M Bockris & A.K.N. Reddy, Maria Gamboa – Aldeco 2nd Edition, 1st Indian reprint,2006 Springer
6. Visible & U.V. Spectroscopy, Analytical Chemsitry by Open Learning R. Demny and R. Sinclair M 1991 John Wiley & Sons
7. Classical Methods , Vol 1 Analytical Chemistry by Open Learning D. Cooper & C. Devan,1991 John Wiley & Sons
8. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
9. The Elements of Physical Chemistry, P.W. Atkins, 2nd Edition, Oxford Universtity Press Oxford
10. Physical Chemistry, G.K. Vemullapallie, 1997, Prentice Hall of India, Pvt.Ltd. New Delhi.

References for Paper-II.(Inorganic Chemistry).

1. D. Banerjea, *Coordination chemistry*, Tata McGraw Hill, New Delhi, (1993).
2. D. F. Shriver and P. W. Atkins, *Inorganic chemistry*, 3rd Ed., Oxford University Press, (1999).
3. K. F. Purcell and J. C. Kotz, *Inorganic chemistry*, Saunders, Hongkong, (1977).
4. N. N. Greenwood and E. Earnshaw, *Chemistry of elements*,Pergamon Press, Singapore, (1989).
5. W. L. Jolly, *Modern inorganic chemistry*, 2nd Ed. McGraw Hill Book Co., (1991).
6. B. E. Douglas and H. McDaniel, *Concepts and models in inorganic chemistry*, 3rd Ed., John Wiley & Sons, Inc., New York, (1994).
7. G. N. Mukherjee and A. Das, *Elements of bioinorganic chemistry*, Dhuri and Sons, Calcutta, (1988).
8. R. W. Hay, *Bioinorganic chemistry*, Ellis Harwood, England, (1984).

9. R. C. Mehrotra and A. Singh, *Organometallic chemistry: A unified approach*, Wiley Eastern, New Delhi, (1991).
10. For synthesis of iron ethylenediamine sulphate refer Practical Inorganic Chemistry by G. Marr and B. W. Rockett,Van Nostrand Reinhold Company London1972. P 34.
11. For preparation of $CuCl_2$.2DMSO Refer Microscale Inorganic Chemistry by Z. Szafran, Ronald M. Pike and Mono M. Singh. Pub. John Wiley and Sons1991.p.218.

References For Paper-III (Organic Chemistry)

1. Organic Chemistry, Francis A Carey, Pearson Education, 6th Edition, Special Indian Edition 2008
2. Organic Chemistry, R.T. Morrison and R.N. Boyd, 6th Edition, Pearson Edition
3. Organic Chemistry, T.W.G. Solomon and C.B. Fryhle, 8th Edition, John Wiley & Sons, 2004
4. A guide to mechanism in Organic Chemistry, 6th Edition, Peter Sykes, Pearson Education
5. Fundamentals of Organic Chemistry , G. Marc Loudon, 4th Edition Oxford
6. Organic Chemistry, L.G. Wade Jr and M.S. Singh, 6th Edition,2008
7. Organic Chemistry Baula Y. Bruice, Pearson Edition, 2008
8. Organic Chemistry,J.G. Smith, 2nd Editionm Special Indian Edition, Tata McGraw Hill
9. Organic Chemistry, S.H. Pine, McGraw Hill Kogakusha Ltd.
10. Stereochemistry, P.S. Kalsi, New Age International Ltd. 4th Edition,2006

Reference List for Paper-IV (Analytical Chemistry)

1. D. Harvey, Modern Analytical Chemistry, The McGraw-Hill Pub. 1st Edition (2000)
2. H.S. Ray, R Sridhar and K.P. Abraham, Extraction of Nonferrous Metals, AffiliatedEast-West Press Pvt. Ltd. New Delhi (1985) reprint 2007.
3. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney , Vogel's Textbook of Qunatitative Chemical Analysis, Fifth edition, ELBS Publication (1996)
4. D.A. Skoog D.M. West and F.J. Holler, Fundametals of Analytical Chemistry, 7thEdition (printed in India in 2001) ISBN Publication.
5. Analytical Chemistry, J.G. Dick,1973 Tata McGraw Hill Publishing Co. Ltd. New Delhi.
6. Quantitative analysis, Dey & Underwood, Prentice Hall of India, Pvt. Ltd.

New Delhi
7. Fundamentals of Analytical Chemistry, Skoog etal 8th edition, Saunders college publishing.

T Y B Sc Chemistry

Choice Based Credit System

SEMESTER V

Applied Component

(Drugs and Dyes)

COURSE CODE: USACDD501 CREDITS: 02 LECTURES: 60

Unit			Topics	
I	**1.1**		**General Introduction to Drugs**	**(8L)**
		1.1.1	Definition of a drug, sources of drugs, requirements of an ideal drug, classification of drugs (based on therapeutic action),	
		1.1.2	Nomenclature of drugs: Generic name, Brand name, Systematic name	
		1.1.3	Definition of the following medicinal terms: Pharmacon, Pharmacology, Pharmacophore, Prodrug, Half – life efficiency, LD_{50}, ED_{50},GI_{50} Therapeutic Index.	
		1.1.4	Brief idea of the following terms: Receptors, Agonists, Antagonists, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia.	
	1.2		**Routes of Drug Administration and Dosage Forms**	**(3L)**
		1.2.1	Oral and Parenteral routes with advantages and disadvantages.	
		1.2.2	Formulations & combination formulation, Different dosage forms (including Patches & Adhesives, emphasis on sustained release formulations and enteric coated tablets).	
	1.3		**Pharmacodynamic agents:** A brief introduction of the following pharmacodynamic agents and the study with respect to their chemical structure, chemical class, therapeutic uses, and side effects.	
		1.3.1	**CNS Drugs:** Classification based on pharmacological actions: CNS Depressants & CNS Stimulants. Concept of sedation and hypnosis, anaesthesia. • Phenytoin (Hydantoin) • Trimethadione (Oxazolidinediones) (**Synthesis from acetone)** • Alprazolam (Benzodiazepines) • Levetiracetam (Pyrrolidines) • Amphetamine (Phenethylamine) (**Asymmetric synthesis from phenyl acetic acid)** • Chlorpromazine (Phenothiazines)	**(4L)**

UNIT-II (Drugs)

2	**2.1**		**Analgesics, Antipyretics and Anti-inflammatory Drugs.**	**(4L)**

		2.1.1	**Analgesics and Antipyretics** • Morphine (Phenanthrene alkaloids) • Tramadol (Cyclohexanols) (**Synthesis from salicylic acid)** • Aspirin (Salicylates) • Paracetamol (p-Amino phenols)	

		2.1.2	**Anti-inflammatory Drugs** Mechanism of inflammation and various inflammatory conditions. • Steroids: Prednisolone, Betamethasone • Sodium Diclofenac, Aceclofenac (N- Aryl anthranilic acids) **(Synthesis from 2,6-dichlorodiphenyl amine)**	
	2.2		**Antihistaminic Drugs**	**(2L)**
			• Diphenhydramine (Ethanol amines) • Cetrizene (Piperazine) (**Synthesis from 4-Chlorobenzhydryl chloride)** • Chlorpheniramine maleate (Ethyl amines) • Pantoprazole (Benzimidazoles)	
	2.3		**Cardiovascular drugs**	**(3L)**
			Classification based on pharmacological action • Isosorbide dinitrate (Nitrates) • Valsartan (Amino acids) (structure not expected) • Atenolol (Aryloxy propanol amines) (**Synthesis from 3-Hydroxy phenyl acetamide)** • Amlodipine (Pyridines) • Frusemide /Furosemide (Sulfamoyl benzoic acid) • Rosuvastatin (Pyrimidine)	
	2.4		**Antidiabetic Agents**	**(2L)**
			General idea and types of diabetes; Insulin therapy • Glibenclamide (Sulphonyl ureas) • Metformin (Biguanides) • Dapagliflozin (Pyranose) • Pioglitazone (Thiazolidinediones) (**Synthesis from 2-(5-ethylpyridin-2-yl) ethanol)**	
	2.5		**Antiparkinsonism Drugs**	**(2L)**
			Idea of Parkinson's disease. • Procyclidine hydrochloride (Pyrrolidines) • Ethopropazine hydrochloride (Phenothiiazines) • Levodopa (Amino acids) (**Synthesis from Vanillin)**	
	2.6		**Drugs for Respiratory System** General idea of: Expectorants; Mucolytes; Bronchodilators; Decongestants; Antitussives • Ambroxol (Cyclohexanol) (**Synthesis from paracetamol)** • Salbutamol (Phenyl ethyl amines) • Oxymetazoline (Imidazolines)	**(2L)**

			• Codeine Phosphate (Opiates)	

Reference Books: (For units I & II)

1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippmcolt Williams & Wilkins.
2. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.
3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
4. Burger's Medicinal Chemistry, Drug Discovery and Development. Abraham and Rotella. Wiley
5. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
6. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.
7. Principle of medicinal chemistry. Vol 1 &2 S. S. Kadam, K. R. Mahadik, K. G. Bothara
8. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.
9. The organic chemistry of drug design & drug action. 2nd ed. By Richard B Silvermann, Academic Press.
10. The Organic Chemistry of Drug Synthesis. Lednicer and Mitsher, Wliey.

Unit III (Dyes)

3	**3.1**		Introduction to the dye-stuff Industry	**(5L)**
		3.1.1	Dyes	
			Definition of dyes, requirements of a good dye i.e. Colour, Chromophore and Auxochrome, Solubility, Linearity, Coplanarity, Fastness, Substantivity, Economic viability. Definition of fastness and its properties and Mordants with examples Explanation of nomenclature or abbreviations of commercial dyes with at least one example suffixes – G, O, R, B, K, L, C, S H, 6B, GK, 6GK, Naming of dyes by colour index (two examples) used in dye industries.	
		3.1.2	Natural and Synthetic Dyes	
			Natural Dyes: Definition and limitations of natural dyes. Examples and uses of natural dyes w.r.t Heena, Turmeric, Saffron, Indigo, Madder, Chlorophyll –**names** of the chief dyeing material/s in each natural dye **[structures not expected]**, Synthetic dyes: Definition of synthetic dyes, primaries and intermediates. Important milestones in the development of synthetic dyes – Emphasis on Name of the Scientist, dyes and the year of the discovery is required. (structure is not expected)	
	3.2		Substrates for Dyes : Types of fibres	**(3L)**
		3.2.1	Natural: cellulosic and proteinaceous fibres, examples – wool, silk and cotton structures and names of dyes applied on each of them.	
		3.2.2	Semi – synthetic: definition and examples [structures not expected]	
		3.2.3	Synthetic: Nylon, Polyesters and Polyamides structures and names of dyes applied on each of them	
		3.2.4	Blended fabrics: definition and examples [structures not expected]	
		3.2.5	Binding forces of dyes on substrate: ionic forces, covalent linkages, hydrogen bonding, vander-walls forces	
	3.3		Classification of dyes based on applications and dyeing methods	**(7L)**
		3.3.1	Dyeing methods	
			Basic Operations involved in dyeing process: i. Preparation of fibres ii. Preparation of dyebath iii. Application of dyes iv. Finishing	
			Dyeing Method of Cotton Fibres: (i) Direct dyeing (ii) Vat dyeing (iii) Mordant dyeing (iv) Disperse dyeing	

		3.3.2	Classification of dyes based on applicability on substrates (examples with structures) (a) Acid Dyes- Orange II, (b) Basic Dyes-methyl violet, (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes – Diazo components; Fast yellow G, Fast orange R. Coupling components. Naphthol AS, Naphthol ASG (e) Mordant Dyes-Eriochrome Black A, Alizarin. (f) Vat Dyes- Indanthrene brown RRD, (g) Sulphur Dyes- Sulphur Black T (no structure) (h) Disperse Dyes-Celliton Fast brown 3R, (i) Reactive Dyes- Cibacron Brilliant Red B,	
		3.3.3	Optical Brighteners: General idea, important characteristics of optical brighteners and their classes [Stilbene, Coumarin, Heterocyclic vinylene derivatives, Diaryl pyrazolines, Naphthylamide derivatives] general structure of each class.	

Unit – IV (Dyes)

4	**4.1**		**Colour and Chemical Constitution of Dyes**	**(4L)**
		4.1.1	Absorption of visible light, Colour of wavelength absorbed, Complementary colour.	
		4.1.2	Relation between colour and chemical constitution.	
			(i) Armstrong theory (quinonoid theory) and its limitations. (ii) Witt's Theory: Chromophore, Auxochrome, Bathochromic & Hypsochromic Shift, Hypochromic & Hyperchromic effect (iii) Valence Bond theory, comparative study and relation of colour in the following classes of compounds/dyes: Benzene, Nitrobenzene, Nitroanilines, Nitrophenols, Benzoquinones, Azo, Triphenyl methane, Anthraquinones. (iv) Molecular Orbital Theory.	
	4.2		**Unit process and Dye Intermediates**	
		4.2.1	**A brief idea of Unit Processes**	**(3L)**
			Introduction to primaries and intermediates	
			Unit processes: definition and brief ideas of below unit processes: (a) Nitration (b) Sulphonation (c) Halogenation (d) Diazotization: (3 different methods & its importance) (e) Ammonolysis (f) Oxidation NB: Definition, Reagents, Examples of each unit processes mentioned above with reaction conditions (mechanism is not expected)	

		4.2.2	**Preparation of the Following Intermediates**	**(8L)**
			Benzene derivatives: Benzenesulphonic acid; 1,3-Benzenedisulphonic acid; sulphanilic acid; o-, m-, p-chloronitrobenzenes; o-, m-, p-nitroanilines; o-, m-, p-phenylene diamines; Naphthol ASG	
			Naphthalene Derivative: Schaeffer acid; Tobias acid; Naphthionic acid; N.W. acid; cleve-6-acid; H-acid; Naphthol AS	
			Anthracene Derivative: 1-Nitroanthraquinone; 1-Aminoanthraquinone Anthraquinone-2-sulphonic acid; Benzanthrone.	

References (For Units III & IV):

1. Chemistry of Synthetic Dyes, Vol I – VIII, Venkatraman K., Academic Press 1972
2. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995
3. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973

I] Practicals

SEMESTER V

(Drugs and Dyes)

COURSE CODE: USACDD5P1 **CREDITS: 02**

1. Estimation of Ibuprofen (back titration method)
2. Estimation of Acid neutralizing capacity of a drug
3. Preparation of Aspirin from salicylic acid.
4. Separation of components of natural pigments by paper chromatography (eg: chlorophyll)

II] Project:
Preparation of Orange II dye (semi-microscale1.0gms) and its use for dyeing different fabrics

SEMESTER VI

(Drugs and Dyes)

COURSE CODE: USACDD601 **CREDITS: 02** **LECTURES: 60**

UNIT – I (Drugs)

1	**1.1**		**Drug Discovery, Design and Development**	**(6L)**
		1.1.1	Discovery of a Lead compound: Screening, drug metabolism studies and clinical observation, Lipinski's rule of 5	
		1.1.2	Medicinal properties of compounds from Natural Sources: Anti-infective and anticancer properties of Turmeric (Curcumin)	
		1.1.3	Development of drug: The Pharmacophore identification, modification of structure or functional group, Structure activity relationship (Sulphonamides).	
		1.1.4	Structure modification to increase potency: Homologation, Chain branching and Extension of the structure.	
		1.1.5	Computer assisted drug design.	
	1.2		**Drug Metabolism:** Introduction, Absorption, Distribution, Bio-transformation, Excretion Different types of chemical transformation of drugs with specific examples.	**(3L)**
	1.3		**Chemotherapeutic Agents:** Study of the following chemotherapeutic agents with respect to their chemical structure, chemical class, therapeutic uses, side effects and introduction to MDR wherever applicable.	
		1.3.1	**Antibiotics and antivirals:** Definition, • Amoxicillin (β- lactum antibiotics) • Cefpodoxime (Cephalosporins) • Doxycycline (Tetracyclines) • Levofloxacin (Quinolones) (**Synthesis from 2,3,4 – Trifluro -1-nitrobenzene)** • Aciclovir/Acyclovir (Purines)	**(2L)**
		5.3.2	**Antimalarials:** Types of malaria; Symptoms; Pathological detection during window period (Life cycle of the parasites not to be discussed) • Chloroquine (3-Amino quinolones) • Artemether(Benzodioxepins) **Following combination to be discussed:**Atremether-Lumefantrine (no structure)	**(2L)**
		1.3.3	**Anthelmintics and AntiFungal agents** Drugs effective in the treatment of Nematodes and Cestodes infestations.	**(2L)**

			• Diethyl carbamazine (Piperazines) • Albendazole (Benzimidazoles) (**Synthesis from 2- Nitroaniline)** • Clotrimazole (Imidazole) • Fluconazole (Triazole) (**Synthesis from 1- Bromo – 2,4-difluorobenzene)**	

UNIT – II(Drugs)
Chemotherapeutic Agents continued.

2	**2.1**		**Antiamoebic Drugs** Types of Amoebiasis • Metronidazole, Ornidazole, Tinidazole (Imidazole) Synthesis of Metronidazole from glyoxal by Debus-Radziszewski imidazole synthesis route **Following combination therapy to be discussed:** Ciprofloxacin-Tinidazole	**(1L)**
	2.2		**Antitubercular and Antileprotic Drugs** Types of Tuberculosis; Symptoms and diagnosis of Tuberculosis. Types of Leprosy. General idea of Antibiotics used in their treatment. • PAS (Amino salicylates) • Isoniazide (Hydrazides) • Pyrazinamide (Pyrazines) • (+) Ethambutol (Aliphatic diamines) (**Synthesis from 1- Nitropropane)** • Dapsone(Sulphonamides) (**Synthesis from 4- Chloronitrobenzene)** • Clofazimine (Phenazines) • Bedaquiline (Quinoline) **Following combination therapy to be discussed:** (i) Rifampin + Ethambutol + Pyrazinamide (ii) Rifampin + Isoniazide + Pyrazinamide	**(3L)**
	2.3		**Anti-Neoplastic Drugs** Idea of malignancy; Causes of cancer Brief idea of Immuno Stimulants &Immuno depressants • Lomoustine (Nitrosoureas) • Anastrozole(Triazoles) (**Synthesis from 3,5-bis (bromo methyl) toluene)** • Cisplatin (Chloro Platinum) • Vincristine, Vinblastine, Vindesine) (Vinca alkaloids) (structure not expected)	**(2L)**
	2.4		**Anti-HIV Drugs** Idea of HIV pathogenicity, Symptoms of AIDS • AZT/Zidovudine, Lamivudine,DDI (Purines)	**(1L)**
	2.5		**Drug Intermediates:** Synthesis and uses 1. 2,3,6-Triamino-6- hydroxypyrimidine from Guanidine 2. p-[2'-(5-Chloro-2-methoxy benzamido) ethyl]-benzenesulphonamide from Methyl-5-chloro-2- methoxybenzene 3. 3-(p-Chlorophenyl)-3- hydroxypiperidine from 3-Chloroacetophenone	**(2L)**

			4. p-Acetyl amino benzenesulphonyl chloride from Aniline 5. Epichlorohydrine from propene	
	2.6		**Nano particles in Medicinal Chemistry** Introduction; Carbon nano particles (structures) and Carbon nano tubes: • Functionalization for Pharmaceutical applications • Targeted drug delivery • In vaccine (Foot and mouth disease) • Use in Bio-physical treatment. Gold nano particles in treatment of: Cancer; Parkinsonism; Alzheimer. Silver nano particles: Antimicrobial activity.	**(4L)**
	2.7		**Drugs and Environmental Aspects** • Impact of Pharma-industry on environment, • International regulation for human experimentation with reference to: "The Nuremberg Code" and "The Helsinki Declaration".	**(2L)**

Reference Books (For Units I & II):

1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippmcolt Williams & Wilkins.
2. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.
3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
4. Burger's Medicinal Chemistry, Drug Discovery & Development. Abraham & Rotella. Wiley
5. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
6. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.
7. Principle of medicinal chemistry. Vol 1 & 2 S. S. Kadam, K. R. Mahadik, K. G. Bothara
8. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.
9. The organic chemistry of drug design & drug action. 2nd ed. By Richard B Silvermann, Academic Press.
10. The Organic Chemistry of Drug Synthesis. Lednicer and Mitsher, Wliey.
11. Text book of drug design and discovery. Povl-Krog-Sgaard-Larsen, Tommy Liljefors and ULF Madsen, 3rd Edition Taylor & Francis.
12. Bio-applications of nanoparticles. Edited by Warren C.W. Chan, Springer Publication.
13. Nanoparticle and technology for drug delivery (Drugs and pharmaceutical sciences). Ram B.Gupta& Uday B.Kompella Pub. Informa Healthcare.
14. Nano forms of carbon and its applications. Edited by Maheshwar Sharon and Madhuri Sharon.MonadNanotechPvt. Ltd.
15. Environmental Chemistry. A. K. De
16. Text Book on Law and Medicine. Chokhani and Ghormade. 2nd Edition. Hind Law House,Pune.
17. Essentials of Medical Pharmacology. K D Tripathi, Jaypee Brothers Medical publishers Pvt. ltd.

Practical organic chemistry, Vogel.

SEMESTER VI

Unit – III (Dyes)

3	**3.1**		**Classification of Dyes based on Chemical Constitution and Synthesis of Selected Dyes** (Synthesis of the dyes marked with * is expected)	**(12L)**
			i)Nitro Dye: Naphthol Yellow S	
			ii) Nitroso Dye: Gambine Y	
			iii)Azo dyes: a) Monoazo dyes: Orange IV *(from sulphanilic acid) & Eriochrome Black T* (from β- naphthol) b) Bisazo dyes: Congo Red* (from nitrobenzene) c) Trisazo Dye: Direct Deep Black EW* (from benzidine)	
			iv)Diphenylmethane dye: Auramine O* (from N,N-dimethyl aniline)	
			v)Triphenylmethane dye: a) Diamine series: Malachite Green* (from benzaldehyde) b) Triamine series: Acid Magenta c) Phenol series: Rosolic acid	
			vi)Heterocyclic Dyes: a) Thiazine dyes: Methylene Blue b) Azine dyes: Safranin T* (from o-toluidine) c) Xanthene Dyes: Eosin* (from phthalic anhydride) d) Oxazine Dyes: Capri Blue e) Acridine Dyes: Acriflavine	
			vii)Quinone Dyes: a) Naphthaquinone: Naphthazarin b) Anthraquinone Dyes: Indanthrene Blue* (from anthraquinone)	
			viii) Indigoid Dyes: Indigo* (from aniline + monochloroacetic acid)	
			ix) Phthalocyanine Dyes: Monastral Fast Blue B	
	3.2		**Health and Environmental Hazards of Synthetic Dyes and their Remediation Processes**	**(3L)**
		3.2.1	**Impact of the textile and leather dye Industry on the environment** with special emphasis on water pollution	
		3.2.2	**Health Hazards:** Toxicity of dyes w.r.t food colours.	
		3.2.3	**Effluent Treatment Strategies**: Brief introduction to effluent treatment plants (ETP) Primary Remediation processes:(Physical Processes) Sedimentation, Aeration, Sorption (activated charcoal, fly ashetc.) Secondary Remediation processes: Biological Remediation – Biosorption, bioremediation and biodegradation Chemical Remediation: Oxidation Processes (chlorination), Coagulation-flocculation-Precipitation	

Unit – IV (Dyes)

4	**4.1**		**Non-textile uses of dyes:**	**(8L)**
		4.1.1	**Biomedical uses of dyes** i) Dyes used in formulations (Tablets, capsules, syrups etc) Indigo carmine, Sunset yellow, Tartrazine ii) Biological staining agents Methylene blue, Crystal violet and Safranine T iii) DNA markers Bromophenol blue, Orange G, Cresol red iv) Dyes as therapeutics Mercurochrome, Acriflavine, Crystal Violet, Prontosil	
		4.1.2	**Dyes used in food and cosmetics:** i) Properties of dyes used in food and cosmetics ii) Introduction to FDA and FSSAI iii) Commonly used food colours and their limits	
		4.1.3	**Paper and leather dyes** i) Structural features of paper and leather ii) Dyes applicable to paper and leather	
		4.1.4	**Miscellaneous dyes** i) Hair dyes ii) Laser dyes iii) Indicators iv) Security inks iv) Coloured smokes and camouflage colours	
	4.2		**Pigments**	**(3L)**
			Definition of pigments, examples, properties of pigments, difference between dyes and pigments. Definition of Lakes and Toners	
	4.3		**Dyestuff Industry - Indian Perspective**	**(4L)**
		4.3.1	Growth and development of the Indian Dyestuff Industry	
		4.3.2	Strengths, Weaknesses, Opportunities and Challenges of the Dyestuff industry in India	
		4.3.3	Make in India - Future Prospects of the Dye Industry	

References (For Units III & IV)

1. Chemistry of Synthetic Dyes, Vol I – IV, Venkatraman K., Academic Press 1972
2. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995
3. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973
4. Environmental Studies, Joseph Benny, Tata McGraw Hill Education, 2005
5. Fundamental Concepts of Environmental Chemistry,Sodhi. G. S**.,** Alpha Science International, 2009
6. Planning Commission, Niti Aayog, FSSAI and FDA websites
7. Green Chemistry for Dyes Removal from Waste Water- Research Trends and Applications, Ed. Sharma S.K., Wiley, 2015
8. Environmental Pollution- Monitoring and Control, Khopkar S.M., New Age International (P) Ltd, New Delhi, 1982

Practicals

SEMESTER V

(Drugs and Dyes)

COURSE CODE: USACDD6P1 **CREDITS: 02**

1. O-Methylation of β-naphthol.
2. Preparation of Paracetamol form p-aminophenol.
3. Preparation of Fluorescein
4. TLC of a mixture of dyes (safranine-T, Indigo carmine, methylene blue)

II] Preparation of monograph of any one drug from syllabus by I.P. method.

OR

Industrial visit Report.

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Semester I USBO101		**L**	**Cr**
Paper I -- Plant Diversity 1		**45**	**2**
UNIT I		**15**	
ALGAE			
1	Structure, life cycle and systematic position of *Nostoc* and *Spirogyra*.		
2	Economic importance of Algae.		
UNIT II		**15**	
FUNGI			
1	Structure, life cycle and systematic position of *Rhizopus* and *Aspergillus*		
2	Economic importance of Fungi.		
3	Modes of nutrition in Fungi (Saprophytism and Parasitism).		
UNIT III		**15**	
BRYOPHYTA			
1	General characters of Hepaticae		
2	Structure, life cycle and systematic position of *Riccia*.		

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AC 7/4/2014
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Semester I USBO102		**L**	**Cr**
Paper II – Form and Function 1		**45**	**2**
UNIT I		**15**	
CELL BIOLOGY			
1	General structure of plant cell: cell wall Plasma membrane (bilayer lipid structure, fluid mosaic model)		
2	Ultra structure and functions of the following cell organelles: Endoplasmic reticulum and Chloroplast		
UNIT II		**15**	
ECOLOGY			
1	Energy pyramids, energy flow in an ecosystem.		
2	Types of ecosystems: aquatic and terrestrial.		
UNIT III		**15**	
GENETICS			
1	Phenotype/Genotype, Mendelian Genetics- monohybrid, dihybrid; test cross; back cross ratios.		
2	Epistatic and non epistatic interactions; multiple alleles.		

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	Semester I USBOP1	**L**	**Cr**
	PRACTICAL Paper I – Plant Diversity 1	30	1
1	Study of stages in the life cycle of *Nostoc* from fresh/ preserved material and permanent slides.		
2	Study of stages in the life cycle of *Spirogyra* from fresh/ preserved material and permanent slides.		
3	Economic importance of algae: *Ulva* (Biofuel), *Spirulina* (Neutraceutical), *Gelidium* (Agar)		
4	Study of stages in the life cycle of *Rhizopus* from fresh/ preserved material and permanent slides.		
5	Study of stages in the life cycle of *Aspergillus* from fresh/ preserved material and permanent slides.		
6	Economic importance of Fungi: Mushroom , Yeast, wood rotting fungi (any bracket fungus).		
7	Study of stages in the life cycle of *Riccia* from fresh/ preserved material.		
8	Study of stages in the life cycle of *Riccia* with the help of permanent slides.		
	PRACTICAL PAPER II- FORM AND FUNCTION 1	30	1
1	Examining various stages of mitosis in root tip cells (*Allium)*		
2	**Cell inclusions:** Starch grains (Potato and Rice); Aleurone Layer (Maize)		
3	Cystolith (*Ficus*); Raphides (*Pistia*); Sphaeraphides (*Opuntia*).		
4	Identification of cell organelles with the help of photomicrograph: Plastids: Chloroplast, Amyloplast, Endoplasmic Reticulum and Nucleus		
4	**Identification of plants adapted to different environmental conditions:** Hydrophytes: Floating: Free floating (*Pistia*/*Eichornia*); Rooted floating (*Nymphaea*); Submerged (*Hydrilla*)		
5	Mesophytes (any common plant); Hygrophytes (*Typha*/*Cyperus*)		

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6	Xerophytes : Succulent (*Opuntia*); Woody Xerophyte (*Nerium*); Halophyte (*Avicennia* pneumatophore) No sections in ecology, only identification and description of specimens. Morphological adaptations only.		
7	Calculation of mean, median and mode.		
8	Calculation of standard deviation.		
9	Frequency distribution, graphical representation of data- frequency polygon, histogram, pie chart.		
10	Study of Karyoptypes: Human: Normal male and female, *Allium cepa* .		

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	Semester II USBO201	**Hrs**	**Cr**
	Paper I -- Plant Diversity 1	**45**	**2**
UNIT I		**15**	
PTERIDOPHYTES			
1	Structure life cycle, systematic position and alternation of generations in *Nephrolepis*		
2	Stelar evolution		
UNIT II		**15**	
GYMNOSPERMS			
2	Structure life cycle systematic position and alternation of generations in *Cycas*		
3	Economic importance of Gymnosperms		
Unit III			
ANGIOSPERMS		**15**	
1.	Leaf: simple leaf, types of compound leaves, Incisions of leaf, venation, phyllotaxy, types of stipules, leaf apex, leaf margin, leaf base, leaf shapes. Modifications of leaf: spine, tendril, hooks, phyllode, pitcher, *Drosera* or insectivorous plants.		
2	Inflorescence: Racemose: simple raceme, spike, catkin, spadix, panicle. Cymose: monochasial, dichasial, polychasial. Compound: corymb, umbel, cyathium, capitulum, verticellaster, hypanthodium.		
3	Study of following families: Malvaceae, Amaryllidaceae.		

	Semester II USBO202	**Hrs**	**Cr**
	Paper II – Form and Function 1	**45**	**2**
UNIT I		**15**	
ANATOMY			
1	Simple tissues, complex tissues.		
2	Primary structure of dicot and monocot root, stem and leaf.		
3	Epidermal tissue system: types of hair, monocot and dicot stomata.		

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UNIT II		**15**	
PHYSIOLOGY			
1	Photosynthesis: Light reactions, photolysis of water, photophosphorylation (cyclic and non cyclic), carbon fixation phase (C_3, C_4 and CAM pathways).		
UNIT III		**15**	
MEDICINAL BOTANY			
1	Concept of primary and secondary metabolites, difference between primary and secondary metabolites.		
2	Grandma's pouch: Following plants have to be studies with respect to botanical source, part of the plant used, active constituents present and medicinal uses: *Oscimum sanctum, Adathoda vasica, Zinziber officinale, Curcuma longa, Santalum album, Aloe vera*.		

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	Semester II USBOP2	**Cr**
	PRACTICAL Paper I – Plant Diversity 1	**1**
1	Study of stages in the life cycle of *Nephrolepis* : Mounting of ramentum, hydathode, T.S. of rachis.	
2	T.S. of pinna of *Nephrolepis* passing through sorus.	
3	Stelar evolution with the help of permanent slides: Protostele: haplostele, actinostele, plectostele, mixed protostele, siphonostele: ectophloic, amphiphloic, dictyostele, eustele and atactostele.	
4	*Cycas:* T.S of leaflet (*Cycas* pinna)	
5	Megasporophyll, microsporophyll, coralloid root, microspore, L.S. of ovule of *Cycas* – all specimens to be shown.	
6	Economic importance of Gymnosperms: *Pinus* (turpentine, wood, seeds)	
7	Leaf morphology : as per theory	
8	Types of inflorescence: as per theory	
9	Malvaceae	
10	Amaryllidaceae	
	PRACTICALPaper II – Form and Function 1	**1**
1	Primary structure of dicot and monocot root.	
2	Primary structure of dicot and monocot stem.	
3	Study of dicot and monocot stomata.	
4	Epidermal outgrowths: with the help of mountings Unicellular: *Gossypium*/Radish Multicellular: *Lantana*/Sunflower Glandular: *Drosera* and Stinging: *Urtica* – only identification with the help of permanent slides. Peltate: *Thespesia* Stellate: *Erythrina*/*Sida acuta*/*Solanum/Helecteris*	

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	T-shaped: *Avicennia*	
5	Separation of chlorophyll pigments by strip paper chromatography.	
6	Separation of amino acids by paper chromatography.	
7	Change in colour because of change in pH: Anthocyanin: black grapes/Purple cabbage	
8	Test for tannins: tea powder/catechu.	
9	Identification of plants or plant parts for grandma's pouch as per theory.	

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DISTRIBUTION OF TOPICS AND CREDITS
F Y B Sc. BOTANY SEMESTER I

Course	Nomenclature	Credits	Topics
USBO1O1	PLANT DIVERSITY 1	02	1. Algae
			2. Fungi
			3. Bryophyta
USBO1O2	FORM AND FUNCTION I	02	1. Cell Biology
			2. Ecology
			3. Genetics
USBOP1	Plant Diversity I, form and Function I (Practical I & II)	02	

F Y B Sc BOTANY SEMESTER II

Course	Nomenclature	Credits	Topics
USBO2O1	PLANT DIVERSITY I	02	1. Pteridophytes
			2. Gymnosperms
			3. Angiosperms
USBO2O2	FORM AND FUNCTION I	02	1. Anatomy
			2. Physiology
			3. Medicinal Botany
USBOP2	Plant Diversity I, Form and Function I (Practical I & II)	02	

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References

1. College Botany Volume I and II Gangulee, Das and Dutta latest edition. Central Education enterprises
2. Cryptogamic Botany Volume I and II by G M Smith McGraw Hill.
3. Genetics by Russel. Wesley Longman inc publishers. (5th edition)
4. Plant Physiology by Taiz and Zeiger Sinauer Associates inc. publishers
5. Fundamentals of Ecology by E P Odum and G W Barrett. Thompson Asia Pvt Ltd. Singapore.
6. Cell Biology by De Robertis

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Scheme of Examinations

Internal and External Assessment as per CBSS of University of Mumbai

Note:

- Two short field excursions for habitat studies are compulsory.
  Field work of not less than eight hours duration is equivalent to one period per week for a batch of 15 students.
- A candidate will be allowed to appear for the practical examinations only if he/she submits a certified journal of F.Y.B.Sc. Botany or a certificate from the Head of the department / Institute to the effect that the candidate has completed the practical course of F.Y.B.Sc. Botany as per the minimum requirements. In case of loss of journal a candidate must produce a certificate from the Head of the department /Institute that the practicals for the academic year were completed by the student. However such a candidate will be allowed to appear for the practical examination but the marks allotted for the journal will not be granted.

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UNIVERSITY OF MUMBAI

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

(Credit Based Semester and Grading System with effect from the academic year 2015–2016)

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

S.Y.B.Sc. Botany Syllabus
Restructured for Credit Based and Grading System
To be implemented from the Academic year 2015-2016

SEMESTER III

Course Code	UNIT	TOPICS	Credits	L / Week
USBO301		**PLANT DIVERSITY II**		
	I	Thallophyta- Algae	2	1
	II	Bryophyta		1
	III	Angiosperms		1
USBO302		**FORM AND FUNCTION II**		
	I	Instrumentation and Techniques	2	1
	II	Cell Biology		1
	III	Cytogenetics		1
USBO303		**CURRENT TRENDS IN PLANT SCIENCES I**		
	I	Pharmacognosy&Phytochemistry	2	1
	II	Forestry & Economic Botany		1
	III	Molecular Biology		1
USBOP3	Practical based on all the three courses in theory		3	9

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

SEMESTER IV

Course Code	UNIT	TOPICS	Credits	L / Week
USBO401		**PLANT DIVERSITY II**		
	I	Thallophyta: Fungi, Plant Pathology and Lichens	2	1
	II	Pteridophyta and Paleobotany		1
	III	Gymnosperms		1
USBO402		**FORM AND FUNCTION II**		
	I	Anatomy	2	1
	II	Physiology and Plant Biochemistry		1
	III	Ecology and Environmental Botany		1
USBO403		**CURRENT TRENDS IN BOTANY I**		
	I	Horticulture	2	1
	II	Biotechnology		1
	III	Biostatistics & Bioinformatics		1
USBOP4	Practical based on all the three courses in theory		3	9

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

SEMESTER III
THEORY

Course Code	Title	Credits
USBO301	**PLANT DIVERSITTY II**	**2 Credits (45 lectures)**
Unit I : Thallophyta- Algae • General Characters of Division Phaeophyta: Distribution, Cell structure, pigments, reserve food, range of thallus, reproduction: asexual and sexual, Alternation of Generations, Economic Importance. • Structure, life cycle and systematic position of *Dictyota* *Sargassum* • Pigments in Algae.		**15 Lectures**
Unit II : Bryophyta • General Account of Class Anthocerotae and Musci • Structure, life cycle and systematic position of o *Anthoceros* o *Funaria*		**15 Lectures**
Unit III : Angiosperms **Morphology of Flowering Plants** • **Flower Morphology :** o Parts of a flower, flower symmetry; o Flower as a modified shoot, o Thalamus, insertion of floral leaves on the thalamus o The accessory whorls : Calyx types and modifications, Corolla – forms; Aestivation, The Perianth; o The Essential whorls: Androecium parts of the androecium, Number and insertion of stamens, Union of stamens; Types of CoronaGynoecium: the carpel, style and stigma; Union of Carpel; ovary- placentation, types of ovules, evolution of placenta in Angiosperm. o Floral formula, floral diagram. • With the help of Bentham and Hooker's system **of classification for flowering plants**study the vegetative, floral characters and economic importance of the following families: o Magnoliaceae o Myrtaceae o Asteraceae o Apocynaceae o Amaranthaceae o Palmae		**15 Lectures**

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

Course Code	Title	Credits
USBO302	**FORM AND FUNCTION II**	**2 Credits (45 lectures)**
Unit I : Instrumentation and Techniques • Microscopy – Principle and working of Light, and electron microscope. • Chromatography- Principles and techniques in paper and thin layer chromatography. • Principles and techniquesof Horizontal and Vertical electrophoresis.		**15 Lectures**
Unit II : Cell Biology • Ultra Structure and functions of the following cell organelles: o Mitochondrion o Peroxisomes o Glyoxysomes o Ribosomes • Cell Division and its significance o Cell Cycle o Mitosis &Meiosis o Differences between Mitosis and Meiosis • Nucleic Acids: Types, structure and functions of o DNA o RNA		**15 Lectures**
Unit III : Cytogenetics • **Variation in Chromosome structure (Chromosomal Aberrations)** Definition, Origin, Cytological and Genetic Effects of the following: Deletions, Duplications, Inversions and Translocations. • **Variation in Chromosome Number** Origin and production, morphological and cytological features, applications in crop improvement and evolution of Aneuploids and Euploids(Monoploids, Autopolyploids and allopolyploids) • **Extranuclear Genetics** Organelle heredity- o Chloroplast determines heredity -Plastid transmission in plants, Streptomycin resistance in *Chlamydomonas*. o Mitochondrion determined heredity- petite colonies in yeast		**15 Lectures**

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

Course Code	Title	Credits
USBO303	**CURRENT TRENDS IN PLANT SCIENCES I**	**2 Credits (45 lectures)**
Unit I : Pharmacognosy and Phytochemistry • Introduction to pharmacopoeia • Study of secondary metabolites (sources, properties and uses) with reference to o Alkaloids, o Glycosides, o Tannins, o Volatile oils and o Gums and resins (example of one plant for each category)		**15 Lectures**
Unit II : Forestry and Economic Botany • **Types of forests** – classification of forests, different types of forests in India • **Applications of forestry**- Social forestry, Reforestation, Aforestation, Deforestation. • **Economic Botany**: o Fibres: Types of fibres, fibre yielding plants o Paper: Types of paper, paper yielding plants, paper processing. o Spices and condiments: Nutmeg, Mace, Clove, Cardamom and Saffron		**15 Lectures**
Unit III : Molecular Biology • **DNA replication** : Replication(prokaryotic and eukaryotic) • **Protein Synthesis**: o Central dogma of Protein synthesis o Transcription: The transcription process in prokaryotes and eukaryotes, RNA synthesis, RNA processing, Adenylation& Capping.		**15 Lectures**

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

SEMESTER III
PRACTICAL

Semester III USBOP3 PRACTICAL Paper I – Plant Diversity II	Cr 1

Algae

1. Study of stages in the life cycle of *Dictyota*from fresh/ preserved material and permanent slides.
2. Study of stages in the life cycle of *Sargassum* from fresh/ preserved material and permanent slides.
3. Economic importance and range of thallusinPhaeophyta

Bryophyta

4. Study of stages in the life cycle of *Anthoceros*from fresh/ preserved material and permanent slides.
5. Study of stages in the life cycle of *Funaria*from fresh/ preserved material and permanent slides.

Angiosperms

6. Study of Floral Morphology

7- Study of one plant from each family prescribed for theory: morphological

9. peculiarities and economic importance of the members of these families.

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

Semester III USBOP3 PRACTICAL Paper II – FORM AND FUNCTION- II	Cr 1
Instrumentation and Techniques 1 Preparation of herbarium and wet preservation technique 2 Chromatography: Separation of amino by circular paper chromatography 3 Separation of Carotenoids by thin layer chromatography 4 Horizontal and Vertical Gel Electrophoresis – Demonstration **Cell Biology** 5 Study of the ultra-structure of cell organelles prescribed for theory from Photomicrographs 6 Estimation of DNA from plant material (one Std& one Unknown, No Std Graph) 7 Estimation of RNA from plant material (one Std& one Unknown, No Std Graph) **Cytogenetics** 8 Study of inheritance pattern with reference to Plastid Inheritance **9**Aberrations --- karyotypes - Cri – du- chat, Philadelphia, D-G translocation, DownSyndrome.	

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

Semester III USBOP3	Cr
PRACTICAL - Paper III CURRENT TRENDS IN PLANT SCIENCES I	**1**

Pharmacognosy

1 A. Tests for alkaloids from *Strychnos*(seeds) and*Holarrhena*(bark)
B. Tests for glycosides from *Glycyrrhiza*rhizome/ *Aloe* leaf/ Senna leaf.
2 Preparation of any herbal cosmetic.(Demonstration)
3 Stomatal Index
4 Palisade Ratio, Vein islet number

Forestry and Economic Botany

5 Study of Biodiversity Composition of different types of forests in India (tropical, subtropical & temperate)
6 Sources, properties and uses of : fibres & paper
7 Sources , properties and uses of spices and condiments

Molecular Biology

8 DNA sequencing- Sanger's method
9 Determining the sequence of amino acids in the protein molecule synthesised from the given m-RNA strand (prokaryotic and eukaryotic)

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

SEMESTER IV
THEORY

Course Code	Title	Credits
USBO401	**PLANT DIVERSITY II**	**2 Credits (45 lectures)**
Unit II : Thallophyta: Fungi, Plant Pathology and Lichens **Fungi-** • General characters of Ascomycetae • Structure, life cycle and systematic position of *Erysiphe and Xylaria* **Plant Pathology-** • Symptoms, causative organism, disease cycle and control measures of o Powdery mildew and o Late blight of potato **Lichens-** • Classification, Structure, Method of Reproduction, Economic Importance and Ecological Significance of Lichens.		**15 Lectures**
Unit II : Pteridophyta and Paleobotany **Pteridophyta-** • Salient features and classification upto orders (with examples of each) of Psilophyta and Lepidophyta (G M Smith's system of classification to be followed), • Structure, life cycle and systematic position of *Selaginella* **Paleobotany-** • The geological time scale; • Formation and types of fossils; • Structure and systematic position of form genus *Rhynia*		**15 Lectures**
Unit III : Gymnosperms • Salient features, classification up to orders (with examples of each) and economic importance of Coniferophyta (Chamberlain's system of classification to be followed) • Structure life cycle and systematic position of *Pinus* • Structure and systematic position of the form genus *Cordaites*		**15 Lectures**

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

Course Code	Title	Credits
USBO402	**FORM AND FUNCTION II**	**2 Credits (45 lectures)**

Unit I : Anatomy
• Normal Secondary Growth in Dicotyledonous stem and root.
• Secondary growth in Monocot stem – *Dracaena.*
• Mechanical Tissue system
  o Tissues providing mechanical strength and support and their disposition
  o I-girders in aerial and underground organs
• Conducting tissue system :
  o Xylem and its elements,
  o Phloem and its elements
  o Types of Vascular Bundles.
		15 Lectures

Unit II : Plant Physiology and Plant Biochemistry • **Respiration: Aerobic:** Glycolysis, TCA Cycle, ETS &Energetic of respiration; Anaerobic respiration. • **Photorespiration** • **Photoperiodism:**Phytochrome Response and Vernalization with reference to flowering in higher plants, Physico-chemical properties of phytochrome, Pr-Pfrinterconversion, role of phytochrome in flowering of SDPs and LDPs; • **Vernalization** mechanisms and applications.		**15 Lectures**
Unit III : Ecology and Environmental Botany • Biogeochemical Cycles- Carbon, Nitrogen and Water. • Ecological factors: Concept of environmental factors. Soil as an edaphic factor, Soil composition, types of soil, soil formation, soil profile. • Community ecology- Characters of community - Quantitative characters and qualitative characters		**15 Lectures**

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

Course Code	Title	Credits
USBO403	**CURRENT TRENDS IN PLANT SCIENCES I**	**2 Credits (45 lectures)**
Unit I : Horticulture and Gardening • **Introduction to Horticulture**:Branches of Horticulture • **Gardening:** o Locations in the garden- edges, hedges, lawn, flower beds, avenue, water garden (with names of two plants for eachcategory). Focal point. • **Types of gardens** o Formal and informal gardens, o National Park: Sanjay Gandhi National Park. o Botanical Garden: Veer Mata JijabaiUdyan (Victoria Garden).		**15 Lectures**
Unit II : Biotechnology • **Introduction to plant tissue culture** o Laboratory organization and techniques in plant tissue culture o Totipotency o Organogenesis o Organ culture – root cultures, meristem cultures, anther and pollen culture, embryo culture. • **R-DNA technology-** o Gene cloning o Enzymes involved in Gene cloning o Vectors used for Gene cloning.		**15 Lectures**
Unit III : Biostatistics and Bioinformatics • **Biostatistics:** o The chi square test. o Correlation – Calculation of coefficient of correlation. • **Bioinformatics** o Information technology: History and tools of IT, Internet and its uses**.** o Introduction to Bioinformatics- goal, need, scope and limitation o Aims of Bioinformatics: Data organization, Tools of Bioinformatics- tools for web search, Data retrieval tools- Entrez, o BLAST o Bioinformatics programme in India.		**15 Lectures**

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

SEMESTER IV
PRACTICAL

Semester IV USBOTP4 PRACTICAL Paper I – Plant Diversity	Cr 1
Fungi and Plant Pathology 1 Study of stages in the life cycle of *Erysiphe*from fresh/ preserved material and permanent slides. 2 Study of stages in the life cycle ofXylaria from fresh/ preserved material and permanent slides. 3 Study of fungal diseases as prescribed for theory. 4 Study ofLichens (crustose, foliose, &fruiticose). **Pteridophyta and Palaeobotany** 5-6 Study of stages in the life cycle of *Selaginella*from fresh/ preserved material and permanent slides. 7 Study of form genera *Rhynia*with the help of permanent slides/ photomicrographs. **Gymnosperms** 8- Study of stages in the life cycle of *Pinus*from fresh/ preserved material and 9 permanent slides. 10 Study of the form genus *Cordaites*with the help of permanent slide/ photomicrographs.	

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

SEMESTER IV USBOT P4 PRACTICALS Paper II – FORM AND FUNCTION- II	Cr 1

Anatomy

1 Study of normal secondary growth in the stem and root of a Dicotyledonous plant
2 Study of secondary growth in monocot stem (*Dracena*).
3 Types of mechanical tissues, mechanical tissue system in aerial, underground organs.
4 Study of conducting tissues- Xylem and phloem elements in Gymnosperms and Angiosperms as seen in LS and through maceration technique.
5 Study of different types of vascular bundles.

Plant Physiology and Plant Biochemistry

6 Q_{10} – germinating seeds using Phenol redindicator
7 NR activity – *in-vivo*
8 Estimation of proteins by Lowry's method (Prepare standard graph).

Ecology and Environmental Botany

9 Study of the working of the following Ecological Instruments- Soil thermometer, Soil testing kit, Soil pH, Wind anemometer.
10 Mechanical analysis of soil by the sieve method & pH of soil.
11 Quantitative estimation of organic matter of the soil by Walkley and Blacks Rapid titration method.
12 Study of vegetation by the list quadrat method

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

	Cr
SEMESTER IV USBOP4	
PRACTICALS - Paper III – CURRENT TRENTS IN PLANT SCIENCES	**1**

Horticulture

1 Study of five examples of plants for each of the garden locations as prescribed for theory
2 Preparation of garden plans – formal and informal gardens
3 Bottle and dish garden preparation.

Biotechnology

4 Various sterilization techniques
5 Preparation of Stock solutions, Preparation of MS medium.
6 Seed sterilization, callus induction
7 Regeneration of plantlet from callus
8 Identification of the cloning vectors – pBR322, pUC 18, Ti plasmid.

Biostatistics and Bioinformatics

9 Chi square test
10 Calculation of coefficient of correlation
11 Web Search – Google, Entrez.
12 BLAST

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

SEMESTER - III, , S.Y.B.Sc. BOTANY
PRACTICAL SKELETON PAPER (PROPOSED)

TIME - 2 hours 15 min **PAPER – I** **Total Marks – 50**

Q.1. Identify, Classify and describe specimen **'A'** . Sketch neat and labeled diagram. (10)

Q.2. Identify, Classify and describe specimen **'B'** . Sketch neat and labeled diagram. (10)

Q.3. Assign the specimen **'C'** to its family giving reasons. Give the distinguishing characters, floral Diagramand floral formula. Sketch the L.S. of flower and T.S. of ovary. (10)

Q.4. Identify and describe the specimen/ slide/ photograph -**'D', 'E', 'F' , 'G'** and **'H'**. (15)

Q.5. Journal. (05)

KEY :

A. – *Dictyota / Sargasum*

B. –*Anthoceros / Funaria*

C. Any Angiospermic Family as per syllabus.

D. Algae – economic importance / range of thallus in Phaeophyta

E. *Anthoceros / Funaria*

F. Calyx / Corolla (any one type)

G. Androecium / Gynoecium (any one type)

H. Economic importance or morphological peculiarity of any one family.

SEMESTER - III, , S.Y.B.Sc. BOTANY
PRACTICAL SKELETON PAPER (PROPOSED)

TIME - 2 hours 15 min **PAPER – II** **Total Marks – 50**

Q.1. To Separate given material 'A' by any appropriate chromatography technique . (10)

Q.2. To estimate DNA/ RNA from the given sample 'B'. (10)

Q.3. Make an Idiogram from the given Karyotype 'C'. Identify and enlist the symptoms of the chromosomal abberation. (10)

Q.4. Identify and describe the specimen/ photograph - 'D' (05), 'E' (05) and 'F' (05 or 03 + 02). (15)

Q.5. Field Report. (05)

KEY :

A. – Carotenoids/amino acids

B. Cauliflower

C. Cri-du-chat; Philadelphia; D-G translocation, DownSyndrome

D. Electrophoresis

E. *Dry* or wet preservation

F. Cell organelles / Plastid inheritance.

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

SEMESTER - III, , S.Y.B.Sc. BOTANY

PRACTICAL SKELETON PAPER (PROPOSED)

TIME - 2 hours 15 min **PAPER – III** **Total Marks – 50**

Q.1. a). Identify the active constituents present in specimen **'A'** by performing suitable chemical tests. (08)

Q.1. b).Calculate the stomatal index / palisade ratio / vein – islet numbers from the given specimen **'B'**. (07)

Q.2. Describe the ecological factors, enlist the dominant flora and mark the area on the map of a forest type **'C'** . (10)

Q.3. Determine the sequence of bases in a DNA strand by Sanger's method from the given data **'D'or** Determine the sequence of amino acids in the polypeptide synthesized from the given m-RNAstrand **'D'** (08)

Q.4. Identify and describe the specimen/ slide/ photograph - **'E', 'F' , and 'G'.** (12)

Q.5. Viva - Voce. (05)

KEY :

A. Alkaloids / Glycosides.

B.Betel leaf / *Vinca*leaf.

E. Importance of _____ in herbal cosmetics.

F. Fibres / Paper.

G. Spices / Condiments.

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

SEMESTER - IV, , S.Y.B.Sc. BOTANY
PRACTICAL SKELETON PAPER (PROPOSED)

TIME - 2hours 15 min **PAPER – I** **Total Marks – 50**

Q.1. Identify, Classify and describe specimen **'A'** . Sketch neat and labeled diagram. (10)

Q.2. Identify, Classify and describe specimen **'B'** . Sketch neat and labeled diagram. (10)

Q.3. Identify, Classify and describe specimen **'C'** .Sketch neat and labeled diagram. (10)

Q.4. Identify and describe the specimen/ slide/ photograph -**'D', 'E' and 'F' .** (15)

Q.5. Journal. (05)

KEY :

A. – *Xylaria / Erysiphe*

B. –*Selaginella – Stem / strobilus*

C. *Pinus – needle* / stem / male cone.

D. Fungal disease – Powdery mildew / any other disease as per syllabus.

E. Lichen.

F. *Rhynia / Cordaites.*

SEMESTER - IV, ,S.Y.B.Sc. BOTANY
PRACTICAL SKELETON PAPER (PROPOSED)

TIME - 2hours 15 min **PAPER – II** **Total Marks – 50**

Q.1. a). Make a temporary stained preparation of T.S. of specimen **'A'** and comment on the secondary growth . (10)

Q.1. b). Make a temporary stained preparation of T.S. of specimen **'B'** and comment on the mechanical tissue system .

OR

Macerate the given material 'B' and describe the conducting tissue seen. (05)

Q.2. Perform the Physiological experiment **'C'** allotted to you . (12)

Q.3. Perform the Ecological experiment **'D'** allotted to you . (12)

Q.4. Identify and describe the specimen/ slide/ photograph - **'E', and 'F' .** (06)

Q.5. Viva - Voce. (05)

KEY :

A. – Dicot stem/ dicot root / monocot stem.

B. –Mechanical Tissue (*Coleus stem, Typha leaf, Maize stem and* Maize root /*Annona / Magnolia*formaceration).

E. – Vascular bundles / phloem/xXylem.

F. – Ecological Instrument.

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

SEMESTER - IV, , S.Y.B.Sc. BOTANY

PRACTICAL SKELETON PAPER (PROPOSED)

TIME - 2hours 15 min **PAPER – III** **Total Marks – 50**

Q.1. Prepare a garden plan **'A'** . Mention any three garden locations with suitable plants (Botanical names). (10)

Q.2. Prepare MS medium **OR** Perform seed sterilization technique **'B'** . (08)

Q.3. a). Perform Chi- square test **OR** Coefficient of Correlation using the given data **'C'** and analyse the results . (12)

Q.3.b). Perform the experiment **'D'** related to Web search. (06)

Q.4.a). Identify and describe the specimen/ photograph -**'E'** (05)

Q.4.b). Identify and describe the specimen/ photograph - **'F', 'G' and 'H' .** (09)

KEY :

E. Bottle or dish garden.

F. Sterilization Technique.

G. Cloning Vectors.

H. Bioinformatics.

AC 26/2/2015
Item No. 4.70

UNIVERSITY OF MUMBAI

Syllabus for F.Y.B.Sc.
Program BSc
Course: ZOOLOGY

Semester I and II

(Credit Based Semester and Grading System
with effect from the academic year 2015–2016)

Syllabus Committee Members

Dr. Anil S. Singh	-	Convenor
Dr. Manisha Kulkarni	-	Co-convenor
Dr. Jyotsna Mahale	-	Co-convenor
Dr. Meenakshi Sundaresan	-	Co-convenor
Prof. Lata Sardesai	-	Co-convenor
Prof. P.C. Mathew	-	Co-convenor
Dr. Dilip Kakavipure	-	Co-convenor
Dr. V.M. Patole	-	Co-convenor
Dr. Kantilal H. Nagare	-	Co-convenor
Prof. Shanta Janyani	-	Co-convenor
Dr. S. Rangoonwala	-	Co-convenor
Dr. Minakshi Gurav	-	Member (Teacher)
Dr. Shirley B. Agwuocha	-	Member (Teacher)
Dr. Vishakha Shingala	-	Member (Teacher)
Dr. Gayathri N.	-	Member (Teacher)
Dr. Ansariya Rana	-	Member (Teacher)
Dr. Aditya S. Akerkar	-	Member (Teacher)
Dr. Shashikala Prajapati	-	Member (Teacher)
Dr. R.B. Singh	-	Member (Teacher)
Prof. Nitin Wasnik	-	Member (Teacher)
Prof. Nikhil C. Disoria	-	Member (Teacher)
Ms. Purva S. Prabhu	-	Member (Student)
Ms. Sachi R. Mayekar	-	Member (Student)
Ms. NehaVajandar	-	Member (Student)
Ms. Payal A. Shah	-	Member (Student)
Ms. Anuradha Gaikar	-	Member (Student)
Ms. Sonal S. Prabhulkar	-	Member (Student)

Syllabus for
FYBSc
Course – ZOOLOGY

1. Preamble
2. Pedagogy
3. Syllabus Semester I & II
4. References and Additional Reading
5. Scheme of Examination and Paper Pattern
6. Distribution of periods
7. Model Question bank

Aims

- To nurture interest in the students for the subject of Zoology
- To create awareness of the basic and modern concepts of Zoology
- To orient students about the importance of abiotic and biotic factors of environment and their conservation.
- To provide an insight to the basic nutritional and health aspects of human life.
- To inculcate good laboratory practices in students and to train them about scientific handling of important instruments.

Preamble

While presenting this new syllabus to the teachers and students of Semester I and Semester II (F.Y.B.Sc.) Zoology, I am extremely happy to state that for the first time efforts have been made to seek inputs of all the stake holders to make it more relevant.

In the first meeting of the Board of Studies an apex committee was formed to study syllabi worldwide with a view to include modern modules and plan semesters at UG and PG programs in advance to avoid overlapping and duplication of topics in various courses.

Meeting with the industry at the Indian Merchants' Chamber and with the meritorious alumni helped adding need based components. For the first time students were a part of the syllabus committee and the process became participative when the draft was finalized in an open meeting with all the Zoology teachers after having sought democratic criticism on the proposed syllabus placed on the University website for about one month.

While following the guidelines of UGC, use of animals is excluded from the practicals, substituting the same with audiovisual, ICT and simulation aids and that the syllabus is made more interesting with new, innovative topics. Providing the pedagogy as also indicating objectives and desired outcome of every topic for the teachers, and question bank for the students apart from the question paper pattern became an integral part of the syllabus, therefore.

Care is taken to provide the drafts from time to time and declare the final syllabus well in advance enabling the teachers to make preparations before commencement of the academic year and facilitating students to execute their right to know the details before admissions.

The success of this revamped syllabus will depend totally on the enthusiasm of the teachers which is very high all throughout the process and their hands will be strengthened by publishing the University text books for the first time. This curriculum of the Zoologists, for the Zoologists and by the Zoologists developed with the united efforts will take our ever progressive subject to greater heights in the years to come.

- VINAYAK DALVIE, Chairman, BOS in Zoology

Syllabus for
FYBSc.
Course – ZOOLOGY
To be implemented from Academic year 2015-16
SEMESTER - I

COURSE CODE	UNIT	TOPICS	CREDITS	LECTURES/WEEK
USZO101	I	Wonders of animal world	2	1
	II	Biodiversity and its conservation		1
	III	Footsteps to follow		1
USZO102	I	Laboratory safety and Units of Measurement	2	1
	II	Animal Biotechnology		1
	III	Instrumentation		1
USZOP1	Practical based on both courses		2	6

SEMESTER - II

COURSE CODE	UNIT	TOPICS	CREDITS	LECTURES/WEEK
USZO201	I	Population Ecology	2	1
	II	Ecosystem		1
	III	National park and Sanctuaries		1
USZO202	I	Nutrition and Health	2	1
	II	Public health and Hygiene		1
	III	Common human Diseases		1
USZOP2	Practical based on both courses		2	6

SYLLABUS F.Y.B.Sc. ZOOLOGY

UNIT WISE DISTRIBUTION

Semester I		Semester II	
Course 1	**Course 2**	**Course 3**	**Course 4**
Unit 1 Wonders of animal world	Unit 1 Laboratory Safety and Units of Measurement	Unit 1 Population Ecology	Unit 1 Nutrition and Health
Unit 2 Biodiversity and its Conservation	Unit 2 Animal Biotechnology	Unit 2 Ecosystem	Unit 2 Public Health and Hygiene
Unit 3 Footsteps to follow	Unit 3 Instrumentation	Unit 3 National Parks and Sanctuaries	Unit 3 Common Human Diseases
Practical (USZO P1)	Practical (USZO P1)	Practical (USZO P2)	Practical (USZO P2)

PEDAGOGY

F.Y.B.Sc. Syllabus

First year B.Sc. course is the entry point for the students to undergraduate classes which acts like a guiding force for them to make up their mind in selecting a subject they would wish to pursue their studies in future for carving their career in a particular field.

The syllabus committee in the subject of Zoology for F.Y.B.Sc. Class has designed this syllabus with a view that it is most appropriate time when we transform our traditional closed classroom teaching learning practices to more of field and activity based studies, the correct methodology for the study of Natural Sciences. It is recommended to orient the students about ecosystem, bio-diversity, wildlife conservation and management with the help of models, photographs, movies, documentaries, charts and use of ICT and then take learners to field to have realistic experiences. This will enable them to get true insight about endurance of animal life in relation to human activity inducing sentiment of love, care and protection in the young mind and heart leading to understand importance of co-existence and conservation of bio-diversity. An interaction with the officials of wildlife protection force should be allowed to get basic knowledge about the relevant acts through lectures which for creating awareness about these issues and also to make best use of the knowledge in their own interest as well as for the country. Instrumentation and Animal Biotechnology component would initiate academia- industry interface and should be edified in collaboration with expertise from relevant research institutes and industrial establishments and entrepreneurs by inviting them as guest speakers or through industrial visits, excursions for practical experience about the principle, working and application of the instruments for commercial use. Population ecology need to be explained in the context with census to enlighten pupils about the effect of diversity and dynamism of human population on socio economic status of India. Experts from the field of nutrition and health can be invited to enlighten learners on the topics of nutritional value of food, balanced diet, ill-effects of eating junk food and aerated drinks. Medical professionals, relevant NGO's maybe engaged to educate students regarding myth, precautionary measures, immunization drives of common diseases, ill-effects of self-medication and stress, significance of BMI through series of programmes. During medical emergencies it is of immense importance to provide first aid assistance to the diseased within the golden period i.e. of few minutes. This enhances the possibility to save life, thus it is strongly recommended to form a consortium of colleges to conduct training in rotation of first aid techniques for teachers and students both with the help of organizations like Red Cross Society, Health Department of Civic Bodies, Civil Defence Department and Local Self Government etc.

Dr. Anil S. Singh
Convenor

F.Y.B.Sc. ZOOLOGY

(THEORY)

SEMESTER I

USZO101 (Course 1)
Wonders of Animal World, Biodiversity and its Conservation

Unit 1: Wonders of Animal World (15 L)

Objective: *To take learners through a captivating journey of hoarded wealth of marvellous animal world.*

Desired Outcome*: Curiosity will be ignited in the mind of learners, to know more about the fascinating world of animals which would enhance their interest and love for the subject of Zoology.*

1.1**:** Echolocation in Bats and Cetaceans - Dolphins and Whales

1.2**:** Mechanism of Pearl formation in Mollusca

1.3**:** Bioluminescence in Animals: Noctiluca, Glow worm, Firefly, Angler Fish (Mechanism and use for the animal)

1.4**:** Regeneration in Animals - Earthworm (Annelida) and Lizard (Reptile)

1.5**:** Mimicry in Butterflies and its significance: Great Eggfly and Common Crow, Common Palmfly and Plain Tiger.

1.6**:** Mechanism of Coral formation and types of Coral reefs

1.7**:** Bird migration: Definition, types and factors inducing bird migration

1.8**:** Adaptive features of desert animals: Reptiles (Phrynosoma) and Mammals (Camel)

1.9**:** Breeding and Parental care in:

1.9.1**:** Pisces - Ovo-viviparous (Black Molly/Guppy), Mouth brooders (Tilapia), Brood pouches (Sea horse)

1.9.2**:** Amphibia - Mouth brooders (Darwin's Frog), Egg carriers (Midwife Toad)

1.9.3**:** Mammals - Egg-laying (Duck-billed Platypus), Marsupials (Kangaroo)

1.10**:** Aves: Brood Parasitism (Cuckoo)

Unit 2: Biodiversity and its Conservation (15 L)

Objective*: To orient learners about rich heritage of Biodiversity of India and make them understand significance of its conservation.*

Desired Outcome*: Learners would appreciate treasure of Biodiversity, its importance and hence would contribute their best for its conservation*.

2.1: Introduction to Biodiversity - Definition, Concepts, Scope and Significance

2.2: Levels of Biodiversity - Introduction to Genetic, Species and Ecosystem Biodiversity

2.3: Introduction of Biodiversity Hotspots- (Western Ghats and Indo-Burma Border)

2.4: Values of biodiversity - Direct and Indirect use value

2.5: Threats to Biodiversity - Habitat loss and Man-Wildlife conflict

2.6: Biodiversity conservation and management

2.6.1**:** Conservation strategies: *in situ*, ex-situ, National parks, Sanctuaries and Biosphere reserves.

2.6.2**:** Introduction to International efforts : Convention on Biological Diversity (CBD), International Union for Conservation of Nature and Natural Resources (IUCN), United Nations Environment Program - World Conservation Monitoring Centre (UNEP-WCMC)

2.6.3**:** National Biodiversity Action Plan, 2002

2.6.4**:** Introduction to Indian Wildlife (Protection) Act, 1972 and Convention for International Trade of endangered species

Unit 3: Footsteps to follow (15 L)

Objective*: To teach learners about innovative and novel work of scientists/philosopher/entrepreneurs in the field of biological sciences.*

Desired Outcome*: Minds of learners would be impulsed to think differently and would be encouraged ipso facto to their original crude ideas from the field of biological sciences.*

3.1**:** Dr. Hargobind Khorana (Genetic code)

3.2**:** Dr. Varghese Kurien (Amul –White revolution)

3.3**:** Dr. Salim Ali (Ornithologist)

3.4**:** Anna Hazare (Water Conservation-Ralegan Siddhi)

3.5**:** Baba Amte (Anandvan)

3.6**:** Kiran Mazumdar Shaw (Biocon)

3.7**:** Gadre Fisheries (Surimi)

Two cases preferably of local importance to the college be additionally taught.

USZO102 (Course 2)

INSTRUMENTATION and ANIMAL BIOTECHNOLOGY

Unit 1: Laboratory safety, Units and Measurement (15 L)

Objective: *To make learners aware of risks involved in handling of different hazardous chemicals, sensitive (electrical/electronic) instruments and infectious biological specimens especially during practical sessions in the laboratory and to train them to avoid mishap.*

Desired Outcome*: Learners would work safely in the laboratory and avoid occurrence of accidents (mishaps) which will boost their scholastic performance and economy in use of materials/chemicals during practical sessions.*

1.1: Introduction to good laboratory practices

1.2: **Use of safety symbols**: meaning, types of hazards and precautions

1.3: **Units of measurement**:

1.3.1**:** Calculations and related conversions of each: Metric system- length (meter to micrometer); weight (gram to microgram), Volumetric (Cubic measures)

1.3.2**:** Temperature: Celsius, Fahrenheit, Kelvin

1.3.3**:** Concentrations: Percent solutions, ppt, ppm, ppb dilutions, Normality, Molarity and Molality.

1.3.4**:** Biostatistics: Introduction and scope, Sampling and its types, Central Tendencies (mean, median, mode) Tabulation, Graphical representations (Histograms, bar diagrams, pie diagrams).

Unit 2: Animal Biotechnology (15 L)

Objective: *To acquaint learners to the modern developments and concepts of Zoology highlighting their applications aiming for the benefit of human being.*
Desired Outcome*: Learners would understand recent advances in the subject and their applications for the betterment of mankind; and that the young minds would be tuned to think out of the box.*

2.1: **Biotechnology**: Scope and achievements of Biotechnology (Fishery, Animal Husbandry, Medical, Industrial)

2.2: **Transgenesis**: Retro viral method, Nuclear transplantation method, DNA microinjection method and Embryonic stem cell method

2.3: Cloning (Dolly)

2.4: Ethical issues of transgenic and cloned animals

2.5: **Applications of Biotechnology**:

2.5.1**:** DNA fingerprinting: Technique in brief and its application in forensic science (Crime Investigation)

2.5.2**:** Recombinant DNA in medicines (recombinant insulin)

2.5.3**:** Gene therapy: Ex-vivo and *In vivo,* Severe Combined Immunodeficiency (SCID), Cystic Fibrosis

2.5.4**:** Green genes: Green Fluorescent Protein (GFP) from Jelly fish- valuable as reporter genes used to detect food poisoning.

Unit 3: Instrumentation (15 L)

Objective: *To provide all learners a complete insight about the structure and train them with operational skills of different instruments required in Zoology.*
Desired Outcome: *Students will be skilled to select and operate suitable instruments for the studies of different components of Zoology of this course and also of higher classes including research.*

3.1: Microscopy

3.1.1**:** Construction, principle and applications of dissecting and compound microscope.

3.2: Colorimetry and Spectroscopy - Principle and applications.

3.3: pH - Sorenson's pH scale, pH meter - principle and applications.

3.3: Centrifuge - Principle and applications (clinical and ultra centrifuges).

3.4: Chromatography - Principle and applications (Partition and Adsorption)

3.5: Electrophoresis - Principle and applications (AGE and PAGE)

SEMESTER I

Practical USZOP1 (Course I)

1. Mounting of foraminiferan shells from sand (any 3)
2. Study of types of Corals - Brain, Organ pipe, Stag Horn, Mushroom coral Study of

3Study of the following;

a. Symbiosis (Termite and Trychonympha, hermit crab and sea anemone)
b. Camouflage (leaf insect, chameleon)
c. Cannibalistic mate-eating animals (Spider and Praying Mantis)
d. Animal architects: Termites, Harvester ant and Baya weaver bird
e. Study of bioluminescent organisms – Noctiluca, glow worm, fire fly, angler fish.

4. Breeding and parental care in Amphibia- *Rhacophorus*, Midwife toad, Darwin's frog, Caecilian.
5. Mounting of scales of fish (placoid, cycloid and ctenoid)
6 a) Study of Adaptive radiation in Reptiles - Turtle, Tortoise, *Phrynosoma*, *Draco*)
   b) Identification and differentiation of venomous and non-venomous snakes (Scales, Fangs, Bite marks, etc.)
7. Study of Types of feathers(contour, filoplume, down), beaks(Nectar feeding , Insect catching, Fruit eating, Scavenging, Filter feeding), claws (perching, wading, swimming, hopping) in birds
8 a. Identification of birds - Coppersmith Barbet, Bulbul, Rose ringed Parakeet, Magpie Robin, two local birds.
   b. Field Report – To be done in a group of ten students (submission of written / typed report preferably along with photographs/ tables/ graphs.

Other Suggested topics for field observation/survey:

- Butterflies/ Fishes/ Migratory birds of local area.
- Variations in Human like Attached vs. Free Earlobes, Blood Groups, Eye colour, etc. using statistical method.

9. Observations of fauna in the field (with reference to theory syllabus).

***Note - The practicals may be conducted by using specimens authorised by the wild such other regulating authorities though it is strongly recommended that the same sh taught by using photographs/audio-visual aids/ simulations / models, etc. as recomme the UGC and as envisaged in the regulations of the relevant monitoring bodies. specimens, however, shall be procured for the purpose of conducting practicals me here-in-above.**

#There shall be at least one excursion/field trip

SEMESTER I

Practical USZOP1 (Course II)

1. Interpretation of safety symbols (toxic, corrosive, explosive, flammable, skin irritant, oxidizing, compressed gases, aspiration hazards and Biohazardous infectious material.)
   b) Study of Central tendencies and plotting of Bar diagram, histogram and pie diagram.
2. Identification of transgenic fish (Trout and Salmon) / cloned animals (Dolly sheep, cc cat and Snuppy dog) from photograph.
3. Extraction of fruit juice with pectinase from apple/guava/or any other suitable fruit
4. Calculation of pH of three different samples (one each acidic, alkaline and neutral) using pH paper/Universal Indicator and confirming the result with pH meter.
   Application of DNA Fingerprinting in criminology (photograph of electrophoretic pattern to be given for interpretation by the students)
5. a) Study of parts of microscope and their functions.
   b) Technique of focussing a permanent slide under 10x and 45x (objectives).
6. a) Dilution of given sample and estimation of OD by using colorimeter.
   b) Calculation of concentration from the given OD using formula.
7. Calculation of pH of three different samples (one each acidic, alkaline and neutral) using pH paper/universal indicator/pH indicator from red cabbage and confirming the result with pH meter.
8. a) Seperation of amino acids from the mixture by paper chromatography.
   b) Calculation of Rf value of separated pigments/amino acids from given chromatogram and their identification from standard chart.
9. a) Seperation of pigments by adsorption chromatography using chalk.
   b) Seperation of lipids by TLC,

***Note - The practicals may be conducted by using specimens authorised by the wildlife and such other regulating authorities though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/ simulations / models, etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in-above.**

Course I (USZO101)

REFERENCES AND ADDITIONAL READING

1. Wonders of the Animal World - University Text Book of Zoology, F.Y.B.Sc. Semester I Course 1. V.V. Dalvie, G.B. Raje, P. Sardesai, N.S. Prabhu, University Press.
2. Vertebrate Zoology Volume I- Jordan and Verma , S. Chand and Co.
3. Invertebrate Zoology Volume II- Jordan andVerma , S. Chand and Co.
4. Invertebrate Zoology- T. C. Majupuria , S. Nagin and Co.
5. Chordate Zoology- P. S. Dhami and J. K. Dhami , R. Chand and Co.
6. Invertebrate Zoology- P. S. Dhami and J. K. Dhami , R. Chand and Co.
7. Introduction to Vertebrates- Moore Cambridge University- Low Priced Edition
8. Zoology- S. A. Miller and J. B. Harley, Tata McGraw Hill
9. Modern Textbook of Zoology, Invertebrates, R. L. Kotpal
10. Fundamentals of Ecology- E. P. Odum , Sunders Publication
11. Fundamentals of Ecology- M.C.Dash-2nd edition, Tata McGraw Hill
12. Essentials of Ecology and Environmental Science - S.V.S Rana
13. Biodiversity- S.V.S Rana- Prentice Hall Publications
14. Modern Biology- V. B. Rastogi
15. Biology of Mollusca- D. R. Khanna
16. A Textbook of Zoology, Vol. II- T. Jeffery Parker and William. A. Haswell- Low Price Publications
17. Ecology and Environment- P. D. Sharma, R. K. Rastogi Publications
18. Introduction to Ecology- R. Dajoz
19. Wildlife Laws and its Impact on Tribes- Mona Purohit , Deep and Deep Publications
20. Biodiversity- K.C.Agarwal- Agro Botanica Publications
21. Butterflies of India – Isaac Kehimkar- BNHS Publication

Course II (USZO102)

REFERENCES AND ADDITIONAL READINGS

1. Basic Laboratory Techniques, Instrumentation and Biotechnology- University Text Book of Zoology, F.Y.B.Sc. Semester I Course 2. V.V. Dalvie, R. G. Deshmukh, R. D'souza and H.U. Shingadia University Press.

2. Introduction to Practical Biochemistry – David T. Plummer (Tata McGraw Hill Publishing Co. Ltd.)
3. Introductory Practical Biochemistry – S.K. Sawhney and Randhir Singh (Narosa Publishing House)
4. Methods in Biostatistics – B. K. Mahajan, (Jaypee Publications)
5. Microscopy and Cell Biology - V. K. Sharma, (Tata McGraw Hill Publishing Co. Ltd.)
6. Bioinstrumentation – L. Veerakumari, (M.J.P. Publishers)
7. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker, (Cambridge University Press)
8. Biotechnology- Thieman and Pallidino, Pearson edu.
9. Biotechnology –Glick and Pasternak
10. Biochemistry –Satyanarayana
11. Understanding biotechnology- Aluizio Borem ,David Bowe-Low price edition –Pearson Publication
12. A Textbook of Biotechnology – R. C. Dubey, S. Chand Publication.
13. A Manual of Medical Laboratory Technology -A. H. Patel, Navneet Prakashan Ltd.
14. Biological instruments and methodology – Dr. P. K. Bajpai, S. Chand company Ltd.
15. Calculations in Molecular biology and Biotechnology - Frank H. Stephenson, Academic Press.

SCHEME OF EXAMINATION (THEORY)

(a) Internal assessment of twenty five (25) marks per course per semester should be conducted according to the guidelines given by University of Mumbai vide circular number UG/04 of 2014 Dated 5th June 2014 to be implemented from academic year 2014-15.

(b) External assessment of seventy five (75) marks per course per semester should be conducted as per the following skeleton question paper pattern.

(c) One practical examination of fifty (50) marks per course each should be conducted at the end of every semester.

SKELETON- EXAMINATION PATTERN FOR THE ABOVE SYLLABUS

All Questions are compulsory

Figures to the right indicate full marks

Time: 2.5 hours **Total marks: 75**

Q.1.	UNIT 1 Answer any four out of eight (5 marks each)	20 marks
Q.2.	UNIT 2 a. Answer any one of the two (10 marks) b. Answer any two out of the four (5 marks each)	20 marks
Q.3.	UNIT 3 Answer any two out of four (10 marks each)	20 marks
Q.4.	a. Unit 1 - (One note of five marks OR objective type questions) b. Unit 2 - (One note of five marks OR objective type questions) c. Unit 3- (One note of five marks OR objective type questions)	15 marks

*For Question 4 it is recommended to have objective questions such as –

(a) Match the column (b) MCQ

(c) Give one word for (d) True and False

(e) Define the term (f) Answer in one sentence etc.

MODEL QUESTION BANK SEMESTER I

USZO101(COURSE I)

Question bank is suggestive and not exhaustive. The paper setters are free to modify the questions or include new questions to the best of their wisdom

UNIT 1 - (05 Marks)

1. Write a note on echolocation in Dolphins/ Whales
2. Write a short note on : Pearl formation in Mollusca
3. Describe : Mechanism of bioluminescence
4. Enumerate the uses of bioluminescence
5. Describe the uses of bioluminescence for…… (Noctiluca, Glow worm, Firefly, Angler fish, etc.)
6. Write a short note on : Luciferin – Luciferase interaction
7. Describe the process of regeneration in Earthworm
8. What is regeneration? Explain the term with an example
9. What is mimicry? Explain with an example.
10. Describe: mimicry in butterfly
11. Describe briefly the formation of Corals
12. Write a short note on types of coral reefs.
13. Describe needs of migration in birds.
14. Describe briefly, the factors inducing migration in birds.
15. How does Camel adapt itself to the desert environment?
16. Describe parental care and breeding in ……. (Examples of Pisces, Amphibia)
17. Describe briefly: Brood parasite
18. Explain parental care in Duck-billed Platypus

UNIT 2 - (05 Marks/10 Marks)

Questions that could be asked for 10 marks:

1. Explain biodiversity and its importance. What is a biodiversity hotspot? Explain Western Ghats as biodiversity hotspot in India.
2. Explain: Direct use value / Indirect use value
3. Explain biodiversity and its types.
4. Enumerate and explain threats to biodiversity.
5. State the factors which amount to habitat loss.
6. Explain the concept of Man-Wildlife conflict with an example.
7. Give a detailed account on *in situ* hybridization and ex-situ hybridization

8. Describe National Park and state its importance in conservation
9. Describe Sanctuary and state its importance in conservation
10. Give a brief account on biosphere reserve.
11. Give a detailed account on: CBD (Convention on Biological Diversity).
12. Give an account of national biodiversity plan 2002.
13. Describe important clauses of Convention for International Trade of endangered species.

Questions that could be asked for 05 marks:

1. Explain biodiversity and mention its types.
2. Explain biodiversity and give two importance
3. Explain biodiversity hotspot
4. Describe *in situ* conservation strategies.
5. Write note on ex-situ conservation strategies.
6. Give an account of genetic / species / ecosystem biodiversity.
7. Enumerate importance threat to biodiversity.
8. State direct and indirect use value of biodiversity.

UNIT 3 - (10 Marks)

1. Give a detailed account on: ……(Name of the eminent personality) For e.g.: Gadre Fisheries, Kiran Mazumdar Shaw, Baba Amte etc.
2. Describe in detail - ……(Name of the case study)
   For e.g.: Amul white revolution, Biocon, Genetic code etc.
3. Give a detailed account on the contribution made by Dr.Salim Ali in the field of Ornithology.
4. What is white revolution? State contribution of Dr. Verghese Kurian for it.
5. Describe the work of water conservation of Anna Hazare.

MODEL QUESTION BANK SEMESTER I USZO102 (COURSE II)

Question bank is suggestive and not exhaustive. The paper setters are free to modify the questions or include new questions to the best of their wisdom

UNIT I: (5 marks)

1. Describe in brief (Minimum five points)
   a. Good laboratory practices
   b. Chemical hazards in a laboratory
   c. Physical hazards in a laboratory
   d. Biological hazards in a laboratory
   e. Personal hygiene in laboratory
   f. Waste disposal
2. Define and give conversions of the three scales of measuring temperature.
3. Define Molarity. How would you prepare
   a. 1 litre of 0.1 M NaOH solution? (Mol.wt. of NaOH=40)
   b. 100 ml of 1M NaOH
   c. 500 ml of 0.2 M NaOH
4. Define Normality. How would you prepare 1 litre of 2 N NaOH solution?
5. Explain briefly the measures of central tendencies?
6. Define mean, median and mode and explain each with an example.
7. The observations of length (in cm) of 10 fishes are 22, 24, 34, 26, 28, 31, 20, 25, 36, 32. Calculate the arithmetic mean of fish length (in cm).
8. Calculate the arithmetic mean for the following data on fish length by Direct method.

Class interval (length in cm)	5-15	15-25	25-35	35-45	45-55
Frequency (no. of fish)	9	21	40	22	8

9. Calculate the arithmetic mean for the above data on fish length by shortcut method.
10. How do you find the median of the data and state the significance of median?
11. What is mode? How do you calculate mode for ungrouped and grouped data?
12. What is random sampling? State the significance.
13. Explain simple, subdivided and multiple bar diagrams.
14. What is a pie diagram? Write the formula for calculating the angles of degrees for different components.
15. The following data shows the areas in million square miles of the oceans of the world. Construct a pie diagram for the data.

16.

Ocean	Pacific	Atlantic	Indian	Antarctic	Arctic	Total
Area (million sq. miles)	70.8	41.2	28.5	7.6	4.8	152.9

t

Plot a histogram/Bar diagram? Explain how it is constructed.

UNIT 2: (5 marks)

1. Give applications of Biotechnology in the field of Medicine / Fishery / Animal Husbandry.
2. Give the Scope of Biotechnology in different areas as a diagrammatic sketch
3. What is SCID? Name the scientist who discovered the gene therapy for it.
4. In SCID which enzyme does not work properly?
5. Which cells are used for SCID gene therapy?
6. Which gene is defective in SCID?
7. Define transgenesis and mention any two transgenic animals.
8. Ethical issues of transgenesis.
9. Enlist five applications of DNA finger printing.
10. What are green genes? State one application of it.

(10 marks)

1. Describe SCID and its treatment with suitable diagram.
2. Explain various methods of transgenesis.
3. What is Cystic fibrosis? Explain its diagnostic biotechnological method.
4. Define transgenesis and explain retro viral method with its application.

UNIT 3: (10 marks)

1. Describe the components of a compound microscope giving function.

2. Explain the principle and the applications of compound microscope.
3. Discuss in detail the principle, construction and applications of dissecting microscope.
4. Write the principle and applications of
    a. Colorimeter
    b. Centrifuge
    c. Spectroscopy
    d. Compound microscope
    e. Dissecting microscope
5. Explain the principle of centrifugation and add a note on its application.
6. What is pH? Give the principle and applications of pH meter.
7. Describe paper chromatography as a separation technique.
8. Describe Agarose gel electrophoresis. Add a note on its applications.
9. Explain the principle and applications of Polyacrylamide gel electrophoresis.
10. With the help of a diagram, explain the parts of a colorimeter. Discuss the principle and uses.
11. Describe principle and uses of colorimeter.
12. Explain the principle and application of adsorption chromatography.

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PRACTICALS

USZOP1 (Course I)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Q.1. From the given sample mount foraminiferan shells (Minimum three types) (15 Marks)

OR

Mounting of scales (placoid and cycloid/ctenoid) from fishes.

Q.2. Identify the photograph of the given animals and comment on the type of interaction /speciality. (symbiosis, camouflage, cannibalistic mate eating animals and animal architects,bioluminiscence). Any two (10 Marks)

Q.3. Identify giving reasons - Venomous/Non-venomous snake (from photographs). (5 Marks)

Q.4. Identification (one specimen each) (10 Marks)

a. Types of corals

b. Amphibians-breeding and parental care

c. Adaptive radiation in reptiles

d. Types of feathers/ claws in birds

e. Types of beaks in birds

Q.5. Field study report (Biodiversity) and viva on it. (10 Marks)

Semester I

USZOP1 (Course II)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Q. 1 Dilute the given sample and estimate the OD using colorimeter (Three dilutions) (15marks)

OR

Calculate concentration from given OD by formula (3 concentrations)

OR

Find pH of water samples (three) and comment on their chemical nature.

OR

Using red cabbage pH indicator, determine pH of the given samples and comment on their chemical nature

OR

Extract fruit juice using pectinase and compare the result with a set without using pectinase.

Q. 2. Perform experiment for separation of pigments by adsorption chromatography. (10Marks)

OR

Perform experiment for separation of mixture of amino acids by paper chromatography

OR

Calculate R_f value and identify the pigment from chromatogram.

OR

Perform Thin Layer Chromatography (TLC) for separation of lipids

Q. 3. Focus the given slide under 10 X and 45 X and show it to examiner. (5 Marks)

OR

Prepare a frequency distribution table / Plot histogram / Pie diagram / Bar diagram from the given data.

Q. 4. Identification (10 Marks)
(Safety Symbols (two), parts of compound microscope, transgenic animals, DNA fingerprinting)

Q. 5. Journal and Viva voce(on practical component) (10 Marks)

SEMESTER-II

USZO201 (Course: 3)

Ecology and Wildlife Management

Unit 1: Population ecology: (15 L)

Objective: *To facilitate the learning of population ecology, its dynamics and regulatory factors important for its sustenance.*

Desired Outcome: *This unit would allow learners to study about nature of animal population, specific factors affecting its growth and its impact on the population of other life form.*

1.1: Population dynamics

- 1.1.1: Population density
- 1.1.2: Natality
- 1.1.3: Mortality
- 1.1.4: Fecundity
- 1.1.5: Age structure
- 1.1.6: Sex ratio
- 1.1.7: Life tables
- 1.1.8: Survivorship curves
- 1.1.9: Population dispersal and distribution patterns
- 1.1.10 Niche concept

1.2: Population growth regulation

- 1.2.1: Intrinsic mechanism – Density dependent fluctuations and oscillations
- 1.2.2: Extrinsic mechanism- Density independent, environmental and climate factors, population interactions

1.3: Population growth pattern

- 1.3.1: Sigmoid
- 1.3.2: J Shaped

1.4: Human census (India) – Concept, mechanism and significance

Unit 2: Ecosystem: (15 L)

Objective: *To impart knowledge of different components of ecosystem and educate about essentials of coexistence of human beings with all other living organisms.*

Desired Outcome: *Learners will grasp the concept of interdependence and interaction of physical, chemical and biological factors in the environment and will lead to better understanding about implications of loss of fauna specifically on human being, erupting spur of desire for conservation of all flora and fauna.*

2.1: Concept of Ecosystems

2.1.1**:** Ecosystem - Definition and components
2.1.2**:** Impact of temperature on biota
2.1.3**:** Biogeochemical cycles (Water, Oxygen, Nitrogen, Sulphur)
2.1.4**:** Fresh water ecosystem – Lentic and Lotic
2.1.5**:** Food chain and food web in ecosystem (Fresh water and Grass land).
2.1.6**:** Ecological pyramids - energy, biomass and number.
2.1.7**:** Animal interactions (commensalism, mutualism, predation, antibiosis, parasitism)

Unit 3: National parks and Sanctuaries of India (15 L)

Objective: *To enlighten learners about the current status of wild life conservation in India in the light of guidelines from different relevant governing agencies vis-à-vis with adversity of poaching and biopiracy.*
Desired Outcome: *Learners would be inspired to choose career options in the field of wild life conservation, research, photography and ecotourism*.

3.1: Concept of Endangered and Critically Endangered species using examples of Indian Wildlife with respect to National Parks and Wildlife

Sanctuaries of India (Sanjay Gandhi National Park, Tadoba Tiger Reserve, Corbett National Park, Kaziranga National Park, Gir National Park, Silent Valley, Pirotan Island Marine Park, Keoladeo Ghana National Park, Bandipur Sanctuary)

3.2: Management strategies with special reference to Tiger and Rhinoceros in India

3.3: Ecotourism

3.4: Biopiracy

SEMESTER-II

Course: 4 [USZO 202]

NUTRITION, PUBLIC HEALTH AND HYGIENE

Unit 1: Nutrition and Health (15 L)

Objective: *To make learners understand the importance of balanced diet and essential nutrients of food at different stages of life.*

Desired Outcome: *Healthy dietary habits would be inculcated in the life style of learners in order to prevent risk of developing health hazards in younger generation due to faulty eating habits*.

1.1**:** Concept of balanced diet, dietary recommendations to a normal adult, infant, pregnant woman and aged.
1.2**:** Malnutrition disorders – Anemia (B_{12} and Iron deficiency), Rickets, Marasmus, Goiter, Kwashiorkar (cause, symptoms, precaution and remedy).
1.3**:** Constipation, piles, starvation, acidity, flatulence, peptic ulcers (cause, symptoms, precaution and remedy).
1.4**:** Obesity (Definition and consequences).
1.5**:** Importance of fibres in food.
1.6**:** Significance of breast feeding.
1.7**:** Swine flu and Dengue (cause, symptoms, precaution and remedy).
1.8**:** BMI calculation and its significance.

Unit 2: Public Health and Hygiene (15 L)

Objective: *To impart knowledge about source, quantum and need for conservation of fast depleting water resource and essentials of maintaining proper sanitation, hygiene and optimizing use of electronic gadgets.*

Desired Outcome: *Promoting optimum conservation of water, encouragement for maintaining adequate personal hygiene, optimum use of electronic gadgets, avoiding addiction, thus facilitating achievement of the goal of healthy young India in true sense.*

2.1: Health

2.1.1**:** Definition of Health, the need for health education and health goal.

2.1.2**:** Physical, psychological and Social health issues.

2.1.3**:** WHO and its programmes - Polio, Small pox, Malaria and Leprosy (concept, brief accounts and outcome with respect to India).

2.1.4: Ill effects of self-medication.

2.2: Water and water supply

2.2.1**:** Sources and properties of water.

2.2.2**:** Purification of water, small scale, medium scale and large scale (rapid sand filters)

2.2.3 **:** Water footprint (concept, brief accounts and significance).

2.3: Hygiene:

2.3.1**:** Hygiene and health factors at home, personal hygiene, oral hygiene and sex hygiene.

2.4: Radiation risk:

2.4.1**:** Mobile Cell tower and electronic gadgets (data of recommended level, effects and precaution).

2.5: First Aid:

2.5.1**:** Dog bite and its treatment.

2.6: Blood bank – Concept and significance

UNIT 3: Common Human Diseases and Disorders (15 L)

Objective: *To educate learners about causes, symptoms and impact of stress related disorders and infectious diseases.*

Desired Outcome: *Learners will be able to promptly recognize stress related problems at initial stages and would be able to adopt relevant solutions which would lead to psychologically strong mind set promoting positive attitude important for academics and would be able to acquire knowledge of cause, symptoms and precautions of infectious diseases*.

3.1: Stress related disorders

3.1.1**:** Hypertension, Diabetes type II, anxiety, insomnia, migraine, depression (cause, symptoms, precaution and remedy)

3.2: Communicable and non-communicable diseases

3.2.1**:** Tuberculosis and Typhoid

3.2.2**:** Hepatitis (A and B), AIDS, Gonorrhea and Syphilis

3.2.3**:** Diseases of respiratory system- Asthma, Bronchitis.

3.2.4: Oral Cancer

(Discuss cause/causative agents, symptoms, diagnostics, precaution /prevention and remedy)

SEMESTER II

Practical USZOP2 (Course III)

1. Interpretation of the given graphs/ tables and comment on pattern of population nature :
   i. Survivorship curve
   ii. Life tables
   iii. Fecundity tables
   iv. Age structure
   v. Sex ratio

2. a) Calculation of Natality, Mortality, Population density from given data
   b) Estimation of population density by capture recapture method

3. Interpretation of Growth curves (Sigmoid and J shaped)

4. Estimation of hardness from given water sample (tap water v/s well water)
5. Estimation of Free carbon dioxide (Free CO_2) from two different samples- aerated drinks(diluted) v/s tap water
6. Identification and interpretation of aquatic and terrestrial (Grassland) food chains and food webs
7. Construction of food chain/food web using given information/data.
8. a) Identification and interpretation of ecological pyramids of energy, biomass and number
   b) Construction of different types of pyramid from given data.

9. Study of the following:
   a) Endangered (Great Indian Bustard, Asiatic lion, Blackbuck, Olive Ridley sea turtle) and critically endangered species (Slender-billed vulture, Gharial, Malabar civet) of Indian wildlife and state reasons for their decline
   b) Study Biodiversity hotspots using world map (Western Ghats and Indo-Burma)
   Study of sanctuaries, national parks, biosphere reserves in India with respect to its brand fauna (as listed in theory)

***Note - The practicals may be conducted by using specimens authorised by the wildlife and such other regulating authorities though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/ simulations / models, etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in-above.**

#There shall be at least one excursion/field trip

SEMESTER II

Practical USZOP2 (Course IV)

. 1. Qualitative estimation of Vitamin C by Iodometric method.

2. Study of microscopic structure of starch granules of different cereals (wheat, maize and jowar).

3. a) Estimation of maltose from brown/white bread.
   b) Moisture content from biscuits or other suitable food products.

4. Food adulteration Test:
   a) Milk adulterants (starch and glucose), methylene blue reduction Test (MBRT).
   b) Adulterants in Cheese, Butter, Jaggery, Ghee, Honey, Iodised Salt.

5. a) Estimation of protein content of two egg varieties.
   b) Study of efficacy of different antacids (any two antacids).

6. .Study of Human Parasites

   Endoparasites - Protozoans (*Entamoeba, Plasmodium*),
   Helminths (*Ascaris, Wuchereria*),
   Ectoparasites (Head louse, tick) and Exoparasites (Bed bug, Mosquito).

7. Screening of anaemic/non-anaemic persons using $CuSO_4$ method.

8. First Aid – Demonstration Practical Training for teachers and students to be conducted by the experts from Redcorss, Civil defence, Civic authorities by individual institute or cluster colleges in rotation.

9. BMI analysis - Measurement of Height/ Weight and calculation of BMI using formula, preparation and submission of report. (10 students/ group-50 readings/group)

***Note - The practicals may be conducted by using specimens authorised by the wildlife and such other regulating authorities though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/ simulations / models, etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in-above.**

Semester II USZOP2 (Course III)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Q.1. Estimate Hardness from given water samples and compare the results. (15 Marks)

OR

Estimate Free CO_2 from given samples and compare the results.

Q.2. Solve the given problems (using statistical approach wherever possible) based on (Any two) (10Marks)

Natality
Mortality
Sex Ratio
Fecundity
Population density

Q.3. Identify brand animals (Min. 4) and place them in their respective National parks/ Sanctuaries on the given map quoting reasons for their decline. (5 Marks)

OR

Mark National parks and Sanctuaries on the map of India and mention the name of their brand animals stating reason for their decline. (Min. 4)

(5 Marks)

OR

Identify endangered and critically endangered animals (photographs) one each and state their reason of decline (5 Marks)

Q.4. Study the given information and give answers on the basis of food chain/food web and ecological pyramids. (10 Marks)

OR

Prepare food chain/food web and ecological pyramid from the given data and give its significance. (10 Marks)

OR

Identify and interpret the given graph/growth curve/age structure and comment on the pattern of population dispersal. (10 Marks)

OR

Determine Population density by capture and recapture method. (10 Marks)

Q.5. Journal and Viva voce (Based on practical component) (10 Marks)

Semester II USZOP2 (Course IV)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs **Marks: 50**

Q.1. Estimate Vitamin C from given sample. (15 Marks)

OR

Estimate Maltose content from bread.

OR

Estimate protein content from two different types of eggs.

Q.2. Analyse the given food sample and identify food adulterants (any 2 samples). (10 Marks)

OR

Evaluate milk quality by Methylene Blue Reduction Test (MBRT).

OR

Determine efficacy of different antacids (any two) on acidic solution.

Q.3. Determine moisture content from biscuits/ any other suitable food product. (5 Marks)

OR

On the basis of microscopic structure of starch granules identify different cereals (any two).

OR

Detect adulterants present in th given milk sample (any two).

OR

Determine whether given blood sample is from anaemic/non-anaemic person using $CuSO_4$ Method and suggest the appropriate diet.

Q.4. Identification (10 Marks)

a) One specimen of Protozoan Parasites.

b) One specimen of Helminth Parasites.

c) One specimen from Ectoparasite

d) One specimen from Exoparasite

e) One specimen from Endoparasite

Q.5. Submission of report of Body Mass Index (viva based on it) (10 Marks)

Note: There shall be at least one excursion/field trip.

USZO201 (Course III)

REFERENCES AND ADDITIONAL READING

1. Introduction to Ecology and Wildlife - University Text Book of Zoology, F.Y.B.Sc. Semester II Course 3. University Press.
2. Fundamentals of Ecology - Eugene P. Odum and Grey W. Barrett, Brook Cole/ Cengage learning
3. Fundamentals of Ecology - M. C. Dash , Tata McGraw Hill company Ltd, New Delhi
4. Ecology - Mohan P. Arora , Himalaya Publishing House
5. Field Biology and Ecology -- Alen H. Benton and William E. Werner ,Tata McGraw Hill ltd, New Delhi
6. Ecology and Environment - Sharma P. D , Rastogi Publication, Mumbai
7. Ecology : Principles and Applications - Chapman J.L , Cambridge University trust
8. Ecology - Subramaniam and Others, Narosa Publishing House
9. Wildlife laws and its impact on tribes - Mona Purohit, Deep and deep Publication
10. Biology - Eldra Solomon, Linda R. Berg and Diana W. Martin, Thomson/ Brooks/ Cole
11. Economic Zoology, Biostats and Animal Behaviour - Shukla, Mathur, Upadhyay, Prasad. Rastogi Publications.

USZO202 (Course IV)

REFERENCES AND ADDITIONAL READING

1. Common Diseases, Health and Hygiene - University Text Book of Zoology, F.Y.B.Sc. Semester II Course 4. University Press.
2. Common Medical Symptoms edited - P. J. Mehta National Inblisents and Distributions
3. Parks Textbook of Preventive and Social Medicine K. Park M/S Banarasidas Bhanot Jabalpar.
4. Human Physiology – Volume I – II C. C. Chatterjee, Medical Allied agency, Kolkatta.
5. Parasitology (Protozoology and Helminthoology) - K. D. Chatterjee, Chatterjee Medial Publishers.

6. Nand's handbook of Forensic Medicine and Toxicology - Apurba Nandy, NCBA publication.
7. Essentials of Public Health and Sanitation- Part I and Part II. All India Institute of Local Self Government.
8. Epidemiology and Management for Health Care for all. P.V. Sathe, A. P. Sathe, Popular Prakashan, Mumbai.
9. Textbook of Medical Parasitology- C. K. JayaramPaniker. Jaypee Brothers.
10. A Treatise on Hygiene and Public Health. -B. N. Ghosh. Calcutta Scientific Publishing Company.
11. Prevention of Food Adulteration, Act 1954. Asian Law House.
12. Clinical Dietetics and Nutrition - F. P. Antia and Philip, Oxford University Press.
13. A Complete Handbook of Nature Cure - Dr. H. K. Bakru, Jaico Publishing House.
14. Dietetics - B. Srilakshmi, New Age International (P) Ltd. Publishers.
15. Nutrition: Principles and Application in Health Promotion - J. B. Lippincott Company. Philadelphia.
16. Are You Healing Yourself Mr. Executive - Dr. R. H. Dastur. IBH Publishing Company.
17. Food Nutrition and Health- Dr. Shashi Goyal, Pooja Gupta, S. Chand Publications.
18. Public Health Nutrition. Edited - Michael J. Gidney, Barrie M. Margetts, John M. Kearney and Lenore Arab. Willey Blackwell Publication.
19. Food and Nutrition – Vol. I and II - Dr. Swaminathan , Bappco Publication.
20. Textbook of Human Nutrition - Mahtab Bamji, Prahlad Rao.
21. Total Health by Paramjit Rana.

SCHEME OF EXAMINATION THEORY

(a) Internal assessment of twenty five (25) marks per course per semester should be conducted as class test according to the guidelines given by University of Mumbai vide circular number UG/04 of 2014 Dated 5th June 2014 to be implemented from academic year 2014-15.

(b) External assessment of seventy five (75) marks per course per semester should be conducted as per the following skeleton paper pattern.

(c) One practical examination of fifty (50) marks per course each should be conducted at the end of every semester.

SKELETON- EXAMINATION PATTERN FOR THE ABOVE SYLLABUS

All Questions are compulsory

Figures to the right indicate full marks

Time: 2.5 hours **Total marks: 75**

Q.1.	UNIT 1 Answer any four out of eight (5 marks each)	20 marks
Q.2.	UNIT 2 a. Answer any one of the two (10 marks) b. Answer any two out of the four (5 marks each)	20 marks
Q.3.	UNIT 3 Answer any two out of four (10 marks each)	20 marks
Q.4.	a. Unit 1 - (One note of five marks OR objective type questions) b. Unit 2 - (One note of five marks OR objective type questions) c. Unit 3- (One note of five marks OR objective type questions)	15 marks

*For Question 4 it is recommended to have objective questions such as –

(a) Match the column (b) MCQ

(c) Give one word for (d) True and False

(e) Define the term (f) Answer in one sentence etc.

MODEL QUESTION BANK

SEMESTER II

USZO203 (COURSE III)

Question bank is suggestive and not exhaustive. The paper setters are free to modify the questions or include new questions to the best of their wisdom

UNIT 1: (10 marks)

Describe with suitable Example

1. J-Shaped and Sigmoid growth patterns
2. Population dispersal and distribution patterns
3. Natality and Mortality
4. Natality and Fecundity
5. Fecundity and Mortality
6. Density dependant fluctuation and oscillations
7. Population interactions
8. Age structure and population density
9. Concept of niche and its significance in population ecology.

Write notes on / Give a brief account of: (5 marks)

1. Population density
2. Natality
3. Mortality
4. Fecundity
5. Age structure
6. Sex ratio
7. Survivorship curve
8. Sigmoid growth pattern
9. J-shaped growth curve
10. Intrinsic mechanism
11. Extrinsic mechanism
12. Niche
13. Population dispersal and distribution pattern

UNIT 2: (5 marks)

1. Effect of temperature on metabolism

16. Impact of temperature on reproduction
17. Effect of temperature on animal behaviour
18. Define ecosystem and describe any two abiotic factors
19. Define ecosystem and describe any two biotic factors
20. Explain producers / autotrophs
21. Give a brief account of various levels of consumers in an ecosystem
22. Describe in short the inter-relationship between biotic and abiotic factors
23. Describe the following (any one of the cycles can be asked) water cycle, nitrogen cycle and oxygen cycle, sulphur cycle.
24. Explain any one of the following - lake or river
25. Explain food chain from terrestrial or aquatic ecosystem
26. What is food web and explain the same with a suitable example
27. Give a brief account of: Energy pyramid, Pyramid of biomass, Pyramid of numbers.

Unit 3: (10 marks question)

1. State the differences between National park and Wildlife Sanctuary?
2. Write an account of critically endangered species of Indian wildlife with at least two examples.
3. Explain briefly management strategy of any one tiger project in India.
4. Briefly explain management strategy of Rhinoceros project in India.
5. Write in detail about Indian Wildlife (Protection) Act 1972.
6. What is biopiracy? Explain with suitable examples.
7. Write a note on flora and fauna of Sanjay Gandhi national park.
8. Write an account of Tadoba tiger reserve project.
9. Give an account of biodiversity of Jim Corbett national park.
10. Write a note on Ranthambore Tiger reserve.
11. Write in details about Gir Lion project.
12. Write a note on Keoladeo Ghana National park.
13. Write an account of biodiversity of Silent valley.
14. Describe in detail about Bandipur sanctuary.
15. Write a note on ecotourism in India with few examples.

MODEL QUESTION BANK (COURSE IV) SEMESTERII

Question bank is suggestive and not exhaustive. The paper setters are free to modify the questions or include new questions to the best of their wisdom

Unit I (5 marks)

Explain the following:

1. Concept of balanced diet and dietary recommendations of any one of the following:
   a) Normal adult b)Infant c) Pregnant woman d) Aged
2. Cause and symptoms of the following: a) Anemia b) B_{12} deficiency c) Vitamin D deficiency d) Marasmus e) Kwashiorkar f) Goiter, g) Swine flu, h) Dengue
3. Precautions and remedy for all above mentioned health conditions.
4. Significance of breast feeding.
5. Importance of fibres in food.
6. Food adulterants and toxins with two side effects of each.
7. Causes, symptoms, precautions and treatment of a) Constipation, b) Piles, c) Insomnia, d) Starvation, e) Flatulence, f) Peptic ulcer, g) Obesity
8. BMI and its significance.

Unit II (5/10 marks)

Question of 5 marks:

1. Give a brief account and outcome of WHO Programs:
   a) Polio b) Smallpox c) Malaria d) Leprosy
2. a) Explain the concept of health goal and health knowledge.
   b) Enlist different needs of health education.
   c) State five points of social health issues.

Question of 10 marks:

1. Describe sources and properties of water in relation to human consumption.

2. Describe methods of purification of water – small scale, medium scale and large scale.
3. Explain the concept of water footprint and give its significance.
4. Describe disposal of human and animal waste – STP and ETP, its functioning and significance.
5. Give a brief of risk of radiation from mobile cell towers and electronic gadgets.
6. Explain the concepts of physical health, psychological health and myth related to it.
7. Describe the term hygiene and explain in brief health factors related to it at home.
8. Explain personal hygiene, oral hygiene and sex hygiene with significance of each.
9. Describe ill effects of self medication with respect to antibiotics and steroids.
10. Give brief account of first aid symbols.

Unit III (10 marks)

1. Explain causes, symptoms, precautions and remedy
   a) Hypertension b) Diabetes Type II c) Anxiety and Insomnia d) Migraine and depression
2. Explain causes, symptoms, precautions and remedy
   a) Tuberculosis b) Common flu c) Dengue d) Malaria e) Typhoid f) Hepatitis A g) Hepatitis B h) AIDS

UNIVERSITY OF MUMBAI
No. UG/34 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/02 of 2016-17, dated 21st April, 2016 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 Zoology at its meeting held on 9th April, 2018 have been accepted by the Academic Council at its meeting held on 5th May, 2018 **vide** item No. 4.31 and that in accordance therewith, the revised syllabus as per the (CBCS) for the S.Y.B.Sc. in Zoology (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
22nd June, 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/4.31/05/05/2018

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No. UG/ 34 -A of 2018 MUMBAI-400 032 22nd June, 2018

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Zoology,
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

AC- 05/05/2018
Item No. 4.31

UNIVERSITY OF MUMBAI

Program: S.Y.B. Sc.

Course: Zoology

Syllabus for Semester III & IV

(Choice Based Credit System with effect from the academic year 2018-2019)

S. Y. B. Sc. Syllabus Framing Committee

Sr. No.	Name	Address	Status
1	Dr. Anita Jadhav readersmailbox@rediffmail.com	Head & Associate Prof., Department of Zoology, ICL College, Vashi, Navi-Mumbai	I/C Chairperson, BoS in Zoology
2	Mr. Vinayak Dalvie dalvie@gmail.com	Head & Associate Prof., Mithibai College, Vile Parle (W), Mumbai-56	Chief Coordinator
3	Dr. Gulabrao B. Raje drgbraje@rediffmail.com	Head & Associate Prof., Department of Zoology, D. B. J College, Chiplun, Dist: Ratnagiri	Coordinator
4	Capt. Nilima S. Prabhu nilsprabhu@rediffmail.com	Assistant Prof., Department of Zoology, S.S. &L.S. Patkar College, Goregaon, Mumbai-62	Convenor USZO301& USZO401
5	Dr. Dilip K. Kakavipure dlpkakavipure@gmail.com	Associate Prof., Depsartment of Zoology, BNN College, Bhiwandi, Dist: Thane	Convenor USZO302& USZO402
6	Mr. Venkatesh Hegde drvnhegde@rediffmail.com	Assistant Prof., Department of Zoology, Mithibai College, Vile Parle (W), Mumbai-56	Convenor USZOE303A & USZOE403A (Elective 1)
7	Dr. Surekha Manoj Gupta gupta.surekha@yahoo.com	Assistant Prof., Department of Zoology, G. N. Khalsa College, Matunga, Mumbai-19	Convenor USZOE303B& USZOE403B (Elective 2)
8	Dr. Shaheda Rangoonwala shaheda.rangoonwala@gmail.com	Principal, V. N. College, Murud Janjira, Dist: Raigad	Co-Convenor USZO301 & USZO401
9	Dr. Shashibhal M. Pandey pandey.shashibhal@gmail.com	Assistant Prof., Department of Zoology, CHM College, Ulhasnagar-3	Co-Convenor USZO302 & USZO402
10	Dr, Leena Murlidharan leena.doctor@gmail.com	Associate Prof., Department of Zoology, VKK Menon College, Bhandup (E), Mumbai -42	Co-Convenor USZOE303A & USZOE403A (Elective 1)
11	Dr. Shirley Bless Agwuocha shirley_bless@rediffmail.com	Assistant Prof., Department of Zoology, Thakur College of Science & Com., Kandivali (E)	Co-Convenor USZOE303A & USZOE403A (Elective 1)
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13	Dr. Sushant Mane sushantmane@yahoo.com	Assistant Prof., Department of Zoology, Wilson College, Girgaon, Mumbai-7	Member USZO301 & USZO401
14	Dr. Meena Poonja meenaprasad123@gmail.com	Assistant Prof., Department of Zoology, CHM College, Ulhasnagar-3	Member USZO301 & USZO401
15	Mr. T. V. Bicheesh Balan bicheesh@gmail.com	Assistant Prof., Department of Zoology, Mithibai College, Vile Parle (W), Mumbai-56	Member USZO301 & USZO401

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19	S/Lt. (Dr.) Kantilal Hiridas Nagare birlasparc11@gmail.com	Assistant Prof., Department of Zoology, Birla College, Kalyan, Dist: Thane -421304	Member USZOE303A & USZOE403A (Elective 1)
20	Mr. Nikhil Disoria nikhil.disoria@gmail.com	Assistant Prof., Department of Zoology, National College, Bandra (W), Mumbai -50	Member USZOE303A & USZOE403A (Elective 1)
21	Dr. Minakshi Gurav minakshi.gurav@ruparel.edu	Assistant Prof., Department of Zoology, Ruparel College, Mahim, Mumbai -16	Member USZOE303B& USZOE403B (Elective 2)
22	Dr. Harish T. Babar harishbabar@gmail.com	Assistant Prof., Department of Zoology, D. B. J College, Chiplun, Dist: Ratnagiri- 415605	Member USZOE303B& USZOE403B (Elective 2)

CONTENT

PREFACE

Holistic development of students is the main purpose of the curriculum. While this is attempted through prescribing dynamic and updated curricular inputs, the new course that will be effective from the academic year 2018- 2019, will follow the Semester mode. The main aim of the revision of syllabus was to modify it to meet the unique requirements of students, up gradation of knowledge in the subject of zoology and to inculcate the skill of reasoning. The contents of the syllabus have been drawn-up to accommodate the widening horizons of the discipline of Biological Sciences. All possible attempts have been made to update the syllabus by incorporating current and most recent developments in various branches of Zoological Sciences, nevertheless, classical zoology also has been given due weightage. Introduction of an elective paper in zoology will also provide a glimpse of its application. Inclusion of research methodology to the undergrads is the highlight of the course. I am sure that these revised syllabi will cater to better understanding of the subject and beyond.

I appreciate and congratulate the entire team of syllabus framing for the co-operation, tireless work and wish them success.

Chairperson,
Ad-hoc Board of Studies in Zoology

PREAMBLE

As a traditional procedural norm of the University of Mumbai, it is the Board of Studies that includes various disciplines, which revive the syllabi after completion of a cycle of five years. Due to rapid advancement in technology, new ideas and concepts, and an ocean of information being generated every day that necessitates updating the students in this present era of exponential information and knowledge. However, in the former practice of syllabus revision, students were unable to imbibe new ideas and concepts as there was limited scope of including them within the syllabi that was theoretical with poor applicability

Looking at the employment generating potential and need of trained human resource in various service sectors in our state, it was became imperative to make a breakthrough from the traditional practice of revising syllabus; and instead giving an opportunity to the stakeholders to adapt and acclimatize with the changes around them and imbibe knowledge which shall enable them to develop entrepreneurship and / or employment avenues and opportunities after pursuing the coveted degree.

With this intention, the Board of Studies in Zoology took decision to put before the S. Y. B. Sc. Zoology students one elective, so that they can study topics of their interest. Board of Studies in Zoology is the only Board in the University that has offered two electives for the S. Y. B. Sc. students and safeguarded their career. Further, BoS formulated Four Syllabus Review Committees (one per course with composition of 01 Convenor and 04 Members). All the committee members worked extensively and exhaustively; and prepared draft of the syllabus. The said draft was uploaded on the website of University of Mumbai for public criticism. The invited opinions were thereby incorporated in the syllabus to make it versatile and student friendly with high applicability. Further, the draft syllabus was re-discussed in the workshop where several teachers and students contributed their views to improve it. In the academic year 2016-17, new syllabus was introduced but it is revived immediately after two years with inclusion of new concepts and techniques. Due care is taken to make the syllabus interdisciplinary, flexible and choice based. All the member teachers have tried their level best to come out with “Need Based Syllabus” that may spark motives in all the stakeholders. We hope that the stakeholders will enjoy the learning of this syllabus in the classrooms, laboratories and on the field.

Dr. G. B. Raje
Coordinator

PEDAGOGY

While disseminating the content of the present syllabus, it is imperative and expected that the facilitator is well versed or/and develops their Pedagogical Content Knowledge (PCK),which would include aspects like content, methodology, evaluation and so on. At the onset, the facilitator may include various topic-specific instructional strategies, employing the use of organizers (topic announcement in advance, making models, flip charts, photography, etc). Learning of topics on chromosomes, nucleic acids, cell biology, biomolecules, physiological processes are hence revised, and during the presentations by the learner, the facilitator is able to gauge the preconceptions and learning disabilities. Any misunderstanding of basic concepts can thus be clarified such as 'difference between gene and allele'. Peer teaching is another aspect of pedagogy which takes into account participative learning thus enhancing the learning of the content and making it enjoyable, for example, the use of 'Punnet squares' for working out the crosses in various illustrations on monohybrid and dihybrid ratios, problems based on inheritance, pedigree analysis, molecular biology etc. A declarative learning strategy, which employs the use of familiar contexts and analogies, illustrative diagrams, questioning techniques, discussions, may be used for topics like multiple alleles, polygenic inheritance, DNA testing for paternity issues, scientific attitude, methodology, scientific writing etc. This would enhance the relevance of these topics and engender motivation, thereby balancing the blend of content and pedagogy in teaching. The syllabus includes practical investigations, individual or group student experiments, simulations to assist learners in visualizing and /or internalizing the concepts and processes. The learner could be encouraged to organize field trips, nature trails and treks in and around the ecosystems like lakes, beaches, sanctuaries, national-parks etc. for learning topics like ethology and conservation, amazing animals, applied zoology, pollution and other such, where sensitization, awareness and action are to be invoked within the learner. Visits to museums, and an interdisciplinary approach with various departments like geology, history, geography, chemistry, psychology, medicine would bring about a multi and cross approach to learning concepts such as paleontological evidences, nucleic acids, physiological processes, biomolecules, holistic health and neurological and genetic diseases . ICT enabled learning is the need of the hour and could include screening of documentaries, videos, animations, PPT's, and the use of social media such as Whatsaap, Instagram, Facebook be employed for impactful and continued learning. Facilitators can upload the teaching material, videos of lectures, links to websites for not only enhancing but also focusing and developing the topics of interest by the learner by way of self-study. More importantly, the syllabus endeavours to develop life skills by discovering and

honing entrepreneurial skills of the learner. To accomplish this purpose, visits to apiary, vermicomposting units, and dairy could be encouraged, also interviews with various entrepreneurs, officials of funding agencies must be undertaken to comprehend the nuances of business. Also small projects on various entrepreneurial aspects like setting up vermicomposting bins and aquaria, sale of the vermicompost or setting up an ornamental fish farms, innovations in dairy products and its sale could be encouraged in the campuses. The elective papers are so construed that the learner is driven to gain knowledge, experience through activity-based assignments, and projects, which would enhance entrepreneurial skills, a logical understanding and analysis of business functions.

Capt. Nilima Prabhu
Dr. Dilip Kakavipure
Mr. Venkatesh Hegde
Dr. Surekha Gupta
Convenors

Syllabus for S. Y. B. Sc. Course: ZOOLOGY
Credit Based Semester and Grading System
(To be implemented from the Academic Year 2018-2019)

SEMESTER – III

COURSE CODE	UNIT	TOPIC	CREDITS	LECTURES /WEEK
USZO301	I	Fundamentals of Genetics	2	1
	II	Chromosomes and Heredity		1
	III	Nucleic Acids		1
USZO302	I	Nutrition and Excretion	2	1
	II	Respiration and Circulation		1
	III	Control and Coordination of Life Processes, Locomotion and Reproduction		1
USZOE303A ELECTIVE 1	I	Ethology	2	1
	II	Parasitology		1
	III	Economic Zoology		1
USZOE303B ELECTIVE 2	1	Maintenance of Aquarium	2	1
	II	Agricultural, Household Pests and their Control		1
	III	Amazing Animals		1
USZOP3		Practicals based on all three courses	03	**9**

<u>Important Note:</u> College may choose either Elective 1 or Elective 2 for Semester III and Semester IV as their third course depending on the preference selected by majority of the students and endorsed by Head of the Department of Zoology and the Principal of the college.

SEMESTER IV

COURSE CODE	UNIT	TOPIC	CREDITS	LECTURES /WEEK
USZO401	I	Origin and Evolution of Life	2	1
	II	Population Genetics and Evolution,		1
	III	Scientific Attitude, Methodology, Scientific Writing and Ethics in Scientific Research		1
USZO402	I	Cell Biology	2	1
	II	Endomembrane System		1
	III	Biomolecules		1
USZOE403A ELECTIVE 1	I	Comparative Embryology	2	1
	II	Aspects of Human Reproduction		1
	III	Pollution and its Effect on Organisms		1
USZOE403B ELECTIVE 2	I	Dairy Industry	2	1
	II	Sericulture		1
	III	Aquaculture		1
USZOP4		Practicals based on all three courses	03	9

<u>Important Note:</u> College may choose either Elective 1 or Elective 2 for Semester III and Semester IV as their third course depending on the preference selected by majority of the students and endorsed by Head of the Department of Zoology and the Principal of the college.

UNIT WISE DISTRIBUTION OF SYLLABUS

Semester III				Semester IV			
Course 5	**Course 6**	**(Elective 1) Course 7A**	**(Elective 2) Course 7B**	**Course 8**	**Course 9**	**(Elective 1) Course 10A**	**(Elective 2) Course 10B**
Unit 1 Fundamentals of Genetics	**Unit 1** Nutrition & Excretion	**Unit 1** Ethology	**Unit 1** Maintenance of Aquarium	**Unit 1** Origin & Evolution of Life	**Unit 1** Cell Biology	**Unit 1** Comparative Embryology	**Unit 1** Dairy Industry
Unit 2 Chromosomes & Heredity	**Unit 2** Respiration & Circulation	**Unit 2** Parasitology	**Unit 2** Agricultural & Household Pests& their Control	**Unit 2** Population Genetics & Evolution	**Unit 2** Endomembrane System	**Unit 2** Aspects of Human Reproduction	**Unit 2** Sericulture
Unit 3 Nucleic Acids	**Unit 3** Control and Coordination of Life Processes, Locomotion & Reproduction	**Unit 3** Economic Zoology	**Unit 3** Amazing Animals	**Unit 3** Scientific Attitude, Methodology, Scientific Writing & Ethics in Scientific Research	**Unit 3** Biomolecules	**Unit 3** Pollution & its Effects on Organisms	**Unit 3** Aquaculture
Practical (USZO P3)	**Practical (USZO P3)**	**Practical (USZO P3)**	**Practical (USZO P3)**	**Practical (USZO P4)**	**Practical (USZO P4)**	**Practical (USZO P4)**	**Practical (USZO P4)**

SEMESTER III

Sr. No.	USZO301 (Course-V)	No. of lectures allotted	Learning pleasure
	Fundamentals of Genetics, Chromosomes and Heredity, Nucleic acids		
	Unit 1: Fundamentals of Genetics	**15L**	**25hrs**
	Objectives: ➢ *To introduce basic terms of genetics.* ➢ *To develop conceptual clarity of Mendelian principles of inheritance and other forms and pattern of inheritance*		
	Desired outcome: ➢ *Learner would comprehend and apply the principles of inheritance to study heredity.* ➢ *Learner will understand the concept of multiple alleles, linkage and crossing over.*		
1.1	**Introduction to Genetics** • Definition, Scope and Importance of Genetics. • Classical and Modern concept of Gene (Cistron, Muton, Recon). • Brief explanation of the following terms: Allele, Wild type and Mutant alleles, Locus, Dominant and Recessive traits, Homozygous and Heterozygous, Genotype and Phenotype, Genome.	**02L**	**02hrs**
1.2	**Mendelian Genetics** • Mendelian Genetics: Monohybrid & Dihybrid Cross, Test Cross, Back Cross, Mendel's Laws of Inheritance, Mendelian Traits in Man. • Exceptions to Mendelian inheritance: Incomplete dominance, Co-dominance, Lethal Genes, Epistasis - Recessive, Double recessive, Dominant and Double dominant. • Chromosome theory of inheritance. • Pedigree Analysis-Autosomal dominant and recessive, X- linked dominant, and recessive.	**08L**	**12hrs**

1.3	**Multiple Alleles and Multiple Genes** • Concept of Multiple Alleles, Coat colour in rabbit, ABO and Rh blood group system • Polygenic inheritance with reference to skin colour and eye colour in humans. • Concept of Pleiotropy.	**03L**	**06hrs**
1.4	**Linkage and Crossing Over** • Linkage and crossing over, Types of crossing over, Cytological basis of crossing over.	**02L**	**05hrs**
	Unit: 2: Chromosomes and Heredity	**15L**	**26hrs**
	Objectives: ➢ *To familiarize the learners with the structure, types and classification of chromosomes.* ➢ *To introduce the concept of sex determination and its types, sex influenced and sex-limited genes.*		
	Desired outcome: ➢ *Learner will comprehend the structure of chromosomes and its types.* ➢ *Learner will understand the mechanisms of sex determination.* ➢ *Learner would be able to correlate the disorders linked to a particular sex chromosome.*		
2.1	**Chromosomes** • Types of Chromosomes–Autosomes and Sex chromosomes • Chromosome structure - Heterochromatin, Euchromatin • Classification based on the position of centromere • Endomitosis, Giant chromosomes- Polytene and Lampbrush chromosomes and Significance of Balbiani rings	**04L**	**08hrs**

2.2	**Sex- determination** • Chromosomal Mechanisms: XX-XO, XX-XY, ZZ-ZW • Sex determination in Honey bees: Haplo-diploidy • Sex determination in *Drosophila*- Genic balance theory, Intersex, Gynandromorphs • Parthenogenesis • Hormonal influence on sex determination- Freemartin and Sex reversal. • Role of environmental factors- *Bonelia* and Crocodile • Barr bodies and Lyon hypothesis	**07L**	**10hrs**
2.3	**Sex linked, sex influenced and sex-limited inheritance.** • X-linked: Colour-blindness, Haemophilia • Y-linked: Hypertrichosis • Sex-influenced genes • Sex-limited genes	**04L**	**08hrs**
	Unit: 3 Nucleic acids	**15L**	**30hrs**
	Objectives: ➢ *To introduce the learner to the classical experiments proving DNA as the genetic material.* ➢ *To introduce the learner the structure of nucleic acids and the concept of central dogma of molecular biology.* ➢ *To familiarize the learner with the concept of gene expression and regulation.*		
	Desired outcome: ➢ *Learner will understand the importance of nucleic acids as genetic material.* ➢ *Learner would comprehend and appreciate the regulation of gene expressions.*		
3.1	**Genetic material** • Griffith's transformation experiment, Avery-Macleod &McCarty	**07L**	**14hrs**

	experiment and Hershey Chase experiment of Bacteriophage infection • Chemical composition and structure of nucleic acids • Double helix nature of DNA, Solenoid model of DNA • Types of DNA – A, B, Z & H forms • DNA in Prokaryotes - Chromosomal and Plasmid • Extra nuclear DNA - Mitochondria and Chloroplast • RNA as a genetic material in virus • Types of RNA: Structure and function		
3.2	**Flow of genetic information in a eukaryotic cell** • DNA Replication • Transcription of mRNA • Translation • Genetic code	**05L**	**08hrs**
3.3	**Gene expression and regulation** • One gene-one enzyme hypothesis /one polypeptide hypothesis • Concept of Operon • Lac Operon	**03L**	**08hrs**

	SEMESTER – III		
Sr. No	**USZO302 (COURSE-VI)**	**No. of lect allotted**	**Learning pleasure**
	Nutrition and Excretion, Respiration and Circulation, Control and Coordination of Life Processes, Locomotion and Reproduction		
	Unit: 1 Nutrition and Excretion	**15L**	**23hrs**
	Objectives: ➢ *To introduce the concepts of physiology of nutrition, excretion and osmoregulation.* ➢ *To expose the learner to various nutritional apparatus, excretory and osmoregulatory structures in different classes of organisms.*		
	Desired outcome: ➢ *Learner would understand the increasing complexity of nutritional, excretory and osmoregulatory physiology in evolutionary hierarchy.* ➢ *Learner would be able to correlate the habit and habitat with nutritional, excretory and osmoregulatory structures.*		
1.1	Comparative study of nutritional apparatus (structure and function): Amoeba, Hydra, Cockroach, Amphioxus, Pigeon, Ruminants.	**05L**	**06hrs**
1.2	Physiology of digestion in man.	**02L**	**04hrs**
1.3	Comparative study of excretory and osmoregulatory structures and functions. a) Amoeba -Contractile vacuole b) Planaria -Flame cells c) Cockroach- Malpighian tubules	**05L**	**08hrs**
1.4	Categorization of animals based on principle nitrogenous excretory products	**01L**	**01hrs**
1.5	Structure of kidney, uriniferous tubule and physiology of urine formation in man	**02L**	**04 hr**

	Unit: 2 Respiration and Circulation	**15L**	**27hrs**
	Objectives: ➢ *To introduce the concepts of physiology of respiration and circulation* ➢ *To expose the learner to various respiratory and circulatory organs in different classes of organisms.*		
	Desired outcome: ➢ *Learner would understand the increasing complexity of respiratory and circulatory physiology in evolutionary hierarchy.* ➢ *Learner will be able to correlate the habit and habitat of animals with respiratory and circulatory organs.*		
2.1	Comparative study of respiratory organs (structure and function): Earthworm, Spider, Any bony fish (Rohu */ Anabas /Clarius),* Frog and Pigeon.	**03L**	**06hrs**
2.2	Structure of lungs and physiology of respiration in man	**02L**	**03hrs**
2.3	Comparative study of circulation: (a) Open and Closed type, (b) Single and Double type.	**02L**	**04hrs**
2.4	Types of circulating fluids- Water, Coelomic fluid, Haemolymph, Lymph and Composition of blood	**02L**	**03hrs**
2.5	Comparative study of hearts (structure and function): Earthworm, Cockroach, Shark, Frog, Crocodile and Pigeon.	**04L**	**07hrs**
2.6	Structure and mechanism of working of heart in man.	**02**	**04hrs**
	Unit: 3 Control and Coordination, Locomotion and Reproduction	**15L**	**25hrs**
	Objectives: ➢ *To introduce the concepts of physiology of control and coordination, locomotion and reproduction.* ➢ *To expose the learner to various locomotory and reproductive structures in different classes of organisms.*		
	Desired outcome: ➢ *Learner would understand the process of control and coordination by nervous and endocrine regulation.*		

	➢ *Learner would be amazed by various locomotory structures found in the animal kingdom.* ➢ *Learner would be acquainted with various reproductive strategies present in animals.*		
3.1	**Control and co-ordination** • Irritability in *Paramoecium*, nerve net in *Hydra*, nerve ring and nerve cord in earthworm. • Types of neurons based on the structure and function. • Conduction of nerve impulse: Resting potential, Action potential and Refractory period • Synaptic transmission	**05L**	**08hrs**
3.2	**Movement and Locomotion** Locomotory organs- structure and functions; a. Pseudopodia in Amoeba (Sol- Gel theory), Cilia in *Paramoecium* b. Wings and legs in cockroach c. Tube feet in starfish d. Fins of fish	**04L**	**08hrs**
3.3	Structure of striated muscle fibre in human and sliding filament theory	**02L**	**02hrs**
3.4	**Reproduction** **a. Asexual Reproduction**- Fission, Fragmentation, Gemmule formation and Budding **b. Sexual reproduction** i. Gametogenesis ii. Structure of male and female gametes in human iii. Types of fertilization iv. Oviparity, Viviparity, Ovo-viviparity	**04L**	**07hrs**

	SEMESTER III		
	USZOE1303 (COURSE-VIIA) ELECTIVE 1		
	Ethology, Parasitology, Economic Zoology	**15L**	**26hrs**
	Unit: 1 Ethology		
	Objectives: ➢ *To equip learner with a sound knowledge of how animals interact with one another and their environment.* ➢ *To enable the learner to understand different behavioural patterns.*		
	Desired Outcome: ➢ *Learner would gain insight into different types of animal behaviour and their role in biological adaptations.* ➢ *Learner would be sensitized to the feelings which are instrumental in social behaviour.*		
1.1	**Introduction to Ethology:** • Definition, History and Scope of Ethology • Animal behaviour : Innate and Learned behaviour • Types of learning: Habituation, Imprinting and Types of imprinting - Filial and sexual, Classical conditioning • Instrumental learning and insight learning.	**04L**	**06hrs**
1.2	**Aspects of animal behaviour:** • Communication in bees and ants • Mimicry and colourations • Displacement activities, Ritualization • Migration in fish, schooling behaviour • Habitat selection, territorial behaviour.	**07L**	**12hrs**
1.3	**Social behaviour:** • Social behaviour in primates-Hanuman langur • Elements of socio-biology: Altruism and Kinship	**04L**	**08hrs**

	Unit: 2 Parasitology	15L	27hrs
	Objectives: ➢ *To acquaint the learner with the concepts of parasitism and its relationship in the environment.* ➢ *To introduce the learner to modes of transmission of parasites.*		
	Desired Outcome: ➢ *Learner would understand the general epidemiological aspects of parasites that affect humans and take simple preventive measures for the same.* ➢ *Learner would comprehend the life cycle of specific parasites, the symptoms of the disease and its treatment.*		
2.1	**Introduction to Parasitology and Types of Parasites** • Definitions: Parasitism, Host, Parasite, Vector-biological and mechanical • Types of parasite- Ectoparasite, Endoparasite and their subtypes • Parasitic adaptations in Ectoparasites and Endoparasites • Types of host: Intermediate and definitive, reservoir	**03L**	**06hrs**
2.2	**Host-parasite relationship and host specificity** • Different types of host- parasite relationship, structural specificity, physiological specificity and ecological specificity	**02L**	**06hrs**
2.3	**Life cycle, pathogenicity, control measures and treatment** • *Entamoeba histolytica, Fasciola hepatica, Taenia solium, Wuchereria bancrofti*	**04L**	**06hrs**
2.4	**Morphology, life cycle, pathogenicity, control measures and treatment** • Head louse (*Pediculus humanus capittis*), Mite (*Sarcoptes scabei)*, Bed bug (*Cimex lectularis)*	**02L**	**06hrs**
2.5	**Parasitological significance** • Zoonosis- Bird flu, Anthrax, Rabies and Toxoplasmosis	**04L**	**03hrs**

	Unit 3 Economic Zoology	**15L**	**24hrs**
	Objectives: ➢ *To disseminate information on economic aspects of animals like apiculture, vermiculture and dairy science.* ➢ *To encourage young learner for self-employment.*		
	Desired Outcome: ➢ *Learner would gain knowledge on animals useful to mankind and the means to make the most of it.* ➢ *Learner would learn the modern techniques in animal husbandry.* ➢ *Learner would pursue entrepreneurship as a career.*		
3.1	**APICULTURE**	**06L**	**08hrs**
3.1.1	**Methods of bee keeping and management** • Introduction to different species of honey bees used in apiculture. • Selection of flora and bees for apiculture. • Advantages and disadvantages of traditional and modern methods of apiculture. • Pests and Bee enemies- Wax moth, wasp, black ants, bee-eaters, king crow and disease control		
3.1.2	**Economic importance** • Honey- Production, chemical composition and economic importance • Bee wax- Composition and economic importance. • Role of honey bee in pollination.		
3.2	**VERMICULTURE**	**04L**	**08hrs**
3.2.1	**Rearing methods, management and economic importance** • Introduction to different species of earthworms used in vermiculture. • Methods of vermiculture. • Maintenance and harvesting		

	• Economic importance: Advantages of vermiculture, demand for earthworms; market for vermicompost and scope for entrepreneurship.		
3.3	**DAIRY SCIENCE**	**05L**	**08hrs**
3.3.1	**Dairy development in India** • Role of dairy development in rural economy, employment opportunities		
3.3.2	**Dairy Processing** • Filtration, cooling, chilling, clarification, pasteurization, freezing		
3.3.3	**Milk and milk products** • Composition of milk • Types of milk: a) Buffalo milk b) Cow milk (A1 &A2) • Whole milk and toned milk • Milk products		

	SEMESTER III		
	USZOE2303 (COURSE-VIIB) – ELECTIVE 2		
	Maintenance of Aquarium, Agricultural and Household pests and their control , Amazing animals	**15L**	**26hrs**
	Objectives: ➢ *To develop skills for maintenance of aquarium and budgeting for setting up an aquarium and ornamental fish farm.* ➢ *To study the biology of ornamental fishes, its food and feeding and their transportation.*		
	Desired Outcome: ➢ *Learner will develop skills for maintenance of aquarium and become familiar with the budgeting aspects for setting up an ornamental fish farm.* ➢ *Learner will derive knowledge about the biology of ornamental fishes, its food and feeding habits and their transportation.*		
	Unit.1 Maintenance of Aquarium		
1.1	Introduction and scope.	**02L**	**04hrs**
1.2	Exotic and Endemic species.	**02L**	**06hrs**
1.3	Biology of aquarium fishes: • Guppy • Molly • Gold fish	**02L**	**08hrs**
1.4	Common characters and sexual dimorphism of marine fishes: • Anemone fish • Butterfly fish	**02L**	**06hrs**

1.5	Food and feeding: • Live fish feed • Formulated fish feed	**02L**	**04hrs**
1.6	Fish transportation: i) Handling ii) Packing iii)Transport	**03L**	**05hrs**
1.7	General maintenance of aquarium and budget for setting up an ornamental fish farm.	**02L**	**04hrs**
	Unit: 2 Agricultural pests and their control	**15L**	**27hrs**
	Objectives: ➢ *To study different types of pests.* ➢ *To comprehend various aspects of agricultural and household pests and their economic implications.* ➢ *To learn about the different pest control measures and plant protection appliances.*		
	Desired Outcome: ➢ *Learner will gain information on the different types of pests and comprehend various aspects of agricultural and household pests and its economic implications.* ➢ *Learner will derive knowledge of pest control measures and appliances used for plant protection against pests.*		
2.1	Introduction and concept of pest	**02L**	**06hrs**
2.1.1	Types of pests: • Agricultural: Locust • Household: Bed bug • Stored grains: Flour beetle • Structural: Termites • Veterinary: Tick • Forestry: Grasshopper	**03L**	**06hrs**

2.2	Major insect pests of agricultural importance (Life cycle, nature of damage and control measures). a) Jowar stem borer b) Brinjal fruit borer c) Aphids d) Rice weevil e) Pink bollworm	**03L**	**06hrs**
2.3	Other pests: Rats, bandicoots, crabs, snails, slugs, birds and squirrels	**02L**	**06hrs**
2.4	Pest control measures: i) Cultural control ii) Physical control iii) Mechanical control iv) Chemical control v) Biological control, vi) Concept of IPM	**03L**	**03hrs**
2.5	Plant protection appliances: Rotary duster, knapsack sprayer and cynogas pump, hazards of pesticides and antidotes.	**02L**	**03hrs**
	Unit 3 Amazing animals	**15L**	**24hrs**
	Objectives: ➢ *To comprehend the concept of life timeline, and the natural history of some amazing animals.* ➢ *To kindle interest and yearning to study amazing animals.*		
	Desired Outcome: ➢ *Learner would understand the concept of life time-line.* ➢ *Learner will gain knowledge of and develop various skills while studying amazing animals.*		
3.1	Natural History a) Introduction and life timeline b) Butterflies the flying jewels- Blue Mormon, Striped tiger c) Herpetofauna of India- Flying frog, Fan Throated	**04L**	**08hrs**

	lizard and Gharial d) Feathered Bipeds: Kingfisher, Drongo e) Mammals of India: Malabar giant squirrel		
3.2	The world's most amazing animals (emphasis should be given only on amazing aspects) a) Octopus b) Spider c) Mudskipper d) Flying fish e) Pebble toad f) Strawberry poison frog g) Komodo dragon h) Lesser flamingo i) Great white pelican j) Spatule-tailed hummingbird k) Cheetah	**05L**	**10hrs**
3.3	Five most incredible animals discovered within the last decade a) The Purple (joker) crab, b) The African dwarf saw-shark (stabbing shark), c) The Psychedelic (crime fighting) gecko, d) The Matilda viper e) The Myanmar snub-nosed monkey	**03L**	**5hrs**
3.4	Marvels of Animals a) Mantis shrimp: Fastest punch b) Homing in Pacific salmon c) Sperm whale: Mechanism of deep sea diving.	**03L**	**08hrs**

	PRACTICAL SEMESTER III
	Practical USZOP3 (Course - V)
1	Extraction and detection of DNA
2	Extraction and detection of RNA
3	Mounting of Barr bodies
4	Study of polytene chromosome
5	Study of mitosis- temporary squash preparation of Onion root tip
6	Detection of blood groups and Rh factor
7	Problems in Genetics a) Monohybrid/ Dihybrid Cross: b) X- linked inheritance: c) Multiple Alleles
8	Chromosome morphology: (photograph to be provided)
9	Pedigree analysis
10	Problems based on molecular biology

	SEMESTER III
	Practical USZOP3 (Course - VI)
1	Urine analysis—Normal and Abnormal constituents
2	Detection of ammonia excreted by fish from aquarium water
3	Detection of uric acid from excreta of birds
4	Study of striated and non-striated muscle fibre
5	Study of nutritional apparatus (Amoeba, Hydra, Earthworm, Pigeon, Ruminant stomach)
6	Study of respiratory structures: a. Gills of bony fish and cartilaginous fish b. Lungs of frog c. Lungs of mammal d. Accessory respiratory structure in *Anabas* / *Clarius* e. Air sacs of Pigeon
7	Study of locomotory organs (Amoeba, Bivalve, Cockroach, Starfish, Fish, and Bird).
8	Study of different types of hearts (Cockroach, Shark, Frog, Garden lizard, Crocodile and Mammal).
9	Study of permanent slides on Reproduction: (a) Sponge gemmules, (b) Hydra budding, (c) T.S. of mammalian testis, (d) T.S. of mammalian ovary.

	SEMESTER III
	Practical USZOE1P3 (Course - VIIA) Elective I
1	Extraction of casein from milk and its qualitative estimation
2	Preparation of paneer from given milk sample
3	Measurement of density of milk using different samples by Lactometer
4	Study of Honey Bee: a) Life Cycle of Honey Bee and Bee Hive b) Mouthparts of Honey Bee c) Legs of Honey Bee d) Sting Apparatus of Honey Bee
5	Study of ethological aspects: a) Warning colouration b) Animal instinct c) Imprinting d) Communication in animals: Chemical signals and Sound signals e) Displacement activities in animals: Courtship and mating behaviour in animals and Ritualization
6	Study of Protozoan parasites: a. *Trypanosoma gambiense* b. *Giardia intestinalis*
7	Study of Helminth parasites: a. *Ancylostoma duodenale* b. *Dracunculus medinensis*
8	Parasitic adaptations: Scolex and mature proglottid of Tapeworm
9	Study of Ectoparasites: a) Leech b)Tick c)Mite
10	Project- Suggested topics on economic zoology (e.g. Apiculture/ Sericulture/ Lac culture / Vermicompost technique / Construction of artificial beehives /Animal husbandry/ Aquaculture / any other)

	SEMESTER III
	Practical USZOE2P3 (Course - VIIB) Elective 2
1	Maintenance of Aquarium– Equipments required for setting up of aquarium – types of filter, type of gravel, aerator pump, lighting, nets, different species of aquatic plants and ornamental fishes.
2	Types of pest – Agricultural-aphids, Household-cockroaches, housefly, Structural-termites, Stored grains- borer, Veterinary- fleas, Forestry- caterpillar.
3	Other pests- a) Invertebrates -nematodes, leech, snails, slugs. b) Vertebrates-rats, birds
4	Types of pest control –a) Physical b) Biological c) Electronic d) Insecticides, Rodenticides and Special Treatments
5	Hybrid animals- a) Liger b) Wholphin c) Zebroid d) Savannah cat
6	Most incredible animals in last decades – a) Joker crab b) Snub nose monkey c) Matilda viper
7	Endangered animals of India – a) Amboli bush frog b) Indian egg- eating snake (Wester mann's snake) c) Spoon- billed sandpiper d) Snow leopard
8	A project on aquarium setting in laboratory / vermicomposting.
9	A field visit to study the natural flora and fauna; and submission of report with photographs.

***Note-** The practicals may be conducted by using preserved specimens/permanent slides authorized by the wild life and such other regulating bodies though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/simulations/ models etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for conducting practicals mentioned here in above.

N.B:

I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).

II) Apart from the Institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority/Body from time to time, every college should constitute the following Committees:

1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA)
2) A Dissection Monitoring Committee (DMC) to ensure that no dissections or mountings are done, using animals

Composition of DMC shall be as follows:

i) Head of the Concerned Department (Convener/Chairperson)
ii) Two Senior Faculty Members of the concerned Department
iii) One Faculty of related department from the same College
iv) One or two members of related department from neighboring colleges.

USE OF ANIMALS FOR ANY EXPERIMENT/DISSECTION/MOUNTING IS BANNED. SIMULATIONS, AUTHORISED PERMANENT SPECIMENS/SLIDES, CHARTS, MODELS AND OTHER INNOVATIVE METHODS ARE ENCOURAGED.

Semester –III

REFERENCE BOOKS AND ADDITIONAL READING

USZO301 (COURSE-V)

1. Principles of Genetics. Gardner, E. J., Simmons, M.J and Snustad, D.P. John Wiley and Sons
2. Concepts of Genetics. Klug, W. S., Cummings M. R., Spencer, C.A. Benjamin Cummings
3. Genetics- A Molecular Approach. Russell, P. J Benjamin Cummings
4. Genetics: Analysis of Genes and Genomes. Daniel L., Hartl, Elizabeth W. Jones Jones & Bartlett Publishers
5. Introduction to Genetic Analysis. Griffiths, A. J. F., Wessler. S.R., Lewontin, R.C. and Carroll, S. B. W. H. Freeman and Co
6. Cell Biology Genetics, Molecular Biology Evolution and Ecology Verma P. S. and Agrawal P.K., 9thedition, S. Chand Publication, New Delhi
7. Principles of Genetics – Eight edition- Eldon john Gardner, Michael J. Simmons, D. Peter Snustad
8. Genetics- Weaver, Hedrick, third edition, McGraw Hill Education
9. Genetics A Mendelian approach Peter J. Russel, Pearson Benjamin Cummings
10. Genetics A conceptual approach, Benjamin A. Pierce, Southwestern University, W.H. Freeman and company, New York
11. Genetics, Third Edition, Monroe W. Strickberger
12. Genetics from gene to genome, third edition, Leeland H. Hartwell, Leeroy Hood, Michael 7. L. Goldberg, Ann E. Reynolds, Lee M. Silver, McGraw Hill Education

USZO302 (COURSE-VI)

1. Vertebrate Zoology Volume I- Jordan and Verm , S. Chand and Co.
2. Invertebrate Zoology Volume II- Jordan and Verma , S. Chand and Co.
3. Invertebrate Zoology- Majupuria T. C., NaginS.and Co.
4. Chordate Zoology- Dhami P. S. and Dhami J. K., R. Chand and Co.
5. Invertebrate Zoology- Dhami P. S. and Dhami J. K., R. Chand and Co.
6. Introduction to Vertebrates- Moore Cambridge University- Low Priced Edition.
7. Zoology- Miller S. A. and Harley J. B., Tata McGraw Hill.
8. Modern Textbook of Zoology, Invertebrates, Kotpal R. L

9. Biological Science, Taylor D.J., Stout G.W., Green N.P.O, Soper R., Cambridge University Press.

USZOE1303 (COURSE-VIIA)

1. Animal Behaviour- David McFarland
2. Animal Behaviour- Mohan Arora
3. Animal Behaviour- Reena Mathur
4. An introduction to Animal Behaviour- Dawkins
5. Animal Behaviour-Agarwal
6. Animal Behaviour- Tinbergen
7. Biology of Insects- 1992 Saxena S. C. Oxford and IBH Publishing Co New Delhi. Bombay. Calcutta
8. Bee and Bee Keeping- Roger A. Morse, Cornell University Press London
9. Vermiculture Technology - Clive A. Edwards, Norman Q. Arancon and Rhonda Sherman
10. Parasitology- Chatterjee K. D., Chatterjee Medical Publishers.
11. Medical Parasitology- Arora
12. Textbook of Medical Parasitology-.C.K Jayaram Paniker, Jaypee Brothers.
13. A text book of Parasitology- Kochhar S. K. Dominant Pub. & Dis, New Delhi.
14. Essentials of Parasitology- Gerald D. Schmidt: Universal Bookstall, New Delhi.
15. Introduction to Parasitology- Sharma P. N. and Ratnu L.S., Chand S & Co. Pvt. Ltd.
16. Introduction to Parasitology- Chandler and Read John Wiley & Sons
17. Economic Zoology Biostatistics and Animal behaviour – S. Mathur, Rastogi Publicatons.
18. Economic Zoology- Shukla G.S. & Upadhyay V. B., Rastogi Publications.
19. A handbook on Economic Zoology, S. Chand & Co.

USZOE2303 (COURSE-VIIB)

1. A General textbook of entomology -- A D Imms. Asia Publication.
2. Agricultural insect pests and their control. V.B. Awasthi. Scientific Publication.
3. A manual of practical entomology. – M. M. Trigunayat. Scientific Publication.
4. Applied Entomology – Alaka Prakash and Fennemore. New Age Publishers.
5. Applied Entomology – Awasthi. Scientific Publication.
6. A Text book of insect morphology, physiology and endocrinology – Tembhare D. B.– Chand Publication
7. Entomology and Pest Management –Larry P. Pedigo. Pearson Education.

8. Forensic Entomology-The utility of Arthropods in legal investigations. –Jason H. Byrd and James L. Castner. CRC Press.
9. General and applied Entomology – David and Ananthakrishnan. Tata McGraw Hill
10. Insect endocrinology and physiology – Tembhare D B – S Chand publication.
11. Insect Jewelry by Roger D. Akre., Laurel D. Hansen, and Richards S. Zack: in Summer (1991). (Online available as research article).
12. Insect Year Book of Agriculture- American Agriculture Department Publication.
13. Economic Zoology- Shukla G.S. & Upadhyay V. B., Rastogi Publications.
14. A handbook on Economic Zoology, S. Chand & Co.
15. Candler, W., & Kumar, N. (1998). India: The dairy revolution: The impact of dairy development in India and the World Bank's contribution. World Bank Publications.
16. Milk and dairy products in human nutrition: production, composition and health. John Wiley & Sons, Park, Y. W., & Haenlein, G. F. (Eds.). (2013).
17. Dairy development in India: An appraisal of challenges and achievements. Concept Publishing Company, Venkatasubramanian, V., Singh, A. K., & Rao, S. V. N. (2003).
18. Dairy Development in The New Millennium (The Second White Revolution). Deep and Deep Publications, Shrivastava, J. S. M. (2008).
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21. dailynewsdig.com/top-10-amazing-animal-hybrids.
22. https://www.pinterest.com/pin/16044142395584735/
23. www.naturalhistorymag.com/
24. https://naturalhistory.si.edu/.

SEMESTER IV

Sr. No	USZO401 (COURSE-VIII)	No. of lect allotted	Learning pleasure
	Origin and Evolution of Life, Population Genetics and Evolution, Scientific Attitude, Methodology, Scientific Writing and Ethics in Scientific Research		
	Unit 1: Origin and Evolution of Life	**15L**	**30hrs**
	Objective: ➢ *To impart scientific knowledge about how life originated on our planet*		
	Desired outcomes: ➢ *Learner will gain insights into the origin of life.* ➢ *Learner will analyse and critically view the different theories of evolution.*		
1.1	**Introduction** • Origin of the Universe • Chemical evolution - Miller-Urey experiment, Haldane and Oparin theory • Origin of life • Origin of eukaryotic cell	**05L**	**10hrs**
1.2	**Evidences in favour of organic evolution** • Evidences from geographical distribution, palaeontology, anatomy, embryology, physiology and genetics	**04L**	**08hrs**
1.3	**Theories of organic evolution** • Theory of Lamarck • Theory of Darwin and Neo- Darwinism • Mutation Theory • Modern synthetic theory • Weismann's Germplasm theory	**06L**	**12hrs**

	Unit: 2: Population Genetics and Evolution	15L	28hrs
	Objective: ➢ *To develop an understanding of genetic variability within a population and learn as to how the change in the gene pool leads to evolution of species*		
	Desired outcomes: ➢ *Learner would understand the forces that cause evolutionary changes in natural populations* ➢ *Learner would comprehend the mechanisms of speciation* ➢ *Learner will be able to distinguish between microevolution, macroevolution and megaevolution*		
2.1	**Introduction to Population genetics** • Definition • Brief explanation of the following terms: Population, Gene pool, Allele frequency, Genotype frequency, Phenotype frequency, Microevolution	**01L**	**03hrs**
2.2	**Population genetics** • Hardy- Weinberg Law • Factors that disrupt Hardy Weinberg equilibrium: Mutation, Migration (gene flow), Non-random mating (inbreeding, inbreeding depression, assortative mating(positive and negative), disassortative mating, Genetic drift (sampling error, fixation, bottleneck effect and founder effect) • Natural Selection: Patterns of Natural Selection-Stabilizing selection, Directional selection (examples: peppered moth, antibiotic resistance in bacteria, pesticide resistance) and Disruptive selection	**05L**	**08hrs**
2.3	**Evolutionary genetics** • Genetic variation: Genetic basis of variation-mutations and recombination (crossing over during meiosis, independent assortment of chromosomes during meiosis and random union of gametes during fertilization) • Nature of genetic variations: Genetic polymorphism, Balanced polymorphism, Mechanisms that preserve balanced polymorphism-	**07L**	**13hrs**

	Heterozygote advantage and frequency dependent selection, • Neutral variations • Geographic variation (Cline) • Species concept: Biological species concept and evolutionary species concept • Speciation and Isolating mechanisms**:** Definition and modes of speciation (allopatric, sympatric, parapatric and peripatric) • Geographical isolation • Reproductive isolation and its isolating mechanisms (prezygotic and postzygotic)		
2.4	Macroevolution and megaevolution: Concept and Patterns of macroevolution (stasis, preadaptation /exaptation, mass extinctions, adaptive radiation and coevolution), Megaevolution	**02L**	**04hrs**
	Unit: 3 Scientific Attitude Methodology, Scientific Writing and Ethics in Scientific Research	**15L**	**32hrs**
	Objective: ➢ *To inculcate scientific temperament in the learner*		
	Desired outcome: ➢ *The learner would develop qualities such as critical thinking and analysis* ➢ *The learner will imbibe the skills of scientific communication and he/she will understand the ethical aspects of research*		
3.1	**Process of science:** • A dynamic approach to investigation: The Scientific method, Deductive reasoning and inductive reasoning, Critical thinking, Role of chance in scientific discovery (serendipity) • Scientific research: Definition, difference between method and methodology, characteristics, types • Steps in the Scientific method: Identification of research problem, formulation of research hypothesis, testing the hypothesis using experiments or surveys, preparing research/study design including	**04L**	**10hrs**

	methodology and execution (appropriate controls, sample size, technically sound, free from bias, repeat experiments for consistency), documentation of data, data analysis and interpretation, results and conclusions • Dissemination of data: Reporting results to scientific community (publication in peer- reviewed journals, thesis, dissertation, reports, oral presentation, poster presentation) • Application of knowledge: Basic research, Applied research and Translational research		
3.2	**Scientific writing:** • Structure and components of a research paper: preparation of manuscript for publication of research paper- title, authors and their affiliations, abstract, keywords and abbreviations, introduction, material and methods, results, discussion, conclusions, acknowledgement, bibliography; figures, tables and their legends	**04L**	**10hrs**
3.3	**Writing a review paper** • Structure and components of review • Report writing and types of report • Computer application: Plotting of graphs, Statistical analysis of data. Internet and its application in research-Literature survey, online submission of manuscript for publication	**03L**	**05hrs**
3.4	**Ethics** • Ethics in animal research: The ethical and sensitive care and use of animals in research, teaching and testing, approval from Dissection Monitoring Committee (DMC) • Ethics in clinical research: Approval from clinical research ethics committee or/and informed consent	**03L**	**05hrs**
3.5	**Plagiarism**	**01L**	**02hrs**

	SEMESTER IV		
Sr. No.	**USZO402 (Course - IX)**	**No. of lectures allotted**	**Learning pleasure**
	Unit 1: Cell Biology	**15L**	**24hrs**
	Objective: ➢ *To study the structural and functional organization of cell with an emphasis on nucleus, plasma membrane and cytoskeleton.*		
	Desired outcome: ➢ *Learner would acquire insight into the composition of the transport mechanisms adopted by the cell and its organelles for its maintenance and composition of cell*		
1.1	**Introduction to cell biology** • Definition and scope • Cell theory • Generalized prokaryotic, eukaryotic cell: size, shape and structure	**02L**	**04hrs**
1.2	**Nucleus** • Size, shape, number and position • Structure and functions of interphase nucleus • Ultrastructure of nuclear membrane and pore complex • Nucleolus: general organization, chemical composition & functions • Nuclear sap/ nuclear matrix • Nucleocytoplasmic interactions	**05L**	**06hrs**
1.3	**Plasma membrane** • Fluid Mosaic Model • Junctional complexes • Membrane receptors • Modifications: Microvilli and Desmosomes	**04L**	**08hrs**
1.4	**Transport across membrane** • Diffusion and Osmosis • Transport: Passive and Active • Endocytosis and Exocytosis	**02L**	**04hrs**
1.5	**Cytoskeletal structures** • Microtubules: Composition and functions • Microfilaments: Composition and functions		

	Unit: 2: Endomembrane System	**15L**	**28hrs**
	Objective: ➢ *To acquaint the learner with ultrastructure of cell organelles and their functions*		
	Desired outcome: ➢ *Learner would appreciate the intricacy of endomembrane system.* ➢ *Learner would understand the interlinking of endomembrane system for functioning of cell*		
2.1	**Endoplasmic reticulum (ER):** General morphology of endomembrane system, ultrastructure, types of ER and biogenesis of ER • Functions of Rough Endoplasmic Reticulum (RER) and Smooth Endoplasmic Reticulum (SER)	**01L**	**03hrs**
2.2	**Golgi complex:** Ultrastructure of Golgi complex, functions of Golgi complex (protein glycosylation, lipid and polysaccharide metabolism, protein sorting and secretion, Golgi Anti-Apoptotic Protein -GAAP)	**06L**	**10hrs**
2.3	**Lysosomes:** Origin, occurrence, polymorphism and functions; Peroxisomes: Origin, morphology & functions	**03L**	**5hrs**
2.4	**Mitochondria:** Ultrastructure, chemical composition, functions of mitochondria and bioenergetics (Chemical energy & ATP, Kreb's cycle, respiratory chain and oxidative phosphorylation)	**05L**	**10hrs**
	Unit: 3 Biomolecules	**15L**	**30hrs**
	Objective: ➢ *To give learner insight into the structure of biomolecules and their role in sustenance of life.*		
	Desired outcome: ➢ *The learner will realize the importance of biomolecules and their clinical significance.*		
3.1	**Biomolecules**: Concept of micromolecules and macromolecules	**02L**	**05hrs**

3.2	**Carbohydrates:** • Definition classification, properties and isomerism, glycosidic bond • Structure of Monosaccharides (glucose and fructose); Oligosaccharides (lactose and sucrose); Polysaccharides (cellulose, starch, glycogen and chitin) • Biological role and clinical significance	**04L**	**08hrs**
3.3	**Amino Acids and Proteins:** • Basic structure, classification of amino acids, • Essential and Non-essential amino acids, Peptide bond, • Protein conformation: Primary, Secondary, Tertiary, Quaternary • Types of proteins – Structural (collagen) and functional proteins (haemoglobin) • Biological role and clinical significance	**05L**	**08hrs**
3.4	**Lipids:** • Definition, classification of lipids with examples, ester linkage • Physical and chemical properties of lipids • Saturated and unsaturated fatty acids • Essential fatty acids; Triacylglycerols; Phospholipids (lecithin and cephalin); Steroids (cholesterol) • Biological role and clinical significance	**04L**	**05hrs**
3.5	**Vitamins**: • Water soluble vitamins (e.g. Vit C, Vit B_{12}) • Lipid soluble vitamins (e.g. Vit A, Vit D) • Biological role and clinical significance	**02L**	**04hrs**

	SEMESTER IV		
	USZOE1403 (Course-XA) Elective 1		
	Comparative Embryology, Aspects of Human Reproduction, Pollution and its effect on organisms		
	UNIT 1: Comparative Embryology	**15L**	**25hrs**
	Objective: ➢ *To acquaint the learner with key concepts of embryology.*		
	Desired Outcome: ➢ *Learner will be able to understand and compare the different types of eggs and sperms* ➢ *Learner will be able to understand and compare the different pre- embryonic stages*		
1.1	Types of Eggs- Based on amount and distribution of yolk	03L	4hrs
1.2	Structure and Types of Sperm	02L	4hr
1.3	Types of Cleavages	02L	4hrs
1.4	Types of Blastulae	02L	4hrs
1.5	Types of Gastrulae	02L	4hrs
1.6	Coelom -Formation and types	04L	6hrs
	UNIT 2: Aspects of Human Reproduction	**15L**	**30 hrs**
	Objectives: ➢ *To acquaint the learners with different aspects of human reproduction.* ➢ *To make them aware of the causes of infertility, techniques to overcome infertility and the concept of birth control*		
	Desired Outcome: ➢ *Learners will able to understand human reproductive physiology* ➢ *Learners will become familiar with advances in ART and related ethical issues.*		
2.1	**Human reproductive system and hormonal regulation** • Anatomy of human male and female reproductive system	02L	4hrs

	• Hormonal regulation of reproduction and impact of age on reproduction - menopause and andropause		
2.2	**Contraception & birth control** • Difference between contraception and birth control • Natural Methods: Abstinence, rhythm method, temperature method, cervical mucus or Billings method, coitus interruptus, lactation amenorrhea • Artificial methods **:** Barrier methods, hormonal methods, intrauterine contraceptives, sterilization, termination, abortion	02L	4hrs
2.3	**Infertility** **Female infertility:** • **Causes -** Failure to ovulate; production of infertile eggs; damage to oviducts (oviduct scarring and Pelvic inflammatory disease -PID, TB of oviduct), Uterus (TB of uterus and cervix) • **Infertility associated disorders -** Endometriosis, Polycystic Ovarian Syndrome (PCOS), Primary ovarian failure (POF),Sexually Transmitted Infections (STIs) - gonorrhoea, chlamydia, syphilis and genital herpes; Antibodies to sperm; Genetic causes- recurrent abortions • **Role of endocrine disruptors**	04L	8hrs
2.5	**Treatment of infertility** • Removal /reduction of causative environmental factors • Surgical treatment • Hormonal treatment- fertility drugs • Assisted Reproductive Technology (ART) - *In vitro* fertilization (IVF); Embryo transfer (ET); Intra-Fallopian transfer (IFT), Gamete Intra-Fallopian Transfer (GIFT) &Intra-Zygote Transfer (ZIFT); Intra-cytoplasmic Sperm Injection (ICSI) with ejaculated sperm and sperm retrieved from testicular biopsies; Testicular sperm extraction (TESE).	04L	8hrs

	• Sperm bank, cryopreservation of gametes and embryos • Surrogacy		
	UNIT3: Pollution and its effect on organisms	**15L**	**27hrs**
	***Objective*:** ➢ *To provide a panoramic view of impact of human activities leading to pollution and its implications.*		
	Desired Outcome: ➢ *The learners will be sensitized about the adverse effects of pollution and measures to control it.*		
3.1	**Air Pollution** • Types and sources of air pollutant • Effects of air pollution on organisms, its control and abatement measures	03L	6hrs
3.2	**Water Pollution** • Types and sources of water pollutant • Effects of water pollution on organisms, its control and abatement measures	03L	6hrs
3.3	**Soil Pollution** • Types and sources of soil pollutant • Effects of soil pollution on organisms, its control and abatement measures	03L	4hrs
3.4	**Sound pollution** • Different sources of sound pollution • Effects of sound pollution on organisms, its control and abatement measures	01L	3hrs
3.5	**Pollution by radioactive substances**	01L	2hrs
3.6	**Pollution by solid wastes** • Types and sources, • Effects of solid waste pollution, its control and abatement measures	02L	4hrs
3.7	**Pollution –** Climate Change and Global Warming	02L	2hrs

	USZOE2403 (Course-XB) Elective 2		
	Dairy Industry, Sericulture and Aquaculture		
	UNIT 1: Dairy Industry	**15L**	**30hrs**
	Objectives: ➢ *To comprehend the functioning of various aspects of dairy industry.* ➢ *To study different indigenous and exotic cattle breeds including buffalo breeds of India.* ➢ *To develop an understanding of the different systems of breeding and various aspects dealing with housing of dairy animals.*		
	Desired Outcome: ➢ *Learner would gain knowledge on the functioning of various aspects of dairy industry, indigenous, exotic cattle and buffalo breeds in India.* ➢ *Learner will study different systems of breeding and gain information regarding various aspects pertaining to housing of dairy animals.*		
1.1	Indian Cattle breeds – Origin, distribution, distinguishing characters and economic uses: • Malvi • Hariyana • Deoni • Red sindhi • Khillari	02L	4hrs
1.2	Exotic breeds - Origin, distribution, distinguishing characters and economic uses: • Jersy • Holstein	02L	4hr
1.3	Indian buffalo breeds - Origin, distribution, distinguishing	02L	4hrs

	characters and economic uses: • Nagpuri • Bhadawari • Murrah • Jafrabadi		
1.4	Systems of inbreeding and crossbreeding	03L	6hrs
1.5	Maintenance of dairy farm	02L	4hrs
1.6	Weaning of calf, castration and dehorning	02L	4hrs
1.7	Diseases and control	02L	4hrs
	UNIT 2: Sericulture	**15L**	**30 hrs**
	Objectives: ➢ *To comprehend the functioning of sericulture industry and its scope in India.* ➢ *To study the varieties of silk-worms and host plants.* ➢ *To critically study the life history and rearing of Bombyx mori, harvesting, processing of cocoon, production of silk and diseases afflicting silk-worms.*		
	Desired Outcome: ➢ *Learner would understand the basics of the functioning of sericulture industry and its scope in India.* ➢ *Learner shall gain knowledge on the varieties of silk-worms, host-plants and aspects on silk extraction and the diseases afflicting silk-worms.*		
2.1	Introduction and scope of sericulture	02L	4hrs
2.2	Varieties of silk worm, host plants	02L	4hrs
2.3	Life history and rearing of *Bombyx mori*	02L	8hrs
2.4	Harvesting and processing of cocoon	02L	4hrs

2.5	Reeling and extraction of silk	03L	4hrs
2.6	Diseases and control measures	03L	4hrs
	UNIT3: Aquaculture	**15L**	**27hrs**
	Objectives: ➢ *To comprehend various kinds of aquaculture practices and its scope as fishery resource in India.* ➢ *To study various techniques employed in aquaculture practices*		
	Desired Outcome: ➢ *Learner shall understand the aquaculture practices and the scope of fishery in India.* ➢ *Learner would gain knowledge of various techniques employed in aquaculture practices.*		
3.1	**Pisciculture:** • Definition and scope of fishery resources in India • Finfish culture – monoculture and polyculture • Role of exotic fishes in polyculture • Cage culture • Fish seed transport • Fish diseases -- symptoms and control	05L	6hrs
3.2	**Prawn/shrimp culture:** Sources, seed, culture methods – • Giant fresh water prawn (*Macrobrachium rosenbergii*) • White shrimp (*Penaeus vannamei*)	05L	6hrs
3.3	**Pearl culture:** • Pearl producing species and their distribution • Pearl culture methods • Composition of pearl	05L	4hrs

	SEMESTER IV
	Practical USZOP4 (Course - VIII)
1	Study of population density by Line transect method & Quadrant method and calculate different diversity indices. • Index of Dominance • Index of frequency • Rarity Index • Shannon Index • Index of species diversity
2	Study of prokaryotic cells (bacteria) by Crystal violet staining technique
3	Study of eukaryotic cells (WBCs) from blood smear by Leishman's stain
4	Identification and study of fossils: • Arthropods: Trilobite • Mollusca: Ammonite • Aves: Archaeopteryx
5	Identification of : • Allopatric speciation (Cyprinodont species) • Sympatric speciation (Hawthorn fly and Apple maggot fly) • Parapatric speciation (Snail)
6	Bibliography/ Abstract writing
7	Preparation of Power Point Presentation based on research paper.

	SEMESTER IV
	Practical USZOP4 (Course - IX)
1	Study of permeability of cell through plasma membrane (osmosis in blood cells)
2	Measurement of cell diameter by occulometer (by using permanent slide)
3	Qualitative tests for carbohydrates (Molisch's test, Benedicts test, Barfoed's test, Anthrone test)
4	Qualitative tests for protein (Ninhydrin test, Biuret test, Millon's test, Xanthoproteic test)
5	Qualitative test for lipids (Solubility test, Sudan III test)
6	Study of rancidity of lipids by titrimetric method
7	Ultrastructure of cell organelles (Electron micrographs) of: • Nucleus • Endoplasmic reticulum (Smooth and Rough) • Mitochondria. • Golgi apparatus • Lysosomes
8.	Study of clinical disorders due to carbohydrates, proteins and lipid imbalance (Photograph to be provided / symptoms to be given and disorder to be identified): • Hyperglycemia • Hypoglycemia • Anemia • Kwashiorkar • Marasmus • Fatty Liver

	SEMESTER IV
	Practical USZOE1P4 (Course - XA)
1	Study of air microflora.
2	Estimation of dissolved oxygen from the given water sample.
3	Estimation of salinity by refractometer from the given water sample.
4	Estimation of conductivity by conductometer from the given water sample.
5	Study of physical properties of soil: temperature, moisture and texture
6	Study of chemical properties of soil- pH, organic matter
7	Study of sound pollution monitoring device
8	Detection of pregnancy from given sample of urine
9	Study of birth control measures applicable to humans – IUD, condom and hormonal pills.
10	Study of the following permanent slides, museum specimens and materials • Mammalian sperm and ovum • Types of Egg– fish, frog and hen • Cleavage, blastula and gastrula (Amphioxus, Frog and Bird)
11	Review writing based on programmes telecast by Doordarshan, Gyandarshan, UGC programmes or other media sources
12	Study of natural ecosystem and field report of the visit

	SEMESTER IV
	Practical USZOE2P4 (Course - XB) – Elective 2
1	Estimation and comparison of protein content in Cow and Buffalo milk sample
2	Estimation and comparison of fat content in Cow and Buffalo milk sample
3	Preparation of falooda
4	Preparation of caramel custard
5	Restraining devices used in cattle farming- Halters, gags, bull-rings, muzzles, cradle, crush and ropes.
6	Study of life cycle of *Bombyx mori*
7	Study of commercially important fishery. (Catla, Rohu, Catfish, Mackeral, Pomfret, Bombay duck, Prawn/Shrimp, Crab, Lobster, Edible oyster)
8	Study of Crustacean fishery – common characters and sexual dimorphism in lobster (*Panulirus spp.*), prawn (*Penaeus spp.*), crab (*Scylla spp.*)
9	Visit to dairy farm /aquaculture/ fish landing centre/fishery institute and submit report of the same

For Additional and Latest Information on the topics, various Web Sites can be visited.

Note: The practicals may be conducted by using specimens authorised by the wildlife and such other regulating authorities though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/ simulations / models, etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for conducting practicals mentioned here in above.

 # There shall be at least one excursion / field trip.

N. B:

I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).

II) Apart from the Institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority/Body from time to time, every college should constitute the following Committees:

1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and
2) A Dissection Monitoring Committee (DMC)

Composition of DMC shall be as follows:

i) Head of the Concerned Department (Convener/Chairperson)
ii) Two Senior Faculty Members of the concerned Department
iii) One Faculty of related department from the same College

One or two members of related department from neighboring colleges

USE OF ANIMALS FOR ANY EXPERIMENT/DISSECTION/MOUNTING IS BANNED. SIMULATIONS, AUTHORISED PERMANENT SPECIMENS/SLIDES, CHARTS, MODELS AND OTHER INNOVATIVE METHODS ARE ENCOURAGED.

Semester IV
References and additional reading

USZO401 (COURSE-VIII)

1. Theory of Evolution- Smith, Cambridge Press, and Low price Ed
2. Evolution - Strickberger, CBS publication
3. Evolution- P. S. Verma and Agarwal
4. Introduction to Evolution by Moody
5. Biology. E. P. Solomon, L. R. Berg, D. W. Martin, Thompson Brooks/Cole
6. Biology -The Unity and Diversity of Life**.** C. Starr, R. Taggart, C. Evers, L. Starr, Brooks/Cole Cengage learning International Edition
7. Research Methodology, Methods and Techniques- by C.R. Kothari, Wiley Eastern Ltd. Mumbai
8. Practical research planning and design 2nd edition- Paul D Leedy, Macmilan Publication

USZO402 (COURSE - IX)

1. Cell Biology, Singh and Tomar, Rastogi Publication.
2. Cell and Molecular Biology, E.D.P De Robertis and E.M.R Robertis, CBS Publishers and Distributors.
3. The cell, A molecular approach, Goeffrey M. Coper ASM Press Washington D.C.
4. A textbook of cytologym Suruchi Tyagi Dominant Publishers and Distributors New Delhi.
5. Cell and molecular biology, Gupta P. K., Rastogi Publication, India.
6. Cell Biology, Pawar C.B. Himalaya publication
7. Molecular Biology of the cell, (6th ed) by the Insertus
8. Principles of Biochemistry, 2005, 2nd and 3rd edn. Lehninger A.L. Nelson D.L. and Cox M.M ,
9. Biochemistry, Dushyant Kumar Shrma, 2010, Narosa Publishing house PVT.Ltd.
10. Fundamentals of Biochemistry, Dr AC Deb, 1983, New Central Book Agency Ltd.
11. A Textbook of Biochemistry, 9th edition, Dr. Rama Rao A.V.S.S and Dr A Suryalakshmi.
12. Biochemistry- G Zubay, Addison Wesley, 1983
13. Biochemistry, L Stryer, 3rd/4th/5th ed, 1989, Freeman and Co. NY
14. Harper's Biochemistry,1996, 26th edition, Murray R.K. Granner D.K. Mayes P.A. Rodwell V.M. Hall international USA
15. Outline of Biochemistry, 1976, E.E. Conn and P.K. Stumpf. John Wiley and Sons USA

USZOE1403 (COURSE-XA)

References of Elective 1

1. Developmental Biology- 5th Edition, Scot F. Gilbert, Sinauer Associates Inc.
2. Developmental Biology- Subramoniam T., Narosa Publishers.
3. Developmental Biology-BerrilN.J., Tata McGraw –Hill Publication.
4. Essential Reproduction-Martin H. Johnson, Wiley-Blackwell Publication.
5. Chick Embryology- Bradley M. Pattern.
6. Embryology-Mohan P. Arora.
7. Chordate Embryology-Dalela,Verma and Tyagi
8. Human Anatomy and Physiology. E. L. Marieb, Pearson Education Low Price Edition
9. Biological Science. Taylor, Green and Stout. Cambridge Publication
10. Biology. E. P. Solomon, L. R. Berg, D. W. Martin, Thompson Brooks/Cole
11. Human Biology-Daniel D. Chiras Jones and Bartlett
12. The Physiology of Reproduction Vol I & II - E. K . Nobil and JU. D. Neil, Raven Press, New York.
13. Air Pollution, Kudesia V. P. Pragati Prakasan, Meerut
14. Fundamentals of Air Pollution Daniel A. Vallero, Academic press 5th Edition
15. Principles and Practices of Air Pollution Control and Analysis J. R. MudakaniI K International Pub. House Pvt. Ltd.
16. Text Book of Air Pollution and its Control, S. C. Bhatia Atlantic
17. Water Pollution, Kudesia V. P., Pragati Prakasan, Meerut
18. A text book of Environmental Chemistry and Pollution Control, S. S. Dogra, Swastic Pub, New Delhi
19. Practical Methods for water and Air Pollution Monitoring, S. K. Bhargava, New Age International
20. Hand Book of Water and waste water Analysis, Kanwaljit Kaur, Atlantic
21. Aquatic Pollution by Edward A. Laws
22. Environmental Science and Technology, Stanely E. Manahan
23. Environmental Chemistry, A. K. De, New Age International
24. A Text Book of Environmental Studies, Gurdeep R.Chatwal, Harish Sharma, Madhu Arora,

USZOE2403 (COURSE-XB)

References of Elective 2

1. Principles of Dairy Chemistry R. Jenness, S. Patton John Wiley and Sons Inc.
2. Fundamentals of dairy chemistry B.H. Webb, A.H. Johnson, J.A. Alford Avi Pub. Co.
3. Food Chemistry Owen R. Fennema CRC Press
4. Food Chemistry John M. De Man Springer
5. Technology of Dairy Products Early, Ralph. Academic & Professional, 1998
6. Quality of milk production and processing technology D.K. Thompkinson and lathasabikhi New India Publishing agency, New delhi
7. Outlines of Dairy Technology Sukumar De Oxford University Press, New delhi
8. Food Microbiology William C. Frazier, dennis C. Westoff Tata Mcgrew Hill publishing Company Ltd. New Delhi
9. Applied Dairy Microbiology Elmer H. Marth, James L. Steele CRC Press
10. Dairy plant engineering and management Tufail Ahmed Kitab Mahal
11. Latest Aquaculture, Principles and Practices by Pillay T.V.R. – Fishing New Books (1988).
12. Course Manual in Fishing Technology by Latha Shenoy, CIFE, Versova, Mumbai.
13. Prawn and Prawn Fisheries by Kurian and Sebestian

MARKING SCHEME OF EXAMINATION (THEORY)

(a) External assessment of one hundred (100) marks per course per semester should be conducted as per the following skeleton question paper pattern.

(c) One practical examination of fifty (50) marks per course each should be conducted at the end of every semester.

SKELETON- EXAMINATION PATTERN FOR THE ABOVE SYLLABUS

All Questions are compulsory

Figures to the right indicate full marks

Draw neat and labeled diagrams wherever necessary

Time: 3 hours **Total Marks: 100**

Q1	Objective questions*	20 marks
Q.2.	UNIT 1 a. Answer any one of the two (10 marks) b. Answer any two out of the four (5 marks each)	20 marks
Q.3.	UNIT 2 a. Answer any one of the two (10 marks) b. Answer any two out of the four (5 marks each)	20 marks
Q.4.	UNIT 3 a. Answer any one of the two (10 marks) b. Answer any two out of the four (5 marks each)	20 marks
Q.5.	Answer any four out of six Unit 1 - (Two notes of five marks each) Unit 2 - (Two notes of five marks each) Unit 3- (Two notes of five marks each)	20 marks

***Note:** For Question No. 01 it is recommended to have objective questions on all units, such as –

(a) Match the column (b) MCQ

(c) Give one word for (d) True and False

(e) Define the term (f) Answer in one sentence

PRACTICAL (SEMESTER III)

USZOP3 (Course - V)

Skeleton-Practical Examination Question Paper Pattern

Time: 2hrs 30 min **Marks: 50**

Major Question **15**

Q1. Extraction and detection of DNA

OR

Q1. Extraction and detection of RNA

Minor Question **07**

Q2. Mounting of Barr bodies / Polytene chromosomes

OR

Q2. Study of mitosis-Temporary squash preparation of Onion root tip

OR

Q2. Detection of blood groups and Rh factor

Q3. Problems based on Genetics and Molecular biology
(Transcription /Genetic code) (01 problem each) **10**

Q4. Identification **08**

A. Chromosome morphology

B. Pedigree analysis

Q5. Viva **05**

Q6. Journal **05**

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PRACTICAL (SEMESTER III)

USZOP3 (Course - VI)

Skeleton-Practical Examination Question Paper Pattern

Time: 2hrs 30 min **Marks: 50**

Major Question 15

Q1. Urine analysis—Normal and abnormal constituents

Minor Question 10

Q2. Detection of ammonia excreted by fish in aquarium water

OR

Q2. Detection of uric acid from excreta of Birds

OR

Q2. Mounting of striated and non-striated muscle fibre

Q3. Identification 15

a. Nutritional apparatus

b. Respiratory structures

c. Locomotory organs

d. Study of hearts

e. Permanent slides on reproduction

Q4. Viva 05

Q5. Journal 05

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PRACTICAL (SEMESTER III)

USZOE1P3 (Course - VIIA) – Elective 1

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min **Marks: 50**

Major Question 12

Q1. Extraction of casein from milk and its qualitative detection

OR

Q1. Preparation of paneer from the given milk sample.

OR

Q1. Measurement of density of different samples of milk by lactometer

Minor Question (Sketch and label) 08

Q2. Life cycle of honey bee

OR

Q2. Mouthparts of honey bee

OR

Q2. Legs of honey bee

OR

Q2. Sting apparatus of honey bee

Q3. Identify and describe as per instructions 15

a. Ethology
b. Protozoan parasite
c. Helminth parasite
d. Ectoparasite
e. Parasitic adaptation

Q4. a) Project submission 06

b) Viva based on project 04

Q5. Journal 05

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PRACTICAL (SEMESTER III)

USZOE2P3 (Course - VIIB) – Elective 2

Skeleton-Practical Examination Question Paper Pattern

Time: 2 hrs 30min **Marks: 50**

Major Question 15

Q1. Identification (5 Marks each)

a) Aquarium equipment.

b) Type of pest (Any insect)

c) Other pest

Q.2. Identification (3 Marks each) 15

a) & b) Types of pest control

c) Hybrid animal

d) Incredible animal

e) Endangered animal

Q.3. Submission of photographs of any five amazing animals with description. 05

Q4. a) Project submission 06

b) Viva based on project 04

Q5. Journal 05

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PRACTICAL (SEMESTER IV)

USZOP4 (Course - VIII)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min **Marks: 50**

Major Question

Q1. Study Population density by Line transect or Quadrant method and calculate Biodiversity Indices. (Any 2) **12**

Minor Question **08**

Q2. Prepare a smear to show prokaryotic cell.

OR

Q2. Prepare a smear to show eukaryotic cell.

Q3. Identify and describe as per instructions. **08**

a) Fossil b) Speciation

Q4. From the given article, prepare the bibliography/ abstract. **06**

Q5. Submission of power point presentation. **06**

Q6. Viva. **05**

Q.7. Journal. **05**

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PRACTICAL (SEMESTER IV)

USZOP4 (Course - IX)

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min **Marks: 50**

Major Question 15

Q1. Study of osmosis in R.B.Cs.

OR

Q1. Measurement of cell diameter by occulometer using permanent slide.

Minor Question 10

Q2. Qualitative tests for carbohydrates (Molisch's test, Benedicts test, Fehling's test, Anthrone test)

OR

Q2. Qualitative tests for protein (Ninhydrin test, Biuret test, Millon's test, Xanthoprotein test)

OR

Q2. Qualitative test for lipid (Solubility test, Sudan III test)

OR

Q2. Estimation of rancidity of lipids by titrimetric method

Q3. Identify and describe as per instructions 15

- Ultrastructure of cell organelles (a, b & c)
- Clinical disorders (d & e)

Q4. Viva 05

Q5. Journal 05

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PRACTICAL(SEMESTER IV)

USZOE1P4 (Course - XA) – Elective 1

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min **Marks: 50**

Major Question 12

Q1. Estimation of Dissolved Oxygen from the given water sample.

OR

Q1. Detection of pregnancy from given sample of urine.

OR

Q1. Determination of organic matter from the given soil sample.

Minor Question 08

Q2. Estimation of salinity by refractometer from the given water sample

OR

Q2. Estimation of conductivity by conductometer from the given water sample

OR

Q2. Determination the pH of the given soil sample

OR

Q2. Determine the texture of the given soil sample

Q3. Identify and describe as per instructions 15

- Permanent slides (a &b)
- Birth control measure (c)
- Fishery (d & e)

Q4. a) Field report submission 06

b)Viva based on field report 04

Q5. Journal 05

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PRACTICAL (SEMESTER IV)

USZOE2P4 (Course - XB) Elective 2

Skeleton -Practical Examination Question Paper Pattern

Time: 2 hrs 30 min **Marks: 50**

Major Question 15

Q1.Comparison of protein content from cow and buffalo milk

OR

Q.1 Comparison of fat content from cow and buffalo milk

Minor Question 08

Q.2 Preparation of falooda

OR

Q.2 Preparation of caramel custard

Q.3 Identification (3 marks each) 12

a) Restraining device

b) Any stage of life cycle of *Bombyx mori*

c) Commercial fishery

d) Crustacean fishery

Q4. a) Project submission 06

b) Viva based on project 04

Q5. Journal 05

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MODEL QUESTION BANK SEMESTER III

Question bank is suggestive. The paper setters are free to modify the questions or include new questions to the best of their perception

USZO301 (COURSE - V)

Unit1 (10 Marks)

1. Define genetics and explain its scope and importance.
2. Explain Mendel's laws of inheritance
3. Describe in detail the monohybrid cross and state the Mendelian principle of inheritance derived from it. Add a note on Co-dominance
4. Describe in detail dihybrid cross and state the Mendelian principles of inheritance derived from it
5. Discuss in brief inheritance of Mendelian phenotypic traits in humans.
6. Describe incomplete dominance with a suitable example
7. Describe Co-dominance with a suitable example
8. What is epistasis? Give a detailed account of double dominant epistasis
9. What is epistasis? Give a detailed account of recessive epistasis
10. What is epistasis? Give a detailed account of dominant epistasis
11. What is epistasis? Give a detailed account of double recessive epistasis
12. Explain the pattern of inheritance of recessive and dominant lethal alleles
13. Explain the inheritance of multiple alleles with the help of a suitable example
14. Describe polygenic inheritance with reference to skin colour and eye colour in man
15. Compare pleiotropy and polygenic inheritance
16. Explain the phenomenon of linkage with respect to Morgan's Experiment. Add a note on the differences between complete and incomplete linkage
17. Describe the pattern of inheritance of blood group and Rh factor in man
18. Explain the cytological basis and molecular mechanisms of crossing over
19. Explain pedigree analysis of X-linked recessive traits

Unit1 (5 Marks)

1. Describe the classical concept of gene
2. Explain the modern concept of gene
3. Differentiate between (Any two):
    (a) Genotype and phenotype of an organism
    (b) Dominant and recessive traits
    (c) Gene and genome
    (d) Homozygous and heterozygous
    (e) Monohybrid and Dihybrid cross
    (f) Incomplete Dominance and Co-dominance
    (g) Multiple alleles and Polygenes
    (h) Test cross and Backcross
4. Write a note on the chromosome theory of inheritance
5. Describe co-dominance with a suitable example
6. Give an account of the symbols used in human Pedigree analysis
7. Characteristics of autosomal dominant traits
8. Characteristics of X-linked recessive traits
9. Characteristics of autosomal recessive traits
10. Characteristics of X-linked dominant traits
11. Intermediate lethal alleles
12. Explain the inheritance of skin colour in humans
13. Write a note on pleiotropy.

Unit 2 (10 Marks)

1. Explain the structure of eukaryotic chromosome

2. Classify chromosomes on the basis of the position of centromere

3. Explain any two mechanisms of chromosomal basis of sex determination

4. Explain the inheritance of colour blindness in man

5. Explain sex determination in honey bee and *Drosophila*

Unit 2 (5 Marks)

1. Describe the terms euchromatin and heterochromatin
2. Write a note on polytene chromosomes
3. Write a note on Lampbrush chromosomes
4. Write a note on salivary gland chromosome of Drosophila
5. Write a note on Balbiani rings
6. Explain endomitosis
7. Write a note on Gynandromorphs
8. Explain the role of environment on sex determination
9. Explain the role of hormones in sex determination
10. Explain hypertrichosis
11. Differentiate between sex limited and sex influenced genes
12. Differentiate between human X and Y chromosomes
13. Differentiate between autosomes and sex chromosomes
14. Write a note on Lyons hypothesis
15. What are Barr bodies? Give a scientific reason that Barr bodies are present only in women and not in men
16. Give a scientific reason that Y chromosome is a sex determining chromosome in man
17. Explain parthenogenesis
18. Give scientific reason that the X-linked genes affect males more than females in human being

Unit 3 (10 marks)

1. Describe Griffith's transformation experiment
2. Explain Avery, Macleod, McCarty's experiment
3. Give an account of Hershey Chase experiment of bacteriophage infection
4. Write a note on types of DNA
5. Explain RNA as a genetic material
6. Describe the process of DNA replication
7. Explain in detail the process of transcription
8. Explain in detail the process of translation
9. What is gene expression? Describe the regulation of genes with lac *operon* model

Unit 3 (5 Marks)

1. Chemical composition of nucleic acid
2. A and B DNA
3. Plasmid
4. Function of rRNA
5. Function of mRNA
6. Function of tRNA
7. Genetic code
8. One gene-one enzyme hypothesis
9. Concept of operon
10. ZDNA
11. H DNA
12. Chromosomal DNA in prokaryotes
13. Mitochondrial DNA
14. DNA in chloroplast

MODEL QUESTION BANK SEMESTER – III

Question bank is suggestive. The paper setters are free to modify the questions or include new questions to the best of their perception.

USZO302 (COURSE-VI)

Unit 1 (10 Marks)

1. Explain in detail the digestive system of cockroach.
2. Describe the digestive system of pigeon.
3. With the help of a labeled diagram describe the structure and functions of ruminant stomach.
4. Explain the physiology of digestion in cockroach.
5. Give an account of the enzymes involved in the process of digestion in cockroach.
6. With the help of a labeled diagram describe the structure of mammalian kidney.
7. Give a detailed account of process of urine formation in man.

Unit 1 (5 Marks)

1. Write a note on nutritional apparatus in amoeba.
2. Describe briefly gastrovascular cavity in hydra.
3. Write a note on wheel-organ of Amphioxus.
4. Write a note on structure of ruminant stomach.
5. Write short note on digestion of proteins with respect to man.
6. Write short note on digestion of carbohydrates with respect to man
7. Write short note on digestion lipids with respect to man
8. Write short note contractile vacuoles in protozoa.
9. Write a note on flame cells.
10. Describe briefly excretory and osmoregulatory structures in cockroach.
11. Diagrammatic representation of structure of mammalian kidney.
12. Write a note on Ammonotelic organisms.
13. Write a note on Ureotelic organisms.
14. Write a note on Uricotelic organisms.
15. Schematic diagram of ultrafiltration in mammalian kidney.

Unit 2 (10 Marks)

1. Describe briefly air sacs in pigeon.
2. Describe briefly the process of cellular respiration inhuman
3. Describe briefly the process of respiration inhuman
4. Give a brief account of types of circulating fluids present in animals.
5. Describe briefly mechanism of working of heart.
6. Describe briefly the heart of shark/fish.
7. Describe briefly the heart of frog.
8. Describe briefly heart of crocodile.
9. Give a brief account of heart of man.

Unit 2 (5 Marks)

1. Write short note on cutaneous respiration.
2. Write a note on book lungs in spider.
3. Explain the structure of gills of bony fish
4. Describe briefly lungs as respiratory organs in frog.
5. Describe briefly lungs as respiratory organs in man.
6. Write short note on open circulation.
7. Write short note on closed circulation.

8 Write a note on heart of cockroach

10. Write a note on heart of earthworm

Unit 3(10 Marks)

1. Describe different types of neurons on the basis of structure and function.
2. Explain conduction of nerve impulse.
3. Briefly describe synaptic transmission.
4. Explain Sol-Gel theory of amoeboid movement.
5. Describe ciliary movement in *Paramecium*.
6. Give an account on types of wings in insects.
7. Describe different types of fins in fishes.
8. Describe sliding filament theory.
9. Describe briefly asexual reproduction in animals.
10. Describe the structure and function of tube feet.

11. Describe spermatogenesis.
12. Describe oogenesis.
13. Describe briefly the structure of mammalian gametes.
14. Give a brief on types of fertilization.

Unit 3 (5 Marks)

1. Write a note on irritability in *Paramecium*.
2. Write a note on resting potential of nerve membrane.
3. Write a note on action potential of nerve membrane.
4. Describe different types of neurons on the basis of structure.
5. Describe briefly different types of neurons on the basis of functions.
6. Describe the structure of synapse.
7. Describe striated muscle fibre.
8. Describe the structure of cilia.
9. Give an account on types of legs in insects.
10. Write a note on ovo-viviparity.
11. Write a note on viviparity.
12. Write a note on oviparity.
13. Describe the structure of mammalian egg.
14. Describe the structure of mammalian sperm.
15. Describe the formation of gemmule in sponges.
16. Write a note on budding as asexual reproduction in animals.

MODEL QUESTION BANK SEMESTER – III

Question bank is suggestive. The paper setters are free to modify the questions or include new questions to the best of their perception.

USZOE1303 (COURSE - VIIA) – Elective 1

Unit 1 (10 marks each)

1. How do honey bees communicate for foraging?
2. What is classical conditioning? Explain with an example.
3. What is imprinting? Explain different types of imprinting.
4. What do you mean by animal learning? Describe any two types of learning.
5. Describe the various ways in which ants communicate.
6. What is the significance of mimicry and warning coloration?
7. What is mimicry? Explain different types of mimicry with examples.
8. What is displacement activity? In what situations do displacement activities occur? Explain with examples.
9. Comment on any two aspects of non-human primate social behaviour.

Unit 1 (5 marks)

i. Mimicry
ii. Innate learning
iii. Acquired learning
iv. Warning colouration
v. Imprinting
vi. Classical Conditioning
vii. Territorial behaviour
viii. Schooling behaviour
ix. Altruism
x. Kinship
xi. Displacement activities
xii. Ritualization

Unit 2 (10 Marks)

1. Give an account of the life history and pathogenecity of the parasite causing amoebic dysentery.
2. Describe the life history of *Taenia solium.*
3. Give an account of parasitic adaptive features of *Taenia solium*.
4. Give an account of the life history of *Fasciola hepatica.*
5. Give an account of the life history of filarial worm and discuss its pathogenic effects.
6. Describe the life history of bedbug and suggest some control measures.
7. Give an account of the life history of *Sarcoptes scabiei.*
8. Give an account of the life history of head louse *Pediculus.*
9. What is bird flu? How it spreads and what are its symptoms?
10. How would you control the transmission of anthrax among humans?
11. How is anthrax transmitted to man?

Unit 2 (5 Marks)

1. Describe the structure of *E. histolytica.*
2. Write a brief note on amoebiasis.
3. Write a short note on pathogenecity of *E. histolytica*.
4. Briefly describe the life cycle of *E. histolytica*.
5. Illustrate the complete life history of *T. solium* with the help of diagram only.
6. What is the effect of *Fasciola* on the hosts?
7. Describe the life cycle of *Wuchereria bancrofti*.
10. What is host specificity?
11. What are the signs and symptoms of bird flu?
12. How is rabies transmitted in human?
13. What are the preventive measures to be taken to prevent infection of rabies virus?
14. What is toxoplasmosis and what are its causes?
15. Write notes on:
    i. Parasitic adaptations in endoparasites
    ii. Cysticercus or bladder worm.
    iii. Pathogenecity of *Wuchereria*
    iv. Control measures of bedbug.
    v. Types of hosts

Unit 3 (10 Marks)

1. What does the modern method of apiculture include? Explain in brief.
2. How is an artificial bee hive constructed?
3. How do you select the flora and bee species for apiculture?
4. Enumerate the advantages of vermiculture
5. Describe any two methods of vermiculture.
6. Describe the processing of raw milk.
7. Write a brief note on Type A1 and A2 cow milk.

Unit 3 (5 Marks)

1. State the economic importance of honey and beeswax.
2. What are the disadvantages of the indigenous method of apiculture?
3. How does the wax moth cause damage to the honey comb?
4. Name any two bee enemies and explain how they harm the bees.
5. Give an account of the commonly found species of honey bee in India.
6. What are the advantages of the modern method of apiculture?
7. Which type of flora is beneficial for apiculture?
8. Which type of bee is suitable for apiculture?
9. What is the chemical composition of honey?
10. What is the suitable material for culturing earthworms?
11. What are the advantages of processing dairy products?
12. What is whole milk and toned milk? How is toned milk prepared?

MODEL QUESTION BANK SEMESTER – III

Question bank is suggestive. The paper setters are free to modify the questions or include new questions to the best of their perception.

USZOE2303 (COURSE - VIIB)

Unit 1 10 mark each

1. Give a brief account on exotic species used in aquarium.
2. Give a brief account on endemic species used in aquarium.
3. Give sexual dimorphism in fresh water fishes along with examples.
4. Give sexual dimorphism in marine water fishes along with examples.
5. Give a brief account on feed used in aquarium.
6. Give a brief account on fish transportation in aquarium.

Unit 2 (10 mark each)

1. Explain agricultural pests along with suitable example.
2. Explain household pests along with suitable example.
3. Explain stored grains pests along with suitable example.
4. Explain structural pests along with suitable example.
5. Explain veterinary pests along with suitable example.
6. Explain forestry pests along with suitable example.

Unit 3(10 mark questions):

1. Give a brief account on Blue Mormon butterfly and Striped Tiger butterfly
2. Describe the behaviour of Octopus and spider as most dedicated mothers in the world.
3. Describe marvellous characters of fan throated lizard and flying frog.
4. Describe marvellous characters of Mantis shrimp.
5. Give a brief account on Malabar giant squirrel
6. Describe marvellous characters of the Purple (Joker) crab and lesser flamingo.
7. Describe marvellous characters of the Stabbing Shark and Crime fighting gecko.
8. Describe marvellous characters of the Gharial and the Matilda Viper

Unit 1 (5 Marks)

Write short note on:-

1. Budgeting for setting up of an aquarium
2. Fish packing
3. Formulated fish feed
4. Gold fish
5. Molly
6. Guppy

Unit 2(5 Marks)

Write short note on:-

1. Jowar stem borer
2. Brinjal fruit borer
3. Aphids
4. Rice weevil.
5. Non-insect pests
6. Cultural control of pests
7. Physical control of pests
8. Mechanical control of pests
9. Chemical control of pests
10. Biological control of pests
11. Concept of IPM

Unit 3(5 Marks)

Write short note on the amazing characters in following amazing animals.

1. Blue Mormon butterfly
2. Striped Tiger butterfly
3. Mudskipper
4. Komodo dragon
5. Pebble toad
6. Lesser flamingo
7. Great white pelican
8. Drongo

9. Malabar giant squirrel
10. Cheetah
11. Octopus

MODEL QUESTION BANK SEMESTER - IV

Question bank is suggestive. The paper setters are free to modify the questions or include new questions to the best of their perception

USZO401 (COURSE - VIII)

Unit 1 (10 Marks)

1. Write explanatory notes on: 1. Lamarckism 2. Darwinism and Neo Darwinism 3. Mutation Theory 4. Modern Synthetic theory 5. Weismann's germplasm theory
2. Discuss evidences in favour of organic evolution by giving examples of geographical distribution
3. Discuss evidences in favour of organic evolution by giving examples based on genetic studies.
4. Discuss evidences in favour of organic evolution by giving examples based on physiological studies.
5. Give a brief account on the origin of eukaryotic cell

Unit 1 (5 Marks)

1. Describe Miller-Urey experiment simulating Chemical evolution.
2. Describe chemical evolution as postulated by the Haldane and Oparin theory
3. Write short notes on: 1. Mutation Theory 2. Modern Synthetic theory

Unit 2 (10 Marks)

1. Define the term 'population genetics'. Describe in brief the various evolutionary forces that tend to disturb genetic equilibrium and introduce changes in the gene pool of a population
2. State Hardy Weinberg's law of equilibrium and discuss its salient features
3. Give an account of the different factors involved in speciation
4. Describe the different types of speciation
5. Explain the role of geographic isolation in the development of new species
6. Explain the role of reproductive isolation in the development of new species
7. Discuss the pre-zygotic barriers responsible for reproductive isolation

8. Discuss the post-zygotic barriers which lead to reproductive isolation
9. Describe the sources of genetic variation in natural populations
10. Explain the nature and extent of genetic variation within populations
11. Describe the mechanisms that preserve balanced polymorphisms
12. Describe the salient features of microevolution
13. Compare and contrast microevolution and macroevolution
14. Explain the salient features of macroevolution
15. Give an account of the different patterns of macroevolution
16. Elaborate on the role of adaptive radiation and extinction in macroevolution
17. What do you understand by the term natural selection? Describe the different types of natural selection with suitable examples
18. What is megaevolution? Explain the mechanism of megaevolution using a suitable example

Unit 2(5 Marks)

1. Explain the term ‘gene pool’. How does evolution operate via the gene pools of populations?
2. Differentiate between:
    - **a.** Allopatric and Sympatric speciation
    - **b.** Biological and evolutionary species
    - **c.** Microevolution and macroevolution
    - **d.** Stabilizing selection and disruptive selection
3. Explain stabilizing selection with the help of a suitable example
4. How does the example of sickle cell allele illustrate heterozygote advantage?
5. How does frequency-dependent selection affect genetic variation within a population over time?
6. Write short notes on:
    - **a.** Role of mutations in evolution
    - **b.** Role of migration in evolution
    - **c.** Non-random mating
    - **d.** Role of natural selection in evolution
    - **e.** Genetic drift

f. Bottleneck effect

g. Founder effect

h. Directional evolution in peppered moth

i. Evolution of Antibiotic resistance in bacteria

j. Geographic variation

k. Genetic polymorphism

l. Parapatric speciation

m. Adaptive radiation

7. What is the biological species concept? What are its limitations? How does it differ from the evolutionary species concept?
8. Explain the concept of coevolution using suitable examples

Unit 3 (10 Marks)

1. Describe briefly, the steps towards preparing a research design
2. Describe literature survey, collection of data and its analysis
3. What is a patent and how is it obtained?
4. Write an account on application of statistics in research

Unit 3 (5 Marks)

1. Define research. State the difference between research method and research methodology
2. Write a note on computer application in research
3. Describe briefly identification of research problem and formulation of research hypothesis
4. Write a note on abstract writing?
5. Write a note on plagiarism?
6. Write a note on bibliography?
7. Write a short note on ethics in scientific research

MODEL QUESTION BANK SEMESTER - IV

Question bank is suggestive. The paper setters are free to modify the questions or include new questions to the best of their perception

USZO402 (COURSE - IX)

Unit 1 (10 Marks)

1. Explain prokaryotic cell.
2. Explain Eukaryotic cell.
3. Give an account of cell theory.
4. Describe the ultrastructure of nuclear membrane.
5. State the chemical composition and functions of nucleolus.
6. Describe nucleocytoplasmic interactions.
7. Describe fluid mosaic model of plasma membrane.
8. Give an account of active and passive transport
9. Describe various modifications of plasma membrane
11. Explain endocytosis and exocytosis
12. Give an account on cell permeability
13. Differentiate prokaryotic and eukaryotic cell

Unit 1 (5 Marks)

Write a short note on:

1. Virus
2. Nuclear matrix
3. Number and position of nucleus.
4. Nucleolus
5. Membrane receptors

Unit 2 (10 Marks)

1. Write a note on structural organization & importance of endomembrane system.
2. Describe ultrastructure of Endoplasmic Reticulum
3. Describe the types and functions of ER.
4. Give an account of ultrastructure and functions of Golgi complex.
5. Write an essay on functions of Golgi complex.

6. Give an account of polymorphism in lysosomes.
7. Write an essay on peroxisomes.
8. Describe the structure and chemical composition of mitochondria.
9. Write a note on mitochondria as powerhouse of the cell.
10. Describe the major functions of mitochondria.

Unit 2 (5 Marks)

1. Importance of endomembrane system
2. Write a short note on biogenesis of endomembrane system
3. Functions of Rough Endoplasmic Reticulum
4. Functions of Smooth Endoplasmic Reticulum
5. Structure of Golgi complex
6. Chemical composition of Golgi complex
7. Lipid & polysaccharide metabolism in Golgi complex
8. Secretion and protein sorting by Golgi complex
9. Write a brief note on GAAP
10. Write a brief note on protein glycosylation by Golgi complex
11. Origin and functions of lysosomes
12. Write a short note on peroxisomes
13. Structure of mitochondria
14. Chemical composition of mitochondria
15. Write a short note on ATP
16. Write a short note on glycolysis
17. Write a short note on Kreb’s cycle
18. Write a short note on oxidative phosphorylation

Unit 3 (10 Marks)

1. Explain the concept of micromolecules and macromolecules.
2. Define carbohydrate. Add a note on its classification.
3. What are carbohydrates? Classify carbohydrate with suitable examples.
4. Explain with suitable example monosaccharide and disaccharide.
5. Discuss the properties of carbohydrates.
6. Explain oligosaccharides with suitable examples.

7. What are polysaccharides? How are they classified? Write the structures of glycogen and heparin/ chitin and heparin.
8. Discuss about chemical structure of the monosaccharides / disaccharides.
9. What are amino acids? Classify amino acids based on functional group.
10. Give an account of primary and secondary structure of proteins.
11. Write an account on tertiary and quaternary structure of proteins.
12. Describe the structure of saturated and unsaturated fatty acids.
13. What are fatty acids? Add a note on types of fatty acids.
14. Describe the structure and functions of water soluble vitamins.
15. Describe the structure and functions of lipid soluble vitamins.

Unit 3 (5 Marks)

1. Write a short note on monomers and polymers.
2. Write note on properties of carbohydrates.
3. Give an account of polysaccharides.
4. With suitable example explain glycosidic bond.
5. Explain the linkage in lactose and sucrose.
6. Give the biological importance of carbohydrates.
7. What are essential and nonessential amino acids?
8. Give an account of properties of amino acids.
9. Define and explain peptide bond with suitable example.
10. Explain the different types of proteins with suitable examples.
11. Explain the biological role of proteins.
12. Peptide bond
13. Types of fatty acids.
14. Biological role of lipids
15. Sterols
17. Describe properties of lipids.
18. Discuss the clinical significance of protein / carbohydrate.
19. Write short note on clinical significance of lipids.
20. Write a note on isomerism in carbohydrates/amino acids.
21. Describe the structure and functions of vitamin A/ vitamin B/ vitamin C/ vitamin D.

MODEL QUESTION BANK SEMESTER - IV

Question bank is suggestive. The paper setters are free to modify the questions or include new questions to the best of their perception

USZOE1403 (COURSE - XA) – Elective 1

Unit-1 (10 Marks)

1) Classify the different types of eggs.
2) Briefly explain types and structure of sperms (any two animals).
3) Define cleavage Explain types of cleavages.
4) Give brief account on various types of blastulae.
5) What is gastrulation? Explain gastrulation in frog.
6) Give an account of process of coelom formation and its types

Unit-1 (5 Marks)

1) Draw neat labeled diagram and explain any one of the following:
   (Microlecithal, Alecithal, Homolecithal, Heterolecithal, Isolecithal, Telolecithal, Centrolecithal, Discoidal).
2) Explain structure of sperm of frog/ reptile/ bird/ mammal.
3) Short note on holoblastic cleavage/ meroblastic cleavage.
4) Short note on equal or unequal cleavage.
5) Short note on discoblastula /coeloblastula.
6) Short note on centroblastula /amphiblastula /stereoblaastula,
7) Explain the process of coelom formation
8) Explain the process of gastrulation.

Unit 2 (10 Marks)

1. Describe male reproductive system and its hormonal regulation.
2. Describe female reproductive system and its hormonal regulation.
3. Define reproduction. Explain the hormonal regulation of reproduction.
4. What is contraception? Explain different methods of contraception.
5. Explain the various measures of birth control.
6. Define infertility and explain the causes of female infertility.
7. What are the causes of male infertility?
8. Explain the hormonal treatment for infertility using drugs.

9. Describe the methods of treatment of infertility.
10. Give a brief account of infertility related disorders.
11. What are sperm banks? Add a note on cryopreservation of sperms.
12. What is testicular biopsy? Explain Testicular sperm extraction (TESE), Pronuclear stage transfer (PROST).
13. What are the steps involved in Embryo transfer (ET) and / Intra-fallopian transfer (IFT)/IVF? Add a note on its ethics.

Unit 2 (5 Marks)

1. Write a note on impact of age on reproductive stage –
    a. Menopause
    b. Andropause
2. Write a note on amenorrhea.
3. How does sterilization act as a method of contraception?
4. Write a note on birth control.
5. What is the difference between natural and artificial methods of contraception?
6. How is T.B. a cause of female infertility?
7. What are the genetic causes of infertility?
8. Write a note on STD's as infertility related disorders?
9. What are the roles of endocrine disruptions in infertility?
10. Explain the role of the following in infertility:
    a. Gonorrhoea
    b. Syphilis
    c. Genital Herpes
    d. Chlamydia
11. Write a note on treatment of infertility by removal of causative environmental factors.

Unit 3 (10 Marks)

1. What are the causes, effects and control measures for air pollution?
2. What are the causes, effects and control measures for water pollution?
3. What are the causes, effects and control measures for soil pollution?
4. What are the causes, effects and control measures for sound pollution?
5. Define air pollution and give an account of hazardous air pollutants.

6. What is ocean littering? Explain in detail the causes and control measures for ocean littering?
7. Describe the alteration of metabolism of micro-organisms due to soil pollution.
8. Explain sound pollution along with its measurement and permissible limits.
9. Give a brief account of methods to control gaseous / particulate matters.
10. What is pollution? Add notes on:
    a. Effect of air pollution on vegetation.
    b. Effect of sound pollution on animals.

Unit 3 (5 Marks)

1. Explain the effects of air pollution on human beings.
2. What are different types of pollutants that cause air pollution?
3. Write short notes on:
    a. Ozone depletion
    b. Green house gases
    c. Global warming
    d. Acid rain
    e. Sonic boom
    f. Acoustic zoning
4. Explain the effect of thermal pollution on biodiversity.
5. Write a note on ionizing radiation
6. How is oil spill becomes a cause of water pollution / ocean littering?
7. How do pesticides and fertilizers contaminate water?
8. How can oil be retracted back from sea / ocean?
9. What are the effects of soil pollution on food chain?
10. What are the auditory / non – auditory effects of sound pollution?

MODEL QUESTION BANK SEMESTER - IV

Question bank is suggestive. The paper setters are free to modify the questions or include new questions to the best of their perception

USZOE2403 (COURSE - XB) – Elective 2

Unit 1 (10 Marks)

1. Give in brief different indigenous breed of cattle with a suitable example.
2. Give in brief different exotic breeds of cattle with a suitable example.
3. Give in brief different breed of buffalo with a suitable example.
4. Give in brief different housing types in dairy farm.
5. Explain different types of diseases in cattle and add a note on its control.

Unit 1(05 Marks)

Write short note on

1. Malvi
2. Hariyana
3. Deoni
4. Red sindhi
5. Khillari
6. Jersy
7. Holstein
8. Nagpuri
9. Bhadawari
10. Murrah
11. Jafrabadi
12. Weaning of calf
13. Castration
14. Dehorning
15. Cleaning and sanitation.

Unit 2 (10 Marks)

1. Give in brief life history of silkworm.
2. Give in brief reeling and extraction of silk.
3. Give in brief diseases and control measures in sericulture.

4. Give in brief harvesting and processing of cocoon.

Unit 2 (5 Marks)

1. Varieties of silkworm
2. Rearing of silkworm
3. Silk extraction
4. Host plants for sericulture

Unit 3 (10 Marks)

1. Give an account on pisciculture, add a note on finfish culture
2. Explain monoculture with respect to aquaculture
3. Explain polyculture with respect to polyculture
4. Give an account on fresh water prawn culture
5. Give an account on pearl culture.

Unit 3 (5 Marks)

Write short notes on:-

1. Composition of pearl
2. White shrimp culture
3. Cage culture
4. Fish diseases
5. Symptoms of diseases
6. Control of diseases

----------*The End*----------

AC - 11th May, 2017
Item No. 4.239

PREFACE

For the development of any modern society Science play a key role. Progress in various fields of Science and Technology has become the tools to understand life processes. Since knowledge in all branches and fields is growing globally at a fast pace with new disciplines emerging. This approach has necessitated the revision of the present curriculum. At the undergraduate level effectual science education can be communicated only by restructuring the curriculum . To achieve this goal, it is, therefore, imperative to update the existing syllabus accordingly, taking into account the broader perspective of Curriculum. Effort is taken to make the syllabi compatible with other universities and at the same time it is ensured that the syllabus is not very intense. The present curriculum will expose students to various fields in Zoology. Curricula with basic as well as advanced concepts in the Zoology at the third year shall inspire the students for pursuing higher studies in Zoology. It is foresee that students will have more avenue to pursue their own interests and chosen field of courses, it will also enable students to get employed in the Biological research Institutes, Industries, Educational Institutes and in the range of concerning departments based on subject Zoology. The syllabus contains different components and learning outcomes specified. The other major components of the new syllabus is project .The aim of introducing project is to provide experiential learning through active participation that enables the student to develop and demonstrate analytical, judgmental, presentation and communication skills. Format provided along with the syllabus gives guidelines to engrave the project systematically. Committee comprising senior teachers were nominated from degree colleges after several interactive session and discussion the syllabus was prepared. On behalf of the Board Members, I place on record the endeavor by the committee and help rendered by one and all, It is hoped that this curriculum document, prepared would provide the level of competency.

From

Dr Anita S. Jadhav
Chairperson Ad-hoc BoS in Zoology

T. Y. B. Sc. Zoology
Semester based Credit and Grading System
(To be implemented from Academic Year 2017-18)
Semester V

Theory				
Course	**Unit**	**Topic**	**Credits**	**Lectures/week**
USZO501	I	Levels of organization	2.5	1
	II	Taxonomy of Phylum Protozoa to Phylum Nemathelminthes		1
	III	Taxonomy of Phylum Annelida to Phylum Echinodermata		1
	IV	Type study : Sepia		1
USZO502	I	Basic Hematology	2.5	1
	II	Applied Hematology		1
	III	Basic Immunology		1
	IV	Applied Immunology		1
USZO503	I	Molecular Biology	2.5	1
	II	Genetic engineering		1
	III	Human Genetics		1
	IV	Tissue Culture		1
USZO504	I	Integumentary system and derivatives	2.5	1
	II	Endocrine glands and regulation		1
	III	Human Osteology		1
	IV	Experimental and Chick Embryology		1
			10	**16**
Practical				
USZOP05		Practicals of Course USZO501 and Practicals of Course USZO502	3	8
USZOP06		Practicals of Course USZO503, USZO504 and Project Component	3	8
			6	**16**
Total			**16**	**32**

T. Y. B. Sc. Zoology
Semester V (Theory)

Course 11
Course Code: USZO501

Unit 1: Levels of organization

(15 lectures)

Learning objectives:
To comprehend, compare and distinguish the levels of organisation in the animal kingdom.
Learning outcome:
Learners will develop conceptual clarity with regard to the anatomy of animals at different levels. Learners shall comprehend the evolutionary perspective of each level of organisation. Learners will know the importance of the significance and advantages of each level of organisation.

1.1: Levels of Organization (3 lectures)

1.1.1: Unicellularity, multicellularity, colonization
1.1.2: Cellular grade of organization, tissue grade of organization, formation of germ layers

1.2: Symmetry (4 lectures)

1.2.1: Evolutionary perspective and definition
1.2.2: Types -
a. Asymmetry – e.g. *Amoeba*
b. Radial – e.g. Bi-radial - *Aurelia* (Jellyfish); Penta-radial - *Asterais* (Starfish)
c. Bi-lateral – e.g. Simple – *Planaria;* Complex - *Mus* (Rat)
1.2.3: Significance and Advantages

1.3: Coelom (4 lectures)

1.3.1: Evolutionary perspective and definition
1.3.2: Development of Coelom -
a. Organization of tissues
b. Diploblastic and Triploblastic organization
1.3.3: Types -
a. Acoelomate – e.g. Platyhelminthes - *Planaria*
b. Pseudocoelomate – e.g. Nematoda - *Ascaris* (Round worm)
c. Coelomate – e.g. Annelida - *Pheretima* (Earthworm)
1.3.4: Significance and Advantages

1.4: Segmentation/ Metamerism (4 lectures)

1.4.1: Evolutionary perspective and definition
1.4.2: Theories of segmentation
1.4.3: Types -
a. Homonymous – e.g. Annelida - *Pheretima* (Earthworm)
b. Heteronomous – e.g. Crustacean - *Panulirus* (Lobster)
c. Cephalization – e.g. Insecta - *Periplanata* (Cockroach)
d. Tagmatization – e. g. *Panulirus* (Lobster)
e. Cephalothorax – e.g. *Penaeus* (Prawn)
1.4.4: Significance and Advantages

Unit 2: Taxonomy of Phylum Protozoa to Phylum Nematoda (15 lectures)

Learning objectives:
To introduce the learners to the modern system of animal classification. To describe the distinguishing characters of major invertebrate phyla and their adaptive features with reference to their habitat.
Learning outcome:
Learners will understand that scientific classification of animals is based on certain characteristics they have in common. Learners will be able to recall characteristics features and examples of each phylum. Learners will be familiar with protozoan and helminth parasites.

2.1: Principles of Taxonomy **(1 lecture)**

Linnaean Hierarchy, Binomial Nomenclature,
Five Kingdom classification

2.2: Phylum Protozoa **(5 lectures)**

2.2.1: General characters and classification
2.2.2: Locomotion in Protozoa - amoeboid, flagellar, ciliary, gliding
2.2.3: Reproduction in Protozoa - asexual and sexual
2.2.4: Morphology, life cycle, pathogenicity and control measures:
Plasmodium, Entamoeba

2.3: Phylum Porifera **(3 lectures)**

2.3.1: General organization and classification
2.3.2: Skeleton in sponges
2.3.3: Canal system in sponges

2.4: Phylum Cnidaria **(2 lectures)**

2.4.1: General characters and classification
2.4.2: *Obelia* - Polymorphism, life cycle and alternation of generations

2.5: Phylum Platyhelminthes **(2 lectures)**

2.5.1: General characters and classification
2.5.2: Life history of *Fasciola hepatica*

2.6: Phylum Nematoda **(2 lectures)**

2.6.1: General characters and classification
2.6.2: Life history of *Ascaris lumbricoides* and its parasitic adaptations

Unit 3: Taxonomy of Phylum Annelida to Phylum Hemichordata **(15 lectures)**

Learning objectives:
To introduce basic concepts of invertebrate classification in animal kingdom from phylum Annelida to Echinodermata. To study general characteristics and salient features of animals belonging to phylum Annelida to Hemichordata.
Learning outcome:
Learners will get an idea of higher groups of invertebrate animal life and their classification.

3.1: Phylum Annelida **(3 lectures)**

3.1.1: General characters and classification
3.1.2: Diversity in habit and habitat
3.1.3: Adaptive radiation in Class Polychaeta

3.2: Phylum Arthropoda **(4 lectures)**

3.2.1: General characters and classification
3.2.2: Larval forms of Crustacea; social life, moulting and metamorphosis in Insecta; Vision in Arthropoda
3.2.3: Affinities of Onychophora

3.3: Phylum Mollusca **(3 lectures)**

3.3.1: General characters and classification
3.3.2: Torsion and detorsion

3.4: Phylum Echinodermata **(2 lectures)**

3.4.1: General characters and classification
3.4.2: Water vascular system

3.5: Hemichordates **(2 lectures)**

General characters and classification, e.g. Balanoglossus

3.6: Basic concepts of phylogeny **(1 lecture)**

Unit 4: Type study - Sepia **(15 lectures)**

Learning objectives:
To study one invertebrate type animal, e.g. Sepia
Learning outcome:
Learners will get an idea of general characteristics and details of invertebrate animal systems.

4.1:

General characters and classification; Habit and habitat; External characters; Mantle cavity; locomotion; economic importance **(5 lectures)**

4.2:

Digestive system, Respiratory system, Circulatory system, Excretory system, Nervous system, Sense organs and Reproductive system **(10 lectures)**

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T. Y. B. Sc. Zoology
Semester V (Theory)

Course 12
Course Code: USZO502

Unit 1: Basic Hematology **(15 lectures)**

Learning objectives:
To introduce the learners to composition of blood. To acquaint the learners with the physiology of blood clotting, transport of gases and clinical aspects of haematology.
Learning outcome:
Learners would be able to realize the fundamental concepts in haematology.

1.1: Composition of blood **(1 lecture)**

Plasma & formed elements

1.2: Blood volume **(2 lectures)**

Total quantity and regulation; haemorrhage

1.3: Plasma proteins **(2 lectures)**

Inorganic constituents, respiratory gases, organic constituents other than proteins (include internal secretions, antibodies and enzymes)

1.4: RBCs **(2 lectures)**

Structure and functions, abnormalities in structure, total count, variation in number; types of anaemia and genetic disorders; ESR

1.5: Hemoglobin **(3 lectures)**

Structure, formation and degradation, role in transport of oxygen and carbon dioxide (Chloride shift and Bohr's effect); types of hemoglobin (foetal, adult and sickle)

1.6: WBCs **(2 lectures)**

Types of leukocytes and function; total count and variation in number; leucopoiesis and leukemia and its types

1.7: Blood clotting **(3 lectures)**

Thrombocytes; factors and mechanism of coagulation; anticoagulants; formation of blood platelets (thrombopoiesis); clotting mechanism; bleeding and clotting time; failure of clotting mechanism; haemophilia and purpura

Unit 2: Applied Hematology **(15 lectures)**

Learning objectives:

To introduce the learners to basics of applied hematology. To impart knowledge of basic diagnostic techniques used in pathology.

Learning outcome:

Learners will be familiar with different terminologies and diagnostic tests performed in a pathological laboratory. Learners will be better equipped for taking any further pathological course or working in a diagnostic laboratory.

2.1: Introduction to Applied Hematology **(3 lectures)**

Definition, scope and brief introduction of basic branches: clinical, microbiological, oncological and forensic hematology

2.2: Diagnostic techniques used in hematology

2.2.1: Microscopic examination of blood: For detection of blood cancers (Lymphoma, Myeloma); infectious diseases (Malaria, Filariasis, Leishmaniasis); hemoglobinopathies (Sickle cell, Thalassemia) **(2 lectures)**

2.2.2: Coagulopathies: Diagnostic methods (hemophilia and purpura) **(1 lecture)**

2.2.3: Microbiological examination: Blood culture: Method and application in diagnosis of infectious diseases (Typhoid and TB) **(1 lecture)**

2.2.4: Biochemical examinations of blood for: **(5 lectures)**

Liver function tests: Albumin, AST, ALT, AST:ALT ratio, Total bilirubin, Direct bilirubin, Prothrombin time / International normalized ratio (PT/INR), Serum glucose, LDH and Alkaline phosphatase

Kidney function tests: Serum creatinine, blood urea nitrogen

Carbohydrate metabolism tests: Blood sugar, Glucose tolerance test, Glycosylated hemoglobin test

Other biochemical tests: Blood hormones (Thyroid, FSH, LH), Cancer Antigen test (CA124 or CA125)

2.2.5: Blood Bank: Collection, storage, preservation of its components **(1 lecture)**

2.2.6: Blood transfusion: Crossing matching, Transfusion of blood and bone marrow transplant **(2 lectures)**

Unit 3: Basic Immunology **(15 lectures)**

Learning objectives:

To introduce the topic of immunology by emphasizing the basic concepts to build a strong foundation. To give an overview of the immune system that plays an important role in disease resistance.

Learning outcome:

Learners would comprehend the types of immunity and the components of immune system. Learners would realize the significant role of immune system in giving resistance against diseases.

3.1: Overview of Immunology **(1 lecture)**

Definition and scope

3.2: Components of immune system:

3.2.1: Innate immunity – Definition, Factors affecting innate immunity, Mechanisms of innate immunity – physical barriers, chemical barriers and cellular barriers **(2 lectures)**

3.2.2: Adaptive or Acquired immunity – Active Acquired immunity – Natural and Artificial; Passive Acquired immunity – Natural and Artificial **(1 lecture)**

3.3: Cells and Organs of immune system

3.3.1: Cells of immune system – B cells, T cells and null cells, macrophages, dendritic cells and mast cells **(1 lecture)**

3.3.2: Organs of immune system – Primary – Thymus and bone marrow; Secondary - Lymph node and spleen **(2 lectures)**

3.4: Antigens

Definition, properties of antigens; haptens **(1 lecture)**

3.5: Antibodies **(2 lectures)**

Definition, basic structure, classes of antibodies – IgG, IgA, IgM, IgD and IgE **(2 lectures)**

3.6: Hypersensitivity, Autoimmunity and Immunodeficiency **(3 lectures)**

3.6.1: Definition of Hypersensitivity; Classification of hypersensitivity reactions: Type-I, Type-II, Type-III and Type-IV (one example of each type)

3.6.2: Introduction and a brief account of autoimmunity and example, Rheumatoid arthritis

3.6.3: Introduction to immunodeficiency – Congenital, e.g. SCID; Acquired, e.g. AIDS

Unit 4: Applied Immunology (15 lectures)

Learning objectives:
To introduce the learners to immune related pathologies. To make the learners understand the concept of vaccines and vaccination. To familiarise the learners to immunological perspectives of organ transplant and tumour treatment.
Learning outcome:
Learners would understand immune related pathologies. Learners would understand the principle and applications of vaccines. Learners would develop basic understanding of immunology of organ transplantation and cancer treatment.

4.1: Antigen-Antibody interaction (5 lectures)
General features of antigen-antibody interaction; Precipitation reaction: Definition, characteristics and mechanism, precipitation in gels (slide test) - Radial immunodiffusion (Mancini method), Double immunodiffusion (Ouchterlony method); Agglutination reaction: definition, characteristics and mechanism, Haemagglutination (slide and micro-tray agglutination), passive agglutination, Coomb's test and ELISA

4.2: Vaccines and Vaccination (5 lectures)
Brief history of vaccination, principles of vaccines, Active and Passive immunization; Routes of vaccine administration
Classification of Vaccines: Live attenuated, Whole-Killed or inactivated, Sub-unit vaccines: Toxoids, Protein vaccines, Viral-like particles, DNA vaccines
Adjuvants: Introduction and application; Adjuvants used for human vaccines (Alum, Virosomes and Liposomes, Saponins, Water-in-oil emulsions)
Vaccines against human pathogens: Polio; Hepatitis A and B; Rotavirus; Tuberculosis (BCG); Diphtheria, Tetanus and Pertussis (DPT); Typhoid (TAB) vaccines

4.3: Transplantation and Tumour immunity (5 lectures)
Transplantation: Introduction to transplantation; Types of grafts; Immunologic basis of graft rejection: MHC compatibility in organ transplantation, Lymphocyte mediated graft rejection, Antibody mediated graft rejection; Prevention of graft rejection; Immunosuppressive therapy
Tumour immunology (Cancer immunology): Introduction to cellular transformation and cancer; Tumour antigens and immune surveillance; Immunotherapy: Antigen-independent cytokine therapy, Stimulation of cell-mediated immune responses, Passive immunotherapy

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T. Y. B. Sc. Zoology
Semester V (Theory)

Course 13
Course Code: USZO503

Unit 1: Molecular Biology (15 lectures)

Learning objectives:
Introduce the learners to chemical and molecular processes that affect genetic material. It also intends to make them understand the concept of DNA damage and repair, and how gene control is necessary for cell survival.
Learning outcome:
The course will prepare learners to recognize the significance of molecular biology as a basis for the study of other areas of biology and biochemistry. Moreover, it will also assist them in understanding related areas in relatively new fields of genetic engineering and biotechnology.

1.1: Types of mutation (4 lectures)

1.1.1: Point mutations – substitution, deletion and insertion mutations
Substitution mutations – silent (same-sense), missense and nonsense mutations, transition and transversion
Deletion and Insertion mutations – frameshift mutations
1.1.2: Trinucleotide repeat expansions – fragile X syndrome, Huntington disease
1.1.3: Spontaneous mutation – tautomeric shifts, spontaneous lesions

1.2: Induced mutations/mutagens/mutagenic agents/DNA damage (4 lectures)

1.2.1: Physical agents – ionizing radiation (X-rays, α, β and γ rays), non-ionizing radiation (UV light)
1.2.2: Chemical agents – base analogs (5-bromouracil, 2-aminopurine), intercalating agents (acridine dyes, ethidium bromide and ICR compounds), deaminating agents (bisulfite compounds and nitrous acid), hydroxylating agents (hydroxylamine), alkylating agents (ethylmethanesulphonate, ethylethane sulphonate, mustard gas, nitrogen mustard, polycyclic aromatic hydrocarbons), aflatoxin (aflatoxin B_1)

1.3: Preventative and repair mechanisms for DNA damage (5 lectures)

1.3.1: Mechanisms that prevent DNA damage – superoxide dismutase and catalase

1.3.2: Mechanisms that repair damaged DNA – direct DNA repair (alkyltransferases, photoreactivation, excision repair)

1.3.3: Postreplication repair – recombination repair, mismatch repair, SOS repair, transcription - repair coupling

1.4: Eukaryotic gene expression (2 lectures)

1.4.1: Regulatory proteins – zinc fingers, helix-turn-helix domain and leucine zipper

1.4.2: DNA methylation

Unit 2: Genetic Engineering (15 lectures)

Learning objectives:

To introduce learners to a set of techniques to modify an organism's genome to produce improved or novel genes and organisms.

Learning outcome:

The learners will get acquainted with the vast array of techniques used to tamper genes which can be applied in numerous fields like medicine, research, etc. for human benefit.

2.1: Tools in Genetic Engineering

2.1.1: Enzymes involved in Genetic Engineering: **(2 lectures)**

Introduction, nomenclature and types with examples, working mechanism, Ligases – E.coli DNA ligase, T4 DNA ligase, polynucleotide kinase, phosphatases, DNA and RNA polymerases, reverse transcriptase, terminal transferase

2.1.2: Vectors for gene cloning: **(2 lectures)**

General properties, advantages and disadvantages of cloning vectors - plasmid vectors, phage vectors, cosmid vectors, phasmid vectors, BAC vectors

2.1.3: Cloning techniques: **(2 lectures)**

Cloning after restriction digestion - blunt and cohesive end ligation, creation of restriction sites using linkers and adapters, cloning after homopolymer tailing, cDNA synthesis (Reverse transcription), genomic and cDNA libraries

2.1.4: Transfection techniques: **(2 lectures)**

Liposome mediated gene transfer, calcium phosphate precipitation method, electroporation, virus mediated gene transfer - Retrovirus

2.2: Techniques in Genetic Engineering

2.2.1: PCR techniques: **(1 lectures)**

Principle of polymerase chain reaction (PCR), Variants in PCR, Applications of PCR

2.2.2: Sequencing techniques: **(2 lectures)**

DNA sequencing: Maxam-Gilbert method, Sanger's method – Manual and automated methods

Protein sequencing: Sanger's method, Edman's method, Applications of sequencing techniques

2.2.3: Separation and detection techniques: **(4 lectures)**

Blotting techniques: Southern blotting, Northern blotting and Western blotting Applications of blotting techniques

Microarray techniques: ESTs, DNA Microarray and Applications

Unit 3: Human Genetics **(15 lectures)**

Learning objectives:
To introduce learners with genetic alterations in human genome and their diagnosis.

Learning outcome:
The learners will become aware of the impact of changes occurring at gene level on human health and its diagnosis.

3.1: Non-disjunction during mitosis and meiosis **(5 lectures)**

3.1.1: Chromosomal Aberrations:
Structural: Deletion: types, effects and disorders; Translocation: types: robertsonian and non-robertsonian, disorders; Inversion: types, effects and significance; Duplication and their evolutionary significance (multigene families)
Numerical: Aneuploidy and Polyploidy (Autoploidy and Alloploidy)

3.2: Genetic Disorders **(5 lectures)**

3.2.1: Inborn Errors of Metabolism: Phenylketonuria, G-6-PD deficiency, Alkaptonuria, Albinism, Niemann Pick syndrome
3.2.2: Single gene mutation: Cystic fibrosis, Muscular dystrophy
3.2.3: Multifactorial: Breast Cancer, Diabetes mellitus, Ischemic heart
3.2.4: Uniparental Disomy: Angelman Syndrome and Prader Willi Syndrome

3.3: Diagnosis **(5 lectures)**

3.3.1: Prenatal Diagnosis (Amniocentesis) and chorio-villus sampling - Ultrasound scanning and Fetoscopy, Banding techniques (G, C, Q), FISH and M-FISH, Protein truncation test (PTT), Single Nucleotide Polymorphism and its applications
3.3.2: Applications: Principles and strategies in identifying the abnormal genes (position independent and dependent), use of abnormalities, confirming a candidate gene
3.3.3: Genetic counselling: Psycho-social aspects for the individual and the family in connection with genetic investigations

Unit 4: Tissue Culture **(15 lectures)**

Learning objectives:
Introduce the learners to fundamental concepts of cell culture and guide them progressively to certain areas which now-a-days are basic to the performance of animal cell culture.
Learning outcome:
The course will prepare learners to understand significance of cell culture as a tool in specialized areas of research and its applications in industries like biotechnology, in fields such as in vitro fertilization and replacement of animals in medical and toxicology experiments.

4.1: Introduction to animal cell culture **(2 lectures)**

4.1.1: Advantages of tissue culture – control of the environment, characterization and homogeneity of sample, economy, scale and mechanization, *in vitro* modeling of *in vivo* conditions

4.1.2: Limitations of tissue culture – expertise, quantity, dedifferentiation and selection, origin of cells, instability

4.2: Aseptic techniques (3 lectures)

4.2.1: Objectives of aseptic techniques – maintaining sterility

4.2.2: Sterilization – basic principles of sterilization, importance of sterility in cell culture

4.2.3: Sterile handling – swabbing, capping, flaming, handling bottles and flasks, pipetting, pouring

4.3: Culture media (5 lectures)

4.3.1: Physicochemical properties – pH, CO_2 and bicarbonate, buffering, O_2, osmolality, temperature, viscosity, surface tension and foaming

4.3.2: Types of media – Natural and Artificial media

4.3.3: Serum – protein, growth factors, hormones, nutrients and metabolites, lipids, minerals and inhibitors

4.3.4: Balanced Salt Solutions

4.3.5: Complete Media– amino acids, vitamins, salts, glucose, oxygen supplements, hormones and growth factors, antibiotics

4.4: Primary culture and establishment of cell lines (5 lectures)

4.4.1: Establishment of primary cultures from various sources – normal 'versus' tumour, adult 'versus' embryo, human 'versus' animal, source of material

4.4.2: Isolation of cells – enzyme digestion, perfusion, mechanical disaggregation, explants cultures

4.4.3: Substrate for attachment

4.4.4: Culture conditions – selection against some cell types, conditioned medium, feeder cells

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T. Y. B. Sc. Zoology
Semester V (Theory)

Course 14

Course Code: USZO504

Unit 1: Integumentary system and derivatives (15 lectures)

Learning objectives:
To introduce the learners to understand different integumentary structures and derivatives in the vertebrates and to acquaint learners with special derivatives of epidermis.
Learning outcome:
Learners will be able to understand the importance of epidermal and dermal derivatives and their functions.

1.1: Basic structure of integument (2 lectures)
Epidermis and dermis; classification of keratinized and non-keratinized derivatives

1.2: Epidermal derivatives of Vertebrates (5 lectures)
Hair, hoof, horn, claw, teeth, beak, epidermal scales (large scales, small scales, modified scales - spine), glands - types and functions (mucous, serous, ceruminous, poison, uropygial, salt), feathers

1.3: Dermal derivatives of vertebrates (3 lectures)
Scales in fish; scutes in reptiles and birds; dermal scales in mammals - Armadillo, Antler - Caribou

1.4: Special derivatives of integument (Epidermal) (5 lectures)
Wart in toad; rattle in snake; horny beak in turtle, birds, monotremes; spur in male birds - jacana, fowl; whale bone - baleen whale; liliac callosities – African mandrill; kneepads - camel

Unit 2: Endocrine glands and regulation (15 lectures)

Learning objectives:
To introduce the learners about the details of endocrine glands and their regulation.
Learning outcome:
Learners will be able to understand the types & secretions of endocrine glands and their functions.

2.1: (2 lectures)
General organization of mammalian endocrine system

2.2: (6 lectures)
Hormones: Classification, properties, mechanism of hormone action, hormone secretion and transport

2.3: (7 lectures)
Histology, functions and disorders of the following endocrine glands: Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal, Testis and Ovaries

Unit 3: Human Osteology **(15 lectures)**

Learning objectives:
To introduce the learners about different bones of human skeleton and their importance.
Learning outcome:
Learners will be able to understand the structure, types and functions of human skeleton.

3.1: Introduction **(2 lectures)**

Cartilage & Bone Structure
Physical properties, chemical composition & functions of bones

3.2: Axial skeleton **(7 lectures)**

3.2.1: Skull: general characteristics of skull bones
1) cranial bones 2) facial bones
3.2.2: Vertebral column: General characteristics of a vertebra, structure of different types of vertebrae (cervical, thoracic, lumbar, sacrum & coccyx)
3.2.3: Ribs & sternum (Thorax): General skeleton of ribs & sternum
3.2.4: Hyoid bone: General structure

3.3: Appendicular skeleton **(4 lectures)**

3.3.1: Pectoral girdle and Pelvic girdle
3.3.2: Forelimbs and Hindlimbs

3.4: Sexual dimorphism of human skeleton **(2 lectures)**

3.4.1: Sternum
3.4.2: Sacrum
3.4.3: Pelvis

Unit 4: Experimental and Chick embryology **(15 lectures)**

Learning objectives:
To introduce to the learners the basics of developmental biology with reference to chick as a model and also understand experiments related to it.
Learning outcome:
Learners will be able to understand the processes involved in embryonic development and its application.

4.1: Introduction to experimental embryology **(5 lectures)**

Germplasm theory, Mosaic theory, Regulative theory, Gradient theory, Spemann's theory of organizers
Basic concept and principles of experimental embryology - brief idea of morphogenesis and organogenesis, fate maps, cell adhesion, cell affinity and differentiation

4.2: Development of Chick **(5 lectures)**

Structure of chick embryo - 24 hours, 36 hours, 48 hours, 72 hours

4.3: Signaling pathways and intercellular communication during development (2 lectures)

Induction and competence, epithelial-mesenchymal interaction

4.4: Recent trends in developmental biology (3 lectures)

Methods to determine the role of genes during development (transgenic and chimeric mouse, "knockout" experiments), Genes contributing to developmental defects (oncogenes), multipotent and pluripotent stem cells and their niche

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T. Y. B. Sc. Zoology
Semester V (Practical)

Course 11
Course Code: USZO501

1. **Levels of organization**

a. Symmetry:
   i. Asymmetry, e.g. Sponge
   ii. Radial: Bi-radial, e.g. Comb jelly
   Penta-radial, e.g. Adult Brittle star
   iii. Bi- lateral, e.g. Larva of Brittle star and human

b. Coelom:
   i. Acoelomate, e.g. Tapeworm
   ii. Pseudocoelomate, e.g. Ascaris
   iii. Coelomate, e.g. Frog

c. Segmentation:
   i. Homonymous, e.g. Nereis
   ii. Heteronomous, e.g. Cockroach

d. Cephalization:
   i. Cephalization, e.g. Honey bee
   ii. Cephalothorax, e.g. Crab

2. Taxonomy of Protozoa to Hemichordata

a. Phylum Protozoa:
   i. Class Rhizopoda, e.g. Amoeba - amoeboid locomotion, asexual reproduction – binary fission
   ii. Class Ciliophora, e.g. Vorticella - ciliary locomotion, sexual reproduction - conjugation
   iii. Class Flagellata, e.g. Noctiluca - flagellar locomotion
   iv. Class Sporozoa, e.g. Monocystis - gliding locomotion

b. Phylum Porifera:
   i. Class Calcarea - Canal system, e.g. Scypha - Sycon type
   Leucosolenia - Ascon type
   ii. Class Demospongia - Canal system, e.g. Spongilla larva - Rhagon type
   Adult - Leuconoid type
   iii. Class Hexactinellida - Observation of sponge spicules (permanent slide/photograph),
   e.g. Hyalonemma

c. Phylum Cnidaria:
   i. Class Hydrozoa, e.g. Vellela
   ii. Class Scyphozoa, e.g. Rhizostoma
   iii. Class Anthozoa, e.g. Corallium (Red coral)

d. Phylum Platyhelminthes:
   i. Class Turbellaria, e.g. Planaria
   ii. Class Trematoda, e.g. Liverfluke
   iii. Class Cestoda, e.g. Taenia solium

e. Phylum Nemathelminthes, e.g. Trichinella

f. Phylum Annelida:
   i. Class Polychaeta, e.g. Arenicola/ Nereis
   ii. Class Oligochaeta, e.g. Tubifex/ Earthworm
   iii. Class Hirudinea, e.g. Pontobdella/ Leech

g. Phylum Arthropoda:
i. Class Merostomata, e.g. Limulus (King crab)
ii. Class Arachnida, e.g. Scorpion
iii. Class Crustacea, e.g. Balanus
iv. Class Myriapoda, e.g. Scolopendra (Centipede)
v. Class Insecta, e.g. Coccinella (Ladybird beetle)
vi. Class Onychophora, e.g. Peripatus
vii. Observation and identification of planktonic crustaceans
viii. Types of Metamorphosis in insects

h. Phylum Mollusca:
i. Class Aplacophora, e.g. Chaetoderma
ii. Class Polyplacophora, e.g. Tonicella/ Chiton
iii. Class Monoplacophora, e.g. Neopilina
iv. Class Gastropoda, e.g. Achatina
v. Class Pelycypoda, e.g. Donax/ Unio
vi. Class Scaphopoda, e.g. Dentalium
vii. Class Cephalopoda, e.g. Octopus

i. Phylum Echinodermata:
i. Class Asteroidea, e.g. Starfish
ii. Class Ophiuroidea, e.g. Brittle star
iii. Class Echinoidea, e.g. Echinus
iv. Class Holothuroidea, e.g. Holothuria (Sea cucumber)
v. Class Crinoidea, e.g. Crinoid (Sea lily)

j. Phylum Hemichordata (Acorn worms):
i. Class Enteropneusta, e.g. Saccoglossus/ Balanoglossus
ii. Class Pterobranchia, e.g. Rhabdopleura
iii. Class Planctosphaeroidea, e.g. Planctosphaera

Note: Visit to local fish market to study available invertebrates

T. Y. B. Sc. Zoology
Semester V (Practical)

Course 12
Course Code: USZO502

1. Enumeration of erythrocytes - Total count

2. Erythrocyte Sedimentation Rate by suitable method – Westergren or Wintrobe method

3. Estimation of haemoglobin by Sahli's acid haematin method

4. Enumeration of leucocytes –Total Count

5. Differential count of WBC

6. Determination of Serum LDH

7. Estimation of total plasma proteins by Folin's method

8. Estimation of serum/ plasma total triglycerides by Phosphovanillin method

9. Latex agglutination test - Rheumatoid Arthritis

T. Y. B. Sc. Zoology
Semester V (Practical)

Course 13
Course Code: USZO503

1. Isolation & Estimation of RNA by Orcinol method (formula method and standard graph)
2. Isolation & Estimation of DNA by Diphenylamine method (formula method and standard graph)
3. Separation of proteins by SDS-PAGE from the given sample (plasma proteins)
4. Colorimetric estimation of proteins from given sample by Bradford's method
5. Karyotype (Idiogram) analysis for the following syndromes with comments on numerical & structural variations in chromosomes (no cutting of chromosomes):
   a. Turner's syndrome
   b. Klinefelter's syndrome
   c. Down's syndrome
   d. Cri-du-chat syndrome
   e. D-G translocation
   f. Edward's syndrome
   g. Patau's syndrome
6. Problems in genetics based on abnormalities in chromosomes:
   a. Interpret the following formula:
      46, XY, t (2;5) (q21; q31)
      Answer:
      Total number of chromosomes present = 46, male.

Reciprocal translocation between chromosomes 2 and 5. Breakage and reunion has occurred between long arm of 2nd chromosome, band 21 and long arm of 5th chromosome, band 31

b. Duplication:

46, XX, dup (1) (q22qq25)

Total number of chromosomes = 46, female. Duplication on chromosome number 1, long arm between band 1q22 and 1q25

c. Turner's Syndrome:

45, X

d. Klinefelter's Syndrome:

47, XXY

7. Stained preparation of Onion root tip and calculation of Mitotic index (permanent slide to be provided)
8. Survey of human traits following Mendelian inheritance:
   (Hair on back of hand, Bent little finger, widows peak, tongue rolling, ear lobe, Cephalic index) Preparation of report
9. Identification of contrasting traits in drosophila using photographs
10. Culture of drosophila, crossing based on traits, study of inheritance pattern (demonstration only)
11. Sterilization technique (Workplace, Glassware, Chemicals, Biological fluids or samples)
12. Use of autoclave for sterilization of equipments for tissue culture
13. Packaging of glassware
14. Trypsinization and vital staining using Trypan blue stain
15. Tissue culture media preparation, aseptic transfer & inoculation of culture
16. Streaking of butt, slant and plate (continuous and discontinuous methods) with E.coli (Demonstration only)

T. Y. B. Sc. Zoology
Semester V (Practical)

Course 14
Course Code: USZO504

1. To study T.S. of integument: amphibian, reptilian, avian, mammalian
2. To study horns, antlers
3. To study different types of scales: dermal, epidermal
4. To study epidermal glands: mucous, sebaceous, sweat, poison, uropygial
5. To study special integumentary derivatives
6. To study the histology of glands: T.S. of pitutary, thyroid, pancreas, adrenal, ovary, testis
7. To study human skeleton: study of axial skeleton
   1. Skull bone
   2. Ossicles of middle ear
   3. Hyoid bone
   4. Rib cage
   5. Sternum
   6. Vertebral column -
      I. Cervical vertebrae
         a. Typical cervical vertebrae (3-6)
         b. Atlas or 1st cervical vertebra

c. Axis or 2nd cervical vertebra
d. 7th cervical vertebra

II. Thoracic vertebrae (8-19)
III. Typical lumbar vertebra (20-24)
IV. Sacral vertebrae and coccyx (synsacrum)
Sacrum (25-29)
Coccyx (30-33)

8. Observation of developing chick embryo -18 hours, 24 hours, 36 hours, 48 hours, 72 hours
9. To prepare temporary mounting of chick embryo up to 72 hours
10. To study the effect of temperature in the development of chick embryo upto 48 hours/ 72

Theory

hours

T. Y. B.Sc. Zoology
Semester based Credit and Grading System
(To be implemented from Academic Year 2017-18)
Semester VI

Course	Unit	Topic	Credits	Lectures/week
USZO601	I	Minor Phyla and Protochordata	2.5	1
	II	Taxonomy – Pisces and Amphibia		1
	III	Taxonomy – Reptilia, Aves and Mammals		1
	IV	Type study : Shark		1
USZO602	I	Enzymology	2.5	1
	II	Homeostasis (Temperature and Ionic regulation)		1
	III	Histology		1
	IV	General Pathology		1
USZO603	I	Zoogeography	2.5	1
	II	Toxicology		1
	III	Biostatistics		1
	IV	Bioinformatics		1
USZO604	I	Environment management	2.5	1
	II	Wildlife management		1
	III	Bioethics, Bioprospecting and Zoopharmacognosy		1
	IV	General Entomology		1
			10	**16**
Practical				
USZOP07		Practicals of Course USZO601 and Practicals of Course USZO602	3	8
USZOP08		Practicals of Course USZO603, USZO604 and Project Component	3	8
			6	**16**
Total			**16**	**32**

T. Y. B. Sc. Zoology
Semester VI (Theory)

Course 15
Course Code: USZO601

Unit 1: Minor Phyla and Protochordata **(15 lectures)**

Learning objectives:

To introduce classification, general characters and phylogeny of minor phyla and protochordates.

Learning outcome:

Learners will get an idea of basic morphological and physiological details of minor phyla and protochordates. Study of phylogeny will help learners to understand the evolutionary relationships between organisms.

1.1: Minor phyla **(6 lectures)**

1.1.1: General features

a. Acoelomate – Phylum Acanthocephala, e.gs. *Macracanthorynchus, Moniloformis* (3 lectures)

b. Coelomate – Phylum Chaetognatha, e.g. *Sagitta* (3 lectures)

1.2: The Protochordates **(9 lectures)**

1.2.1: General overview, characteristics and salient features of Urochordates and Cephalochordates (2 lectures)

a. Urochordata, e.g. *Ascidia* (2 lectures)

b. Cephalochordata, e.g. *Branchiostoma* (2 lectures)

1.2.2: Retrogressive metamorphosis in Ascidian (1 lecture)

1.2.3: Phylogeny of Urochordates and Cephalochordates (2 lectures)

Unit 2: Taxonomy - Pisces and Amphibia **(15 lectures)**

Learning objectives:

To describe general features and classify fish and amphibians.

Learning outcome:

Learners will be able to identify classes of fish and amphibians by their anatomical features. Learners will be able to compare and contrast characters of fishes and amphibians. Learners will be able to describe evolutionary trends implied by their classification.

2.1: Division - Agnatha **(3 lectures)**

2.1.1: Classification of living Agnatha up to classes

2.1.2: General characters of the jawless fishes, e.gs.*Petromyzon* (lamprey) and *Myxine* (hagfish)

2.2: Division - Gnathostomata – Superclass - Pisces **(6 lectures)**

2.2.1: General characters and classification up to order Placoderms, Chondrichthyes and Osteichthyes

Examples: a. Sharks, e.g. *Sphyrna* (Hammer headed shark)

b. Skates and rays, e.gs. *Pristis* (Saw fish), *Dasyatis* (Sting ray)

c. Chimeras, e.g. *Hydrolagus* (Spotted rat fish)

d. Lung fish, e.g. *Lepidosiren* (Australian lungfish)

e. Flying fish, e.g. *Exocoetus*

2.3: Superclass Tetrapoda; Class Amphibia **(6 lectures)**

2.3.1: General overview, classification, characteristics and salient features up to orders

Examples of each order namely -

a. Limb-less amphibian, e.g. *Ichthyophis*

b. Tailed amphibian, e.g. *Amphiuma*
c. Tail-less amphibian, e.g. *Hyla*

2.3.2: Neoteny in Amphibia, e.g. Axolotl larva

Unit 3: Taxonomy - Reptilia, Aves and Mammals (15 lectures)

Learning objectives:

To introduce the learners to the modern system of animal classification. To describe the distinguishing characters of classes Reptilia, Aves and Mammalia and their adaptive features with reference to their habitat.

Learning outcome:

Learners will understand that scientific classification of animals is based on certain characteristics they have in common. Learners will be able to recall characteristic features and examples of each class of Reptilia, Aves and Mammalia.

3.1: Class Reptilia (3 lectures)

3.1.1: General overview, classification, characteristics and salient features of subclasses and orders

Examples of each order namely -

a. Aquatic reptile, e.g. *Chelone*
b. Extinct reptile, e.g. *Ichthyosaurus*
c. Living fossil, e.g. *Sphenodon*
d. Arboreal reptile, e.g. *Chamaeleon*

3.2: Class Aves (6 lectures)

3.2.1: General overview, classification, characteristics and salient features of orders

Examples of each order in accordance to groups -

a. Arboreal birds, e.g. *Treron* (Green pigeon)
b. Terrestrial birds, e.g. *Gallus* (Jungle fowl)
c. Swimming / diving birds, e.gs. *Pelicanus/ Phalacrocoracidae* (Pelican/Cormorant)
d. Shore birds and wading birds, e.gs. *Scolopacidae* (Sandpiper), *Ardeola grayii* (Pond heron)
e. Birds of prey, e.gs. *Strigiformes* (Owl), *Accipitriformes* (Eagle)

3.3: Class Mammalia (6 lectures)

3.3.1: General overview, classification, characteristics and salient features of orders

Examples of each order in accordance to groups -

a. Egg-laying mammals, e.g. *Ornithorhynchus anatinus* (Duck-billed platypus)
b. Pouched mammals, e.g. *Macropus* (Kangaroo)
c. Insect eating mammals, e.g. *Sorex araneus* (Common shrew)
d. Toothless mammals, e.g. *Folivora* (Sloth)
e. Gnawing mammals, e.g. *Sciuridae* (Squirrel)
f. Aquatic mammals, e.g. *Delphinus* (Dolphin)
g. Primates, e.g. *Lemuroidea* (Lemur)

Unit 4: Type study - Shark (15 lectures)

Learning objectives:

To study general characteristics and salient features of animal type - shark. To study in depth one vertebrate animal type.

Learning outcome:

Learners will get an idea of vertebrate animal life and its classification.

4.1: (3 lectures)

Habit & habitat, distribution, external characters and classification, and economic importance

4.2: (12 lectures)

Skin, exoskeleton, endoskeleton, digestive system, respiratory system, blood vascular system, nervous system, receptor organs, urinogenital system, copulation, fertilization and development

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T. Y. B. Sc. Zoology
Semester VI (Theory)

Course 16
Course Code: USZO602

Unit 1: Enzymology (15 lectures)

Learning objectives:

To introduce the learners to the basic concepts of enzyme biochemistry. To make the learners realize the power and application of enzymes in basic and applied science.

Learning outcome:

Learners must be able to understand basics of enzyme structure and function. Learners must comprehend variations in enzyme activity and kinetics. Learners must appreciate the enzyme assay procedures and the therapeutic application of enzymes.

1.1: (3 lectures)

Definition, nomenclature and classification (based on Enzyme Commission) of enzymes, cofactors and coenzymes, the concept and properties of active site

1.2: (3 lectures)

Factors affecting enzyme activity - pH and temperature; concept of activation energy; Enzyme structure (lysozyme and serine protease)

1.3: (3 lectures)

Enzyme kinetics, Concept of steady state, Derivation of Michaelis-Menton equation and Lineweaver-Burk plot, Enzyme assay, concept and significance of k_m, V_{max} and k_{cat}, modulation of enzyme activity with reference to GDH

1.4: (2 lectures)

Enzyme inhibitors, competitive and non-competitive inhibitors and their kinetics; therapeutic applications of enzyme inhibitors

1.5: (2 lectures)

Regulation of enzyme activity; Hill equation; allosteric regulation and regulation by covalent modification of enzymes; Zymogen (pepsinogen and proelastase); Isozymes (LDH)

1.6: (2 lectures)

Clinical significance and industrial applications of enzymes

Unit 2: Homeostasis (Temperature and Ionic regulation) (15 lectures)

Learning objectives:

To introduce the learners to the concept of homeostasis. To familiarize the learners with thermoregulation, osmoregulation and feedback mechanism.

Learning outcome:

Learners would be able to understand the concept of positive and negative feedback mechanisms. Learners would comprehend the adaptive responses of animals to environmental changes.

2.1: Homeostasis (5 lectures)

External and internal environment; Acclimation and acclimatization; Control systems in biology: Feedback mechanism - negative feedback and positive feedback with suitable examples

2.2: Thermoregulation (5 lectures)

Endothermy, ectothermy (relation between temperature and biological activities); temperature balance; heat production - shivering and non shivering thermogenesis; brown fat - special thermogenic tissue in mammals, mechanisms of heat loss; adaptive response to temperature - daily torpor, hibernation, aestivation

2.3: Osmotic and Ionic regulation (5 lectures)

Maintaining water and electrolyte balance; ionic regulation in iso-osmotic environment; living in hypo-osmotic and hyper-osmotic environment; problems of living in terrestrial environment: water absorption, salt water ingestion and salt excretion, salt glands, role of kidney in ionic regulation, metabolic water

Unit 3: Histology (15 lectures)

Learning objectives:

To familiarize the learners with the cellular architecture of the various organs in the body. To make the learners understand the need and importance of different types of tissues in the vital organs and their functions.

Learning outcome:

Learners would appreciate the well planned organization of tissues and cells in the organ systems.

3.1: Vertical section (V.S.) of skin **(3 lectures)**

Layers and cells of epidermis; papillary and reticular layers of dermis; sweat glands, sebaceous glands and skin receptors

3.2: Digestive System

3.2.1: Vertical Section (V.S.) of tooth – hard tissue – dentine and enamel; soft tissue – dentinal pulp and periodontal ligaments **(2 lectures)**

3.2.2: Transverse section (T.S.) of tongue – mucosal papillae and taste buds **(2 lectures)**

3.2.3: Alimentary Canal – basic histological organization with reference to transverse section (T.S.) of oesophagus, stomach, duodenum, ileum and rectum of mammal **(3 lectures)**

3.2.4: Glands associated with digestive system - histology with reference to transverse section (T.S.) of salivary glands, liver, pancreas **(3 lectures)**

3.3:

Respiratory organs – transverse section (T.S.) of trachea and lung **(2 lectures)**

Unit 4: General pathology

Learning objectives:

To introduce the learners to basics of general pathology. To impart knowledge of retrogressive, necrotic, circulatory neoplastic pathological conditions in the body. To explain repair mechanism of the body.

Learning outcome:

Learners will gain knowledge of various infective agents and diseases caused by them. Learners will be familiar with various medical terminology pertaining to pathological condition of the body caused due to disease.

4.1: **(2 lectures)**

Infectious diseases: aetiology, infectious agents, viruses - hepatitis, bacteria - tuberculosis, fungi - skin diseases

4.2: Retrogressive changes **(2 lectures)**

Definition, cloudy swelling, degeneration: fatty, mucoid and amyloid (causes and effects)

4.3: Disorders of pigmentation **(1 lecture)**

Endogenous: Brief ideas about normal process of pigmentation, melanosis, jaundice (causes and effects)

4.4: Necrosis **(1 lecture)**

Definition and causes; nuclear and cytoplasmic changes; Types: Coagulative, Liquefactive, Caseous, Fat and Fibroid

4.5: Gangrene

Definition and types (dry, moist and gas gangrene) **(1 lecture)**

4.6: Circulatory disturbances **(2 lectures)**

Causes and effects of Hyperaemia, Ischaemia, Thrombosis, Embolism, Oedema and Infarction

4.7: Inflammation **(2 lectures)**

Definition and causes (pathogenic and immune), cardinals of inflammation; acute and chronic inflammation

4.8: Applied pathology **(2 lectures)**

Anatomical, clinical and molecular; investigating methods: biopsy and surgery (for pathological examination of tissue)

4.9: Forensic pathology **(2 lectures)**

Autopsy, post mortem changes - Algor mortis - body cooling, Rigor mortis - stiffening of limbs, state of decomposition - autolysis (process of self-digestion) and putrefaction

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T. Y. B. Sc. Zoology
Semester VI (Theory)

Course 17
Course Code: USZO603

Unit 1: Zoogeography (15 lectures)

Learning objectives:
To introduce learners to a branch of science dealing with the geographic distribution of animals.
Learning outcome:
The learners will become acquainted with how and why different animal species are distributed around the globe.

1.1: Introduction (2 lectures)

1.1.1: Origin of oceans and continents
1.1.2: Plate tectonics and continental drift

1.2: Distribution of animals in space and time (5 lectures)

1.2.1: In space – horizontal or superficial
1.2.2: In time – geological or durational
1.2.3: Patterns of animal distribution – continuous, discontinuous, isolation and bipolarity
1.2.4: Theories of animal distribution

1.3: Barriers of distribution of animals (3 lectures)

1.3.1: Topographic, climatic, vegetative, large water masses, land mass, lack of salinity and special characteristic habits like homing instinct, etc.
1.3.2: Means of dispersal – land bridges, natural rafts and drift wood, favouring gales, migration by host, accidental transportation and by human agencies

1.4: Zoogeographical realms (5 lectures)

1.4.1: Palearctic, Ethiopian, Oriental, Australian, Neotropical, Nearctic and Antarctic

Unit 2: Toxicology (15 lectures)

Learning objectives:

Introduce the learners to principles of toxicology with particular emphasis on toxic responses to chemical exposures, nature and effect of toxicity and toxicity testing. It also intends to develop amongst students an introductory understanding of regulatory affairs in toxicology.

Learning outcome:

The course will prepare learners to develop broad understanding of the different areas and significance of toxicology. Moreover, it will also develop critical thinking and assist students in preparation for employment in pharmaceutical industry and related areas.

2.1: Basic toxicology (10 lectures)

2.1.1: Introduction to toxicology – brief history, different areas of toxicology, principles and scope of toxicology

2.1.2: Toxins and Toxicants – Phytotoxins (caffeine, nicotine), Mycotoxins (aflatoxins), Zootoxins (cnidarian toxin, bee venom, scorpion venom, snake venom)

2.1.3: Characteristics of Exposure – Duration of exposure, Frequency of exposure, Site of exposure and Routes of exposure

2.1.4: Types of toxicity – Acute toxicity, subacute toxicity, subchronic toxicity, chronic toxicity, immediate toxicity, delayed toxicity, reversible toxicity, irreversible toxicity, local toxicity, systemic toxicity

2.1.5: Concept of LD_{50}, LC_{50}, ED_{50}

2.1.6: Dose Response relationship – Individual/ Graded dose response, Quantal dose response, shape of dose response curves, Therapeutic index, Margin of safety

2.1.7: Dose translation from animals to human – Concept of extrapolation of dose, NOAEL (No Observed Adverse Effect Level), Safety factor, ADI (Acceptable Daily Intake)

2.2: Regulatory toxicology (5 lectures)

2.2.1: OECD guidelines for testing of chemicals (an overview)

2.2.2: CPCSEA guidelines for animal testing centre, ethical issues in animal studies

2.2.3: Animal models used in regulatory toxicology studies

2.2.4: Alternative methods in toxicology (*in vitro* tests)

Unit 3: Biostatistics (15 lectures)

Learning Objectives:

To make learners familiar with biostatistics as an important tool of analysis and its applications.

Learning outcome:

The learners will be able to collect, organize and analyze data using parametric and non-parametric tests. They will also be able to set up a hypothesis and verify the same using limits of significance.

3.1: Probability Distributions (3 lectures)

Normal, Binomial, Poisson distribution, Z-transformation, p-value

Probability - Addition and multiplication rules and their applications

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3.2: Measures of Central Tendency and Dispersion **(2 lectures)**

Variance, standard deviation, standard error

3.3: Parametric and non-parametric tests **(4 lectures)**

Parametric tests: two-tailed Z-test and t-test

Non-parametric test: Chi-square test and its applications

3.4: Regression and Correlation **(3 lectures)**

Simple linear regression: main features, applications

Correlation coefficient and its significance

3.5: Testing of Hypothesis **(3 lectures)**

Basic concepts, types of hypothesis: Null hypothesis and Alternate hypothesis

Levels of significance and testing of hypothesis

Unit 4: Bioinformatics **(15 lectures)**

Learning objectives:

To introduce learners to bioinformatics – a computational approach to learning the structure and organization of genomes, phylogeny, metabolism and immunology.

Learning outcome:

The learners will become aware of the computational point of view of studying the genomes.

4.1: Introduction **(2 lectures)**

4.1.1: Introduction to Bioinformatics and Bioinformatics web resource (NCBI, EBI, ExPASy, OMIM, PubMed, OMIA)

4.1.2: Applications of Bioinformatics

4.2: Databases – Tools and their uses **(4 lectures)**

4.2.1: Biological databases:

Primary sequence databases:

Nucleic acid sequence databases (GenBank, EMBL-EBI, DDBJ)

Protein sequence data bases (UniProtKB, PIR, PDB)

Secondary sequence databases:

Derived databases - PROSITE, BLOCKS, Pfam/ Prodom, Structure databases and bibliographic databases

4.3: Sequence alignment methods **(4 lectures)**

4.3.1: BLAST, FASTA

4.3.2: Significance of sequence alignment

4.3.3: Pairwise sequence alignment (Needleman & Wunsch, Smith & Waterman methods)

4.3.4: Multiple sequence alignment (PRAS, CLUSTALW)

4.4: Predictive applications using DNA and protein sequences **(5 lectures)**

4.4.1: Evolutionary studies: Concept of phylogenetic trees, Parsimony and Bayesian approaches, synonymous and non-synonymous substitutions, convergent and parallel evolution

4.4.2: Pharmacogenomics: Discovering a drug: Target identification

4.4.3: Protein Chips and Functional Proteomics: Different types of protein chip, detecting and quantifying; applications of Proteomics

4.4.4: Metabolomics: Concept and applications

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Semester VI (Theory)

Course 18
Course Code: USZO604

Unit 1: Environment management (15 lectures)

Learning objectives:
To introduce the learners to understand the importance of factors governing environment and its management.
Learning outcome:
Learners will be able to understand the different factors affecting environment, its impact and laws governing environmental management.

1.1: Natural resources and their classification (2 lectures)
Forest resources, water resources (surface and ground), mineral resources, food resources, energy resources: Renewable and non-renewable resources

1.2: Exploitation and modification of natural resources (2 lectures)
Impact on climate, flora, fauna & mineral resources

1.3: Sustainable development (3 lectures)
Ex-situ conservation (zoos, botanical gardens, cryogenics, seedbank, germplasm, gene bank), in-situ conservation (Bio-reserves, Sanctuaries & National parks)

1.4: Waste Management (2 lectures)
3 Rs (Reduce, Reuse & Recycle) of solid waste, e-waste, hazardous waste

1.5: Water management (2 lectures)
Rain water harvesting, watershed management, effluent treatment, recycling plants, control and treatment of water

1.6: Laws governing environment (4 lectures)
(Environment Protection Act), Air (Prevention and Control of Pollution) Rules - 1982, Water (Prevention and Control of Pollution) Rules - 1978, Hazardous Wastes (Management and Handling) Rules - 1989. EIA (Environmental Impact Assessment), ISO18001
Role of government, NGOs, International treaties and conventions in environmental protection & conservation

Unit 2: Wildlife Management (15 lectures)

Learning objectives:
To introduce the learners to the importance of wildlife conservation.

Learning outcome:
Learners will be able to understand the wildlife habitat projects for animal protection.

2.1: Habit, habitat, territory & niche of animals (3 lectures)
Herbivores, carnivores; solitary, pack and herd

2.2: Threats to wildlife **(6 lectures)**

Diseases (zoonosis and reverse zoonosis), competition, hunting, poaching, encroachment, deforestation, tourism, overgrazing, human animal conflict and climate change

2.3: Techniques and methods of wildlife conservation **(6 lectures)**

Wildlife Census, conservation of wildlife - frozen zoo, schedules, rules, national and international conservation bodies; IUCN UNDP, FAO, ESA, INCPEN, CITES, CEEDS,WWF

Unit 3: Bioethics, Bioprospecting and Zoopharmacognosy **(15 lectures)**

Learning objectives:

To introduce the learners to understand the concept of ethics and prospecting in biology and importance of pharmacognosy.

Learning outcome:

Learners will be able to understand paradigms of discovery and commercialization of biological resources and knowledge gained by self medication by animals.

3.1: Bioethics **(4 lectures)**

Intellectual property rights and patenting, forms of protection, patents, copyrights, trade secrets, trademarks, patenting biological materials, live forms, genes and DNA sequences

3.2: Bioprospecting **(4 lectures)**

Traditional, modern bioprospecting, Chemical prospecting, Genetic prospecting, Bionic prospecting, Economic value and benefit sharing, Bioprospecting and conservation, pros and cons of bioprospecting

3.3: Zoopharmacognosy **(7 lectures)**

3.3.1: Definition, history and types
3.3.2: Self-medication and its mechanism
3.3.3: Methods of self-medication through - Ingestion – ants and mammals, Geophagy – invertebrates and birds
3.3.4: Absorption and adsorption
3.3.5: Topical application – birds and mammals
3.3.6: Applications of zoopharmacognosy - Social and transgenerational zoopharmacognosy
3.3.7: Value to humans

Unit 4: General Entomology **(15 lectures)**

Learning objectives:

To introduce the learners about the importance of insects and their application in different fields of human life.

Learning outcome:

Learners will be able to understand the role of useful and harmful insects in human life.

4.1: Introduction **(1 lecture)**

Definition, distinguishing features of insects, harmful and useful insects

4.2: Importance & Scope of Entomology, Branches of Entomology (1 lecture)
Agricultural, Medical, Forest, Forensic & Industrial

4.3: Metamorphosis in insects (3 lectures)
Definition, types, hormones

4.4: Insect pheromones, bioluminescence, sound production (3 lectures)
Definitions, types, significance

4.5: General body structure of insects (3 lectures)
a) Mouth parts - cutting, chewing, lapping, sucking, sponging
b) Modification of legs in insects - e.g. honey bee, cockroach, beetle

4.6: Significance of insects as biological tool (4 lectures)
Biological weapon; tissue culture; gene study; Productive insects - honey bee, silk worm, lac insect; insect products; insects pests (general): bollworm, rice weevil, tribolium, flour moth, locust

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T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 15
Course Code: USZO601

1. Levels of organization

Minor Phyla

a. Acoelomate:

Phylum Acanthocephala (Spiny headed worms), e.g. Echinorhyncus

b. Coelomate:

Phylum Chaetognatha (Arrow worms), e.g. Sagitta

2. Taxonomy of phylum Chordata

a. Subphylum Urochordata (Sea squirts)

1. Class Larvaceae, e.g. Oikopleura
2. Class Ascidiacea, e.g. Ciona/ Herdmania

3. Class Thaliacea, e.g. Salpa/ Doliolum

b. Subphylum Cephalochordata:
Class Leptocardii, e.g. Branchiostoma (Amphioxus)

c. Subphylum Vertebrata:
I. Group Agnatha
1. Class Ostracodermi, e.g. Pharyngolepis
2. Class Cyclostomata, e.g. Petromyzon

II. Group Gnathostomata
i. Superclass - Pisces:
1. Class Placodermi (Armoured fishes), e.g. Bothriolepis
2. Class Elasmobranchi (Chondrichthyes), e.g. Rhinobatos
3. Class Holocephali (Chimaera), e.g. Rabbit fish / Rat fish
4. Class Dipnoi (Lung fishes), e.g. Protopterus (African lungfish)
5. Class Teleostomi, e.g. Latimera (Coelacanth), Catfish

ii. Superclass - Tetrapoda :
1. Class Amphibia
a. Order Apoda, e.g. Siphonops/ Ichthyophis
b. Order Anura, e.g. Alytes (Midwife toad)
c. Order Urodela, e.g. Triton (Semi-aquatic salamander)
2. Class Reptilia:
a. Order Synapsida, e.g. Dimetrodon
b. Order Parapsida, e.g. Chasmosaurus (Dinosaur)
c. Order Anapsida, e.g. Geochelone (Indian star tortoise)
d. Order Diapsida, e.g. Mabuya (Skink)

3. Class Aves:
a. Subclass Archaeornithes, e.g. Archaeopteryx
b. Subclass Neornithes
- Superorder Paleognathae (Flightless birds), e.g. Emu, Penguin
- Superorder Neognathae (Flying birds), e.g. Flamingo, Vulture

4. Class Mammalia:
a. Subclass Prototheria (Egg laying mammals), e.g. Duck-billed platypus
b. Subclass Theria
- Infraclass- Metatheria (Marsupials/ Pouched mammals), e.g. Dasyurus (Tiger cat)
- Infraclass – Eutheria (Placental mammals), e.g. Gangetic Dolphin, Gorilla

3. Study of endoskeleton of shark:
a. Axial (skull and vertebral column)
b. Appendicular (pelvic and pectoral fins, pelvic and pectoral girdle)

Note: Visit to local fish market to study available vertebrates

REFERENCES

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- Practical zoology; K.C. Ghose and B. Manna; Central publication; 2007
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T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 16
Course Code: USZO602

1. Effect of pH on activity of enzyme Acid Phosphatase
2. Effect of varying enzyme concentration on activity of enzyme Acid Phosphatase
3. Effect of varying substrate concentration on activity of enzyme Acid Phosphatase
4. Effect of inhibitor on the activity of enzyme Acid Phosphatase
5. Study of separation of LDH isozymes by agarose gel electrophoresis
6. To study the effect of enzymes in detergents
7. Study of mammalian tissues:
   i. V. S. of Skin
   ii. V.S. of Tooth
   iii. T.S. of Stomach
   iv. T.S. of Ileum
   v. T.S. of Liver
   vi. T.S. of Pancreas
   vii. T.S. of Lung
8. i. Identification of following diseases or conditions (from slides or pictures) – Melesma, Vitiligo, Psoriasis, Bed sores, Necrosis, Oedema, Malaria, Filariasis, Leishmaniasis
   ii. Vidal's Test

iii. Study and interpretation of pathological reports: Blood, Urine and Stool (feces)

T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 17
Course Code: USZO603

1. To estimate phosphate phosphorus from sample water
2. To estimate BOD from sample water
3. To estimate COD from sample water
4. To estimate Nitrite Nitrogen and Nitrate Nitrogen from sample water
5. To study the intensity of sound by Decibel meter & prepare a survey report
6. To study acidity and alkalinity of sample water by methyl orange and phenolphthalein
7. To study the effect of CCl_4 on the level of enzyme activity in liver on aspartate and alanine amino transferase (*in vitro* approach)
8. To study the effect of paracetamol on the level of enzyme activity in liver on aspartate and alanine amino transferase (*in vitro* approach)

9. Following biostatistics practicals will be done using data analysis tool of Microsoft Excel (DEMONSTRATION in regular practicals) & manually:
    1. From the given data derive mean, standard deviation
    2. Correlation, regression analysis using given data
    3. Problems based on Z test
    4. Problems based on t test
    5. Problems based on Chi square test
    6. Problems based on ANOVA
10. Exploring the integrated database system at NCBI server and querying
    (Querying a nucleotide sequence, querying a protein sequence, use of operators (AND, OR & NOT)

11. Exploring tools on ExPASy
    (Querying a nucleotide sequence, querying a protein sequence, use of operators (AND, OR & NOT)
12. Exploring BLAST tool (nucleotide sequence comparison)
13. Exploring Uniprot tool (protein sequence comparison)
14. Exploring bibliographic database PubMed (Data mining - Downloading a research paper on subject of interest, use of operators (AND, OR & NOT)
15. Indicate the distribution of genus/species/subspecies in the given world map w.r.t. to its realm and comment on the pattern of distribution
16. Indicate the realms and the fauna found in that realm on the given world map, justify

T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 18
Course Code: USZO604

1. To estimate phosphate phosphorus from sample water
2. To estimate COD, BOD from sample water
3. To estimate Nitrite Nitrogen and Nitrate Nitrogen from sample water
4. To study the intensity of sound by Decibel meter
5. To study acidity and alkalinity of sample water by methyl orange and phenolphthalein
6. To observe the animals in the chart and place them in endangered, vulnerable category
7. To study different types of mouth parts: cutting, chewing, lapping, sucking, sponging
8. To study metamorphosis in insects: ametabolic - lepisma, hemimetabolic - cicada, holometabolic - butterfly, mosquito
9. To study mechanism of bioluminescence in insects (Need to design practical)
10. Insect pests and control: rice weevil, flour moth, aphids, tribolium

T. Y. B. Sc. Zoology
Semester V (Practical)

Course 11
Course Code: USZO501

Skeleton of Practical Examination Question Paper

Time: 9:30 a.m. to 2:30 p.m. **Total Marks: 50**

Q.1 Identify and describe- **06**
a. Symmetry / Coelom/ Segmentation / Cephalization (Any two)
b. Observe the animal (photo/existing preserved specimen) and state its phylum giving reasons

Q.2 Identify and classify giving reasons- **12**
a. Protozoa / Porifera / Cnidaria
b. Platyhelminthes / Nemathelminthes
c. Annelida / Arthropoda
d. Mollusca / Echinodermata

Q.3 Identify, classify and describe - **03**
a. Phylum Hemichordata

Q.4 Identify and describe- **09**
a. Locomotion / Reproduction in Protozoa
b. Canal system in Sponges / Metamorphosis in insects
c. Spicules in sponges / Planktonic crustaceans

Q.5 Field Report and Viva based on theory paper **10**

Q.6 Journal **10**

T. Y. B. Sc. Zoology
Semester V (Practical)

Course 12
Course Code: USZO502

Skeleton of Practical Examination Question Paper

Time: 9:30 a.m. to 2:30 p.m. **Total Marks: 50**

Q.1 Enumeration of erythrocytes - Total count **15**

OR

Q.1 Enumeration of leucocytes - Total count

OR

Q.1 Differential count of leucocytes

Q.2 Estimation of serum /plasma total proteins by Folin's method **10**

OR

Q.2 Estimation of serum/plasma total triglycerides by Phosphovanillin method

Q.3 Estimation of haemoglobin by Sahli's acid haematin method **10**

OR

Q.3 Estimate Erythrocyte Sedimentation Rate by suitable method

OR

Q.3 Determination of serum LDH

Q.4 Latex agglutination test - Rheumatoid Arthritis **05**

Q.5 Viva voce **05**

Q.6 Journal **05**

T. Y. B. Sc. Zoology
Semester V (Practical)

Course 13 and Course 14
Course Code: USZO503 and USZO504

Skeleton of Practical Examination Question Paper

Time: 9:30 a.m. to 2:30 p.m. **Total Marks: 50**

Q.1 Isolation & Estimation of RNA by Orcinol method **15**

OR

Q.1 Isolation & Estimation of DNA by Diphenylamine method

OR

Q.1 Trypsinization and vital staining using Trypan blue stain

Q.2 Separation of proteins by SDS-PAGE from the given sample **10**

OR

Q.2 Demonstrate transfer of liquids between burners aseptically

OR

Q.2 Demonstrate packaging of glassware for sterilization

Q.3 Problems in genetics (Idiogram - 2 marks, Calculations - 3 marks) **05**

Q.4 Identification **15**
Spot a) Based on histology
Spot b) Based on histology
Spot c) Based on osteology - human axial skeleton
Spot d) Based on osteology - human appendicular skeleton
Spot e) Based on chick embryology

Q.5 Submission of report (based on human traits following Mendelian inheritance) **05**

T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 15
Course Code: USZO601

Skeleton of Practical Examination Question Paper

Time: 9:30 a.m. to 2:30 p.m. **Total Marks: 50**

Q.1 a. Identify, classify and describe **06**
(Any one example from Urochordates/ Cephalochordates / Ostracodermi / Cyclostomata/ Minor Phyla)
b. Observe the animal (photo/existing preserved specimen) and state its class giving reasons
(Any one example from superclass Pisces and Tetrapoda)

Q.2 Identify and classify giving reasons - **15**
a. Pisces
b. Amphibia / Reptilia
c. Aves / Mammalia

Q.3 Identify, sketch and label/ Identify and label marked portion in given diagram - **09**
a. Skull or Vertebra of shark
b. Fin of shark (Pectoral / Pelvic)
c. Girdle of shark (Pectoral / Pelvic)

Q.4 Field Report and Viva based on theory paper **10**

Q.5 Journal **10**

T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 16
Course Code: USZO602

Skeleton of Practical Examination Question Paper

Time: 9:30 a.m. to 2:30 p.m. **Total Marks: 50**

Q.1 Demonstrate the effect of _____ on the activity of acid phosphatase **15**
(Substrate concentration/pH variation/Enzyme concentration/Inhibitor concentration)

Q.2 Study of separation of LDH isozymes by agarose gel electrophoresis **10**

OR

Q.2 To study the effect of enzymes in detergents

OR

Q.2 Perform Vidal's Test and give the clinical significance of the result

Q.3 Identify and describe a, b, c, d, e **15**

a and b - Study of mammalian tissues (V. S. of Skin, V.S. of Tooth, T.S. of Stomach, T.S. of Ileum, T.S. of Liver, T.S. of Pancreas T.S. of Lung)

c and d - Identification of following diseases or conditions (from slides or pictures) – Melesma, Vitiligo, Psoriasis, Bed sores, Necrosis, Oedema, Malaria, Filariasis, Leishmaniasis

e – Interpret the pathological report – blood / urine / stool

Q.4 Viva voce **05**

Q.5 Journal **05**

T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 17 and Course 18
Course Code: USZO603 and USZO604

Skeleton of Practical Examination Question Paper

Time: 9:30 a.m. to 2:30 p.m. **Total Marks: 50**

Q.1 Demonstrate the effect of CCl_4 on the level of enzyme activity of aspartate/alanine amino transferase in liver (*in vitro* approach) **15**

OR

Q.1 Demostrate the effect of paracetamol on the level of enzyme activity of aspartate/ alanine amino transferase in liver (*in vitro* approach)

Q.2 Estimate Phosphate Phosphorus/ Nitrite Nitrogen and Nitrate Nitrogen /acidity /alkalinity /COD /BOD from sample water **10**

OR

Q.2 Demonstrate the use of bioinformatics tools to explore DNA, Protein sequence

Q.3 Indicate the distribution of genus/species/subspecies in the given world map w.r.t. to its realm and comment on the pattern of distribution **05**

OR

Q.3 Indicate the realms and the fauna found in that realm on the given world map, justify

Q.4 Problems in Biostatistics **06**

Q.5 Identification **06**
Spot a) Based on types of mouth parts
Spot b) Based on types of metamorphosis
Spot c) Based on insect pest

Q.6 Submission of report (based on sound/ noise measurements using sound meter) and journal (Report submission – 3 marks; Journal – 5 marks) **08**

TYBSc proposed practical pattern for revised syllabus in the subject of Zoology

For students opting for 6 units of Zoology to be effective from academic year 2017-2018

Practical pattern for Semester V

Course Code	Practicals	Marks
US ZO P05	Practicals based on US ZO 501 (Paper 1)	50
US ZO P05	Practicals based on US ZO 502 (Paper 2)	50
US ZO P06	Practicals based on US ZO 503 and US ZO 504 (Papers 3 and 4)	50
US ZO P06	Project component * (kindly refer to the note below for details)	50
		Total marks = 200

Details of Project component* for Semester V are as follows:

1. In semester V the students will submit an outline / scheme of the project proposal.
2. Actual execution/practical work of this project to be done only in semester VI.
3. The project proposal will be prepared by a group of students (not more than 5 in a group).
4. The project proposal will involve study of topic (covered in the UG syllabi) / interdisciplinary topic.
5. Each group to be mentored by one teacher from the department.
6. The concerned teacher will mentor the group by giving orientation/instructions about writing the project proposal.
7. The outline / scheme of the project proposal will include literature search/survey, introduction, objectives, purpose and rationale, materials and methods, expected outcomes/results, relevance of the project and bibliography.
8. The student will prepare a hard copy of the project proposal which will have titles discussed in point no. 7.

Evaluation of Project Proposal during practical examination for Semester V will be as follows:

1. Although the students would have prepared the project proposal as a group in Semester V, however, they are expected to submit the project proposal individually.

2. Each student will submit a project proposal (hard copy) during practical examination.

3. The soft copy of this project proposal can be kept in the department for documentation and record.

4. The project proposal will be evaluated by **internal examiner** (preferably the mentor) and external examiner as per the evaluation criteria given below:

Title	**Marks**
Literature search/survey	04 marks
Objectives, Purpose and Rationale	04 marks
Materials and Methods	04 marks
Expected outcome/ hypothesis	03 marks
Work plan with milestones/ Timeline	03 marks
Overall approach and conduct	07 marks
Total	**25 marks**

- The **external examiner** will evaluate the hard copy of the project proposal as per the evaluation criteria given below:

Title	**Marks**
Literature search/survey	04 marks
Objectives, Purpose and Rationale	04 marks
Materials and Methods	04 marks
Expected outcome/ hypothesis	03 marks
Bibliography	03 marks
Viva voce based on the proposal	07 marks
Total	**25 marks**

Practical pattern for Semester VI

Course Code	**Practicals**	**Marks**
US ZO P07	Practicals based on US ZO 601 (Paper 1)	50
US ZO P07	Practicals based on US ZO 602 (Paper 2)	50
US ZO P08	Practicals based on US ZO 603 and US ZO 604 (Papers 3 and 4)	50

US ZO P08	Project component * (refer to the note below for details)	50
		Total marks = 200

Details of Project component* for Semester VI are as follows:

1. In semester VI the students will actually execute their respective project submitted in Semester V.
2. Actual execution may involve laboratory/table work and or field work and or survey as per the specifications mentioned in their project proposal.
3. The mentor for the respective group will keep a track of the actual execution of the project.
4. After completion of the practical work the student will prepare a '**Dissertation**' which will have an abstract/synopsis, brief introduction, materials and methods, observations, interpretation of results, conclusion and discussion, future plans/extension of work.
5. The student will also give a '**Power point presentation**' about the project (not more than 7 slides and not more than 7 minutes per presentation).

Evaluation of Project Proposal during practical examination for Semester VI will be as follows:

1. The external examiner will evaluate the '**Dissertation**' carrying **30** marks as per the evaluation criteria given below:

Title	Marks
Abstract/synopsis	05 marks
Materials and Methods	05 marks
Observations	05 marks
Interpretation of results	05 marks
Conclusion and Discussion	05 marks
Relevance of work	05 marks

Total	**30 marks**

2. The external examiner will evaluate the '**Power point presentation**' carrying **20** marks as per the evaluation criteria given below:

Title	**Marks**
Content of the presentation	05 marks
Quality of the presentation	05 marks
Presentation skills	05 marks
Viva /Question- Answer session	05 marks
Total	**20 marks**

Document prepared by:

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AC - 11th May, 2017
Item No. 4.285

AC Item No.

UNIVERSITY OF MUMBAI

Program: B.Sc.

(Credit Based Semester and Grading System)

Course: Environmental Science

(Applied Component)

Syllabus for Semester V & VI

(with effect from the academic year 2017-18)

CONTENTS

PREFACE

Applied Component was introduced for T. Y. B. Sc. class in the academic year 1979-80 with a view to enhance the essence for employability. The syllabus is a blend of concepts with four electives. It gives me immense pleasure to present these four applied component courses namely Marine Science, Fishery Biology, Economic Entomology and Environmental Science under the umbrella of BOS in Zoology.

In the syllabi of these applied components, applied topics having commercial propositions have been incorporated that further ads to the enhancement of entrepreneurial potential and skills amongst the learners. In the past our syllabus focused mainly on theory as a way of providing knowledge base and preparation for students. We have attempted to go beyond this tradition, while doing so; equal emphasis is laid on theory and corroborative practicals. From the academic year 2011-12, the University has introduced Credit Based Semester and Grading System (CBSGS). Accordingly the existing syllabi of these applied components were restructured to fit into the CBSGS pattern. The concept of flexi syllabus was introduced offering opportunity to learners to study any four out of a total of eight units in each course. Now that the syllabus is restructured and to be introduced from the academic year 2017-2018, we have included a novel concept of open unit and case studies. This approach, I'm sure will enhance the critical and analytical thinking abilities of the students.

I take this opportunity to thank the experts in various fields for giving valuable, beneficial and constructive suggestions during framing of the syllabus. The syllabus committee under the convenorship of Mr. Vinayak Dalvie has done a commendable job of timely framing the syllabus with a highest degree of precision and accuracy. While appreciating the efforts, I also express my thanks and heartfelt gratitude to the entire team.

– Dr. Anita Jadhav
Chairperson,
Ad-hoc BOS in Zoology

PREAMBLE

As a convener when I mooted the concept of flexi-syllabus, first of its kind, in the academic year 2009-10 it was grossly misconstrued. To add to it I also placed an idea of including case studies and introducing a new concept of ‘Open Unit’. Both were rejected then. I had also proposed a new subject ‘Entrepreneurial and Industrial Biology’ in place of the existing Applied Components usually offered by the students of Biological Sciences. Twenty workshops in different districts with teachers and students of various subjects were conducted to explain these four concepts. A twenty one days refresher course for teachers, sponsored by UGC was also conducted in the new subject of ‘Entrepreneurial and Industrial Biology’ which was much appreciated by the then Director of NAAC, Prof H. A. Ranganath, who is from Biological Sciences, understanding the potential of the subject. However, implementation was postponed for technical reasons thus permitting innovation limited to the flexi-syllabus, implemented in 2010-11, which has inherent capacity to cater to the diverse needs of the region and the industry by allowing students and teachers to choose a desired capsule of eight topics, with various permutations and combinations from the menu of sixteen based on the interest, resources, expertise and need. It took care of a range of students by also providing learners' space to high IQ students. Yet the possibility of exclusion of some important topics cannot be ruled out apart from some new avenues developed during the lag phase of revision of syllabi. Open unit will permit a good teacher to keep pace with the development and adopt latest topics instantly without waiting till it becomes obsolete in the gap of 5 years that the University generally takes to revise the syllabus. It may also allow students to learn the existing topic in more details and depth under the open unit thus making them specialized in need based areas enhancing employability. Assignments would add to their understanding of Government schemes, regulations and market, while projects will augment Business Sense or Scientific Acumen, as the case may be. Case studies and simulations, introduced for the first time in Zoology, would pose challenge for true application of knowledge to real life situations with thought provoking questions demanding analytical solutions. Pedagogy of such dynamic syllabus will range from use of ICT in the class to teaching directly in the field with a blend of participative and experiential learning with group dynamics gaining true knowledge apart from developing personality of the students and above all making them apply ‘Common Sense’ which is the essence of life. I am sure dedicated team of Zoologists which has placed the subject on top in the past 5 years is poised to make it a success in every college befitting the purpose of introducing applied component by the University in the academic year 1979-80.

- VINAYAK DALVIE
Convener,
Syllabus Committee

PEDAGOGY

The concept of having a flexi syllabus is a unique feature of this syllabus and implementing it creatively and diligently would be a meaningful exercise. The concept of flexi syllabus would ensure that learner and facilitator have the liberty to select any four units out of eight which can be decided by both the stake-holders collectively. While selecting, both shall ensure that it is done systematically, maintaining the relevance of topics in every unit taught in the semester. An exciting aspect adding a new dimension to the flexi-syllabus concept is the idea of making various permutations and combinations of the units in every semester that would take into consideration the need, resources and the expertise that the department, college possesses/ provides or can make available.

A major thrust should be to direct the learner to maximize the use of ICT, watch films related to the topics, You-tube clippings and extra read material in the form of articles and magazines for all the topics, 'Buzz sessions' should be held after showing films, short video clippings etc, whereby the learner is encouraged to summarize the contents, or debate or ask questions related to the topics. This exercise would initiate a 'thought process' with respect to the subject, ensuring that the learner develops a habit of ruminating over the information to gain conceptual clarity and insights.

It is recommended that the facilitator employs a variety of approaches in teaching learning methods that are necessarily active and participatory in nature. These may include debate and discussions, field trips, study tours and industrial visits, both short and long, to places of environmental concerns relevant to the units prescribed and selected for teaching so as to provide desired exposure. For e.g. Units on Biodiversity Conservation and Ecotourism, Industrial Consultancy, Business Analytics of Environment testing, Neo avenues should not be taught only in class-rooms but, on locations, to promote experiential learning.

'Case studies' should be conducted through discussion in a group of 10 students for every case. A case study approach to investigate an environmental issue would help the learner to appreciate the importance of gathering relevant evidence, evaluating its quality and interpreting the results. It must be developed and presented by the facilitator (teacher) with thought provoking approaches expecting students to think analytically and derive an appropriate solution after critically evaluating all the solutions, given within the group.

The inclusion of the concept of 'open unit' encourages the creative teacher-facilitator to choose a topic from the existing units which needs to be further elucidated or taught or researched so as to gain in depth knowledge on the topic and can hence be covered extensively. On the other hand the topic taught could also be a 'need based' one either comprehensively covered by the syllabus or totally ignored. If the facilitator has the ability to include a newly developed area, within the vicinity, then it may be included in the open unit with the consent of the Head of the Department and the Principal of the institution.

This new syllabus takes into consideration the applied approach, and therefore the topics chosen are practical although few theory based topics are retained. All the practical experiments are application oriented and simple since the learners have had exposure to them while performing them in the former years or in their mainstream subject covered under the science streams. While performing them the learner develops the aptitude of putting them into practice scientifically, logically and appropriately for studying various aspects of the environment and the pollution caused due to anthropogenic activities. Facilitators must encourage the learners to comprehend and generate ideas for the applicative value of these experiments.

Furthermore the syllabus has also incorporated the skeleton question paper for the practical examination and the model question paper for the theory units so as to resolve any doubts and ensure uniformity in the drafting of the question paper pattern for the semester end examination.

Co-Convenors,

Syllabus Committee

T. Y. B. Sc.

Credit Based Semester and Grading system

Environmental Science & Pollution (Applied Component)

Syllabus

(to be implemented from the academic year 2017-18)

Semester V
Applied Environmental Sciences

Theory (Any four units to be opted)				
Course	**Unit**	**TOPIC**	**Credits**	**L/Week**
USACEVS501	1	Introduction to Environment and Pollution	2	4
	2	Green Chemistry and Sustainability		
	3	Alternate Energy Resources		
	4	Applications of Analytical methods		
	5	Green/Environmental Audit		
	6	Industrial Consultancy		
	7	Neo-avenues		
	8	Case Study and Simulation		
Practical				
USACEVS5P1		Practicals based on Course**USACEVS501**	2	4

Semester VI
Environmental Management

Theory (Any four units to be opted)				
Course	**Unit**	**TOPIC**	**Credits**	**L/Week**
USACEVS601	1	Business Analytics of Environment Testing	2	4
	2	Ecological Restoration		
	3	Impact Assessment through Ecological modeling		
	4	Finance		
	5	Biodiversity Conservation and Ecotourism		
	6	Climate Change		
	7	Environmental Education and Legislation		
	8	Open Unit		
Practical				
USACEVS6P1		Practicals based on Course **USACEVS601**	2	4

Semester V: Theory
Applied Environmental Sciences
Course code: USACEVS501

(Any four units to be opted**)**

Lectures 60
Credits 2

Unit 1: Introduction to Environment and Pollution
Objective:

- *To revise the important concepts of environment and its impact on the inter-relationship between various components of the environment.*
- *To recognise and realise, the harmful effects of pollutants on the environment, when their balance shifts as a result of anthropogenic activities*.

Desired Outcome:

- *Learner shall comprehend the impact of the interrelationship between various components of environment.*
- *Learner will apply the knowledge of pollutants to undertake research projects/studies.*

1.1 Components of environment; biotic and abiotic. Composition of various segments of environment–atmosphere, hydrosphere, lithosphere, biosphere (with respect to composition and interrelationship).
1.2 Types of pollution
1.2.1 Water pollution: Pesticides and heavy metals.
1.2.2 Air pollution: Challenges posed by present day pollutants.
1.2.3 Others- Noise and nuclear pollution.

Unit 2: Green chemistry and Sustainability
Objective:

- *To direct the learner's aptitude and skills to develop innovative chemical technology, aimed to reduce or eliminate the use or generation of hazardous substances.*

Desired Outcome:

- *Learner would be critical and creative during the designing, manufacturing and utilization of chemical products, which would reduce or eliminate the use or generation of hazardous substances.*

2.1 The Twelve Principles of Green Chemistry.
2.2 Sustainable Development- Principles and sustainable development indicators.
2.3 Areas highlighted by Agenda 21.
2.4 Transition from Industrial economy to Green economy.

Unit 3: Alternate Energy Resources
Objective:

- *To comprehend, the importance of alternative energy resources.*
- *To emphasise the need, to conserve the energy resources.*

Desired Outcome*:*

- *Learner shall value the alternative energy resources and hence follow the 4 R's (Reduce, Reuse, Recycle & Reinvent).*
- *Learner may discover and design products, operations or processes, which conserve the energy resources.*

3.1 Solar energy, wind energy, tidal energy, nuclear energy.

3.2 Biomass & bio-fuels, petro crops.

3.3 Use of wastes: Water-based biomass, energy from waste & solid waste.

Unit 4: Applications of Analytical Methods

Objective:

- *To re-familiarise the principles, methods as also develop perspectives on the application of analytical methods to the study of environment.*

Desired outcome:

- *Learner shall develop skills in instrumentation used for the study and analysis of various substances related to the environment.*

4.1 Sampling: Various methods for gases, liquids and solids (Principles and applications only)

4.2 Analysis:

4.2.1 Classical Methods-Volumetric (Acid-Base; Redox, Complexometric titrations), Gravimetric.

4.2.2 Modern Methods -Spectroscopy

a) Absorption Methods-Colorimetry and Spectrophotometry, Turbidometry, Nephelometry, Atomic Absorption Spectroscopy, Fluorescence Spectrometry, X-Ray Absorption Spectroscopy, X-Ray Diffraction.

b) Emission Methods: Flame Photometry, Atomic Emission Spectroscopy.

4.2.3 Separation Methods

a) Extraction Techniques- Distillation, Solvent Extraction and Column Chromatography.

b) Chromatography- Gas Chromatography (GSC, GLC) HPLC.

c) Electrophoresis.

4.3 Interpretation and presentation- Introduction to the application of statistical tools and software.

Unit 5: Green / Environmental Audit

Objective:

- *To introduce the learner to the concept of green environmental audit.*

Desired outcome:

- *Learner and facilitator both will develop conceptual clarity on pollution control and green environmental auditing, besides gaining knowledge about these programmes in the Indian scenario.*

5.1 Concept & economics of pollution control.

5.2 Environmental accounting: definition, concept & issues.

5.3 Concept of environmental audit.

5.4 Benefits of environmental auditing.

5.5 Environmental audit programmes in India.

Unit 6: Industrial consultancy
Objective:

- *To expose and augment the avenues of employability and entrepreneurship in the arena of industrial consultancy.*
- *To ensure that the learner applies the learning gained during the under-graduate days for enhancing his skills and employability quotient in relevant industries.*
- *To develop an understanding of the MPCB norms and procedure for liaison.*

Desired outcome:

- *Learner and facilitator both will be exposed to the various areas and facets of industrial consultancy, and shall also develop competency and confidence to explore it.*
- *Learner will be able to grasp the importance of various norms required for MPCB permits and procedure for liaison.*

6.1 Types of consultancies.
6.2 Calculating consultancy fees.
6.3 Industrial marketing.
6.4 Logistic services for medical, microbiological, carcinogenic, toxic, nuclear waste.
6.5 MPCB and CPCB norms and liaison.

Unit 7: Neo Avenues
Objective:

- *To expose the learner to the array of environmental related domestic products with a view to develop, market and discover their application for the purpose of a better environment.*

Desired Outcome:

- *Learner will develop an acumen to tap the potential for entrepreneurship with respect to environment related products and indoor plants.*

7.1 Understanding market niche of domestic pollution control devices –air purifiers, smoke absorbers and chimneys, Heating, Ventilation and A.C. Systems (HVAC).
7.2 Green marketing:
  7.2.1 Greenhouse gas reduction market.
  7.2.2 LOHAS (Lifestyle Of Health and Sustainability) and Green Washing.
7.3 Indoor Plants to Reduce Pollution:
  7.3.1 Radiation absorbing plant, example – *Adiantum capillus-veneris* (Venus or Black Maiden hair fern)*, Ocimum sanctum* (Holy basil or Tulsi*), Hedera helix* (Ivy*).*
  7.3.2 Natural air filtering system, example – *Chlorophytum comosum* (Spider plant*), Monstera deliciosa* (Swiss cheese plant*)*
  7.3.3 Smoke absorbing plant, example – *Philodendron bipinnatifidum* (Lacy tree philodendron or Selloum)*, Dracena reflexa* (Song of India*), Dendrantehema grandiflora (*Chrysanthemum or Shevanthi*), Gerberajamesonii* (Transvaal daisy*)*

Unit 8: Case Studies and Simulations

Case Studies and Simulations is one of the eight units and hence may or may not be opted by the college. If opted, teachers in consultation with the students shall select the case studies for this unit every year, if required, and shall seek endorsement of the Head and the Principal.

Colleges/institutes have to select the topics as per their needs and available resources. It is pertinent to note that the case studies and simulations shall be operational and available in the syllabus only until it comes under the scope of internal assessment.

Objective:

- *To encourage abilities of learner to better understand the concepts.*
- *To develop better analytical abilities to assess varying dimensions while making decisions*.

Desired outcome:

- *Learner will comprehend and develop better acumen so as to, take wise and necessary decisions while participating in environment related projects or framing policies/assessing environmental damages/carrying out entrepreneurial activities beneficial to environment.*
- *Learner shall primarily learn to tackle real life situations with common sense.*

(Any eight from suggested below or more, developed by teacher)

8.1 Avhan- Disaster management model of the Chancellor.

8.2 Shirpur model of water conservation.

8.3 Powai lake conservation, Mumbai.

8.4 Fukushima Daiichi nuclear disaster, Japan.

8.5 Itai-itai disease for cadmium toxicity.

8.6 Chernobyl disaster.

8.7 Environmental Education in Finland – A Case Study of Environmental Education in Nature Schools.

8.8 An international environmental law case study: Bhopal Gas Tragedy.

8.9 Case Study on Green Building, Hotel Orchid- Ecotel.

8.10 Mumbai rain disaster of 26th July 2005.

8.11 Serial bomb blasts.

8.12 Tsunami at Andamans.

8.13 Govardhan Eco Village.

8.14 Planning development of prescribed land with constraint (Simulation).

8.15 Ralegan Siddhi / Hiware bazaar as model of environment conservation.

Semester V Practicals
Course Code USACEVS5P1

2 Credits

1) Study of Physico-chemical properties of sewage/ effluent water: conductivity, turbidity, dissolved oxygen, salinity & total hardness.
2) Estimation of Pollution: BOD &COD.
3) Microbiological parameters: MPN and Gram staining
4) Study of air micro flora.
5) Measurement of intensity of light by Lux meter.
6) Bioassay studies using water hyacinth or any suitable material.
7) Study of types of pollution: water, air, land.
8) Study of product derived by application of green chemistry (Laundry detergents, Polylactic acid packaging, Green paints, Pharmaceutical drugs- Ibuprofen)
9) Study of application of alternative energy resources (Solar panel, Biogas plant, Photovoltaic cell, Windmill, Nuclear reactor, Harnessing tidal energy)
10) Study of applications of various Spectroscopy (any 4), Chromatography and Electrophoresis instruments.
11) Study of logistic services for medical, toxic waste (Containers, Incinerator, Autoclave).
12) Study of indoor plants for reduction of pollution (*Adiantum, Ocimum sanctum, Ivy, Chlorophytum, Monstera, Philodendron, Dracena, Chrysanthemum, Gerbera).*
13) Photographic documentation of environment related issues/ conservation Submission of soft & hard copy of 5 original photographs taken by the learner (Exif details required)
14) Assignment (may be submitted in a group not exceeding three students).

Please refer to Annexure- I for suggested topics for assignment.

***Note- The practicals may be conducted by using preserved specimens/permanent slides authorised by the wild life and such other regulating bodies though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/simulations/ models etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in above.**

N.B:

I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).

II) Apart from the institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority/Body from time to time, every college should constitute the following Committees:

1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and
2) A Dissection Monitoring Committee (DMC) to ensure that no dissections or mountings are done, using animals.

Composition of DMC shall be as follows:

i) Head of the Concerned Department (Convener/Chairperson)
ii) Two Senior Faculty Members of the concerned Department
iii) One Faculty of related department from the same College
iv) One or two members of related department from neighbouring colleges.

USE OF ANIMALS FOR ANY EXPERIMENT/DISSECTION/MOUNTING IS BANNED. SIMULATIONS, AUTHORISED PERMANENT SPECIMENS/SLIDES, CHARTS, MODELS AND OTHER INNOVATIVE METHODS ARE ENCOURAGED.

Semester VI: Theory
Environmental Management
Course code: USACEVS601

(Any four units to be opted)

Lectures 60
Credits 2

Unit 1: Business Analytics of Environmental Testing

Objective:

- *To explore business analytics of environmental testing and monitoring laboratories for research purposes and as career ventures*.

Desired outcome:

- *Learner will gain knowledge about environmental testing and monitoring laboratories, air, water quality and noise exposure standards and methods of physico-chemical and bacteriological sampling.*
- *Learner will be exposed to the know-how regarding establishing environmental testing and monitoring laboratories.*

1.1 Establishing environmental testing laboratory.
1.2 Methods of monitoring and control of air pollution. Air quality standards.
1.3 Physico–chemical and bacteriological sampling and analysis of water quality standards.
1.4 Measurement of noise and its indices. Noise exposure levels and standards.

Unit 2: Ecological restoration

Objective:

- *To focus the learner towards the immediate need to develop and practise the present and future systems, processes, technologies used for treatment of domestic waste water and industrial effluents.*
- *To seek and explore alternatives to conventional resources*.

Desired outcome:

- *Learner will study and comprehend the treatment practices applied for domestic waste water and industrial effluents.*
- *Learner will be equipped with the knowledge of some alternatives to conventional resources.*

2.1 Domestic waste water treatment.
2.2 Effluent treatment of Industrial waste.
2.3 Bioremediation.
2.4 Alternatives to conventional resources: biodegradable plastic, biodiesel, bio ethanol& bio pesticides.
2.5 Developing effluent treatments.

Unit 3: Impact Assessment through Ecological Modelling
Objective:

- *To introduce the learner to the concept of statistical modelling and neural networking.*
- *To direct and broaden the perspective of the learner to comprehend the importance of modelling while summarising the findings of research and survey data, or while accepting new applications in systems and processes.*

Desired outcome:

- *Learner will develop an understanding on the concept, application and limitation of modelling as a tool for summarising or applying the research and survey findings.*
- *Learner will develop skills on the application of neural networking and statistical modelling.*

3.1 Concept, applications and limitations.
3.2 Impact prediction with physical models.
3.3 Introduction to the concept of Artificial Neural Networking (ANN) and statistical modelling.

Unit 4: Finance
Objective:

- *To introduce the various concepts of costing, book keeping and final accounts.*

Desired outcome:

- *Learner will gain an insight into the basics of costing, book keeping and accountancy.*
- *Learner will be equipped to apply the concepts in his entrepreneurial ventures.*

4.1. Costing

4.1.1. Basic concept: Types of cost (historical, standard and managerial).
4.1.2. Budget: Budgetary control (process, batch, job and service).
4.1.3. Variances: Material, labor and overheads.

4.2. Basic accountancy:

4.2.1. Basic terms, golden rules in accounts, types of accounts (Indian), journal entry, ledger posting, subsidiary book, single column cash book, double column cash book.
4.2.2. Depreciation: fixed installment, reducing balance method.
4.2.3. Bank reconciliation.
4.2.4. Rectification of error.
4.2.5. Final account.

Unit 5: Biodiversity Conservation & Ecotourism
Objective:

- *To sensitize the learner towards the importance of conserving the existing biodiversity.*
- *To explore possibilities within learners to be nature enthusiasts, passionate naturalists, adventurists and eco friendly tourists.*

- *To tap the ecotourism avenues within and outside the country.*

Desired outcome:

- *Learner will develop aptitude to examine and assess the outcome of the framework of current biodiversity hotspots and biosphere reserves.*
- *Learner will be able to list the different aspects of wildlife photography and inspect the positive and negative aspects of it, also be able to recommend how wildlife photography can support biodiversity conservation.*
- *Learner will be able to assess the future challenges that ecotourism can generate for biodiversity conservation.*

5.1 Hotspots of biodiversity and biosphere reserve.
5.2 Strategies for biodiversity conversation (in-situ and ex-situ).
5.3 Commercial wildlife photography.
5.4 Ecotourism–definition, policies and practices.

Unit 6: Climate Change
Objective:

- *To awaken the learner towards focussing on the critical issue of climate change.*
- *To establish the impact of climate change, the greatest destabilizing force that undermines global economy, and threatens our health.*

Desired outcomes:

- *Learner will ponder upon and find out the what, why, where, whom and which of climate change and global warming.*
- *Learner will be able to identify and evaluate the effects of the different sources of greenhouse substances.*

6.1 Introduction to climate change, global warming and its effects.
6.2 Greenhouse substances: Sources & effects.
6.3 Geospatial technology- Remote Sensing & GIS.
6.4 Role of IPCC in climate change monitoring; Kyoto Protocol, Montreal Protocol, Earth Summit & UN Convention on Climate Change.

Unit 7: Environmental Education & Legislation
Objective:

- *To develop the knowledge and thinking ability regarding environmental issues. To help the learner to acquire a set of values for environment protection.*

Desired outcome:

- *Learner will imbibe positive changes in attitudes, commitments and civic actions required to combat harmful effects of anthropogenic activities and development on environment.*
- *Learner would inculcate ethical values and responsibilities towards protection of environment*.
- *Learner will be equipped to implement goals of environment protection.*

7.1 Goals, objectives & principles of environmental education.
7.2 Environmental education programmes in India.
7.3 Environmental organizations & agencies-CITES, EPA, IUCN & MAB.
7.4 Environmental laws in India: Wild life Protection Act, 1972, Water Prevention & Control of Pollution Act, 1974, Air Prevention & Control of Pollution Act, 1981, Environment Protection Act, 1986 & Biological Diversity Act, 2002.

Unit 8: Open Unit

Open unit is one of the eight units that may or may not be opted by the college. Teachers in consultation with the students shall define syllabus under this unit every year, if required, and shall seek endorsement of the Head and the Principal.

Colleges/institutes have to select the topics as per their needs and available resources. It is pertinent to note that the open unit shall be operational and available in the syllabus only until it comes under the scope of internal assessment.

Objectives:

- *To teach any one of the units prescribed in the syllabus with more details and in depth leading to specialization in the capsule of units selected.*
- *To incorporate the topics of special need of the area, that is otherwise not covered in the syllabus.*
- *To give scope to creativity and wisdom of a teacher who wants to deal with the latest developments in the subject without waiting for the university to revise the syllabus.*

Semester VI Practicals
Course Code USACEVS6P1

2 Credits

1) Study of soil microflora and determination of sedimentation rate.
2) Study of physical properties of soil: Temperature, moisture, & texture of soil.
3) Study of chemical properties of soil: pH, Organic matter and Calcium carbonate.
4) Detection of heavy metal cations : Zinc, Cadmium, Lead from soil sample.
5) Population analysis by Quadrant method & Line transect method.
6) Observation & study of indicator species.
7) Study of air &noise pollution monitoring device, geospatial instrument.
8) Study of any five biodiversity hotspots, bio reserves of India.
9) Study of any four effects of global warming and climate change.
10) Study of ANN chart and statistical model.
11) Study the role of environmental organisations and agencies (CITES, EPA, IUCN & MAB).
12) Study of environmental laws of India.
13) Problems on accounting/costing.
14) Study of microbes & plants used in bioremediation.
15) Study of biodegradable plastic products, bio pesticides brands.
16) Visit to any industry/laboratory/plant/national park and submission of report.
17) Project and submission of report (Project report may be submitted in a group not exceeding three students).

Please refer to Annexure- II for suggested Field Visits and Annexure III for suggested topics for projects for Course code USACEVS6P1.

***Note- The practicals may be conducted by using preserved specimens/ permanent slides authorised by the wild life and such other regulating bodies though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/simulations/ models etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in above.**

N.B:

I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).

II) Apart from the institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority/Body from time to time, every college should constitute the following Committees:

1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and
2) A Dissection Monitoring Committee (DMC) to ensure that no dissections or mountings are done, using animals.

Composition of DMC shall be as follows:

i) Head of the Concerned Department (Convener/Chairperson)
ii) Two Senior Faculty Members of the concerned Department
iii) One Faculty of related department from the same College
iv) One or two members of related department from neighbouring colleges.

USE OF ANIMALS FOR ANY EXPERIMENT/DISSECTION/MOUNTING IS BANNED. SIMULATIONS, AUTHORISED PERMANENT SPECIMENS/SLIDES, CHARTS, MODELS AND OTHER INNOVATIVE METHODS ARE ENCOURAGED.

References and Additional Reading
USACEVS501 & USACEVS601

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SCHEME OF EXAMINATION (THEORY & PRACTICAL)

(a) Internal assessment of twenty five (25) marks per course per semester should be conducted according to the guidelines given by University of Mumbai vide circular number UG/04 of 2014 Dated 5th June 2014 to be implemented from academic year 2014-15.

(b) External assessment of seventy five (75) marks per course per semester should be conducted as per the following skeleton question paper pattern.

(c) One practical examination of one hundred (100) marks per course each should be conducted at the end of every semester.

Modality of Assessment:
Theory Examination Pattern:

A) Internal Assessment - 25% 25 marks
Theory 25 marks

Sr. No.	Evaluation type		Marks
1.	Class test to be conducted as per following pattern		**20**
	a.	Match the column/Fill in the blanks/Multiple Choice Questions(1/2 mark each)	**05**
	b.	Answer in 1 or 2 lines(Concept based questions) (1 mark each)	**05**
	c.	Answer in brief (Attempt any 2 out of the 3) (5 marks each)	**10**
2.	Overall conduct as a responsible student, manners, attentive and inquisitiveness, skill in articulation, leadership qualities demonstrated through organizing co curricular activities, etc.		**05**

B) External examination - 75 %
Semester End Theory Assessment - 75% 75 marks

1) Duration - The examination shall be of two and half hours duration.
2) Theory question paper pattern:

a. Q1 shall comprise of 16 short notes (14 if case studies/open unit is not opted) representing all the units in the syllabus equally, of which students are expected to solve any five.

b. Q2 to Q9 (Q8 if case study/open unit is not opted) will be based on unit I to unit VIII of the syllabus respectively.

c. Q2 to Q9 (Q8if case studies/ open unit is not opted) shall have the following pattern.

A) 15 marks

OR

B) i) 7 marks
ii) 8 marks

Practical Skeleton Paper Course code: USACEVS5P1

Duration: 04 hrs **Maximum Marks: 100**

Q1.**Identification**:
20

Identify spots ‘a’ to ‘e’ as per instructions

a) Identify and describe the type of pollution.

b) Identify and describe the product derived by application of green chemistry.

c) Identify and describe the applications of bio analytical instrument / energy resource.

d) Identify and describe the type of logistic service.

e) Identify and describe the plant and its role in reducing pollution.

Major Experiment

Q2. Estimate Biological Oxygen Demand/Chemical Oxygen Demand from the given water samples (2) and submit the report. **25**

OR

Q2. Estimate the total acidity and total alkalinity of the given samples (2) and compare the results.
25

Minor Experiment

Q3. Estimate total hardness and turbidity/ conductivity of the given sample and submit a report. **15**

OR

Q3. Estimate total acidity/ alkalinity/ salinity of the given sample and submit a report**.** **15**

OR

Q3. Estimate Dissolved Oxygen from the given water sample and submit the report. **15**

OR

Q3. a. Determine the intensity of light using Lux meter. **08**

Q3. b. Estimate the conductivity of the given sample. / Determine the MPN of the given water sample. **07**

Q4. a. Submission of five environment related original photographs. **10**

Q4. b. Submission of assignment& viva based on it. **20**

Q5. Certified journal. **10**

Practical Skeleton Paper Course code: USACEVS6P1

Duration: 04 hrs **Maximum Marks: 100**

Q1.**Identification**: **20**

Identify spots ‘a’ to ‘e’ as per instructions

a. Identify and describe air / noise pollution monitoring device / geospatial instrument.

b. Identify and describe biodiversity hotspots / bio reserve marked on the map.

c. Give the full form of and describe the role of CITES/EPA/IUCN/MAB.

d. Identify the act from the given clause and comment on it / Identify and describe the effect of global warming or climate change.

e. Identify and describe ANN chart/ statistical model or solve the given problem.

Major experiment

Q2. Estimate organic matter content from the given sample and submit a report. **25**

OR

Q2. Estimate calcium carbonate content from the given sample and submit a report**.** **25**

OR

Q2. Investigate the given sample and report about the presence of any (or all) of the following heavy metal cations:- Zn (II)/Cd (II)/ Pb (II) from the given soil sample. **25**

Minor experiment

Q3. Analyse the texture and moisture content of the given soil sample and submit a report. **15**

OR

Q3. Analyse the texture and pH (pH paper, pH meter and universal indicator) of the given soil sample and submit a report. **15**

Q4. Project and viva based on it. **20**

Q5. Field report. **10**

Q6. Certified journal. **10**

ANNEXURES

Annexure I: Suggested topics for assignment USACEVS5P1

(Teachers are expected to develop additional innovative topics, varying every year, to be assigned to the students).

1. List out the instruments or funding agencies or permits required for setting up an environment testing laboratory.
2. Survey of NGO's working in the environmental field in your area.
3. Preparation of proposal for green building and sustainable development.
4. Prepare a cost sheet for setting up a bio degradable plastic unit.
5. Make an inventory of the water bodies presently existing/which existed in the urban/rural area of about 5kms.
6. Find out information regarding pollution testing booths that the Government proposes to set up.(List out the personnel who will man the booths and the indigenous equipment that these booths will have).
7. Make a report on amenities, trees, dimensions of open spaces in your locality. Assess their role in maintaining the ecological balance in the region.
8. Survey housing societies/institutions/organisations to find out whether they are converting household/kitchen waste into anything utilisable like vermicomposting etc.
9. Meet entrepreneurs involved with manufacture of eco-friendly products/best out of waste etc. Make a report regarding how the entrepreneur decided to pursue such an initiative, its need, the process and benefits to the environment.
10. Calculate carbon footprint of your family/class-room or laboratory/housing society by visiting the appropriate site on internet.
11. Visit architectural /horticulturist firms that deal with vertical gardening /urban farming and prepare a first-hand report on the concept, where implemented and the advantages.

All topics mentioned above are suggestive, more creative and innovative topics are expected from the students, under the able guidance of the concerned teacher, to suit the expertise, human resources, infrastructure and local needs as also the interest of the students.

The assignment may be submitted in a group not exceeding three students.

Annexure II: Suggested Field Visits USACEVS6P1

- There shall be various short and long excursions / study tours / field visits / industrial visits in every semester, at least one of which shall be financially affordable to every student in the class; and that assessment and marks of field trips shall be solely based upon such where no student was restrained for financial limitations.
- Field visits are to be organized to facilitate students to have firsthand experience & exposure to technology/production/functioning of organization/units or witness a relevant activity.
- Each student must make at least 01 (one) such visit to the units/treatment plants/aquatic or terrestrial habitat organized by the College.
- The list is suggestive and not exhaustive.

1. Visit to Sewage treatment plant.
2. Visit to Vermicomposting unit.
3. Visit to Air Monitoring Laboratory.
4. Visit to Environment Pollution Detecting Laboratory.
5. Visit to Cooling towers in industries.
6. Visit to Rain Water Harvesting System.
7. Visit to Biogas Plant.
8. Visit to Green Building/Ecotel Hotel.
9. Visit to Water Filtration Plant.
10. Visit to office of Pollution Control Board.
11. Visit to Greenhouse.
12. Visit to Solid Waste Management Plant.
13. Visit to hydro/thermal power plants.
14. Visit to Environmental Agencies-CITES
15. Visit to National Parks, Sanctuaries, Biosphere Reserves etc. in Maharashtra/India/abroad.
16. Visit to NEERI.
17. Visit to Enviro Vigil, CSM Hospital Campus, Kalwa (W), Thane.

Annexure III: **Suggested Topics for Projects USACEVS6P1**

(Teachers are expected to develop additional innovative topics, varying every year, to be assigned to the students).

1) Effects of anthropogenic activities on different ecosystems; for example mangroves/ wetlands.
2) Effect of tourism activities on different ecosystems.
3) Assessment of ecotourism potential-SGNP, different sanctuaries.
4) Water audit in your area.
5) Costing, accounting & budgeting of eco-friendly idols during festivals.
6) Costing, accounting & budgeting for paper making from waste.
7) Study the role of microbes in biodegradation of: plastic, pesticides, heavy metals, hydrocarbons, etc.
8) Preparation of feasibility Report of eco-friendly products.
9) Preparation of feasibility report of environment testing laboratory.
10) Preparation of feasibility report for manufacture of any domestic pollution control device.

The project may be submitted in a group not exceeding three students.

Annexure IV: Learners' space

When the education system today has identified special needs of slow learners we are still silent about needs of high IQ students. Teachers are therefore recommended to identify and encourage such students to undertake research with a view to publish paper/s in peer reviewed International Indexed Journals with high impact factor thus providing 'learners' space'.

Some of the suggestive avenues are listed below which are certainly not exhaustive since the said students under the guidance of teachers can identify latest areas of research. Needless to say that 'learners' space' is an optional additional activity which may not be undertaken by college if not befitting.

1. Effluent analysis for heavy metals with speciation.
2. Environmental impact due to monsoon runoff from farms containing pesticides.
3. Ecological modelling of a water body.
4. Environment impact assessment of human activities.
5. Heavy metals accumulation and transfer to all three trophic levels.

Annexure V: Play and Ponder

While learner's space is for high IQ Students, 'Play and Ponder' could be a general activity creating interest in the subject and could also be a part of pedagogy wherein it may be considered as innovative teaching methodology. Needless to say that 'Play and Ponder' again is not mandatory and is an additional activity if desired by the students.

Following are some suggestive activities though of course teachers can creatively develop more, each year, to be assigned to the students.

1. Make a compost heap for your garden by recycling household wastes.
2. Make a bird feeder from waste plastic bottles.
3. Create your own organic garden.
4. Make a model of a natural cooling system and study its effectiveness.
5. Make your own recycled paper and create handmade crafts from it.
6. Make a self-sustaining closed ecosystem viz. bottle garden/aquarium ecosphere.
7. Make a model for harvesting rain water in your house/building.
8. Prepare your own solar oven.
9. Place a bird feeder in your garden and evaluate whether it really helps birds that need conservation?

Model Question Paper USACEVS501

Duration 2.5 hrs **Maximum Marks: 75**

N.B.: 1. Q 1 is compulsory.
2. Attempt any four questions from Q 2 to Q 9.
3. Draw neat and labelled diagrams wherever necessary.

Q1. Write short notes on any **five** of the following (Mixed questions from all units): **15**

a. Zones of atmosphere
b. Soil profile
c. Significance of green chemistry
d. Concept of sustainable development
e. Sources of noise pollution
f. Petro crops
g. Application of flame photometry
h.Application of gas chromatography
i. Concepts of environmental accounting
j. Concept of environmental auditing
k. Logistics services for medical waste
l. MPCB norms
m. *Adiantum*, as a radiation absorbing plant
n. Green washing
o. _____ (from case study, if opted)
p. _____ (from case study, if opted)

Q 2. **Question based on Unit 1**

Describe the various segments of lithosphere and biosphere. Comment on their composition and inter- relationship. **15**

OR

2a. Describe the various sources of water pollution. Add a note on effect of pesticides on aquatic ecosystem**.** **8**

2b. Explain the challenges posed by present day gaseous air pollutants on environment. **7**

Q3. **Question based on Unit 2**

What are the principles of sustainable development? Give a detailed account of sustainable development indicators **15**

OR

3 a. Comment on the areas highlighted in Agenda 21**.** **8**

3 b. Comment on green economy. **7**

Q4. **Question based on Unit 3**

Give a detailed account on solar energy, wind energy and tidal energy as an

alternative energy resource. **15**

OR

4 a. Nuclear energy, a boon or a curse. Discuss. **8**

4 b. Explain the use of solid waste as a source of energy. **7**

Q5. **Question based on Unit 4**

Explain different types of Spectroscopy. Discuss the application of X-ray diffraction. **15**

OR

5 a. Describe the application of statistical tools and software in field of environmental science**.** **8**

5 b. Discuss the application of electrophoresis as separation technique. **7**

Q6. **Question based on Unit 5**

Explain the concept and economics of pollution control. Add a note on Environmental accounting. **15**

OR

6 a. Write a note on Environmental audit programmes in India. **8**

6 b. Comment on the benefits of environmental auditing. **7**

Q7.Question based on Unit 6

Explain the types of industrial consultancies and add a note on industrial marketing. **15**

OR

7 a. Discuss the criteria for calculating industrial consultancy fees? **8**

7 b. Describe the norms and procedures related to MPCB liasioning. **7**

Q 8. **Question based on Unit 7**

Explain the marketing of Heating, Ventilation and A.C. systems and air purifiers as domestic pollution control devices. **15**

OR

8 a. Discuss the concept of Green washing giving suitable examples**.** **8**

8 b. Describe *Chlorophytum* as a natural air filtering system. **7**

Q 9.**Question based on Unit 8**

Question based on case study/ simulation (if opted). **15**

A paper on disaster management was presented at the International Conference on 'Urban Planning and Environment Strategies and Challenges' organized by Elphinstone College, Mumbai in the year 2007. It was picked up by the then DDG, Maharashtra NCC, Brigadier Shard who contacted the author, Vinayak Dalvie, Joint secretary to the Governor through an ANO, insisting him to implement the model through NCC. The then Secretary to the Governor, Shri Sitaram Kunte convened a meeting of NCC officials with the Governor H.E. Shri S.M.Krishna for presentation on Avhan by Shri Dalvie. The Governor immediately issued necessary orders integrating NCC, universities and the government disaster management agencies. Based on the modalities, Colonel Samuel from Pune worked out the first training camp at Shivaji University, Kolhapur.

The said model proposes a self-sufficient and strategic training and capacity building of University students, mainly NCC cadets, for disaster management, who can, on call reach any nook and corner of the State instantaneously along with equipment and resources of their own from a self-generated fund.

A platoon of 30 cadets (20 boys+10 girls), preferably from first year NCC to make the said trained force available for two more years, selected from each district of the State shall be trained by the host University from 22nd May to 5th June (Paryavaran Diwas) every year in the areas of administration, medical and operations simulating various natural and manmade disasters with an emphasis on practical approach. Each heading has twelve modules. 36 specialised resource persons would be deputed in the camp for 12 days, each addressing a district platoon at a given point of time in rotation as per the scheduled time table. Three cadets from each district, portraying the best performance; one each in administration, medical and operations respectively will be selected for Phase II training during the Diwali vacation. Thus three platoons of 36 cadets each are formed to receive special inputs at places like Yashada and JBIMS for administration; INS Ashwini, AFMC, MUHS for medical; Home guards, Civil defence establishments and Army for operations respectively. After Phase II training each district has a platoon of 30 cadets with three section I/C to take a lead role equipped with special training in administration, medical and operations. This platoon can reach the site of disaster within an average of two hours on receiving communication from the concerned ANO. During the academic year, every platoon will perform practice drills in each taluka to raise awareness in the common man, who is the first responder in any disastrous situation. Further, manpower of trained 1000 cadets can reach within a day from the remaining districts of Maharashtra. One Associate NCC officer from each district will also be trained in the course who can take charge of the situation.

This trained force called Chancellor's brigade would come into operation only on call from a disaster management authority playing a complimentary role and coming into action immediately since funds are made available by the local Vice Chancellor within an hour.

Each University can purchase basic necessary equipment and build infrastructure from the interest earned on the corpus fund collected for last few years by charging Rs. 10/- to each student as disaster management fund every year. The host University can

arrange for the training of 1000 cadets also from the same funds. The host University may also receive approximately Rs.60 lakhs @ Rs.2/- per student out of Rs.20/- collected each year as Ashwamedh fund from all students. The local Vice Chancellor, concerned ANO and NCC officer shall prepare a budget based on estimated need. Financial decisions can be taken by a committee of three Vice Chancellors i.e. of the previous, the current and the next host University over telephone/e-mail/fax to be endorsed by the Secretary to Governor or in his absence the next officer in hierarchy for easy disbursement, on call, to the Vice Chancellor in whose jurisdiction falls the district facing the disaster. The Vice Chancellor of host University shall reimburse the said amount from surplus in Rs. 60 lakhs after the cost of training camp which is about Rs.30 lakhs.

Since the concerned ANO and NCC officer are empowered to purchase ration, medicine and utilities as per the pre sanctioned rate charts, Chancellors brigade comes into action instantaneously with no financial burden on the Government thus befitting the motto 'Swayam purna Swayamsiddha Samarth'.

Q1. The present model is not being effectively implemented in real life situations. What are your suggestions?

Q2. Plan a training schedule for 12 days in all the modules.

Q3. Enlist possible modules under each head.

OR

Shirpur Model- 'Angioplasty in Water Conservation'

Shirpur model gets its name from the place Shirpur, a taluka in Dhule district of North-East Maharashtra. Once an obscure and drought-hit region, it is now referred to as 'Green taluka'. Shirpur taluka has a geographical area of 837.39 sq.km. About 78.07% of this is cultivable of which only 12.94% is under irrigation. This area receives an annual rainfall of 617 mm in over 36 days with most water draining into the river Tapi. The distribution of rainfall is highly erratic and the surface water resources are hence unevenly distributed. As a result of this, the use of groundwater for irrigation, drinking, and industrial purposes has increased many fold. The main cash crops in Shirpur are sugarcane, cotton and banana which rely heavily on ground water for irrigation.The soil in Shirpur is partly of Tapi alluvium type and partly Deccan Basalt type. Alluvium consists of alternate layers of clay and sand, gravel and boulders of variable thickness. The effective porosity of sand bed in Tapi Alluvium is about 30%. In Basalt, alternate layers of weathered basalt and hard massive basalt is observed. The porosity in the Basalt is about 2-3% and wells dug in Basalt hardly saturate. The saturated sand beds cater to the needs of drinking water and irrigated agriculture mainly cash crops. Indiscriminate withdrawal and overexploitation of this source to meet these needs resulted in the decline of ground water level and led to acute water shortage. All the dug wells in Tapi alluvium in Shirpur became dry by 1990. Even tube wells having a depth of about 200-500 meters became dry. Alternate layers of silt transmit very little water and the wells remain dry in heavy rainfall also. In the Basalt area, due to heavy

rainfall within short duration, there was only run off with hardly any percolation. That is why dug wells and bore wells in Deccan Basalt hardly yielded water maximum up to December. There was severe scarcity after December for drinking water as well as for irrigation. As a result, the huge amount invested on dug wells, pump sets and other development works by the individual farmers became futile. The most affected were the bore wells drilled for drinking water and situated in the elevated regions. With increased use of groundwater for irrigation, bore wells were drilled in the close proximity of the drinking water bore wells. This resulted in drying up of drinking water wells in manyparts of the taluka. Thus, drying of wells and tube wells in alluvial area and insufficient availability of water after December in the Deccan Basalt area were the main problems of Shirpur Taluka. There was an urgent need to take suitable measures to augment groundwater resources and to make the existing groundwater structures sustainable.

Troubled by acute water shortage crisis, the local MLA Shri Amrish Patel wanted to use rain water conservation methods to meet the water demands of the taluka. He along with geologist Shri Suresh Khanapurkar devised a plan to trap this rain water and started the project in 2004.Patel set aside Rs 3 crore every year for this ambitious project. To overcome the water shortage it was necessary to ensure that the ground water levels were fully saturated in spite of erratic rainfall and impervious layers in Alluvium and Deccan Basalt. The plan included three measures:

1.Building of cement structures (bundhs) on streams, with weirs (water blocking walls on streams) without gates, so that water flows downstream, only when the dam is full. The volume of water that percolates down in this method is eight times the storage capacity of a check dam.

2. To deepen the stream up to15 to 20 metres and widen up to 30 metres in Deccan Basalt and Alluvium.

3.To recharge the deeper layers in the Alluvial area using the surplus water of the dams in the Deccan Basalt area artificially through the dry dug wells having depth of about 40 to 50metres.

To ensure the success of the plan, a novel method to build the check dam was adopted. The Deccan Basalt rock that lies below the top soil is impermeable and not much water percolates down. Below this, is the layer of red gravel that holds water. It is this water that is drawn from wells and bore wells. The rock layer below the streams was blasted and removed so that water could percolate into the gravel. Since the stream was also widened, the increased volume of water exerted greater pressure on the soil. The volume of water that percolates down in this method is eight times the storage capacity of a check dam. Shri Khanapurkar calls this ‘Angioplasty of streams’, as it is recharging groundwater by removing obstructions through pressure.

The methods adopted proved to be successful and yielded encouraging results. The water level in Basalt area which had depleted up to 150 metres has risen by 140metres. Water level in alluvial area which had depleted up to 150 metres has risen by 110 metres. A minimum of 5 crore litres and a maximum of 15 crore litres of water has been stored because of stream widening and deepening. As a result of this the water level in the bore wells on either bank of the stream up to two km distance

went up by about 150 feet. Drinking water problem has been solved. The area for irrigation has increased and farmers started growing two crops per year. The average per capita income has increased at least by Rs one lakh/Ha. After completion of the 6thyear of the project, sufficient water for irrigation, drinking and for industries is available even in summer.

Shri Amrish Patel (MLC), former Minister of Education, Govt of Maharashtra, and President of Shri Vile Parle Kelvani Mandal feels that Shirpur pattern has innumerable advantages, "There is no need to displace people. The capital cost is low. So far, we have built 91 check dams at a cost of Rs 15 crore. Total water conserved due to these dams is 400 million cubic feet (mcf). If a medium scale dam with this much storage capacity was to be built, it would cost Rs 61 crore." 'If Angioplasty In Water Conservation' is practised on all small streams in all the mini and micro watersheds, entire Maharashtra will be tanker free and water will be available for second crop" claims Mr Amarishbhai, who has a legacy of belonging to the family of Vallabhbhai Patel.

However, Dr.Mukund Ghare, a groundwater expert in Maharashtra, Sourabh Gupta, scientist with the Central Groundwater Board, and Suresh Khandale, Additional Director of GSDA, Pune, felt that the width and depth of a stream gets decided as per the hydro-geology of that area and that deepening the stream bed by 15-20 meters exposes the aquifers which come in contact with muddy rain waters, clogging the aquifers and stopping the flow. Dr Ghare mentioned in his report submitted to the Govt of Maharashtra that deepening the stream beds more than what is required can lead to environmental problems and in basalt areas, the aquifers have become exposed; water has come to surface and is getting evaporated. Shirpur model, however, got support from the Government of Maharashtra which issued a Government Resolution (GR) on 9 May 2013 to replicate the Shirpur model all over Maharashtra.

Himanshu Kulkarni of ACWADAM, a premier NGO working on groundwater, warns that if the Shirpur model is taken up for large scale replication then it can lead to short and long term negative impacts, and some of them could be irreversible. It can play havoc with the hydro-geology of the region threatening the sustainability of stream/river flows. It also raises questions of equity and access to downstream.

While it is true that we need to understand the concept of groundwater well, it is also a fact that sustainable agriculture needs water. If there is no water for years together, any option that will work and give water in the immediate future, even though it could potentially cause harm many years later, is employed by farmers. By now Shirpur model has been accepted by many villages in Maharashtra. A local organisation called Jan Kalyan Samiti operates in the area of Latur-Beed and has implemented Shirpur pattern structures through Gram Panchayats of several villages in the area. People are coming together and are willing to be monetary stakeholders.

Q1. Elucidate the main features of water conservation based on the Shirpur pattern.
Q2. Is the Shirpur model a viable solution in your opinion? Discuss.

Note: Questions of the model question paper are not exhaustive, but suggestive, and teachers have liberty to reframe, modify and add other questions as deemed fit.

Model Question Paper USACEVS601

Duration 2.5 hrs **Maximum Marks: 75**

N.B.: 1. Q 1 is compulsory.
2. Attempt any four questions from Q 2 to Q 9.
3. Draw neat and labelled diagrams wherever necessary.

Q1. Write short notes on any **five** of the following (Mixed questions from all units): **15**

a. Air quality standards
b. Most Probable Number (MPN) Count
c. Bioremediation
d. Bio pesticides
e. Concept of ecological modelling
f. Applications of ecological modelling
g. Depreciation.
h. Fixed and Variable cost giving 2 examples each.
i. Importance of biosphere reserve
h. Western Ghats as biodiversity hotspot
k. Remote sensing and its types
l. Kyoto protocol
m. Wildlife Protection Act, 1972
n. IUCN
o. ——— (from open unit, if opted)
p. ——— (from open unit, if opted)

Q 2.Question based on Unit 1

Give a detailed account on the methods of monitoring and control of air pollutants. **15**

OR

2 a. Discuss the noise levels generated from various sources. **8**

2 b. Discuss the factors to be considered while establishing an environmental testing laboratory. **7**

Q3.**Question based on Unit 2**

Discuss any two alternatives to conventional resources studied by you. **15**

OR

3a. Describe the process to treat domestic effluents**. 8**

3 b. Explain the process of developing effluent treatment plants. **7**

Q 4.Question based on Unit 3

Explain the concept of ANN (Artificial Neural Networking) and Statistical modelling. **15**

OR

4 a. Comment on the application of physical models for impact prediction**. 8**

4 b. Discuss the limitations of ecological modelling**. 7**

Q5. **Question based on Unit 4**

From the books of accounts of M/s Avdhoot Enterprises, the following details have been extracted for the Quarter ending December, 2016:

Particulars	Rs.
Stock of Materials – Opening	2,70,000
Stock of Materials – Closing	3,00,000
Purchase of materials	12,48,000
Direct Wages	3,57,600
Direct Expenses	1,20,000
Indirect Wages	24,000
Salaries to Administrative Staff	60,000
Carriage Inward	48,000
Carriage Outward	37,500
Manager's Salary	72,000
General Expenses	37,200
Legal Expenses for criminal suit	20,000
Commission on sales	28,000
Fuel	96,000
Electricity charges (factory)	72,000
Directors' fees	36,000
Repairs to plant and machinery	63,000
Rent, rates and taxes – factory	18,000
Rent, rates and taxes – office	9,600

Depreciation on Plant & Machinery	45,000
Depreciation on Furniture	3,600
Salesmen's Salary	50,000
Audit fees	18,000

1) The Manager's time is shared between the factory and office in the ratio of 20:80
2) Carriage Outward includes an amount of Rs. 7,500/- carriage inward on Plant & Machinery.
3) Selling price is 120% of cost price.

From the above details prepare the detailed cost sheet for the quarter ended December, 2016 and ascertain sales.

OR

5 a. Write briefly on types of costing, viz; job, batch, process, operating and contract costing. **8**

5b. Write short notes on: **7**

i.Types of accounts and the accounting rules applicable to each of them.

ii. Concepts of accounting.

Q6. Question based on Unit 5

What is Biodiversity? Explain in situ and ex situ strategies for biodiversity conservation. **15**

OR

6 a. Comment on wildlife photography as a tool for biodiversity data collection. **8**

6 b. Elucidate with an illustration the ecotourism policy in India. **7**

Q7. Question based on Unit 6

Discuss climate change. Give a detailed note on global warming and its effects on environment**.** **15**

OR

7 a. Explain the principles and applications of GIS. **8**

7 b. Comment on the UN convention on Climate change. **7**

Q 8.**Question based on Unit 7**

Discuss environmental education programmes in India. **15**

OR

8 a. Explain the goals and principles of environmental education. **8**

8 b. Discuss the Water (Prevention and Control of Pollution) Act, 1974. **7**

Q9. **Question based on Unit 8**

Question based on open unit (if opted) **15**

OR

9 a. _____ **8**

9b. _____ **7**

Note: Questions of the model question paper are not exhaustive, but suggestive, and teachers have liberty to reframe, modify and add other questions as deemed fit.

AC – 11/07/2022
Item No. 6.15 (R)

UNIVERSITY OF MUMBAI

Revised Syllabus for
F.Y.B.Sc.
(Physics)

Semester: I & II
(CBCS)

(With effect from the academic year 2022-23)

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	F.Y.B.Sc. (Physics)
2	Eligibility for Admission	
3	Passing Marks	
4	Ordinances / Regulations (if any)	
5	No. of Years / Semesters	06 Semesters
6	Level	UG
7	Pattern	Semester
8	Status	Revised
9	To be implemented from Academic Year	From Academic Year: 2022-2023

Date: Signature:

Name Dr. Anuradha Majumdar
Chairman of BOS of Physics Dean, Science and Technology

Syllabus for B.Sc. Physics (Theory & Practical)

As per Choice Based and Credit System
First Year B.Sc 2022-2023

The revised syllabus in Physics as per Choice Based and Credit System for the First Year B.Sc Course will be implemented from the academic year 2022-2023.

Preamble:
The systematic and planned curricula from these courses shall motivate and encourage learners to understand basic concepts of Physics.

Objectives:

- To develop analytical abilities towards real world problems
- To familiarize with current and recent scientific and technological developments
- To enrich knowledge through problem-solving, hands-on activities, study visits, projects etc

Course Code	Title	Credits
	Semester I	
USPH101	Classical Physics	02
USPH102	Modern Physics	02
USPHPI	Practical I	02
		Total = 06
	Semester II	
USPH201	Optics I	02
USPH202	Electricity and Electronics	02
USPHPII	Practical II	02
		Total = 06

Scheme of Examination:

- Each theory paper of each semester will have 20% Internal Assessment (IA) and 80% External Assessment (EA). All external examinations will be held at the end of each semester and will be conducted by the University as per existing norms
- There will be no internal assessment for practical. A candidate will be allowed to appear for the semester end practical examination only if the candidate submits a certified journal at the time of practical examination of the semester or a certificate from the Head of the Department/Institute to the effect that the candidate has completed the practical course of that

semester of F.Y.B.Sc Physics as per the minimum requirement. The duration of the practical examination will be two hours per experiment. There will be two experiments (one from each group) through which the candidate will be examined in practical. The questions on slips for the same should be framed in such a way that candidate will be able to complete the task and should be evaluated for its skill and understanding of physics.

SEMESTER-I

Name of the Programme	Duration	Semester	Subject
B.Sc.in Physics	Six semesters	I	Physics
Course Code	Title	Credits	
USPH101	**Classical Physics**	2	

Learning Objectives:

1. Understand Newton's laws and applications in daily life.
2. Understand the concepts of friction
3. Understand Work and Energy Equivalence
4. Understand the concepts of Elasticity, Viscosity and Fluid dynamics
5. Understand behavior of real gases in relation to their thermo dynamical response.

Learning Outcomes:

On successful completion of this course students will be able to:

1. Apply Newton's laws for the calculations of the motion of simple systems.
2. Use Work and Energy equivalence and its applications through suitable numerical.
3. Use Elasticity, Viscosity and Fluid dynamics in daily life.
4. Understand Real gases and validity of the laws of thermodynamics.
5. Demonstrate quantitative problem solving skills in all the topics covered

Unit I **15 Lectures**

1. Newton's Laws of Motion: Newton's first, second and third laws of motion, interpretation and applications, pseudo forces, inertial and non-inertial frames of reference
Worked out examples (with friction present)
HCV: 5.1 to 5.5

2. Friction: Advantages & disadvantages of friction in daily life, Friction as the component of Contact force, Kinetic Friction, Static friction, laws of friction, Understanding friction at Atomic level.
HCV: 6.1 to 6.5

3. Work and Energy: Kinetic Energy, Work and Work-energy theorem, Potential Energy, Conservative and Non Conservative Forces, Different forms of Energy: Mass Energy Equivalence
Worked out Examples
HCV**:** 8.1, 8.2, 8.5, 8.6, 8.11

Unit II **15 Lectures**

1. Elasticity: An introduction to Elasticity, Stress, Strain, Hooke's Law and Moduli of Elasticity and relation between them
HCV**:** 14.2, 14.3, 14.4, 14.5

2. Viscosity: An introduction to Viscosity, Flow through a Narrow Tube: Poiseuille's Equation, Stokes' Law, Terminal velocity, Measuring Coefficient of Viscosity by Stokes' method, Critical velocity and Reynolds number. Worked out Examples
HCV: 14.15, 14.16, 14.17, 14.18, 14.19, 14.20

3. Fluid Mechanics: Streamline and Turbulent flow, Equation of Continuity, Bernoulli's equation, Applications of Bernoulli's equation. Worked out Examples
HCV: 13.8, 13.10, 13.11, 13.12

Unit III **15 lectures**

1. Behavior of real gases: An introduction, Van der Waals equation of state
BSH: 2.8

2. Laws of Thermodynamics: Thermodynamic Systems, Zeroth law of thermodynamics, Concept of heat, Thermodynamic Equilibrium, Work: A Path dependent function, Internal energy, First law of Thermodynamics, Internal Energy as a state function, Specific heat of gases, Applications of First Law of thermodynamics, The indicator diagram, Work done during Isothermal and Adiabatic processes
BSH: 4.1 to 4.13

3. Heat engine: Definition of Efficiency of heat engine, Carnot's Ideal heat engine, and Numerical examples
BSH: 4.21, 4.22, 4.23

Note: A good number of numerical examples are expected to be covered during the prescribed lectures.

Main References:

1. HCV: H. C. Verma, Concepts of Physics – Part I, (Second Reprint of 2020) Bharati Bhavan Publishers and Distributers
2. BSH: BrijLal, Subrahmanyam and Hemne, Heat Thermodynamics and Statistical Physics, S. Chand , Revised, Multi-coloured, (Reprint 2019)

Additional References:

1. Halliday, Resnick and Walker, Fundamental of Physics (extended) – (6th Ed.), John Wiley & Sons.
2. D.S Mathur, P.S Hemne, Mechanics, 2012, S. Chand
3. M. W Zemansky and R. H Dittman, Heat and Thermodynamics, McGraw Hill.
4. Thornton and Marion, Classical Dynamics (5th Ed.)
5. D. S Mathur, Element of Properties of Matter, S. Chand & Co.
6. R. Murugeshan and K. Shivprasath, Properties of Matter and Acoustics, S. Chand.
7. D. K Chakrabarti, Theory and Experiments on Thermal Physics,(2006 Ed.), Central books.
8. Hans and Puri, Mechanics, (2nd Ed.) Tata McGraw Hill

SEMESTER-I

Name of the Programme	Duration	Semester	Subject
B.Sc.in Physics	Six semesters	I	Physics
Course Code	Title	Credits	
USPH102	**Modern Physics**	2	

Learning Objectives:

1. To grasp and understand the basic concepts of Modern Physics

Learning Outcomes:

On successful completion of this course students will be able to:

1. Understand nuclear properties, nuclear behavior and various types of nuclear reactions
2. Understand the concept of radioactivity, its applications and different types of equilibria in radioactive elements
3. Understand various types of nuclear detectors and their applications
4. Demonstrate and understand the quantum mechanical concepts.
5. Demonstrate quantitative problem solving skills in all the topics covered.

Unit I **15 Lectures**

1. Basic properties of nuclei: Composition, Charge, Size, density, Spin and Magnetic dipole moment, Rutherford's experiment and estimation of nuclear size , mass defect and binding energy, BE/A vs A plot and its interpretation, stability of nuclei (N vs Z plot)

Problems

AB: 11.1, 11.2, 11.3, 11.4

SBP: 4.1.2

2. Radioactivity: Review of properties of α, β and γ-rays.

Law of Radioactive decay, half-life and mean life (derivation required), units of radioactivity, statistical nature of radioactivity, successive radioactive disintegration- A to B to C (stable) type, natural radioactive series, radioactive equilibriums, artificial radioactivity, determination of the age of the Earth, Carbon dating, radioisotopes and its applications, radiation hazards.

Problems

SBP: 2.3, 2.4, 2.6, 2.7, 2.8, 2.9, 2.11, 2.12, 2.13

DCT: 2.13 Page No.86 and 87

AB: 12.1 Page No. 422,423

Additional Reference: https://dae.gov.in/node/191

Unit II **15 Lectures**

1. Radiation Detectors: Interaction between particles and matter, plot of variation of ionization current with applied voltage, Gas filled radiation detectors- Ionization chamber (qualitative), Proportional Counter and GM Counter

Problems

SBP: 1.I.1, 1.I.2, 1.I.3 (i, ii)

SNG: Figure: 7.3 (exclude mode of operation), 7.4

2. Nuclear Reactions: Introduction, types of nuclear reactions, conservation laws (mass, energy and charge), concept of compound and direct reaction, Q value equation and solution of the Q equation, threshold energy

Problems

SBP: 3.1, 3.2, 3.3, 3.4, 3.5

Unit III **15 Lectures**

Review (Photoelectric effect, Black body, Black Body spectrum, Wien's displacement law)

1. Origin of Quantum theory: Matter waves: De Broglie waves, Concept of wave packet, phase velocity, group velocity and relation between them, wave particle duality, Davisson-Germer experiment, Heisenberg's Uncertainty Principle

AB: 3.1, 3.2, 3.3, 3.4, 3.5, 3.7, 3.8, 3.9

2.X-Rays: Production and properties, X-Ray spectra, X-Ray Diffraction, Bragg's Law, Compton Effect, Pair production, Photons and Gravity, Gravitational Red Shift, Black holes

AB: 2.5, 2.6, 2.7, 2.8, 2.9

Note: A good number of numerical examples are expected to be covered during the prescribed lectures

Main References:

1. AB: Arthur Beiser, Concepts of Modern Physics, 6th Edition

2. SBP: S.B. Patel, Nuclear Physics: An Introduction, New Age International Publishers, 2nd Edition

3. SNG: S.N, Ghoshal, Nuclear Physics

4. DCT: D.C. Tayal, Nuclear Physics, Himalaya Publishing House, 5th Edition

Additional References:

1. S.L Kakani and Shubhra Kakani, Nuclear and Particle Physics, Viva Books, 2nd Edition

2. Kenneth S. Krane, Modern Physics, 4th Edition, Wiley.

4. Ronald Gautreau, Schaum's Outline of Modern Physics, Second Edition, McGraw Hill

Besides reference books, Standard websites are expected to be referred

SEMESTER-I

Name of the Programme	Duration	Semester	Subject
B.Sc.in Physics	Six semesters	**I**	**Physics**
Course Code	Title	Credits	
USPHP1	**Practical I**	2	

Instructions:

1. All the measurements and readings should be written with proper units in SI system only.
2. After completing all the required number of experiments in the semester and recording them in journal, student will have to get their journal certified and produce the certified journal at the time of practical examination.
3. While evaluating practical, weightage should be given to circuit/ray diagram, observations, tabular representation, experimental skills and procedure, graph, calculation and result.
4. Skill of doing the experiment and understanding physics concepts should be more important than the accuracy of final result.

Learning Outcome:

1. On successful completion of this course students will be able to:
2. Understand & practice the skills while performing experiments.
3. Understand the use of apparatus and their use without fear & hesitation.
4. Correlate the physics theory concepts to practical application.
5. Understand the concept of errors and their estimation**.**

Note: Exemption of two experiments from section A and / or B and / or C may be given if student carries out any one of the following activity.

- Collect the information of at least five Physicists with their work or any three events on physics, report that in journal.
- Execute a mini project to the satisfaction of teacher in-charge of practical.
- Participate in a study tour or visit & submit a study tour report.
- For practical examinations, the learner will be examined in two experiments (one from each group).
- Each experiment will be of three lecture hours' duration.

- A Minimum 4 from each group and in all minimum 8 experiments must be reported in journal.
- All the skill experiments are required to be completed compulsorily. Students are required to report all these experiments in the journal. Evaluation in viva voce will be based on regular experiments and skill experiments.

A learner will be allowed to appear for the semester and practical examination only if he submits a certified journal of Physics or a certificate that the learner has completed the practical course of Physics Semester I as per the minimum requirements.

A. Regular Experiment:

Sr No	Name of the Experiment
	GROUP A
1	Torsional Oscillation: To determine modulus of rigidity η of a material of wire by Torsional oscillations
2	Bifilar Pendulum: Determination of moment of inertia of rectangular and cylindrical bar about an axis passing through its centre of gravity
3	Moment of inertial of Flywheel
4	Constant volume air thermometer
5	Frequency of AC Mains: To determine frequency of AC mains (Sonometer wire)
6	LDR Characteristics: To study the dependence of LDR resistance on intensity of light
	GROUP B
7	Study of Logic gates & To verify De Morgan's Theorems
8	To study EX-OR Gate and verify its truth table
9	To study half adder and full adder and verify their truth table Ex-OR Gate
10	To study load regulation of a Bridge Rectifier
11	To study Zener Diode as Regulator
12	Study of LASER Beam Divergence

GROUP C:Skill Experiment	
1	Use of Vernier Callipers, Micrometer Screw Gauge and Travelling Microscope
2	Graph plotting (Plot BE/A verses A graph for 30 atoms, Plot Packing Fraction graph for 30 atoms)
3	Spectrometer: Schuster's Method
4	To determine the Resistance & Capacitance using Color code/Number & verify using Multimeter (Analog/Digital)
5	Use of digital multimeter
6	Absolute and relative error calculation

Note: Minimum **8** experiments (Four From each group) and **4** Skill experiments should be completed and reported in the journal, in the first semester. **Certified Journal is a must,** to be eligible to appear for the semester end practical examination.

SEMESTER-II

Name of the Programme	Duration	Semester	Subject
B.Sc.in Physics	Six semesters	II	Physics
Course Code	Title	Credits	
USPH201	**Optics I**	2	

Learning Objectives:
To acquire knowledge of fundamental optics

Learning Outcomes:
After successful completion of the course, the student will be able to:

1. Understand the concept of lens, lens defects and their minimization.
2. Significance of combination of lenses implied to eyepiece of optical instrument.
3. Understand interference of light with few well known daily life examples.
4. Understand Lasers and Optical fibers, their applications in day to day life.

UI Geometrical Optics (15 lectures)

1. Lenses and Lens Maker's Equation: Introduction to lenses, Terminology and sign conventions, Introduction to Thin lenses and Lens equation for single convex lens, Lens maker's equation: Positions of the Principal Foci and Newton's Lens equation.
SBA: 4.1, 4.2, 4.3, 4.7, 4.8, 4.9, 4.10, 4.10.1, 4.11

2. Magnification by a lens and power of lens: Lateral, Longitudinal and Angular magnification, Deviation by a thin lens and its power, Necessity to combine the lenses & equivalent focal length & power of two thin lenses, Concept of cardinal points and their significance
SBA: 4.12, 4.12.1, 4.12.2, 4.12.3, 4.15, 4.16, 4.17, 4.17.1, 4.17.2, 4.17.3, 4.17.4, 5.2

3. Introduction to Aberration in lenses: Spherical aberration & reduction, chromatic aberration & reduction (Qualitative)
SBA: 9.2, 9.5, 9.5.1, 9.10
Suitable numerical with appropriate difficulty level.

U2 Introduction to Optical Instruments and Interference in Thin Films (15 lectures)

1. **Optical Instruments and Eyepieces**: Human Eye as an optical instrument, Camera and Lenses of Camera, Simple Microscope & Compound Microscope, Concept of eyepiece & its significance: Huygens Eyepiece and Ramsden Eyepiece (Principle, Construction, Expression for Equivalent Focal Length, Merits and Demerits), Comparison of Huygens Eyepiece and Ramsden Eyepiece, Gauss Eyepiece, Refracting Astronomical Telescope (Construction and Working), Reflecting Telescope (Qualitative)

SBA: 10.2, 10.3, 10.3.1, 10.5, 10.8, 10.10, 10.11, 10.12, 10.13, 10.14, 10.15, 10.15.1, 10.16

2. **Interference in Thin Films**: Interference due to reflected and transmitted light in plane thin films, Conditions for Maxima and Minima, Interference pattern in wedge-shaped film & Newton's rings

SBA: 15.1, 15.2, 15.2.1, 15.2.2, 15.5, 15.6

Suitable numerical with appropriate difficulty level.

U3 Lasers and Fiber Optics (15 lectures)

1. **An Introduction to LASERS**: Absorption and Emission, Spontaneous and Stimulated Emission, Components of laser, Ruby laser, He-Ne Laser, Laser Beam Characteristics, Applications of Laser

SBA: 22.1, 22.4.1, 22.4.2, 22.8, 22.8.1, 22.8.2, 22.8.3, 22.14.1, 22.14.3, 22.16, 22.19

2. **An Introduction to Optical Fiber**: Total Internal Reflection, Propagation of light through an Optical fiber, Numerical Aperture, Classification of Optical fibers, Single Mode Step Index Fiber, Multimode Step Index Fiber, Graded Index Fiber, Optical Fiber applications (Optical fiber based communication system & Optical Fiber based Temperature sensor)

SBA: 24.2, 24.3, 24.4, 24.6, 24.10, 24.11.1, 24.11.2, 24.11.3, 24.21, 24.23.1

Main Reference:

SBA: Dr. N. Subrahmanyam, Brijlal, and Dr. M. N. Avadhanulu, A Textbook of Optics, 25th Revised Edition 2012(Reprint 2016), S. Chand and Company Pvt. Ltd.

Additional References:

1. Jenkins and White, Fundamentals of Optics by (4th Ed.), McGraw Hill International

2. Ajoy Ghatak, Optics, 6th Edition, Mc Graw Hill Education (India) Private Limited

SEMESTER II

Name of the Programme	Duration	Semester	Subject
B.Sc.in Physics	Six semesters	II	Physics
Course Code	Title	Credits	
USPH202	**Electricity and Electronics**	2	

Learning Outcomes:

On successful completion of this course students will be able to:

1. Understand the basic concepts of Alternating current theory, AC bridges and Circuit Theorems
2. Understand the basics of Analog and Digital Electronics and apply them in real life situations
3. Demonstrate quantitative problem solving skills in all the topics covered

Unit I: Electricity **15 lectures**

1. **Alternating current theory**: (Review: Concept of L, R, and C)

AC circuit containing pure R, pure L and pure C, representation of sinusoids by complex numbers, Series L-R, C-R and LCR circuits, Resonance in LCR circuit (both series and parallel), Power in ac circuit. Q- Factor.

TT: 11.29, 11.30, 11.32, 12.5, 12.6, 13.1, 13.7, 13.9, 13.10, 13.11, 13.12, 13.13, 13.14, 13.17, 13.19, 14.2

2. **AC bridges**: General AC Bridge, Maxwell's Inductance Bridge, Maxwell's L/C Bridge, De Sauty Bridge, Wien Bridge.
(Bridge diagram, balancing condition derivation, applications)

TT: 16.1, 16.2, 16.3, 16.9, 16.11

3. **Circuit Theorems**: (Review: Ohm's law, Kirchhoff's laws) Ideal Current and Voltage Sources, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem.
Problems related to circuit analysis using the above theorems.

TT: 2.15, 2.16, 2.18, 2.25, 2.30

Unit II: Analog Electronics **15 lectures**

1.**DC Power Supply**: Block diagram of a dc power supply – concept of a transformer,(Review: Half wave rectifier, Full wave rectifier) Bridge rectifier, PIV, Efficiency and Ripple factor of full wave rectifier, Capacitor Filter, Need for voltage regulation - Zener diode as voltage stabilizer, Clipper and Clampers (Basic diode based circuits only).

BN: 1.15, 2.6, 2.7, 2.8, 2.9, 2.10, 15.2, 15.3
AD: 4.2, 22.1

2. **Transistor dc Biasing**: (Review: transistor structure and characteristics), Definition of gains α, β (dc and ac) and relation between them, load line analysis, operating point, cut-off and saturation points, Inherent Variations of transistor Parameters, Stabilization, Necessity of a Transistor Biasing Circuit, Stability Factor, Methods of Transistor Biasing, Base Resistor or fixed bias, Emitter Bias and Voltage Divider Bias Methods(Qualitative Analysis only, No mathematical derivation) , Stability factor for Potential Divider Bias.

Transistor as a switch: circuit and working, Transistor as an Amplifier: CE, CB and CC modes, Practical circuit of an amplifier and its operation and phase reversal.

BN: 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 4.1, 4.2, 4.17, 4.18(Transistor Switch)

Unit III: Digital Electronics **15 lectures**

1. **Number Systems** – Binary number system: Binary to decimal and Decimal to binary conversion, Hexadecimal number system: Hexadecimal to decimal Conversion, Decimal to hexadecimal conversion, Hexadecimal to binary conversion, Binary to hexadecimal conversion.

LMS: 5.1 to **5.5**

2. **Derived Gates** (Review: Basic Logic gates),NAND and NOR as Universal Building blocks, Ex-OR gate: logic expression, logic symbol, truth table, Implementation using basic gates and its applications – Parity generator and checker, Half adder and Full adder.

LMS: 2.1, 2.2

Tokheim: 3.6, 3.8, 10.2, 10.3

3. **Boolean Algebra**: Boolean theorems, De-Morgan theorems, Sum of Product (SOP) and Product of sum (POS) methods, Simplification of logical expressions.

LMS: 3.1, 3.2, 3.7, 3.8

References:

1. TT: B.L. Theraja and A.K. Theraja, A Textbook of Electrical Technology Vol. I, S. Chand Publication

2. BN: R. L. Boylestad and L. Nashelsky, Electronic devices and Circuit Theory - 10th Edition, Pearson

3. LMS: Leach, Malvino, Saha, Digital Principles and Applications – 6th Edition.Tata McGraw Hill

5. Tokheim: Digital Electronics, Principles and Applications, 6th Edition, McGraw Hill Edition.

6. AD: Albert Malvino, David Bates, Electronic Principles, 8th Edition, Tata McGraw Hill

SEMESTER-II

Name of the Programme	Duration	Semester	Subject
B.Sc.in Physics	Six semesters	**II**	**Physics**
Course Code	Title	Credits	
USPHP2	**Practical II**	2	

Instructions:

1. All the measurements and readings should be written with proper units in SI system only.
2. After completing all the required number of experiments in the semester and recording them in journal, student will have to get their journal certified and produce the certified journal at the time of practical examination.
3. While evaluating practical, weightage should be given to circuit/ray diagram, observations, tabular representation, experimental skills and procedure, graph, calculation and result.
4. Skill of doing the experiment and understanding physics concepts should be more important than the accuracy of final result.

Learning Outcome:

On successful completion of this course students will be able to:

1. Understand & practice the skills while performing experiments.
2. Understand the use of apparatus and their use without fear & hesitation.
3. Correlate the physics theory concepts to practical application.
4. Understand the concept of errors and their estimation.

Note: Exemption of two experiments from section A and / or B and / or C may be given if student carries out any one of the following activity.

- Collect the information of at least five Physicists with their work or any three events on physics, report that in journal.
- Execute a mini project to the satisfaction of teacher in-charge of practical.
- Participate in a study tour or visit & submit a study tour report.
- For practical examinations, the learner will be examined in two experiments (one from each group).

- Each experiment will be of three lecture hours' duration.
- A Minimum 4 from each group and in all minimum 8 experiments must be reported in journal.
- All the skill experiments are required to be completed compulsorily. Students are required to report all these experiments in the journal. Evaluation in viva voce will be based on regular experiments and skill experiments.

A learner will be allowed to appear for the semester and practical examination only if he submits a certified journal of Physics or a certificate that the learner has completed the practical course of Physics Semester II as per the minimum requirements.

A. Regular Experiment:

Sr No	Name of the Experiments
	GROUP A
1	Young's Modulus of a wire material by method of vibrations
2	Spectrometer: To determine of angle of Prism
3	Spectrometer: To determine refractive index of prism material
4	Combination of Lenses: To determine equivalent focal length of a lens system by magnification method
5	Newton’s Rings: To determine radius of curvature of a given convex lens using Newton's rings.
6	Determination of diameter of thin wire using Wedge Shaped Film
	GROUP B
7	To study NAND/NOR gates as Universal Building Blocks
8	LR Circuit: To determine the value of given inductance and phase angle
9	CR Circuit: To determine value of given capacitor and Phase angle
10	Transistor configurations : CB/CE/CC (study of input-output characteristics)

11	LCR series Resonance: To determine resonance frequency of LCR series circuit
12	To study Thermistor characteristics: Resistance vs. Temperature
GROUP C: DEMONSTRATION EXPERIMENT	
1	Radius of ball bearings (single pan balance)
2	Use of Oscilloscope: Wave forms at output of half wave , bridge rectifiers with and without Capacitor filter, Ripple
3	Use of PC for graph plotting
4	I-V Characteristics of LED
5	Testing of components (Resistors , Diode , Transistor , capacitor)
6	Study of I-V characteristics of solar cell

Note: Minimum **8** experiments (Four From each group) and **4** Demo experiments should be completed and reported in the journal, in the first semester. **Certified Journal is a must,** to be eligible to appear for the semester end practical examination.

University of Mumbai

No. UG/17 of 2020-21

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the recognized Institutions in Humanities, Science & Technology Faculty is invited to this office circular No.UG/57 of 2018-19, dated 6th July, 2018 relating to the revised syllabus for the F.Y.B.Sc/F.Y.B.A. in Mathematics (Sem. I & II).

They are hereby informed that the recommendations made by the Board of Studies in Mathematics at its meeting held on 11th March, 2020 vide item No.1 and subsequently made by the Board of Deans at its meeting held on 20th July, 2020 vide item No.54 have been accepted by the Academic Council at its meeting held on 23rd July, 2020 vide item No. 4.106 and that in accordance therewith, the revised syllabus practical book of F.Y. B.Sc./ F.Y.B.A. in Mathematics under the (CBCS) in 75:25 pattern has been brought into force with effect from the academic year 2020 -21 accordingly. (The same is available on the University's website www.mu.ac.in).

(Dr. Vinod Patil)
I/c REGISTRAR

MUMBAI – 400 032
17th November, 2020

To

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

A.C/4.106/23/07/2020

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No. UG/17 -A of 2020-21 MUMBAI-400 032 17th November, 2020

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Humanities, Science & Technology,
2) The Chairman, Board of Studies in Mathematics,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. Vinod Patil)
I/c REGISTRAR

Copy to :-

1. **The Director of Board of Student Development.,**
2. **The Deputy Registrar (Eligibility and Migration Section)**
3. **The Director of Students Welfare,**
4. **The Executive Secretary to the to the Vice-Chancellor,**
5. **The Pro-Vice-Chancellor**
6. **The Registrar and**
7. **The Assistant Registrar, Administrative sub-centers, Ratnagiri, Thane & Kalyan, for information.**

1. **The Director of Board of Examinations and Evaluation**
2. **The Finance and Accounts Officers**
3. **Record Section**
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5. **The Deputy Registrar, Enrolment, Eligibility and Migration Section**
6. **The Deputy Registrar (Accounts Section), Vidyanagari**
7. **The Deputy Registrar, Affiliation Section**
8. **The Professor-cum- Director, Institute of Distance and Open Learning Education,**
9. **The Director University Computer Center (IDE Building), Vidyanagari,**
10. **The Deputy Registrar (Special Cell),**
11. **The Deputy Registrar, (PRO)**
12. **The Deputy Registrar, Academic Authorities Unit (1 copies) and**
13. **The Assistant Registrar, Executive Authorities Unit**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **The Assistant Registrar Constituent Colleges Unit**
2. **BUCTU**
3. **The Deputy Accountant, Unit V**
4. **The In-charge Director, Centralize Computing Facility**
5. **The Receptionist**
6. **The Telephone Operator**
7. **The Secretary MUASA**
8. **The Superintendent, Post-Graduate Section**
9. **The Superintendent, Thesis Section**

for information.

Cover Page

AC_____
Item No. _____

UNIVERSITY OF MUMBAI

Sr. No.	Heading	Particulars
1	Title of the Course	Mathematics (F.Y.B.Sc / F.Y.B.A)
2	Eligibility for Admission	XII th Science with Maths
3	Passing Marks	40/100
4	Ordinances / Regulations (if any)	-
5	No. of Years / Semesters	Two Semesters
6	Level	~~P.G.~~ / U.G./ ~~Diploma~~ / ~~Certificate~~ **(Strike out which is not applicable)**
7	Pattern	~~Yearly~~ / Semester **(Strike out which is not applicable)**
8	Status	~~New~~ / Revised **(Strike out which is not applicable)**
9	To be implemented from Academic Year	From Academic Year 2020-2021

Date: 20/03/2020

Signature:

Name of BOS Chairperson / Dean: Prof. Dr. R.P. Deore

UNIVERSITY OF MUMBAI

Syllabus

for F. Y. B. Sc. / F. Y. B. A. Semester I & II (CBCS)

Program: B. Sc. / B. A.

Course: Mathematics

with effect from the academic year 2020-2021

F. Y. B. Sc. (CBCS) SEMESTER I

CALCULUS I				
Course Code	UNIT	TOPICS	Credits	L/Week
USMT 101	I	Real Number System	2	3
	II	Sequences in $\mathbb{R}$		
	III	First Order First Degree Differential Equations		
ALGEBRA I				
USMT 102	I	Integers and Divisibility	2	3
	II	Functions, Relations and Binary Operations		
	III	Polynomials		
PRACTICALS				
USMTP01	-	Practicals based on USMT101, USMT102	2	2

F. Y. B. A. (CBCS) SEMESTER I

CALCULUS I				
Course Code	UNIT	TOPICS	Credits	L/Week
UAMT 101	I	Real Number System	3	3
	II	Real Sequences		
	III	First Order First Degree Differential Equations		
Tutorials				
	-	Tutorials based on UAMT101		

F. Y. B. Sc. (CBCS) SEMESTER II

CALCULUS II				
Course Code	UNIT	TOPICS	Credits	L/Week
USMT 201	I	Limits and Continuity	2	3
	II	Differentiability of functions		
	III	Applications of Differentiability		
DISCRETE MATHEMATICS				
USMT 202	I	Preliminary Counting	2	3
	II	Advanced Counting		
	III	Permutations and Recurrence Relation		
PRACTICALS				
USMTP02	-	Practicals based on USMT201, USMT202	2	2

F. Y. B. A. (CBCS) SEMESTER II

CALCULUS II				
Course Code	UNIT	TOPICS	Credits	L/Week
UAMT 201	I	Limits and Continuity	3	3
	II	Differentiability of functions		
	III	Applications of Differentiability		
TUTORIALS				
	-	Tutorials based on UAMT201		

Revised Syllabus in Mathematics
Choice Based Credit System
F. Y. B. Sc. / B. A. 2020-2021

Preamble:
The University of Mumbai has brought into force the revised syllabi as per the Choice Based Credit System (CBCS) for the First year B. Sc/ B. A. Programme in Mathematics from the academic year 2020-2021.

Mathematics has been fundamental to the development of science and technology. In recent decades, the extent of application of Mathematics to real world problems has increased by leaps and bounds. Taking into consideration the rapid changes in science and technology and new approaches in different areas of mathematics and related subjects like Physics, Statistics and Computer Sciences, the board of studies in Mathematics with concern of teachers of Mathematics from different colleges affiliated to University of Mumbai has prepared the syllabus of F.Y.B. Sc. / F. Y. B. A. Mathematics. The present syllabi of F. Y. B. Sc. for Semester I and Semester II has been designed as per U. G. C. Model curriculum so that the students learn Mathematics needed for these branches, learn basic concepts of Mathematics and are exposed to rigorous methods gently and slowly. The syllabi of F. Y. B. Sc. / F. Y. B. A. would consist of two semesters and each semester would comprise of two courses for F. Y. B. Sc. Mathematics and one course for each semester for F. Y. B. A. Mathematics. Course I is 'Calculus I and Calculus II'. Calculus is applied and needed in every conceivable branch of science. Course II, 'Algebra I and Discrete Mathematics' develops mathematical reasoning and logical thinking and has applications in science and technology.

Aims:

(1) Give the students a sufficient knowledge of fundamental principles, methods and a clear perception of innumerous power of mathematical ideas and tools and know how to use them by modeling, solving and interpreting.

(2) Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.

(3) Enhancing students' overall development and to equip them with mathematical modeling abilities, problem solving skills, creative talent and power of communication necessary for various kinds of employment.

(4) A student should get adequate exposure to global and local concerns that explore them many aspects of Mathematical Sciences

Course outcomes:

1. Calculus (Sem I & II): This course gives introduction to basic concepts of Analysis with rigor and prepares students to study further courses in Analysis. Formal proofs are given lot of emphasis in this course which also enhances understanding of the subject of Mathematics as a whole. The portion on first order, first degree differentials prepares learner to get solutions of so many kinds of problems in all subjects of Science and also prepares learner for further studies of differential equations and related fields.

2. Algebra I (Sem I) & Discrete Mathematics (Sem II): This course gives expositions to number systems (Natural Numbers & Integers), like divisibility and prime numbers and

their properties. These topics later find use in advanced subjects like cryptography and its uses in cyber security and such related fields.

Teaching Pattern for Semester I

[1.] Three lectures per week per course.

[2.] One Practical per week per batch for each of the courses USMT101, USMT 102 (the batches to be formed as prescribed by the University).

[3.] One Tutorial per week per batch for course UAMT101 (the batches to be formed as prescribed by the University).

Teaching Pattern for Semester II

[1.] Three lectures per week per course.

[2.] One Practical per week per batch for each of the courses USMT201, USMT 202. (the batches to be formed as prescribed by the University).

[3.] One Tutorial per week per batch for the course UAMT201 (the batches to be formed as prescribed by the University).

F.Y.B.Sc. / F.Y.B.A. Mathematics

SEMESTER I

USMT 101 / UAMT 101: CALCULUS I

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and examples.

Unit 1 : Real Number System (15 Lectures)

(1) Real number system $\mathbb{R}$ and order properties of $\mathbb{R}$, absolute value $|\ |$ and its properties.

(2) AM-GM inequality, Cauchy-Schwarz inequality, Intervals and neighbourhoods, interior points, limit point, Hausdorff property.

(3) Bounded sets, statements of I.u.b. axiom and its consequences, supremum and infimum, maximum and minimum, Archimedean property and its applications, density of rationals.

Unit II: Sequences in $\mathbb{R}$ (15 Lectures)

(1) Definition of a sequence and examples, Convergence of sequences, every convergent sequences is bounded. Limit of a convergent sequence and uniqueness of limit, Divergent sequences.

(2) Convergence of standard sequences like $\left(\frac{1}{1+na}\right)\ \forall a > 0,\ \ (b^n)\ \forall b,\ 0 < b < 1,\ \ (c^{\frac{1}{n}})\ \forall c > 0,\ \ \&\ \ (n^{\frac{1}{n}})$.

(3) Algebra of convergent sequences, sandwich theorem, monotone sequences, monotone convergence theorem and consequences as convergence of $\left(\left(1+\frac{1}{n}\right)^n\right)$.

(4) Definition of subsequence, subsequence of a convergent sequence is convergent and converges to the same limit, definition of a Cauchy sequences, every convergent sequences s a Cauchy sequence and converse.

Unit III: First order First degree Differential equations (15 Lectures)

Review of Definition of a differential equation, order, degree, ordinary differential equation and partial differential equation, linear and non linear ODE. Solution of homogeneous and non-homogeneous differential equations of first order and first degree. Notion of partial derivatives.

(1) Exact Equations: General solution of Exact equations of first order and first degree. Necessary and sufficient condition for $Mdx + Ndy = 0$ to be exact. Non-exact equations: Rules for finding integrating factors (without proof) for non exact equations, such as :

i) $\frac{1}{M\ x + N\ y}$ is an I.F. if $M\ x + N\ y \neq 0$ and $Mdx + Ndy = 0$ is homogeneous.

ii) $\frac{1}{M\ x - N\ y}$ is an I.F. if $M\ x - N\ y \neq 0$ and $Mdx + Ndy = 0$ is of the form $f_1(x,y)\ y\ dx + f_2(x,y)\ x\ dy = 0$.

iii) $e^{\int f(x)\ dx}$ (resp $e^{\int g(y)\ dy}$) is an I.F. if $N \neq 0$ (resp $M \neq 0$) and $\frac{1}{N}\left(\frac{\partial M}{\partial y} - \frac{\partial N}{\partial x}\right)$ $\left(\text{resp}\frac{1}{M}\left(\frac{\partial M}{\partial y} - \frac{\partial N}{\partial x}\right)\right)$ is a function of x (resp y) alone, say $f(x)$ (resp $g(y)$).

iv) Linear and reducible linear equations of first order, finding solutions of first order differential equations of the type for applications to orthogonal trajectories, population growth, and finding the current at a given time.

(2) Reduction of order :

(i) If the differential equation does not contain only the original function y, that is equations of Type $F(x, y', y'') = 0$.

(ii) If the differential equation does not contain the independent variable x that is, equations of Type $F(y, y', y'') = 0$.

Reference Books:

1. R. R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964.
2. K. G. Binmore, Mathematical Analysis, Cambridge University Press, 1982.
3. R. G. Bartle- D. R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 1994.
4. Sudhir Ghorpade and Balmohan Limaye, A course in Calculus and Real Analysis, Springer International Ltd, 2000.
5. G. F. Simmons, Differential Equations with Applications and Historical Notes, McGraw Hill, 1972.
6. E. A. Coddington , An Introduction to Ordinary Differential Equations.Prentice Hall, 1961.
7. W. E. Boyce, R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, Wiely, 2013.

Additional Reference Books

1. T. M. Apostol, Calculus Volume I, Wiley & Sons (Asia) Pte, Ltd.
2. Richard Courant-Fritz John, A Introduction to Calculus and Analysis, Volume I, Springer.
3. Ajit kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.
4. James Stewart, Calculus, Third Edition, Brooks/ cole Publishing Company, 1994.
5. D. A. Murray, Introductory Course in Differential Equations, Longmans, Green and Co., 1897.
6. A. R. Forsyth, A Treatise on Differential Equations, MacMillan and Co.,1956.

ALGEBRA I
USMT 102

Prerequisite :
Set Theory: Set, subset, union and intersection of two sets, empty set, universal set, complement of a set, De Morgan's laws, Cartesian product of two sets, Relations, Permutations ${}^nP_r$ and Combinations ${}^nC_r$.
Complex numbers: Addition and multiplication of complex numbers, modulus, amplitude and conjugate of a complex number.

Unit I : Integers & Divisibility (15 Lectures)

(1) Statements of well-ordering property of non-negative integers, Principle of finite induction (first and second) as a consequence of Well-Ordering Principle.

(2) Divisibility in integers, division algorithm, greatest common divisor (g.c.d.) and least common multiple (l.c.m.) of two non zero integers, basic properties of g.c.d. such as existence and uniqueness of g.c.d. of two non zero integers $a\&b$ and that the g.c.d. can be expressed as $ma + nb$ for some $m, n \in \mathbb{Z}$, Euclidean algorithm.

(3) Primes, Euclid's lemma, Fundamental Theorem of arithmetic, The set of primes is infinite, there are arbitrarily large gaps between primes, there exists infinitely many primes of the form $4n - 1$ or of the form $6n - 1$.

(4) Congruence, definition and elementary properties, Results about linear congruence equations. Examples.

Unit II : Functions, Relations and Binary Operations (15 Lectures)

(1) Definition of relation and function, domain, co-domain and range of a function, composite functions, examples, Direct image $f(A)$ and inverse image $f^{-1}(B)$ for a function f, injective, surjective, bijective functions, Composite of injective, surjective, bijective functions when defined, invertible functions, bijective functions are invertible and conversely, examples of functions including constant, identity, projection, inclusion, Binary operation as a function, properties, examples.

(2) Equivalence relation, Equivalence classes, properties such as two equivalences classes are either identical or disjoint, Definition of partition, every partition gives an equivalence relation and vice versa.

(3) Congruence is an equivalence relation on $\mathbb{Z}$, Residue classes and partition of $\mathbb{Z}$, Addition modulo$n$, Multiplication modulo n, examples.

Unit III: Polynomials (15 Lectures)

(1) Definition of a polynomial, polynomials over F where $F = \mathbb{Q}, \mathbb{R}$ or $\mathbb{C}$, Algebra of polynomials, degree of polynomial, basic properties.

(2) Division algorithm in $F[X]$ (without proof), and g.c.d of two polynomials and its basic properties, Euclidean algorithm (proof of the above results may be given only in the case of $\mathbb{Q}[X]$ with a remark that the results as well as the proofs remain valid in the case of $\mathbb{R}[X]$ or $\mathbb{C}[X]$).

(3) Roots of a polynomial, relation between roots and coefficients, multiplicity of a root. Elementary consequences such as the following.

(i) Remainder theorem, Factor theorem.

(ii) A polynomial of degree n has at most n roots.

(iii) Complex and non-real roots of a polynomials in $\mathbb{R}[X]$ occur in conjugate pairs.

(Emphasis on examples and problems in polynomials with real coefficients).

(4) Necessary condition for a rational number $\frac{p}{q}$ to be a root of a polynomial with integer coefficients (viz. p divides the constant coefficient and q divides the leading coefficient), corollary for monic polynomials (viz. a rational root of monic polynomial with integer coefficients is necessarily an integer). Simple consequence such as the irrationality is necessarily of $\sqrt{p}$ for any prime number p. Irreducible polynomials in $\mathbb{Q}[x]$, Unique Factorisation Theorem. Examples.

Reference Books:

1. David M. Burton, Elementary Number Theory, Seventh Edition, McGraw Hill Education (India) Private Ltd.

2. 2. Norman L. Biggs, Discrete Mathematics, Revised Edition, Clarendon Press, Oxford 1989.

Additional Reference Books

1. I. Niven and S. Zuckerman, Introduction to the theory of numbers, Third Edition, Wiley Eastern, New Delhi, 1972.

2. G. Birkoff and S. Maclane, A Survey of Modern Algebra, Third Edition, Mac Millan, New York, 1965.

3. N. S. Gopalkrishnan, University Algebra, Ne Age International Ltd, Reprint 2013.

4. I .N. Herstein, Topics in Algebra, John Wiley, 2006.

5. P. B. Bhattacharya S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, New Age International, 1994.

6. Kenneth Rosen, Discrete Mathematics and its applications, Mc-Graw Hill, International Edition, Mathematics Series.

PRACTICALS FOR F.Y.B.Sc
USMTP01 – Practicals

A. **Practicals for USMT101/ UAMT 101:**

(1) Algebraic and Order Properties of Real Numbers and Inequalities
(2) Hausdorff Property and LUB Axiom of $\mathbb{R}$, Archimedian Property.
(3) Convergence and divergence of sequences, bounded sequences, Sandwich Theorem.
(4) Cauchy sequences, monotonic sequences, non-monotonic sequences.
(5) Solving exact and non-exact, linear, reducible to linear differential equations.
(6) Reduction of order of Differential Equations, Applications of Differential Equations.
(7) Miscellaneous Theoretical Questions based on full paper.

B. **Practicals for USMT102:**

(1) Mathematical induction ,Division Algorithm, Euclidean algorithm in $\mathbb{Z}$, Examples on expressing the gcd. of two non zero integers $a\&b$ as $ma + nb$ for some $m, n \in \mathbb{Z}$,
(2) Primes and the Fundamental theorem of Arithmetic, Euclid's lemma, there exists infinitely many primes of the form $4n - 1$ or of the form $6n - 1$.
(3) Functions, Bijective and Invertible functions, Compositions of functions.
(4) Binary Operation, Equivalence Relations, Partition and Equivalence classes.
(5) Polynomial (I)
(6) Polynomial (II)
(7) Miscellaneous Theoretical Questions based on full paper.

TUTORIALS FOR F.Y.B.A

Tutorials for UAMT101 :

(1) Algebraic and Order Properties of Real Numbers and Inequalities
(2) Hausdorff Property and LUB Axiom of $\mathbb{R}$, Archimedian Property.
(3) Convergence and divergence of sequences, bounded sequences, Sandwich Theorem.
(4) Cauchy sequences, monotonic sequences, non-monotonic sequences.
(5) Solving exact and non-exact, linear, reducible to linear differential equations.
(6) Reduction of order of Differential Equations, Applications of Differential Equations.
(7) Miscellaneous Theoretical Questions based on full paper.

Semester II
USMT 201 / UAMT201: CALCULUS II

Unit-I: Limits and Continuity (15 Lectures)

{Brief review: Domain and range of a function, injective function, surjective function, bijective function, composite of two functions (when defined), Inverse of a bijective function. Graphs of some standard functions such as $|x|$, e^x, $\log x$, ax^2+bx+c, $\frac{1}{x}$, x^n $n \geq 3$), $\sin x$, $\cos x$, $\tan x$, $\sin\left(\frac{1}{x}\right)$, $x^2 \sin\left(\frac{1}{x}\right)$ over suitable intervals of $\mathbb{R}$. No direct questions to be added.}

(1) $\varepsilon - \delta$ definition of Limit of a function, uniqueness of limit if it exists, algebra of limits, limits of composite function, sandwich theorem, left-hand-limit $\lim\limits_{x \longrightarrow a^-} f(x)$, right-hand-limit $\lim\limits_{x \longrightarrow a^+} f(x)$, non-existence of limits, $\lim\limits_{x \longrightarrow -\infty} f(x)$, $\lim\limits_{x \longrightarrow \infty} f(x)$ and $\lim\limits_{x \longrightarrow a} f(x) = \pm\infty$.

(2) Continuous functions: Continuity of a real valued function at a point and on a set using $\epsilon - \delta$ definition, examples, Continuity of a real valued function at end points of domain using $\epsilon - \delta$ definition, f is continuous at a if and only if $\lim\limits_{x \longrightarrow a} f(x)$ exists and equals to $f(a)$, Sequential continuity, Algebra of continuous functions, discontinuous functions, examples of removable and essential discontinuity.

(3) Intermediate Value theorem and its applications, Bolzano-Weierstrass theorem (statement only): A continuous function on a closed and bounded interval is bounded and attains its bounds.

Unit-II: Differentiability of functions (15 Lectures)

(1) Differentiation of real valued function of one variable: Definition of differentiability of a function at a point of an open interval, examples of differentiable and non differentiable functions, differentiable functions are continuous but not conversely, algebra of differentiable functions.

(2) Chain rule, Higher order derivatives, Leibniz rule, Derivative of inverse functions, Implicit differentiation (only examples)

Unit-III: Applications of differentiability (15 Lectures)

(1) Rolle's Theorem, Lagrange's and Cauchy's Mean Value Theorems, applications and examples, Monotone increasing and decreasing functions, examples.

(2) L-Hospital rule (without proof), examples of indeterminate forms, Taylor's theorem with Lagrange's form of remainder with proof, Taylor polynomial and applications.

(3) Definition of critical point, local maximum/minimum, necessary condition, stationary points, second derivative test, examples, concave/convex functions, point of inflection.

(4) Sketching of graphs of functions using properties.

Reference books:

1. R. R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964.

2. James Stewart, Calculus, Third Edition, Brooks/ Cole Publishing company, 1994.

3. T. M. Apostol, Calculus, Vol I, Wiley And Sons (Asia) Pte. Ltd.

4. Sudhir Ghorpade and Balmohan Limaye, A course in Calculus and Real Analysis, Springer International Ltd, 2000.

Additional Reference:

1. Richard Courant and Fritz John, A Introduction to Calculus and Analysis, Volume-I, Springer.

2. Ajit Kumar and S. Kumaresan, A Basic course in Real Analysis, CRC Press, 2014.

3. K. G. Binmore, Mathematical Analysis, Cambridge University Press, 1982.

4. G. B. Thomas, Calculus, 12th Edition 2009

USMT 202: DISCRETE MATHEMATICS

Unit I: Preliminary Counting (15 Lectures)

(1) Finite and infinite sets, countable and uncountable sets examples such as $\mathbb{N}$, $\mathbb{Z}$, $\mathbb{N} \times \mathbb{N}$, $\mathbb{Q}$ $(0,1)$, $\mathbb{R}$.

(2) Addition and multiplication Principle, counting sets of pairs, two ways counting.

(3) Stirling numbers of second kind. Simple recursion formulae satisfied by $S(n,k)$ for $k = 1, 2, \cdots, n-1, n$.

(4) Pigeonhole principle simple and strong form and examples, its applications to geometry.

Unit II: Advanced Counting (15 Lectures)

(1) Permutation and combination of sets and multi-sets, circular permutations, emphasis on solving problems.

(2) Binomial and Multinomial Theorem, Pascal identity, examples of standard identities such as the following with emphasis on combinatorial proofs.

- $\sum_{k=0}^{r} \binom{m}{k}\binom{n}{r-k} = \binom{m+n}{r}$
- $\sum_{i=0}^{k} \binom{k}{i}^2 = \binom{2k}{k}$
- $\sum_{i=r}^{n} \binom{i}{r} = \binom{n+1}{r+1}$
- $\sum_{i=0}^{n} \binom{n}{i} = 2^n$

(3) Non-negative integer solutions of equation $x_1 + x_2 + \cdots + x_k = n$.

(4) Principal of inclusion and exclusion, its applications, derangements, explicit formula for d_n, deriving formula for Euler's function $\phi(n)$.

Unit III: Permutations and Recurrence relation (15 lectures)

(1) Permutation of objects, S_n, composition of permutations, results such as every permutation is a product of disjoint cycles, every cycle is a product of transpositions, signature of a permutation, even and odd permutations, cardinality of S_n, A_n.

(2) Recurrence Relations, definition of homogeneous, non-homogeneous, linear, non-linear recurrence relation, obtaining recurrence relations of Tower of Hanoi, Fibonacci sequence, etc. in counting problems, solving homogeneous as well as non homogeneous recurrence relations by using iterative methods, solving a homogeneous recurrence relation of second degree using algebraic method proving the necessary result.

Recommended Books:

1. Norman Biggs, Discrete Mathematics, Oxford University Press.
2. Richard Brualdi, Introductory Combinatorics, John Wiley and sons.
3. V. Krishnamurthy, Combinatorics-Theory and Applications, Affiliated East West Press.
4. Discrete Mathematics and its Applications, Tata McGraw Hills.
5. Schaum's outline series, Discrete mathematics,
6. Allen Tucker, Applied Combinatorics, John Wiley and Sons.
7. Sharad Sane, Combinatorial Techniques, Springer.

PRACTICALS FOR F.Y.B.Sc
USMTP02-Practicals

A. **Practicals for USMT201 :**

(1) Limit of a function and Sandwich theorem, Continuous and discontinuous function.

(2) Algebra of limits and continuous functions, Intermediate Value theorem, Bolzano-Weierstrass theorem.

(3) Properties of differentiable functions, derivatives of inverse functions and implicit functions.

(4) Higher order derivatives, Leibnitz Rule.

(5) Mean value theorems and its applications, L'Hospital's Rule, Increasing and Decreasing functions.

(6) Extreme values, Taylor's Theorem and Curve Sketching.

(7) Miscellaneous Theoretical Questions based on full paper.

B. **Practicals for USMT202:**

(1) Counting principles, Two way counting.

(2) Stirling numbers of second kind, Pigeon hole principle.

(3) Multinomial theorem, identities, permutation and combination of multi-set.

(4) Inclusion-Exclusion principle. Euler phi function.

(5) Composition of permutations, signature of permutation, inverse of permutation.

(6) Recurrence relation.

(7) Miscellaneous Theoretical Questions based on full paper.

TUTORIALS FOR F.Y.B.A

Tutorials for UAMT201 :

(1) Limit of a function and Sandwich theorem, Continuous and discontinuous function.

(2) Algebra of limits and continuous functions, Intermediate Value theorem, Bolzano-Weierstrass theorem.

(3) Properties of differentiable functions, derivatives of inverse functions and implicit functions.

(4) Higher order derivatives, Leibnitz Rule.

(5) Mean value theorems and its applications, L'Hospital's Rule, Increasing and Decreasing functions.

(6) Extreme values, Taylor's Theorem and Curve Sketching.

(7) Miscellaneous Theoretical Questions based on full paper.

Scheme of Examination (75:25)

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 25 percent marks in the first part and by conducting the Semester End Examinations with 75 percent marks in the second part. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:-

I. **Internal Evaluation of 25 Marks:**

F.Y.B.Sc. :

(i) One class Test of 20 marks to be conducted during Practical session.
Paper pattern of the Test:
Q1: Definitions/ Fill in the blanks/ True or False with Justification (04 Marks).
Q2: Multiple choice 5 questions. (10 Marks: 5×2)
Q3: Attempt any 2 from 3 descriptive questions. (06 marks: 2×3)

(ii) Active participation in routine class: 05 Marks.

F.Y.B.A. :

(i) One class Test of 20 marks to be conducted during Tutorial session.
Paper pattern of the Test:
Q1: Definitions/ Fill in the blanks/ True or False with Justification (04 Marks).
Q2: Multiple choice 5 questions. (10 Marks: 5×2)
Q3: Attempt any 2 from 3 descriptive questions. (06 marks: 2×3)

(ii) Journal : 05 Marks.

II. **Semester End Theory Examinations :** There will be a Semester-end external Theory examination of 75 marks for each of the courses USMT101/UAMT101, USMT102 of Semester I and USMT201/UAMT201, USMT202 of semester II to be conducted by the college.

1. Duration: The examinations shall be of 2 and $\frac{1}{2}$ hours duration.
2. Theory Question Paper Pattern:
   a) There shall be FOUR questions. The first three questions Q1, Q2, Q3 shall be of 20 marks, each based on the units I, II, III respectively. The question Q4 shall be of 15 marks based on the entire syllabus.
   b) All the questions shall be compulsory. The questions Q1, Q2, Q3, Q4 shall have internal choices within the questions. Including the choices, the marks for each question shall be 25-27.
   c) The questions Q1, Q2, Q3, Q4 may be subdivided into sub-questions as a, b, c, d & e, etc and the allocation of marks depends on the weightage of the topic.
3. **Semester End Examinations Practicals:**
   At the end of the Semesters I & II Practical examinations of three hours duration and 100 marks shall be conducted for the courses USMTP01, USMTP02.
   In semester I, the Practical examinations for USMT101 and USMT102 are held together by the college.
   In Semester II, the Practical examinations for USMT201 and USMT202 are held together by the college.

   Paper pattern: The question paper shall have two parts A and B.
   Each part shall have two Sections.

   Section I Objective in nature: Attempt any Eight out of Twelve multiple choice questions (04 objective questions from each unit) ($8 \times 3 = 24$ Marks).

   Section II Problems: Attempt any Two out of Three (01 descriptive question from each unit) ($8 \times 2 = 16$ Marks).

Practical Course	Part A	Part B	Marks out of	duration
USMTP01	Questions from USMT101	Questions from USMT102	80	3 hours
USMTP02	Questions from USMT201	Questions from USMT202	80	3 hours

Marks for Journals and Viva:
For each course USMTP01 (USMT101, USMT102) and USMTP02 (USMT201, USMT202):

1. Journal: 10 marks (5 marks for each journal).
2. Viva: 10 marks.

Each Practical of every course of Semester I and II shall contain at least 10 objective questions and at least 6 descriptive questions.
A student must have a certified journal before appearing for the practical examination.
In case a student does not posses a certified journal he/she will be evaluated for 80 marks.
He/she is not qualified for Journal + Viva marks.

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University of Mumbai

No. AAMS(UG)/ 97 of 2021-22

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculties of Humanities and Science & Technology.

They are hereby informed that the recommendations made by the Board of Studies in Mathematics at its online meeting held on 23rd April, 2021 vide Item No. 1 (i) and subsequently passed by the Board of Deans at its online meeting held on 11th June, 2021 vide item No. 6.17 (R) have been accepted by the Academic Council at its meeting held on 29th June, 2021 vide item No. 6.17(R) and that in accordance therewith, Finalize the proposed syllabus of S.Y.B.Sc./S.Y.B.A. (Sem-III & IV) in Mathematics under (CBCS) in 75:25 pattern has been brought into force with effect from the academic year 2021-22 accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
8th October, 2021

(Dr. B.N.Gaikwad)
I/c REGISTRAR

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculties of Humanities and Science & Technology.

A.C/6.17 (R) 29/06/2021

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No. AAMS(UG)/ 97 -A of 2021-22 MUMBAI-400 032 8th October, 2021

Copy forwarded with Compliments for information to:-

1) The Dean, Faculties of Humanities and Science & Technology
2) The Chairman, Board of Studies in Mathematics,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-ordinator, University Computerization Centre,

(Dr. B.N.Gaikwad)
I/c REGISTRAR

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC - AC - 29/6/2021
Item No. 6.17

UNIVERSITY OF MUMBAI

Syllabus
for the
Program : S.Y.B.Sc./ S.Y.B.A Sem. III & IV (CBCS)
Course : Mathematics

(Choice Based and Credit System with effect from the academic year 2021-22)

AC 29/6/2021

Item No. 6.17

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	S. Y. B. Sc. /B. A. Mathematics, Sem III & IV
2	Eligibility for Admission	As per university regulations
3	Passing Marks	40% (Internal 10/25 Marks and External 30/75)
4	Ordinances / Regulations (if any)	-
5	No. of Years / Semesters	Three Years / Six Semesters Programme (Syllabus for sem III & IV)
6	Level	UG
7	Pattern	Semester
8	Status	Revised
9	To be implemented from Academic Year	From Academic Year : 2021-2022

Date: 19.05.2021

Signature: 19.05.2021

Name: Prof. R. P. Deore

Chairman of BoS of Mathematics

Dr. Anuradha Majumdar (Dean, Science and Technology)
Prof. Shivram Garje (Associate Dean, Science)
Prof. R. P. Deore , Chairman (BoS) Member(BoS)
Prof. P. Veeramani, Member
Prof. S. R. Ghorpade , Member
Prof. Ajit Diwan, Member
Dr. Sushil Kulkarni, Member
Dr. S. A. Shende, Member
Prof. V. S. Kulkarni
Dr. Sanjeevani Gharge, Member
Dr. Mittu Bhattacharya, Member
Dr. Abhaya Chitre, Member
Dr. S. Aggarwal, Member
Dr. Amul Desai, Member

CONTENTS

1. Preamble

The University of Mumbai has brought into force the revised syllabi as per the Choice Based Credit System (CBCS) for the Second year B. Sc / B. A. Programme in Mathematics from the academic year 2021-2022. Mathematics has been fundamental to the development of science and technology. In recent decades, the extent of application of Mathematics to real world problems has increased by leaps and bounds. Taking into consideration the rapid changes in science and technology and new approaches in different areas of mathematics and related subjects like Physics, Statistics and Computer Sciences, the board of studies in Mathematics with concern of teachers of Mathematics from different colleges affiliated to University of Mumbai has prepared the syllabus of S.Y.B. Sc. / S. Y. B. A. Mathematics. The present syllabi of S. Y. B. Sc. for Semester III and Semester IV has been designed as per U. G. C. Model curriculum so that the students learn Mathematics needed for these branches, learn basic concepts of Mathematics and are exposed to rigorous methods gently and slowly. The syllabi of S. Y. B. Sc. / S. Y. B. A. would consist of two semesters and each semester would comprise of three courses and one practical course for S. Y. B. Sc Mathematics and two courses and one practical course for each semester for S. Y. B. A. Mathematics.

Aims and Objectives :

(1) Give the students a sufficient knowledge of fundamental principles, methods and a clear perception of innumerous power of mathematical ideas and tools and know how to use them by modeling, solving and interpreting.

(2) Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.

(3) Enhancing students' overall development and to equip them with mathematical modeling abilities, problem solving skills, creative talent and power of communication necessary for various kinds of employment.

(4) A student should get adequate exposure to global and local concerns that explore them many aspects of Mathematical Sciences

2. Programme Outcomes:

(1) Enabling students to develop positive attitude towards mathematics as an interesting and valuable subject
(2) Enhancing students overall development and to equip them with mathematical modeling, abilities, problem solving skills, creative talent and power of communication.
(3) Acquire good knowledge and understanding in advanced areas of mathematics and statistics.

3. Course outcomes:

1. Calculus (Sem III) & Multivariable Calculus I(Sem IV): This course gives introduction to basic concepts of Analysis with rigor and prepares students to study further courses in

Analysis. Formal proofs are given lot of emphasis in this course which also enhances understanding of the subject of Mathematics as a whole.

2. Linear Algebra I (Sem III) & Linear Algebra II (Sem IV): This course gives expositions to system of linear equations and matrices, Vector spaces, Basis and dimension, Linear Transformation, Inner product space, Eigen values and eigenvectors.

3. Ordinary Differential Equations (Sem III) prepares learner to get solutions of so many kinds of problems in all subjects of Science and also prepares learner for further studies of differential equations and related fields.

4. Numerical Methods and Statistical Methods: Lerner will learn different types of Numerical methods and statistical methods to apply in different fields of Mathematics.

(UNIVERSITY OF MUMBAI)

Syllabus for: S.Y.B.Sc./S.Y.B.A.

Program: B.Sc./B/A.
Course: Mathematics
Choice based Credit System (CBCS)
with effect from the
academic year 2021-22

4. Course structure with minimum Credits and Lectures/ Week

SEMESTER III

Calculus III				
Course Code	UNIT	TOPICS	Credits	L/Week
USMT 301, UAMT 301	I	Infinite Series	2	3
	II	Riemann Integration		
	III	Applications of Integrations and Improper Integrals		
Linear Algebra I				
USMT 302 ,UAMT 302	I	System of Equations and Matrices	2	3
	II	Vector Spaces over IR		
	III	Determinants, Linear Equations (Revisited)		
ORDINARY DIFFERENTIAL EQUATIONS				
USMT 303	I	Higher Order linear Differential Equations	2	3
	II	Systems of First Order Linear differential equations		
	III	Numerical Solutions of Ordinary Differential Equations		
PRACTICALS				
USMTP03		Practicals based on USMT301, USMT 302 and USMT 303	3	5
UAMTP03		Practicals based on UAMT301, UAMT 302	2	4

SEMESTER IV

Multivariable Calculus I				
Course Code	UNIT	TOPICS	Credits	L/Week
USMT 401, UAMT 401	I	Functions of several variables	2	3
	II	Differentiation of Scalar Fields		
	III	Applications of Differentiation of Scalar Fields and Differentiation of Vector Fields		
Linear Algebra II				
USMT 402 ,UAMT 402	I	Linear transformation, Isomorphism, Matrix associated with L.T.	2	3
	II	Inner product spaces		
	III	Eigen values, eigen vectors, diagonalizable matrix		
Numerical methods (Elective A)				
USMT 403A	I	Solutions of algebraic and transcendental equations	2	3
	II	Interpolation, Curve fitting, Numerical integration		
	III	Solutions of linear system of Equations and eigen value problems		
Statistical methods an their applications(Elective B)				
USMT 403B	I	Descriptive Statistics and random variables	2	3
	II	Probability Distribution and Correlation		
	III	Inferential Statistics		
PRACTICALS				
USMTP04		Practicals based on USMT401, USMT 402 and USMT 403	3	5
UAMTP04		Practicals based on UAMT401, UAMT 402	2	4

5. Teaching Pattern for Semester III & IV

Teaching Pattern for Semester III

1. Three lectures per week per course. Each lecture is of 48 minutes duration.
2. One Practical (2L) per week per batch for courses USMT301, USMT 302 combined and one Practical (3L) per week for course USMT303 (the batches tobe formed as prescribed by the University. Each practical session is of 48 minutes duration.)

Teaching Pattern for Semester IV

1. Three lectures per week per course. Each lecture is of 48 minutes duration.
2. One Practical (2L) per week per batch for courses USMT301, USMT 302 combined and one Practical (3L) per week for course USMT303 (the batches to be formed as prescribed by the University. Each practical session is of 48 minutes duration.)

6. Consolidated Syllabus for Semester III & IV

Semester-III

Note: Unless indicated otherwise, proofs of the results mentioned in the syllabus should be covered.

USMT301/ UAMT301: Calculus III

Unit I. Infinite Series (15 Lectures)

1. Infinite series in $\mathbb{R}$. Definition of convergence and divergence. Basic examples including geometric series. Elementary results such as if $\sum_{n=1}^{\infty} a_n$ is convergent, then $a_n \longrightarrow 0$ but converse not true. Cauchy Criterion. Algebra of convergent series.
2. Tests for convergence: Comparison Test, Limit Comparison Test, Ratio Test (without proof), Root Test (without proof), Abel Test (without proof) and Dirichlet Test (without proof). Examples. The decimal expansion of real numbers. Convergence of $\sum_{n=1}^{\infty} \frac{1}{n^p}$ $(p > 1)$. Divergence of harmonic series $\sum_{n=1}^{\infty} \frac{1}{n}$.
3. Alternating series. Leibnitz's Test. Examples. Absolute convergence, absolute convergence implies convergence but not conversely. Conditional Convergence.

Unit II. Riemann Integration (15 Lectures)

1. Idea of approximating the area under a curve by inscribed and circumscribed rectangles. Partitions of an interval. Refinement of a partition. Upper and Lower sums for a bounded real valued function on a closed and bounded interval. Riemann integrability and the Riemann integral.

2. Criterion for Riemann integrability. Characterization of the Riemann integral as the limit of a sum. Examples.

3. Algebra of Riemann integrable functions. Also, basic results such as if $f : [a, b] \longrightarrow \mathbb{R}$ is integrable, then (i) $\int_a^b f(x)\ dx = \int_a^c f(x)\ dx + \int_c^b f(x)\ dx$. (ii) $|f|$ is integrable and $\left| \int_a^b f(x)\ dx \right| \leq \int_a^b |f|(x)\ dx$ (iii) If $f(x) \geq 0$ for all $x \in [a, b]$ then $\int_a^b f(x)\ dx \geq 0$.

4. Riemann integrability of a continuous function, and more generally of a bounded function whose set of discontinuities has only finitely many points. Riemann integrability of monotone functions.

Unit III. Applications of Integrations and Improper Integrals (15 lectures)

1. Area between the two curves. Lengths of plane curves. Surface area of surfaces of revolution.

2. Continuity of the function $F(x) = \int_a^x f(t)\ dt, x \in [a, b]$, when $f : [a, b] \longrightarrow \mathbb{R}$ is Riemann integrable. First and Second Fundamental Theorems of Calculus.

3. Mean value theorem. Integration by parts formula. Leibnitz's Rule.

4. Definition of two types of improper integrals. Necessary and sufficient conditions for convergence.

5. Absolute convergence. Comparison and limit comparison tests for convergence.

6. Gamma and Beta functions and their properties. Relationship between them (without proof).

Reference Books

1. Sudhir Ghorpade, Balmohan Limaye; A Course in Calculus and Real Analysis (second edition); Springer.

2. R.R. Goldberg; Methods of Real Analysis; Oxford and IBH Pub. Co., New Delhi, 1970.

3. Calculus and Analytic Geometry (Ninth Edition); Thomas and Finney; Addison-Wesley, Reading Mass., 1998.

4. T. Apostol; Calculus Vol. 2; John Wiley.

Additional Reference Books

1. Ajit Kumar, S.Kumaresan; A Basic Course in Real Analysis; CRC Press, 2014

2. D. Somasundaram and B.Choudhary; A First Course in Mathematical Analysis, Narosa, New Delhi, 1996.

3. K. Stewart; Calculus, Booke/Cole Publishing Co, 1994.

4. J. E. Marsden, A.J. Tromba and A. Weinstein; Basic Multivariable Calculus; Springer.

5. R.G. Brtle and D. R. Sherbert; Introduction to Real Analysis Second Ed. ; John Wiley, New Yorm, 1992.

6. M. H. Protter; Basic Elements of Real Analysis; Springer-Verlag, New York, 1998.

USMT/UAMT 302: Linear Algebra I

Unit I. System of Equations, Matrices (15 Lectures)

1. Systems of homogeneous and non-homogeneous linear equations, Simple examples of finding solutions of such systems. Geometric and algebraic understanding of the solutions. Matrices (with real entries), Matrix representation of system of homogeneous and non-homogeneous linear equations. Algebra of solutions of systems of homogeneous linear equations. A system of homogeneous linear equations with number of unknowns more than the number of equations has infinitely many solutions.

2. Elementary row and column operations. Row equivalent matrices. Row reduction (of a matrix to its row echelon form). Gaussian elimination. Applications to solving systems of linear equations. Examples.

3. Elementary matrices. Relation of elementary row operations with elementary matrices. Invertibility of elementary matrices. Consequences such as (i) a square matrix is invertible if and only if its row echelon form is invertible. (ii) invertible matrices are products of elementary matrices. Examples of the computation of the inverse of a matrix using Gauss elimination method.

Unit II. Vector space over $\mathbb{R}$ (15 Lectures)

1. Definition of a vector space over $\mathbb{R}$. Subspaces; criterion for a nonempty subset to be a subspace of a vector space. Examples of vector spaces, including the Euclidean space $\mathbb{R}^n$, lines, planes and hyperplanes in $\mathbb{R}^n$ passing through the origin, space of systems of homogeneous linear equations, space of polynomials, space of various types of matrices, space of real valued functions on a set.

2. Intersections and sums of subspaces. Direct sums of vector spaces. Quotient space of a vector space by its subspace.

3. Linear combination of vectors. Linear span of a subset of a vector space. Definition of a finitely generated vector space. Linear dependence and independence of subsets of a vector space.

4. Basis of a vector space. Basic results that any two bases of a finitely generated vector space have the same number of elements. Dimension of a vector space. Examples. Bases of a vector space as a maximal linearly independent sets and as minimal generating sets.

Unit III. Determinants, Linear Equations (Revisited) (15 Lectures)

1. Inductive definition of the determinant of a $n \times n$ matrix (e. g. in terms of expansion along the first row). Example of a lower triangular matrix. Laplace expansions along an arbitrary row or column. Determinant expansions using permutations
$\Big(\det(A) = \sum_{\sigma \in S_n} \operatorname{sign}(\sigma) \prod_{i=1}^{n} a_{\sigma(i),i} \Big)$.

2. Basic properties of determinants (Statements only); (i) $\det A = \det A^T$. (ii) Multilinearity and alternating property for columns and rows. (iii) A square matrix A is invertible if and only if $\det A \neq 0$. (iv) Minors and cofactors. Formula for A^{-1} when $\det A \neq 0$. (v) $\det(AB) = \det A \det B$.

3. Row space and the column space of a matrix as examples of vector space. Notion of row rank and the column rank. Equivalence of the row rank and the column rank. Invariance of rank upon elementary row or column operations. Examples of computing the rank using row reduction.

4. Relation between the solutions of a system of non-homogeneous linear equations and the associated system of homogeneous linear equations. Necessary and sufficient condition for a system of non-homogeneous linear equations to have a solution [viz., the rank of the coefficient matrix equals the rank of the augmented matrix $[A|B]$]. Equivalence of statements (in which A denotes an $n \times n$ matrix) such as the following.

   (i) The system $A\boldsymbol{x} = \boldsymbol{b}$ of non-homogeneous linear equations has a unique solution.
   (ii) The system $A\boldsymbol{x} = \boldsymbol{0}$ of homogeneous linear equations has no nontrivial solution.
   (iii) A is invertible.
   (iv) $\det A \neq 0$.
   (v) $\operatorname{rank}(A) = n$.

5. Cramers Rule. LU Decomposition. If a square matrix A is a matrix that can be reduced to row echelon form U by Gauss elimination without row interchanges, then A can be factored as $A = LU$ where L is a lower triangular matrix.

Reference books

1 Howard Anton, Chris Rorres, Elementary Linear Algebra, Wiley Student Edition).

2 Serge Lang, Introduction to Linear Algebra, Springer.

3 S Kumaresan, Linear Algebra - A Geometric Approach, PHI Learning.

4 Sheldon Axler, Linear Algebra done right, Springer.

5 Gareth Williams, Linear Algebra with Applications, Jones and Bartlett Publishers.

6 David W. Lewis, Matrix theory.

USMT303: Ordinary Differential Equations

Unit I. Higher order Linear Differential equations (15 Lectures)

1. The general $n-$th order linear differential equations, Linear independence, An existence and uniqueness theorem, the Wronskian, Classification: homogeneous and non-homogeneous, General solution of homogeneous and non-homogeneous LDE, The Differential operator and its properties.

2. Higher order homogeneous linear differential equations with constant coefficients, the auxiliary equations, Roots of the auxiliary equations: real and distinct, real and repeated, complex and complex repeated.

3. Higher order homogeneous linear differential equations with constant coefficients, the method of undermined coefficients, method of variation of parameters.

4. The inverse differential operator and particular integral, Evaluation of $\frac{1}{f(D)}$ for the functions like e^{ax}, $\sin ax$, $\cos ax$, x^m, $x^m \sin ax$, $x^m \cos ax$, $e^{ax}V$ and xV where V is any function of x,

5. Higher order linear differential equations with variable coefficients:
   The Cauchy's equation: $x^3\frac{d^3y}{dx^3} + x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} + y = f(x)$ and
   The Legendre's equation: $(ax+b)^3\frac{d^3y}{dx^3} + (ax+b)^2\frac{d^2y}{dx^2} + (ax+b)\frac{dy}{dx} + y = f(x)$.

Reference Books

1. Units 5, 6, 7 and 8 of E.D. Rainville and P.E. Bedient; Elementary Differential Equations; Macmillan.

2. Units 5, 6 and 7 of M.D. Raisinghania; Ordinary and Partial Differential Equations; S. Chand.

Unit II. Systems of First Order Linear Differential Equations (15 Lectures)

(a) Existence and uniqueness theorem for the solutions of initial value problems for a system of two first order linear differential equations in two unknown functions x, y of a single independent variable t, of the form $\begin{cases} \frac{dx}{dt} = F(t,x,y) \\ \frac{dy}{dt} = G(t,x,y) \end{cases}$ (Statement only).

(b) Homogeneous linear system of two first order differential equations in two unknown functions of a single independent variable t, of the form $\begin{cases} \frac{dx}{dt} = a_1(t)x + b_1(t)y, \\ \frac{dy}{dt} = a_2(t)x + b_2(t)y. \end{cases}$.

(c) Wronskian for a homogeneous linear system of first order linear differential equations in two functions x, y of a single independent variable t. Vanishing properties of the Wronskian. Relation with linear independence of solutions.

(d) Homogeneous linear systems with constant coefficients in two unknown functions x, y of a single independent variable t. Auxiliary equation associated to a homogenous system of equations with constant coefficients. Description fo the general solution depending on the roots and their multiplicities of the auxiliary equation, proof of independence of the solutions. Real form of solutions in case the auxiliary equation has complex roots.

(e) Non-homogeneous linear system of linear system of two first order differential equations in two unknown functions of a single independent variable t, of the form
$\begin{cases} \frac{dx}{dt} = a_1(t)x + b_1(t)y + f_1(t), \\ \frac{dy}{dt} = a_2(t)x + b_2(t)y + f_2(t). \end{cases}$
General Solution of non-homogeneous system. Relation between the solutions of a system

of non-homogeneous linear differential equations and the associated system of homogeneous linear differential equations.

Reference Books

1. G.F. Simmons; Differential Equations with Applications and Historical Notes; Taylor's and Francis.

Unit III. Numerical Solution of Ordinary Differential Equations (15 lectures)

1. Numerical Solution of initial value problem of first order ordinary differential equation using:
   (i) Taylor's series method,
   (ii) Picard's method for successive approximation and its convergence,
   (iii) Euler's method and error estimates for Euler's method,
   (iv) Modified Euler's Method,
   (v) Runge-Kutta method of second order and its error estimates,
   (vi) Runge-Kutta fourth order method.
2. Numerical solution of simultaneous and higher order ordinary differential equation using:
   (i) Runge-Kutta fourth order method for solving simultaneous ordinary differential equation,
   (ii) Finite difference method for the solution of two point linear boundary value problem.

Reference Books

1. Units 8 of S. S. Sastry, Introductory Methods of Numerical Analysis, PHI.

Additional Reference Books

1. E.D. Rainville and P.E. Bedient, Elementary Differential Equations, Macmillan.
2. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand.
3. G.F. Simmons, Differential Equations with Applications and Historical Notes, Taylor's and Francis.
4. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI.
5. K. Atkinson, W.Han and D Stewart, Numerical Solution of Ordinary Differential Equations, Wiley.

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USMT P03 / UAMT P03: Practicals

Suggested Practicals for USMT 301/ UAMT 301

1. Examples of convergent / divergent series and algebra of convergent series.
2. Tests for convergence of series.
3. Calculation of upper sum, lower sum and Riemann integral.
4. Problems on properties of Riemann integral.
5. Problems on fundamental theorem of calculus, mean value theorems, integration by parts, Leibnitz rule.
6. Convergence of improper integrals, different tests for convergence. Beta Gamma Functions.
7. Miscellaneous Theoretical Questions based on full paper.

Suggested Practicals for USMT302 / UAMT 302

1. Systems of homogeneous and non-homogeneous linear equations.
2. Elementary row/column operations and Elementary matrices.
3. Vector spaces, Subspaces.
4. Linear Dependence/independence, Basis, Dimension.
5. Determinant and Rank of a matrix.
6. Solution to a system of linear equations, LU decomposition
7. Miscellaneous Theory Questions.
8. Miscellaneous theory questions from units I, II and III.

Suggested Practicals For USMT 303

1. Finding the general solution of homogeneous and non-homogeneous higher order linear differential equations.
2. Solving higher order linear differential equations using method of undetermined coefficients and method of variation of parameters.
3. Solving a system of first order linear ODES have auxiliary equations with real and complex roots.
4. Finding the numerical solution of initial value problems using Taylor's series method, Picard's method, modified Euler's method, Runge-Kutta method of fourth order and calculating their accuracy.
5. Finding the numerical solution of simultaneous ordinary differential equation using fourth order Runge-Kutta method.
6. Finding the numerical solution of two point linear boundary value problem using Finite difference method.

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Semester-IV

Note: Unless indicated otherwise, proofs of the results mentioned in the syllabus should be covered.

USMT 401/ UAMT 401: Multivariable Calculus I

UNIT I. Functions of Several Variables (15 Lectures)

1. Review of vectors in $\mathbb{R}^n$ [with emphasis on $\mathbb{R}^2$ and $\mathbb{R}^3$] and basic notions such as addition and scalar multiplication, inner product, length (norm), and distance between two points.

2. Real-valued functions of several variables (Scalar fields). Graph of a function. Level sets (level curves, level surfaces, etc). Examples. Vector valued functions of several variables (Vector fields). Component functions. Examples.

3. Sequences, Limits and Continuity: Sequence in $\mathbb{R}^n$ [with emphasis on $\mathbb{R}^2$ and $\mathbb{R}^3$] and their limits. Neighbourhoods in $\mathbb{R}^n$. Limits and continuity of scalar fields. Composition of continuous functions. Sequential characterizations. Algebra of limits and continuity (Results with proofs). Iterated limits.
   Limits and continuity of vector fields. Algebra of limits and continuity vector fields. (without proofs).

4. Partial and Directional Derivatives of scalar fields: Definitions of partial derivative and directional derivative of scalar fields (with emphasis on $\mathbb{R}^2$ and $\mathbb{R}^3$). Mean Value Theorem of scalar fields.

UNIT II. Differentiation of Scalar Fields (15 Lectures)

1. Differentiability of scalar fields (in terms of linear transformation). The concept of (total) derivative. Uniqueness of total derivative of a differentiable function at a point. Examples of functions of two or three variables. Increment Theorem. Basic properties including (i) continuity at a point of differentiability, (ii)existence of partial derivatives at a point of differentiability, and (iii) differentiability when the partial derivatives exist and are continuous.

2. Gradient. Relation between total derivative and gradient of a function. Chain rule. Geometric properties of gradient. Tangent planes.

3. Euler's Theorem.

4. Higher order partial derivatives. Mixed Partial Theorem (n=2).

UNIT III. Applications of Differentiation of Scalar Fields and Differentiation of Vector Fields (15 lectures)

1. Applications of Differentiation of Scalar Fields: The maximum and minimum rate of change of scalar fields. Taylor's Theorem for twice continuously differentiable functions. Notions of local maxima, local minima and saddle points. First Derivative Test. Examples. Hessian matrix. Second Derivative Test for functions of two variables. Examples. Method of Lagrange Multipliers.

2. Differentiation of Vector Fields: Differentiability and the notion of (total) derivative. Differentiability of a vector field implies continuity, Jacobian matrix. Relationship between total derivative and Jacobian matrix. The chain rule for derivative of vector fields (statements only).

Reference books

1. T. Apostol; Calculus, Vol. 2 (Second Edition); John Wiley.
2. Sudhir Ghorpade, Balmohan Limaye; A Course in Multivariable Calculus and Analysis (Second Edition); Springer.
3. Walter Rudin; Principles of Mathematical Analysis; McGraw-Hill, Inc.
4. J. E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus; Springer.
5. D.Somasundaram and B.Choudhary; A First Course in Mathematical Analysis, Narosa, New Delhi, 1996.
6. K. Stewart; Calculus; Booke/Cole Publishing Co, 1994.

Additional Reference Books

1. Calculus and Analytic Geometry, G.B. Thomas and R. L. Finney, (Ninth Edition); Addison-Wesley, 1998.
2. Howard Anton; Calculus- A new Horizon,(Sixth Edition); John Wiley and Sons Inc, 1999.
3. S L Gupta and Nisha Rani; Principles of Real Analysis; Vikas Publishing house PVT LTD.
4. Shabanov, Sergei; Concepts in Calculus, III: Multivariable Calculus; University Press of Florida, 2012.
5. S C Malik and Savita Arora; Mathematical Analysis; New Age International Publishers.

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USMT402/UAMT402: Linear Algebra II

UNIT I. Linear Transformations

1. Definition of a linear transformation of vector spaces; elementary properties. Examples. Sums and scalar multiples of linear transformations. Composites of linear transformations. A Linear transformation of $V \longrightarrow W$, where V, W are vector spaces over $\mathbb{R}$ and V is a finite-dimensional vector space is completely determined by its action on an ordered basis of V.
2. Null-space (kernel) and the image (range) of a linear transformation. Nullity and rank of a linear transformation. Rank-Nullity Theorem (Fundamental Theorem of Homomorphisms).
3. Matrix associated with linear transformation of $V \longrightarrow W$ where V and W are finite dimensional vector spaces over $\mathbb{R}$.. Matrix of the composite of two linear transformations. Invertible linear transformations (isomorphisms), Linear operator, Effect of change of bases on matrices of linear operator.

4. Equivalence of the rank of a matrix and the rank of the associated linear transformation. Similar matrices.

UNIT II. Inner Products and Orthogonality

1. Inner product spaces (over $\mathbb{R}$). Examples, including the Euclidean space $\mathbb{R}^n$ and the space of real valued continuous functions on a closed and bounded interval. Norm associated to an inner product. Cauchy-Schwarz inequality. Triangle inequality.

2. Angle between two vectors. Orthogonality of vectors. Pythagoras theorem and some geometric applications in $\mathbb{R}^2$. Orthogonal sets, Orthonormal sets. Gram-Schmidt orthogonalizaton process. Orthogonal basis and orthonormal basis for a finite-dimensional inner product space.

3. Orthogonal complement of any set of vectors in an inner product space. Orthogonal complement of a set is a vector subspace of the inner product space. Orthogonal decomposition of an inner product space with respect to its subspace. Orthogonal projection of a vector onto a line (one dimensional subspace). Orthogonal projection of an inner product space onto its subspace.

UNIT III. Eigenvalues, Eigenvectors and Diagonalisation

1. Eigenvalues and eigenvectors of a linear transformation of a vector space into itself and of square matrices. The eigenvectors corresponding to distinct eigenvalues of a linear transformation are linearly independent. Eigen spaces. Algebraic and geometric multiplicity of an eigenvalue.

2. Characteristic polynomial. Properties of characteristic polynomials (only statements). Examples. Cayley-Hamilton Theorem. Applications.

3. Invariance of the characteristic polynomial and eigenvalues of similar matrices.

4. Diagonalisable matrix. A real square matrix A is diagonalisable if and only if there is a basis of $\mathbb{R}^n$ consisting of eigenvectors of A. (Statement only - $A_{n\times n}$ is diagonalisable if and only if sum of algebraic multiplicities is equal to sum of geometric multiplicities of all the eigenvalues of $A\ = n$). Procedure for diagonalising a matrix.

5. Spectral Theorem for Real Symmetric Matrices (Statement only). Examples of orthogonal diagonalisation of real symmetric matrices. Applications to quadratic forms and classification of conic sections.

Reference books

1. Howard Anton, Chris Rorres; Elementary Linear Algebra; Wiley Student Edition).

2. Serge Lang; Introduction to Linear Algebra; Springer.

3. S Kumaresan; Linear Algebra - A Geometric Approach; PHI Learning.

4. Sheldon Axler; Linear Algebra done right; Springer.

5. Gareth Williams; Linear Algebra with Applications; Jones and Bartlett Publishers.

6. David W. Lewis; Matrix theory.

USMT403A: Numerical Methods (Elective A)

Unit I. Solution of Algebraic and Transcendental Equations (15L)

1. Measures of Errors: Relative, absolute and percentage errors, Accuracy and precision: Accuracy to n decimal places, accuracy to n significant digits or significant figures, Rounding and Chopping of a number, Types of Errors: Inherent error, Round-off error and Truncation error.

2. Iteration methods based on first degree equation: Newton-Raphson method. Secant method. Regula-Falsi method.
   Derivations and geometrical interpretation and rate of convergence of all above methods to be covered.

3. General Iteration method: Fixed point iteration method.

Unit II. Interpolation, Curve fitting, Numerical Integration(15L)

1. Interpolation: Lagrange's Interpolation. Finite difference operators: Forward Difference operator, Backward Difference operator. Shift operator. Newton's forward difference interpolation formula. Newton's backward difference interpolation formula.
   Derivations of all above methods to be covered.

2. Curve fitting: linear curve fitting. Quadratic curve fitting.

3. Numerical Integration: Trapezoidal Rule. Simpson's 1/3 rd Rule. Simpson's 3/8th Rule. Derivations all the above three rules to be covered.

Unit III. Solution Linear Systems of Equations, Eigenvalue problems(15L)

1. Linear Systems of Equations: LU Decomposition Method (Dolittle's Method and Crout's Method). Gauss-Seidel Iterative method.

2. Eigenvalue problems: Jacobi's method for symmetric matrices. Rutishauser method for arbitrary matrices.

Reference Books:

1. Kendall E. and Atkinson; An Introduction to Numerical Analysis; Wiley.

2. M. K. Jain, S. R. K. Iyengar and R. K. Jain; Numerical Methods for Scientific and Engineering Computation; New Age International Publications.

3. S. Sastry; Introductory methods of Numerical Analysis; PHI Learning.

4. An introduction to Scilab-Cse iitb.

Additional Reference Books

1. S.D. Comte and Carl de Boor; Elementary Numerical Analysis, An algorithmic approach; McGrawHillll International Book Company.

2. Hildebrand F.B.; Introduction to Numerical Analysis; Dover Publication, NY.

3. Scarborough James B.; Numerical Mathematical Analysis; Oxford University Press, New Delhi.

USMT403B Statistical Methods and their Applications (Elective B)

Unit I. Descriptive Statistics and random variables (15 Lectures)
Measures of location (mean, median, mode), Partition values and their graphical locations, measures of dispersion, skewness and kurtosis, Exploratory Data Analysis (Five number summary, Box Plot, Outliers), Random Variables (discrete and continuous), Expectation and variance of a random variable.

Unit II. Probability Distributions and Correlation (15 Lectures)
Discrete Probability Distribution (Binomial, Poisson), Continuous Probability Distribution: (Uniform, Normal), Correlation, Karl Pearson's Coefficient of Correlation, Concept of linear Regression, Fitting of a straight line and curve to the given data by the method of least squares, relation between correlation coefficient and regression coefficients.

Unit III. Inferential Statistics (15 lectures)
Population and sample, parameter and statistic, sampling distribution of Sample mean and Sample Variance, concept of statistical hypothesis, critical region, level of significance, confidence interval and two types of errors, Tests of significance (t-test, Z-test, F-test, Chi-Square Test (only applications))

Reference Books

1. Fundamentals of Mathematical Statistics,12th Edition, S. C. Gupta and V. K. Kapoor,Sultan Chand & Sons, 2020.

2. Statistics for Business and Economics, 11th Edition, David R. Anderson, Dennis J. Sweeney and Thomas A. Williams, Cengage Learning, 2011.

3. Introductory Statistics, 8th Edition, Prem S. Mann, John Wiley & Sons Inc., 2013.

4. A First Course in Statistics, 12th Edition, James McClave and Terry Sincich, Pearson Education Limited, 2018.

5. Introductory Statistics, Barbara Illowsky, Susan Dean and Laurel Chiappetta, OpenStax, 2013.

6. Hands-On Programming with R, Garrett Grolemund, O'Reilly.

USMT P04 / UAMT P04: Practicals

Suggested Practical for USMT 401/ UAMT 401

1. Limits and continuity of scalar fields and vector fields, using "definition and otherwise" , iterated limits.
2. Computing directional derivatives, partial derivatives and mean value theorem of scalar fields.
3. Differentiability of scalar field,Total derivative, gradient, level sets and tangent planes.
4. Chain rule, higher order derivatives and mixed partial derivatives of scalar fields.
5. Maximum and minimum rate of change of scalar fields. Taylor's Theorem. Finding Hessian/Jacobean matrix. Differentiation of a vector field at a point. Chain Rule for vector fields.
6. Finding maxima, minima and saddle points. Second derivative test for extrema of functions of two variables and method of Lagrange multipliers.
7. Miscellaneous Theoretical Questions based on full paper.

Suggested Practicals for USMT402/UAMT 402

1. Linear transformation, Kernel, Rank-Nullity Theorem.
2. Linear Isomorphism, Matrix associated with Linear transformations.
3. Inner product and properties, Projection, Orthogonal complements.
4. Orthogonal, orthonormal sets, Gram-Schmidt orthogonalisation
5. Eigenvalues, Eigenvectors, Characteristic polynomial. Applications of Cayley Hamilton Theorem.
6. Diagonalisation of matrix, orthogonal diagonalisation of symmetric matrix and application to quadratic form.
7. Miscellaneous Theoretical Questions based on full paper.

Suggested Practicals for USMT403A

The Practical no. 1 to 6 should be performed either using non-programable scientific calculators or by using the software Scilab.

1. Newton-Raphson method, Secant method.
2. Regula-Falsi method, Iteration Method..
3. Interpolating polynomial by Lagrange's Interpolation, Newton forward and backward difference Interpolation.
4. Curve fitting, Trapezoidal Rule, Simpson's 1/3rd Rule, Simpson's 3/8th Rule.
5. LU decomposition method, Gauss-Seidel Interative method.

6. Jacobi's method, Rutishauser method..
7. Miscellaneous theoretical questions from all units.

Suggested Practicals for USMT403B
All practicals should be performed using any one of the following softwares: MS Excel, R, Strata, SPSS, Sage Math to carry out data analysis and computations.

1. Descriptive Statistics.
2. Random Variables.
3. Probability Distributions.
4. Correlation and Regression.
5. Testing of hypothesis.
6. Case studies.
7. Miscellaneous Theory questions based on Unit I,II,III.

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7. Scheme of Examination (75:25)

The performance of the learners shall be evaluated into two parts.

- Internal Assessment of 25 percent marks.
- Semester End Examinations of 75 percent marks.

I. **Internal Evaluation of 25 Marks:**

S.Y.B.Sc. :

(i) One class Test of 20 marks to be conducted during Practical session.
Paper pattern of the Test:
Q1: Definitions/ Fill in the blanks/ True or False with Justification (04 Marks).
Q2: Multiple choice 5 questions. (10 Marks: 5×2)
Q3: Attempt any 2 from 3 descriptive questions. (06 marks: 2×3)

(ii) Active participation in routine class: 05 Marks.

OR

Students who are willing to explore topics related to syllabus, dealing with applications historical development or some interesting theorems and their applications can be encouraged to submit a project for 25 marks under the guidance of teachers.

S.Y.B.A. :

(i) One class Test of 20 marks to be conducted during Tutorial session.
Paper pattern of the Test:
Q1: Definitions/ Fill in the blanks/ True or False with Justification (04 Marks).

Q2: Multiple choice 5 questions. (10 Marks: 5×2)

Q3: Attempt any 2 from 3 descriptive questions. (06 marks: 2×3)

(ii) Journal : 05 Marks.

OR

Students who are willing to explore topics related to syllabus, dealing with applications historical development or some interesting theorems and their applications can be encouraged to submit a project for 25 marks under the guidance of teachers.

II. **Semester End Theory Examinations :** There will be a Semester-end external Theory examination of 75 marks for each of the courses USMT301/UAMT301, USMT/USAT 302, USMT 303 of Semester III and USMT/UAMT401, USMT/UAMT 402, USMT 403 of semester IV to be conducted by the college.

1. Duration: The examinations shall be of 2 and $\frac{1}{2}$ hours duration.
2. Theory Question Paper Pattern:
   a) There shall be FOUR questions. The first three questions Q1, Q2, Q3 shall be of 20 marks, each based on the units I, II, III respectively. The question Q4 shall be of 15 marks based on the entire syllabus.
   b) All the questions shall be compulsory. The questions Q1, Q2, Q3, Q4 shall have internal choices within the questions. Including the choices, the marks for each question shall be 25-27.
   c) The questions Q1, Q2, Q3, Q4 may be subdivided into sub-questions as a, b, c, d & e, etc and the allocation of marks depends on the weightage of the topic.

III. **Semester End Examinations Practicals:**

At the end of the Semesters III & IV Practical examinations of three hours duration and 150 marks shall be conducted for the courses USMTP03, USMTP04.

At the end of the Semesters III & IV Practical examinations of two hours duration and 100 marks shall be conducted for the courses UAMTP03, UAMTP04.
In semester III, the Practical examinations for USMT301/UAMT301, USMT302/UAMT302 and USMT303 are held together by the college.
In Semester IV, the Practical examinations for USMT401/UAMT401, USMT402/UAMT402 and USMT403 are held together by the college.

Paper pattern: The question paper shall have two parts A and B.
Each part shall have two Sections.

Section I Objective in nature: Attempt any Eight out of Twelve multiple choice questions (04 objective questions from each unit) ($8 \times 3 = 24$ Marks).

Section II Problems: Attempt any Two out of Three (01 descriptive question from each unit) ($8 \times 2 = 16$ Marks).

Practical Course	Part A	Part B	Part C	Marks out of	duration
USMTP03	Questions from USMT301	Questions from USMT302	Questions from USMT 303	120	3 hours
UAMTP03	Questions from UAMT301	Questions from UAMT302	——	80	2 hours
USMTP04	Questions from USMT401	Questions from USMT402	Questions from USMT403	120	3 hours
UAMTP04	Questions from UAMT401	Questions from UAMT402	——	80	2 hours

Marks for Journals and Viva:
For each course USMT301/UAMT301, USMT302/UAMT302, USMT303, USMT401/UAMT401, USMT402/UAMT402, USMT3031:

1. Journal: 10 marks (5 marks for each journal).

2. Viva: 10 marks.

Each Practical of every course of Semester III and IV shall contain 10 (ten) problems out of which minimum 05 (five) have to be written in the journal. .
A student must have a certified journal before appearing for the practical examination.
In case a student does not posses a certified journal he/she will be evaluated for 120/80 marks. He/she is not qualified for Journal + Viva marks.

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University of Mumbai

No. AAMS(UG)/ 35 of 2022-23

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, Directors of the Recognized Institutions in Faculty of Humanities is invited to this office circular No. UG/122 of 2017-18 dated 28th July, 2017 relating to T.Y.B.A./T.Y.B.Sc. Mathematics (Sem V and VI).

They are hereby informed that the recommendations made by the Board of Studies in **Mathematics** at its meeting held on 9th May, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 17th May, 2022 vide item No. 6.1(R) have been accepted by the Academic Council at its meeting held on 17th May, 2022 **vide** item No. 6.9(R) and that in accordance therewith, the revised syllabus of T.Y.B.Sc./B.A. (Mathematics) (Sem V and VI) (CBCS), has been brought into force with effect from the academic year 2022-23. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
16th June, 2022

(Dr. Vinod Patil)
I/c Director

To

The Principals of the Affiliated Colleges, and Directors of the Recognized Institutions in Faculty of Science & Technology/ Faculty of Humanities.

A.C/6.9/17/05/2022

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No. AAMS(UG)/ 35 -A of 2022-23

16th June, 2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Dean, Faculty of Humanities,
3) The Chairman, Board of Studies Mathematics,
4) The Director, Board of Examinations and Evaluation,
5) The Director, Board of Students Development,
6) The Director, Department of Information & Communication Technology,
7) The Co-ordinator, MKCL.

(Dr. Vinod Patil)
I/c Director

AC – 17/05/2022
Item No. 6.9 (R)

UNIVERSITY OF MUMBAI

Revised Syllabus for T.Y.B. Sc./B.A.

(Mathematics)

Sem – V & VI
(Choice Based Credit System)

(With effect from the academic year 2022-23)

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course O. _____	**T.Y.B. Sc./B.A. (Mathematics)**
2	Eligibility for Admission O. _____	As per University Regulations
3	Passing Marks R. _____	40% (Internal 25 (10) Marks and External 75 (30) Marks)
4	Ordinances / Regulations (if any)	
5	No. of Years / Semesters R. _____	Three Years (Six Semester) Programme
6	Level	~~P.G.~~ / U.G./ ~~Diploma~~ / ~~Certificate~~ **(Strike out which is not applicable)**
7	Pattern	~~Yearly~~ / Semester **(Strike out which is not applicable)**
8	Status	Revised / ~~New /Amended~~ **(Strike out which is not applicable)**
9	To be implemented from Academic Year	From Academic Year 2022-23

Signature
Chairman,
Board of Studies,

Dr Anuradha Majumdar
Dean,
Faculty of Science and Technology

Dean (Science and Technology)

Prof. Anuradha Majumdar (Dean, Science and Technology)

Prof. Shivram Garje (Associate Dean, Science)

Chairperson Board of Studies of Mathematics

Prof. Vinayak Kulkarni

Members of the Board of Studies of Mathematics

Prof. R. M. Pawale

Prof. P. Veeramani

Prof. S. R. Ghorpade

Prof. Ajit Diwan

Dr. S. Aggarwal

Dr. Amul Desai

Dr. S. A. Shende

Dr. Shridhar Pawar

Dr. Sanjeevani Gharge

Dr. Abhaya Chitre

Dr. Mittu Bhattacharya

Dr. Sushil Kulkarni

Dr. Rajiv Sapre

CONTENTS

1. Preamble

The University of Mumbai has brought into force the revised syllabi as per the Choice Based Credit System (CBCS) for the Third year B. Sc / B. A. Programme in Mathematics from the academic year 2022-2023. Mathematics has been fundamental to the development of science and technology. In recent decades, the extent of application of Mathematics to real world problems has increased by leaps and bounds. Taking into consideration the rapid changes in science and technology and new approaches in different areas of mathematics and related subjects like Physics, Statistics and Computer Sciences, the board of studies in Mathematics with concern of teachers of Mathematics from different colleges affiliated to University of Mumbai has prepared the syllabus of T.Y.B. Sc. / T. Y. B. A. Mathematics. The present syllabi of T. Y. B. Sc. for Semester V and Semester VI has been designed as per U. G. C. Model curriculum so that the students learn Mathematics needed for these branches, learn basic concepts of Mathematics and are exposed to rigorous methods gently and slowly. The syllabi of T. Y. B. Sc. / T. Y. B. A. would consist of two semesters and each semester would comprise of four courses and two practical courses for T. Y. B. Sc / T.Y.B.A. Mathematics.

2. Aims and Objectives:

(i) Give the students a sufficient knowledge of fundamental principles, methods and a clear perception of innumerous power of mathematical ideas and tools and know how to use them by modeling, solving and interpreting.

(ii) Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.

(iii) Enhancing students' overall development and to equip them with mathematical modeling abilities, problem solving skills, creative talent and power of communication necessary for various kinds of employment.

(iv) A student should get adequate exposure to global and local concerns that explore them many aspects of Mathematical Sciences.

3. Programme Outcomes:

(i) Enabling students to develop positive attitude towards mathematics as an interesting and valuable subject

(ii) Enhancing students overall development and to equip them with mathematical modeling, abilities, problem solving skills, creative talent and power of communication.

(iii) Acquire good knowledge and understanding in advanced areas of mathematics and physics.

4. Course outcomes:

(i) **Multivariable Calculus II (Sem V):** In this course students will learn the basic ideas, tools and techniques of integral calculus and use them to solve problems from real-life applications including science and engineering problems involving areas, volumes, centroid, Moments of mass and center of mass Moments of inertia. Examine vector fields and define and evaluate line integrals using the Fundamental Theorem of Line Integrals and Green's Theorem; compute arc length.

(ii) **Complex Analysis (Sem VI):** Students Analyze sequences and series of analytic functions and types of convergence, Students will also be able to evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula, they will also be able to represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

(iii) **Group Theory, Ring Theory (Sem V, Sem VI)** Students will have a working knowledge of important mathematical concepts in abstract algebra such as definition of a group, order of a finite group and order of an element, rings, Euclidean domain, Principal ideal domain and Unique factorization domain. Students will also understand the connection and transition between previously studied mathematics and more advanced mathematics. The students will actively participate in the transition of important concepts such homomorphisms & isomorphisms from discrete mathematics to advanced abstract mathematics.

(iv) **Topology of metric spaces (Sem V), Topology of metric spaces and real analysis (Sem VI):**
This course introduces students to the idea of metric spaces. It extends the ideas of open sets, closed sets and continuity to the more general setting of metric spaces along with concepts such as compactness and connectedness. Convergence concepts of sequences and series of functions, power series are also dealt with. Formal proofs are given a lot of emphasis in this course. This course serves as a foundation to advanced courses in analysis. Apart from understanding the concepts introduced, the treatment of this course will enable the learner to explain their reasoning about analysis with clarity and rigour.

(v) **Partial Differential equations (Sem V: Paper IV: Elective A):**

a. Students will able to understand the various analytical methods for solving first order partial differential equations.
b. Students will able to understand the classification of first order partial differential equations.
c. Students will able to grasp the linear and non linear partial differential equations.

(vi) **Integral Transforms (Sem VI: Paper IV- Elective A):**

a. Students will able to understand the concept of integral transforms and their corresponding inversion techniques.
b. Students will able to understand the various applications of integral transforms.

(vii) **Number Theory and its applications I and II (Sem V, Sem VI):**
The student will be able to

a. Identify and apply various properties of and relating to the integers including primes, unique factorization, the division algorithm, and greatest common divisors.
b. Understand the concept of a congruence and use various results related to congruences including the Chinese Remainder Theorem. Investigate Pseudo-primes , Carmichael number, primitive roots.
c. Identify how number theory is related to and used in cryptography. Learn to encrypt and decrypt a message using character ciphers. Learn to encrypt and decrypt a message using Public-Key cryptology.
d. Express a rational number as a finite continued fraction and hence solve a linear diophantine equation. Express a given repeated continued fraction in terms of a surd. Expand a surd as an infinite continued fraction and hence find a convergent which is an approximation to the given surd to a given degree of accuracy .Solve a Pell equation from a continued fraction expansion
e. Solve certain types of Diophantine equations. Represent a Primitive Pythagorean Triples with a unique pair of relatively prime integers.
f. Identify certain number theoretic functions and their properties. Investigate perfect numbers and Mersenne prime numbers and their connection. Explore the use of arithmetical functions, the Mobius function, and the Euler function.

(viii) **Graph Theory (Sem V: Paper IV- Elective C)**
Upon successful completion of Graph Theory course, a student will be able to:

a. Demonstrate the knowledge of fundamental concepts in graph theory, including properties and characterization of graphs and trees.

b. Describe knowledgeably special classes of graphs that arise frequently in graph theory

c. Describe the concept of isomorphic graphs and isomorphism invariant properties of graphs

d. Describe and apply the relationship between the properties of a matrix representation of a graph and the structure of the underlying graph

e. Demonstrate different types of algorithms including Dijkstra's, BFS, DFS, MST and Huffman coding.

f. Understand the concept of Eulerian graphs and Hamiltonian graphs.

g. Describe real-world applications of graph theory.

(ix) **Graph Theory and Combinatorics (Sem VI: Paper IV -Elective C)**

a. Understand and apply the basic concepts of graph theory, including colouring of graph, to find chromatic number and chromatic polynomials for graphs

b. Understand the concept of vertex connectivity, edge connectivity in graphs and Whitney's theorem on 2-vertex connected graphs.

c. Derive some properties of planarity and Euler's formula, develop the under-standing of Geometric duals in Planar Graphs

d. Know the applications of graph theory to network flows theory.

e. Understand different applications of system of distinct representative and matching theory.

f. Use permutations and combinations to solve counting problems with sets and multisets.

g. Set up and solve a linear recurrence relation and apply the inclusion/exclusion principle.

h. Compute a generating function and apply them to combinatorial problems.

(x) **Basic concepts of probability and random variables (Sem V: Paper IV: Elective D)**
Students will be able to understand the role of random variables in the statistical analysis and use them to apply in the various probability distributions including Binomial distribution, Poisson distribution and Normal distribution. Moreover students will able to apply the concepts of expectations and moments for the evaluation of various statistical measures

(xi) **Operations research (Sem VI: Paper IV: Elective D)**
Students should able to formulate linear programming problem and apply the graphical and simplex method for their feasible solution. Moreover students should understand various alternative operation research techniques for the feasible solution of LPP.

(5) Course structure with minimum credits and Lectures/ Week

SEMESTER V

Multivariable Calculus II				
Course Code	UNIT	TOPICS	Credits	L/Week
USMT 501, UAMT 501	I	Multiple Integrals	2.5	3
	II	Line Integrals		
	III	Surface Integrals		
Group Theory				
USMT 502 ,UAMT 502	I	Groups and Subgroups	2.5	3
	II	Normal subgroups, Direct products and Cayley's theorem		
	III	Cyclic Groups and Cyclic Subgroups Homomorphism		
Topology of Metric Spaces				
USMT 503, UAMT503	I	Metric spaces	2.5	3
	II	Sequences and Complete metric spaces		
	III	Compact Spaces		
Partial Differential Equations(Elective A)				
USMT5A4 ,UAMT 5A4	I	First Order Partial Differential Equations.	2.5	3
	II	Compatible system of first order PDE		
	III	Quasi-Linear PDE		
Number Theory and Its applications I (Elective B)				
USMT5B4 ,UAMT 5B4	I	Congruences and Factorization	2.5	3
	II	Diophantine equations and their & solutions		
	III	Primitive Roots and Cryptography		
Graph Theory (Elective C)				
USMT5C4 ,UAMT 5C4	I	Basics of Graphs	2.5	3
	II	Trees		
	III	Eulerian and Hamiltonian graphs		
Basic Concepts of Probability and Random Variables (Elective D)				
USMT5D4 ,UAMT 5D4	I	Basic Concepts of Probability and Random Variables	2.5	3
	II	Properties of Distribution function, Joint Density function		
	III	Weak Law of Large Numbers		
PRACTICALS				
USMTP05/UAMTP05		Practicals based on USMT501/UAMT 501 and USMT 502/UAMT 502	3	6
USMTP06/UAMTP06		Practicals based on USMT503/ UAMT 503 and USMT5A4/ UAMT 5A4 OR USMT5B4/ UAMT 5B4 OR USMT5C4/ UAMT 5C4 OR USMT5D4/ UAMT 5D4	3	6

SEMESTER VI

BASIC COMPLEX ANALYSIS				
Course Code	UNIT	TOPICS	Credits	L/Week
USMT 601, UAMT 601	I	Introduction to Complex Analysis	2.5	3
	II	Cauchy Integral Formula		
	III	Complex power series, Laurent series and isolated singularities		
Ring Theory				
USMT 602 ,UAMT 602	I	Rings	2.5	3
	II	Ideals and special rings		
	III	Factorization		
Topology of Metric Spaces and Real Analysis				
USMT 603 / UAMT 603	I	Continuous functions on Metric spaces	2.5	3
	II	Connected sets		
		Sequences and series of functions		
Integral Transforms(Elective A)				
USMT6A4 ,UAMT 6A4	I	The Laplace Transform	2.5	3
	II	The Fourier Transform		
	III	Applications of Integral Transforms		
Number Theory and Its applications II (Elective B)				
USMT6B4 ,UAMT 6B4	I	Quadratic Reciprocity	2.5	3
	II	Continued Fractions		
	III	Pell's equation, Arithmetic function & and Special numbers		
Graph Theory and Combinatorics (Elective C)				
USMT6C4 ,UAMT 6C4	I	Colourings of Graphs	2.5	3
	II	Planar graph		
	III	Combinatorics		
Operations Research (Elective D)				
USMT6D4 ,UAMT 6D4	I	Basic Concepts of Probability and Linear Programming I	2.5	3
	II	Linear Programming II		
	III	Queuing Systems		
PRACTICALS				
USMTP07/ UAMTP07		Practicals based on USMT601/UAMT 601 and USMT 602/UAMT 602	3	6
USMTP08/UAMTP08		Practicals based on USMT603/ UAMT 603 and USMT6A4/ UAMT 6A4 OR USMT6B4/ UAMT 6B4 OR USMT6C4/ UAMT 6C4 OR USMT6D4/ UAMT 6D4	3	6

Note: i . USMT501/UAMT501, USMT502/UAMT502, USMT503/UAMT503 are compulsory courses for Semester V.

ii . Candidate has to opt one Elective Course from USMT5A4/UAMT5A4, USMT5B4/UAMT5B4, USMT5C4/UAMT5C4 and USMT5D4/UAMT5D4 for Semester V.

iii . USMT601/UAMT601, USMT602/UAMT602, USMT603/UAMT603 are compulsory courses for Semester VI.

iv . Candidate has to opt one Elective Course from USMT6A4/UAMT6A4, USMT6B4/UAMT6B4, USMT6C4/UAMT6C4 and USMT6D4/UAMT6D4 for Semester VI.

v . Passing in theory and practical and internal exam shall be separate.

(6) Teaching Pattern for T.Y.B.Sc/B.A.

i. Three lectures per week per course (1 lecture/period is of 48 minutes duration).

ii. One practical of three periods per week per course (1 lecture/period is of 48 minutes duration).

(7)Consolidated Syllabus for semester V & VI

SEMESTER V
MULTIVARIABLE CALCULUS II
Course Code: USMT501/UAMT501

ALL Results have to be done with proof unless otherwise stated.

Unit I: Multiple Integrals (15L)

Definition of double (resp: triple) integral of a function and bounded on a rectangle (resp:box). Geometric interpretation as area and volume. Fubini's Theorem over rectangles and any closed bounded sets, Iterated Integrals. Following basic properties of double and triple integrals proved using the Fubini's theorem:

(1) Integrability of the sums, scalar multiples, products, and (under suitable conditions) quotients of integrable functions. Formulae for the integrals of sums and scalar multiples of integrable functions.

(2) Integrability of continuous functions. More generally, Integrability of functions with a "small" set of (Here, the notion of "small sets" should include finite unions of graphs of continuous functions.)

(3) Domain additivity of the integral. Integrability and the integral over arbitrary bounded domains. Change of variables formula (Statement only).Polar, cylindrical and spherical coordinates, and integration using these coordinates. Differentiation under the integral sign. Applications to finding the center of gravity and moments of inertia.

Unit 2: Line Integrals (15L)

Review of Scalar and Vector fields on $\mathbb{R}^n$, Vector Differential Operators, Gradient, Curl, Divergence.
Paths (parametrized curves) in $\mathbb{R}^n$ (emphasis on $\mathbb{R}^2$ and $\mathbb{R}^3$), Smooth and piecewise smooth paths. Closed paths. Equivalence and orientation preserving equivalence of paths. Definition of the line integral of a vector field over a piecewise smooth path. Basic properties of line integrals including linearity, path-additivity and behaviour under a change of parameters. Examples.
Line integrals of the gradient vector field, Fundamental Theorem of Calculus for Line Integrals, Necessary and sufficient conditions for a vector field to be conservative. Green's Theorem (proof in the case of rectangular domains). Applications to evaluation of line integrals.

Unit 3: Surface Integrals (15 L)

Parameterized surfaces. Smoothly equivalent parameterizations. Area of such surfaces.
Definition of surface integrals of scalar-valued functions as well as of vector fields defined on a surface. Curl and divergence of a vector field. Elementary identities involving gradient, curl and divergence. Stoke's Theorem (proof assuming the general from of Green's Theorem). Examples.
Gauss' Divergence Theorem (proof only in the case of cubical domains). Examples.
Reference Books:

1. Apostol, Calculus, Vol. 2, Second Ed., John Wiley, New York, 1969 Section 1.1 to 11.8

2. James Stewart, Calculus with early transcendental Functions - Section 16.5 to 16.9

3. Marsden and Jerrold E. Tromba, Vector Calculus, Fourth Ed., W.H. Freeman and Co., New York, 1996 Section 6.2 to 6.4.

Other References :

1. T. Apostol, Mathematical Analysis, Second Ed., Narosa, New Delhi. 1947.

2. R. Courant and F.John, Introduction to Calculus and Analysis, Vol.2, Springer Verlag, New York, 1989.

3. W. Fleming, Functions of Several Variables, Second Ed., Springer-Verlag, New York, 1977.

4. M. H. Protter and C.B.Morrey Jr., Intermediate Calculus, Second Ed., Springer-Verlag, New York, 1995.

5. G. B. Thomas and R.L Finney, Calculus and Analytic Geometry, Ninth Ed. (ISE Reprint), Addison- Wesley, Reading Mass, 1998.

6. D. V. Widder, Advanced Calculus, Second Ed., Dover Pub., New York. 1989.

Course: Group Theory
Course Code: USMT502/UAMT502

Unit 1: Groups and Subgroups (15L)

(1) Definition and elementary properties of a group. Order of a group. Subgroups. Criterion for a subset to be a subgroup. Abelian groups. Center of a group. Homomorphisms and isomorphisms.

(2) Examples of groups including $\mathbb{Z}, \mathbb{Q}, \mathbb{R}, \mathbb{C}$, Klein 4-group, symmetric and alternating groups, S^1(= the unit circle in $\mathbb{C}$), $\mathrm{GL}_n(\mathbb{R}), \mathrm{SL}_n(\mathbb{R}), \mathrm{O}_n$ (= the group of $n \times n$ nonsingular upper triangular matrices), B_n (= the group of $n \times n$ nonsingular upper triangular matrices), and groups of symmetries of plane figures.

(3) Order of an element. Subgroup generated by a subset of the group.

Unit 2: Normal subgroups, Direct products and Cayley's Theorem (15L)

(1) Cosets of a subgroup in a group. Lagrange's Theorem. Normal subgroups. Alternating group A_n. Listing normal subgroups of A_4, S_3. Quotient (or Factor) groups. Fundamental Theorem of homomorphisms of groups.

(2) External direct products of groups. Examples. Relation with internal products such as HK of subgroups H, K of a group.

(3) Cayley's Theorem for finite groups.

Unit 3: Cyclic groups and cyclic subgroups (15L)

(1) Examples of cyclic groups such as $\mathbb{Z}$ and the group μ_n of the $n-$th roots of unity. Properties of cyclic groups and cyclic subgroups.

(2) Finite cyclic groups, infinite cyclic groups and their generators. Properties of generators.

(3) The group $\mathbb{Z}/n\mathbb{Z}$ of residue classes (mod n). Characterization of cyclic groups (as being isomorphic to $\mathbb{Z}$ or $\mathbb{Z}/n\mathbb{Z}$ for some $n \in \mathbb{N}$).

Recommended Books.

1. I. N. Herstein, Topics in Algebra, Wiley Eastern Limied, Second edition.
2. P. B. Bhattacharya, S.K. Jain, S. Nagpaul. Abstract Algebra, Second edition, Foundation Books, New Delhi, 1995.
3. N. S. Gopalkrishnan, University Algebra, Wiley Eastern Limited.
4. M. Artin, Algebra, Prentice Hall of India, New Delhi.
5. J. B. Fraleigh, A first course in Abstract Algebra, Third edition, Narosa, New Delhi.
6. J. Gallian. Contemporary Abstract Algebra. Narosa, New Delhi.

Additional Reference Books

1. T. W. Hungerford. Algebra, Springer.
2. D. Dummit, R. Foote. Abstract Algebra, John Wiley & Sons, Inc.
3. I. S. Luther, I.B.S. Passi. Algebra. Vol. I and II.

Course: Topology of Metric Spaces
Course Code: USMT503/UAMT503

Unit I: Metric spaces (15 L)
Definition and examples of metric spaces such as $\mathbb{R}, \mathbb{R}^2$, $\mathbb{R}^n$ with its Euclidean, sup and sum metrics. $\mathbb{C}$ (complex numbers). l^1 and l^2 spaces of sequences. $C[a, b]$ the space of real valued continuous functions on $[a, b]$. Discrete metric space. Metric induced by the norm. Translation invariance of the metric induced by the norm. Metric subspaces. Product of two metric spaces. Open balls and open sets in a metric space. Examples of open sets in various metric spaces. Hausdorff property. Interior of a set. Properties of open sets. Structure of an open set in $\mathbb{R}$. Equivalent metrics.
Distance of a point from a set, Distance between sets. Diameter of a set. Bounded sets. Closed balls. Closed sets. Examples. Limit point of a set. Isolated point. Closure of a set. Boundary of a set.

Unit II: Sequences and Complete metric spaces (15L)
Sequences in a metric space. Convergent sequence in metric space. Cauchy sequence in a metric space. Subsequences. Examples of convergent and Cauchy sequences in different metric spaces. Characterization of limit points and closure points in terms of sequences. Definition and examples of relative openness/closeness in subspaces. Dense subsets in a metric space and Separability. Definition of complete metric spaces. Examples of complete metric spaces. Completeness property in subspaces. Nested Interval theorem in $\mathbb{R}$. Cantor's Intersection Theorem. Applications of Cantors Intersection Theorem:

(i) The set of real Numbers is uncountable.

(ii) Density of rational Numbers.

(iii) Intermediate Value theorem.

Unit III: Compact spaces (15L)
Definition of a compact metric space using open cover. Examples of compact sets in different metric spaces such as $\mathbb{R}, \mathbb{R}^2, \mathbb{R}^n$ with Euclidean metric. Properties of compact sets: A compact set is closed and bounded, (Converse is not true). Every infinite bounded subset of compact metric space has a limit point. A closed subset of a compact set is compact. Union and Intersection of Compact sets.
Equivalent statements for compact sets in $\mathbb{R}$ with usual metric:

(i) Sequentially compactness property.

(ii) Heine-Borel property.

(iii) Closed and boundedness property.

(iv) Bolzano-Weierstrass property.

Reference books:

1. S. Kumaresan; Topology of Metric spaces.

2. E. T. Copson; Metric Spaces; Universal Book Stall, New Delhi, 1996.

3. P. K. Jain, K. Ahmed; Metric Spaces; Narosa, New Delhi, 1996.

Other references :

1. T. Apostol; Mathematical Analysis, Second edition, Narosa, New Delhi, 1974

2. R. R. Goldberg; Methods of Real Analysis; Oxford and IBH Pub. Co., New Delhi 1970.

3. D. Gopal, A. Deshmukh, A. S. Ranadive and S. Yadav; An Introduction to Metric Spaces, Chapman and Hall/CRC, New York, 2020.

4. W. Rudin; Principles of Mathematical Analysis; Third Ed, McGraw-Hill, Auckland, 1976.

5. D. Somasundaram; B. Choudhary; A first Course in Mathematical Analysis. Narosa, New Delhi

6. G. F. Simmons; Introduction to Topology and Modern Analysis; McGraw-Hi, New York, 1963.

7. Expository articles of MTTS programme.

Course: Partial Differential Equations (Elective A)
Course Code: USMT5A4/UAMT5A4

Unit I: First Order Partial Differential Equations. (15L)

Curves and Surfaces, Genesis of first order PDE, Classification of first order PDE, Classification of integrals, The Cauchy problem, Linear Equation of first order, Lagrange's equation, Pfaffian differential equations. (Ref Book: An Elementary Course in Partial Differential Equations by T. Amaranath, 2nd edition, Chapter 1: 1.1, 1.2, 1.3, Lemma 1.3.1, 1.3.2, 1.3.3, 1.4, Theorem

1.4.1, 1.4.2, 1.5, Theorem 1.5.1, Lemma 1.5.1, Theorem 1.5.2, Lemma 1.5.2 and related examples)

Unit II: Compatible system of first order Partial Differential Equations. (15L)

Definition, Necessary and sufficient condition for integrability, Charpit's method, Some standard types, Jacobi's method, The Cauchy problem. (Ref Book: An Elementary Course in Partial Differential Equations by T. Amaranath, 2nd edition, Chapter 1: 1.6, Theorem 1.6.1, 1.7, 1.8 Theorem 1.8.1, 1.9 and related examples)

Unit III: Quasi-Linear Partial Differential Equations. (15L)

Semi linear equations, Quasi-linear equations, first order quasi-linear PDE, Initial value problem for quasi-linear equation, Non linear first order PDE, Monge cone, Analytic expression for Monge's cone, Characteristics strip, Initial strip. (Ref Book: An Elementary Course in Partial Differential Equations by T. Amaranath, 2nd edition, Chapter 1: 1.10, Theorem 1.10.1, 1.11, Theorem 1.11.1, Preposition 1.11.1, 1.11.2 and related examples)

Reference Books

1. T. Amaranath; An Elementary Course in Partial Differential Equations; 2nd edition, Narosa Publishing house.
2. Ian Sneddon; Elements of Partial Differential Equations; McGraw Hill book.
3. Ravi P. Agarwal and Donal O'Regan; Ordinary and Partial Differential Equations; Springer, First Edition (2009).
4. W. E. Williams; Partial Differential Equations; Clarendon Press, Oxford, (1980).
5. K. Sankara Rao; Introduction to Partial Differential Equations; Third Edition, PHI.

Course: Number Theory and its applications I (Elective B)
Course Code: USMT5B4 / UAMT5B4

Unit I: Congruences and Factorization (15L)

Review of Divisibility, Primes and The fundamental theorem of Arithmetic.
Congruences : Definition and elementary properties, Complete residue system modulo m, Reduced residue system modulo m , Euler's function and its properties, Fermat's little Theorem, Euler's generalization of Fermat's little Theorem, Wilson's theorem, Linear congruence, The Chinese remainder Theorem, Congruences of Higher degree,

Unit II: Diophantine equations and their solutions (15L)

The linear equations $ax + by = c$. The equations $x^2 + y^2 = p$, where p is a prime. The equation $x^2 + y^2 = z^2$, Pythagorean triples, primitive solutions, The equations $x^4 + y^4 = z^2$ and $x^4 + y^4 = z^4$ have no solutions $(x; y; z)$ with $xyz \neq 0$. Every positive integer n can be expressed as sum of squares of four integers, Universal quadratic forms $x^2+y^2+z^2+t^2$. Assorted examples

:section 5.4 of Number theory by Niven- Zuckermann-Montgomery.

Unit III: Primitive Roots and Cryptography (15L)

Order of an integer and Primitive Roots. Basic notions such as encryption (enciphering) and decryption (deciphering), Cryptosystems, symmetric key cryptography, Simple examples such as shift cipher, Affine cipher, Hill cipher, Vigenere cipher. Concept of Public Key Cryptosystem; RSA Algorithm. An application of Primitive Roots to Cryptography.

Reference Books:

1. Niven, H. Zuckerman and H. Montogomery; An Introduction to the Theory of Numbers; John Wiley & Sons. Inc.
2. David M. Burton; An Introduction to the Theory of Numbers; Tata McGrawHillll Edition.
3. G. H. Hardy and E.M. Wright; An Introduction to the Theory of Numbers; Low priced edition; The English Language Book Society and Oxford University Press, 1981.
4. Neville Robins. Beginning Number Theory; Narosa Publications.
5. S.D. Adhikari; An introduction to Commutative Algebra and Number Theory; Narosa Publishing House.
6. N. Koblitz; A course in Number theory and Cryptography; Springer.
7. M. Artin; Algebra; Prentice Hall.
8. K. Ireland, M. Rosen; A classical introduction to Modern Number Theory; Second edition, Springer Verlag.
9. William Stalling; Cryptology and network security.

Course: Graph Theory (Elective C)
Course Code: USMT5C4/UAMT5C4

Unit I: Basics of Graphs (15L)

Definition of general graph, Directed and undirected graph, Simple and multiple graph, Types of graphs- Complete graph, Null graph, Complementary graphs, Regular graphs Sub graph of a graph, Vertex and Edge induced sub graphs, Spanning sub graphs. Basic terminology- degree of a vertex, Minimum and maximum degree, Walk, Trail, Circuit, Path, Cycle. Handshaking theorem and its applications, Isomorphism between the graphs and consequences of isomorphism between the graphs, Self complementary graphs, Connected graphs, Connected components. Matrices associated with the graphs – Adjacency and Incidence matrix of a graph- properties, Bipartite graphs and characterization in terms of cycle lengths. Degree sequence and Havel-Hakimi theorem, Distance in a graph- shortest path problems, Dijkstra's algorithm.

Unit II: Trees (15L)

Cut edges and cut vertices and relevant results, Characterization of cut edge, Definition of a tree and its characterizations, Spanning tree, Recurrence relation of spanning trees and Cayley

formula for spanning trees of K_n , Algorithms for spanning tree-BFS and DFS, Binary and m-ary tree, Prefix codes and Huffman coding, Weighted graphs and minimal spanning trees - Kruskal's algorithm for minimal spanning trees.

Unit III: Eulerian and Hamiltonian graphs (15L)

Eulerian graph and its characterization- Fleury's Algorithm-(Chinese postman problem), Hamiltonian graph, Necessary condition for Hamiltonian graphs using $G \setminus S$ where S is a proper subset of $V(G)$, Sufficient condition for Hamiltonian graphs- Ore's theorem and Dirac's theorem, Hamiltonian closure of a graph, Cube graphs and properties like regular, bipartite, Connected and Hamiltonian nature of cube graph, Line graph of graph and simple results.

Reference Books:

1. Bondy and Murty; Grapgh Theory with Applications.
2. Balkrishnan and Ranganathan; Graph theory and applications.
3. Douglas B. West, Introduction to Graph Theory, 2nd Ed., Pearson, 2000

Additional Reference Book:

1. Behzad and Chartrand; Graph theory.
2. Choudam S. A.; Introductory Graph theory.

Course: Basic Concepts of Probability and Random Variables (Elective D)
Course Code: USMT5D4 / UAMT5D4

Unit I: Basic Concepts of Probability and Random Variables.(15 L)

Basic Concepts: Algebra of events including countable unions and intersections, Sigma field $\mathcal{F}$, Probability measure$P$ on $\mathcal{F}$, Probability Space as a triple $(\Omega, \mathcal{F}, P)$, Properties of P including Subadditivity. Discrete Probability Space, Independence and Conditional Probability, Theorem of Total Probability. Random Variable on $(\Omega, \mathcal{F}, P)$ – Definition as a measurable function, Classification of random variables - Discrete Random variable, Probability function, Distribution function, Density function and Probability measure on Borel subsets of $\mathbb{R}$, Absolutely continuous random variable. Function of a random variable; Result on a random variable R with distribution function F to be absolutely continuous, Assume F is continuous everywhere and has a continuous derivative at all points except possibly at finite number of points, Result on density function f_2 of R_2 where $R_2 = g(R_1), h_j$ is inverse of g over a 'suitable' subinterval $f_2(y) + \sum_{i=1}^{n} f_1(h_j(y))|h_j'(y)|$ under suitable conditions.
Reference for Unit 1, Sections 1.1-1.6, 2.1-2.5 of Basic Probability theory by Robert Ash, Dover Publication, 2008.

Unit II: Properties of Distribution function, Joint Density function (15L)

Properties of distribution function F, F is non-decreasing, $\lim_{x \longrightarrow \infty} F(x) = 1$, $\lim_{x \longrightarrow -\infty} F(x) = 0$, Right continuity of F, $\lim_{x \longrightarrow x_0} F(x) = P(\{R < x_o\}, P(\{R = x_o\}) = F(x_o) - F(\overline{x_0})$. Joint distribution, Joint Density, Results on Relationship between Joint and Individual densities, Related

result for Independent random variables. Examples of distributions like Binomial, Poisson and Normal distribution. Expectation and $k-$th moments of a random variable with properties.

Reference for Unit II:
Sections 2.5-2.7, 2.9, 3.2-3.3,3.6 of Basic Probability theory by Robert Ash, Dover Publication, 2008.

Unit III: Weak Law of Large Numbers

Joint Moments, Joint Central Moments, Schwarz Inequality, Bounds on Correlation Coefficient ρ ,Result on ρ as a measure of linear dependence, $\text{Var}\Big(\sum_{i=1}^{n} R_i\Big) = \sum_{i=1}^{n} Var(R_i) + 2 \sum_{i=1 \le i < j \le n}^{n} \text{Cov}(R_i, R_j)$, Method of Indicators to find expectation of a random variable, Chebyshev's Inequality, Weak law of Large numbers.

Reference for Unit III
Sections 3.4, 3.5, 3.7, 4.1-4.4 of Basic Probability theory by Robert Ash, Dover Publication, 2008.

Additional Reference Books. Marek Capinski, Probability through Problems, Springer.

Course: Practicals (Based on USMT501 / UAMT501 and USMT502 / UAMT502)
Course Code: USMTP05 / UAMTP05

Suggested Practicals (Based on USMT501 / UAMT501)

1. Evaluation of double and triple integrals.
2. Change of variables in double and triple integrals and applications
3. Line integrals of scalar and vector fields
4. Green's theorem, conservative field and applications
5. Evaluation of surface integrals
6. Stoke's and Gauss divergence theorem
7. Miscellaneous theory questions on units 1, 2 and 3.

Suggested Practicals (Based on USMT502 / UAMT502)

1. Examples of groups and groups of symmetries of equilateral triangle, square and rectangle.
2. Examples of determining centers of different groups. Examples of subgroups of various groups and orders of elements in a group.
3. Left and right cosets of a group and Lagrange's theorem.
4. Normal subgroups and quotient groups. Direct products of groups.
5. Finite cyclic groups and their generators

6. Infinite cyclic groups and their properties.
7. Miscellaneous Theory Questions

Course: Practicals (Based on USMT503 / UAMT503 and USMT5A4 OR USMT5B4 OR USMT5C4 OR USMT5D4)
Course Code: USMTP06 / UAMTP06

Suggested Practicals USMT503 / UAMT503:

1. Examples of Metric Spaces, Normed Linear Spaces,
2. Sketching of Open Balls in $\mathbb{R}^2$, Open and Closed sets, Equivalent Metrics
3. Subspaces, Interior points, Limit Points, Dense Sets and Separability, Diameter of a set, Closure.
4. Limit Points ,Sequences , Bounded , Convergent and Cauchy Sequences in a Metric Space.
5. Complete Metric Spaces and Applications.
6. Examples of Compact Sets.
7. Miscellaneous Theory Questions.

Suggested Practicals on USMT5A4/UAMT5A4

1. Find general solution of Langrange's equation.
2. Show that Pfaffian differential equation are exact and find corresponding integrals.
3. Find complete integral of first order PDE using Charpit's Method.
4. Find complete integral using Jacobi's Method.
5. Solve initial value problem for quasi-linear PDE.
6. Find the integral surface by the method of characteristics.
7. Miscellaneous Theory Questions.

Suggested Practicals based on USMT5B4/UAMT5B4

1. Congruences.
2. Linear congruences and congruences of Higher degree.
3. Linear diophantine equation.
4. Pythagorean triples and sum of squares.
5. Cryptosystems (Private Key).
6. Cryptosystems (Public Key) and primitive roots.
7. Miscellaneous theoretical questions based on full USMT5B4 .

Suggested Practicals based on USMT5C4/UAMT5C4

1. Handshaking Lemma and Isomorphism.
2. Degree sequence and Dijkstra's algorithm
3. Trees, Cayley Formula
4. Applications of Trees
5. Eulerian Graphs.
6. Hamiltonian Graphs.
7. Miscellaneous Problems.

Suggested Practicals based on USMT5D4/UAMT5D4

1. Basic concepts of Probability (Algebra of events, Probability space, Probability measure, combinatorial problems)
2. Conditional Probability, Random variable (Independence of events. Definition, Classification and function of a random variable)
3. Distribution function, Joint Density function.
4. Expectation of a random variable, Normal distribution.
5. Method of Indicators, Weak law of large numbers.
6. Conditional density, Conditional expectation.
7. Miscellaneous Theoretical questions based on full paper.

SEMESTER VI
BASIC COMPLEX ANALYSIS
Course Code: USMT601/UAMT601

Unit I: Introduction to Complex Analysis (15 L)
Review of complex numbers: Complex plane, polar coordinates, exponential map, powers and roots of complex numbers, De Moivre's formula, $\mathbb{C}$ as a metric space, bounded and unbounded sets, point at infinity-extended complex plane, sketching of set in complex plane (No questions to be asked).
convergence of sequences of complex numbers and related results. Limit of a function $f : \mathbb{C} \longrightarrow \mathbb{C}$, real and imaginary part of functions, continuity at a point and algebra of continuous functions. Derivative of $f : \mathbb{C} \longrightarrow \mathbb{C}$, comparison between differentiability in real and complex sense, Cauchy-Riemann equations, sufficient conditions for differentiability, analytic function, if f, g analytic then $f + g, f - g, fg$ and f/g are analytic, chain rule.
Theorem: If $f(z) = 0$ everywhere in a domain D, then $f(z)$ must be constant throughout D.
Harmonic functions and harmonic conjugate.

Unit II: Cauchy Integral Formula (15 L)
Evaluation the line integral $\int f(z)\, dz$ over $|z - z_0| = r$ and Cauchy integral formula.

Taylor's theorem for analytic function. Mobius transformations: definition and examples. Exponential function, its properties. trigonometric functions and hyperbolic functions.

Unit III: Complex power series, Laurent series and isolated singularities. (15 L)
Power series of complex numbers and related results. Radius of convergences, disc of convergence, uniqueness of series representation, examples.
Definition of Laurent series , Definition of isolated singularity, statement (without proof) of existence of Laurent series expansion in neighbourhood of an isolated singularity, type of isolated singularities viz. removable, pole and essential defined using Laurent series expansion, examples Statement of Residue theorem and calculation of residue.

Reference Books:

1. J.W. Brown and R.V. Churchill, Complex analysis and Applications : Sections 18, 19, 20, 21, 23, 24, 25, 28, 33, 34, 47, 48, 53, 54, 55 , Chapter 5, page 231 section 65, define residue of a function at a pole using Theorem in section 66 page 234, Statement of Cauchy's residue theorem on page 225, section 71 and 72 from chapter 7.

Other References:

1. Robert E. Greene and Steven G. Krantz, Function theory of one complex variable
2. T.W. Gamelin, Complex analysis

Course: Ring Theory
Course Code: USMT602 / UAMT602

Unit I. Rings (15L)

(1) Definition and elementary properties of rings (where the definition should include the existence of unity), commutative rings, integral domains and fields. Examples, including $\mathbb{Z}, \mathbb{Q}, \mathbb{R}, \mathbb{Z}/n\mathbb{Z}, \mathbb{C}, M_n(\mathbb{R}), \mathbb{Z}[i], \mathbb{Z}[\sqrt{2}], \mathbb{Z}[\sqrt{-5}], \mathbb{Z}[X], \mathbb{R}[X], \mathbb{C}[X], (\mathbb{Z}/n\mathbb{Z})[X]$.

(2) Units in a ring. The multiplicative group of units in a ring R [and, in particular, the multiplicative group F^* of nonzero elemets of a field F]. Description of the units in $\mathbb{Z}/n\mathbb{Z}$. Results such as: A finite integral domain is a field. $\mathbb{Z}/p\mathbb{Z}$, where p is a prime, as an example of a finite field.

(3) Characteristic of a ring. Examples. Elementary facts such as: the characteristic of an itegral domain is either 0 or a prime number.

(Note: From here on all rings are assumed to be commutative with unity).

Unit II. Ideals and special rings(15L)

(1) Ideals in a ring. Sums and products of ideals. Quotient rings. Examples. Prime ideals and maximal ideals. Characterization of prime ideals and maximal ideals in a commutative ring in terms of their quotient rings. Description of the ideals and the prime ideals in $\mathbb{Z}, \mathbb{R}[X]$ and $\mathbb{C}[X]$.

(2) Homomorphisms and isomorphism of rings. Kernel and the image of a homomorphism. Fundamental Theorem of homomorphism of a ring.

(3) Construction of the quotient field of an integral domain (Emphasis on $\mathbb{Z}, \mathbb{Q}$). A field contains a subfield isomorphic to $\mathbb{Z}/p\mathbb{Z}$ or $\mathbb{Q}$.

(4) Notions of euclidean domain (ED), principal ideal domain (PID). Examples such as $\mathbb{Z}, \mathbb{Z}[i]$, and polynomial rings. Relation between these two notions (ED $\Longrightarrow$ PID).

Unit III. Factorization (15L)

(1) Divisibility in a ring. Irreducible and prime elements. Examples.

(2) Division algorithm in $F[X]$ (where F is a field). Monic polynomials, greatest common divisor of $f(x), g(x) \in F[X]$ (not both 0). Theorem: Given $f(x)$ and $g(x) \neq 0$, in $F[X]$ then their greatest common divisor $d(x) \in F[X]$ exists; moreover, $d(x) = a(x)f(x) + b(x)g(x)$ for some $a(x), b(x) \in F[X]$. Relatively prime polynomials in $F[X]$, irreducible polynomial in $F[X]$. Examples of irreducible polynomials in $(\mathbb{Z}/p\mathbb{Z})[X]$ (p prime), Eisenstein Criterion (without proof).

(3) Notion of unique factorization domain (UFD). Elementary properties. Example of a non-UFD is $\mathbb{Z}[\sqrt{-5}]$ (without proof). Theorem (without proof). Relation between the three notions (ED $\Longrightarrow$ PID $\Longrightarrow$ UFD). Examples such as $\mathbb{Z}[X]$ of UFD that are not PID. Theorem (without proof): If R is a UFD, then $R[X]$ is a UFD.

Reference Books

1. N. Herstein; Topics in Algebra; Wiley Eastern Limited, Second edition.
2. P. B. Bhattacharya, S. K. Jain, and S. R. Nagpaul; Abstract Algebra; Second edition, Foundation Books, New Delhi, 1995.
3. N. S. Gopalakrishnan; University Algebra; Wiley Eastern Limited.
4. M. Artin; Algebra; Prentice Hall of India, New Delhi.
5. J. B. Fraleigh; A First course in Abstract Algebra; Third edition, Narosa, New Delhi.
6. J. Gallian; Contemporary Abstract Algebra; Narosa, New Delhi.

Additional Reference Books:

1. S. Adhikari; An Introduction to Commutative Algebra and Number theory; Narosa Publishing House.
2. T.W. Hungerford; Algebra; Springer.
3. D. Dummit, R. Foote; Abstract Algebra; John Wiley & Sons, Inc.
4. I.S. Luthar, I.B.S. Passi; Algebra; Vol. I and II.
5. U. M. Swamy, A. V. S. N. Murthy; Algebra Abstract and Modern; Pearson.
6. Charles Lanski; Concepts Abstract Algebra; American Mathematical Society.
7. Sen, Ghosh and Mukhopadhyay; Topics in Abstract Algebra; Universities press.

Course: Topology of Metric Spaces and Real Analysis
Course Code: USMT603/ UAMT603

Unit I: Continuous functions on metric spaces (15 L)

Epsilon-delta definition of continuity of a function at a point from one metric space to another. Characterization of continuity at a point in terms of sequences, open sets and closed sets and examples. Algebra of continuous real valued functions on a metric space. Continuity of composite function. Continuous image of compact set is compact, Uniform continuity in a metric space, examples (emphasis on $\mathbb{R}$). Results such as: every continuous functions from a compact metric space is uniformly continuous. Contraction mapping and fixed point theorem. Applications.

Unit II: Connected spaces (15L)

Separated sets- Definition and examples. Connected and disconnected sets. Connected and disconnected metric spaces. Results such as: A subset of $\mathbb{R}$ is connected if and only if it is an interval. A continuous image of a connected set is connected.
Characterization of a connected space, viz. a metric space is connected if and only if every continuous function from X to $\{1, -1\}$ is a constant function. Path connectedness in $\mathbb{R}^n$, definition and examples. A path connected subset of $\mathbb{R}^n$ is connected, convex sets are path connected. Connected components. An example of a connected subset of Rn which is not path connected.

Unit III : Sequence and series of functions(15 lectures)

Sequence of functions - pointwise and uniform convergence of sequences of real- valued functions, examples. Uniform convergence implies pointwise convergence, example to show converse not true, series of functions, convergence of series of functions, Weierstrass M-test (statement only). Examples. Properties of uniform convergence: Continuity of the uniform limit of a sequence of continuous function, conditions under which integral and the derivative of sequence of functions converge to the integral and derivative of uniform limit on a closed and bounded interval (statements only). Examples. Consequences of these properties for series of functions, term by term differentiation and integration(statements only). Power series in $\mathbb{R}$ centered at origin and at some point in $\mathbb{R}$, radius of convergence, region (interval) of convergence, uniform convergence, term by-term differentiation and integration of power series, Examples. Uniqueness of series representation, functions represented by power series, classical functions defined by power series such as exponential, cosine and sine functions, the basic properties of these functions.

Reference books:

1. R. R. Goldberg; Methods of Real Analysis; Oxford and International Book House (IBH) Publishers, New Delhi.

2. S. Kumaresan; Topology of Metric spaces.

3. E. T. Copson; Metric Spaces; Universal Book Stall, New Delhi, 1996.

4. Robert Bartle and Donald R. Sherbert; Introduction to Real Analysis; Second Edition, John Wiley and Sons.

Other references:

1. W. Rudin; Principles of Mathematical Analysis.
2. T. Apostol; Mathematical Analysis; Second edition, Narosa, New Delhi, 1974
3. E. T. Copson; Metric Spaces; Universal Book Stall, New Delhi, 1996.
4. P. K. Jain. K. Ahmed, Metric Spaces. Narosa, New Delhi, 1996.
5. W. Rudin, Principles of Mathematical Analysis; Third Ed, McGraw-Hill, Auckland, 1976.
6. D. Somasundaram, B. Choudhary; A first Course in Mathematical Analysis. Narosa, New Delhi
7. G. F. Simmons; Introduction to Topology and Modern Analysis, McGraw-Hi, New York, 1963.
8. Sutherland. Topology.

Course: Intergral Transforms(Elective A)
Course Code: USMT6A4/ UAMT6A4

Unit I: The Laplace Transform (15L)

Definition of Laplace Transform, theorem, Laplace transforms of some elementary functions, Properties of Laplace transform, LT of derivatives and integrals, Initial and final value theorem, Inverse Laplace Transform, Properties of Inverse Laplace Transform, Convolution Theorem, Inverse LT by partial fraction method, Laplace transform of special functions: Heaviside unit step function, Dirac-delta function and Periodic function.

Unit II: The Fourier Transform

Fourier integral representation, Fourier integral theorem, Fourier Sine & Cosine integral representation, Fourier Sine & Cosine transform pairs, Fourier transform of elementary functions, Properties of Fourier Transform, Convolution Theorem, Parseval's Identity.

Unit III: Applications of Integral Transforms

Relation between the Fourier and Laplace Transform. Application of Laplace transform to evaluation of integrals and solutions of higher order linear ODE. Applications of LT to solution of one dimensional heat equation & wave equation. Application of Fourier transforms to the solution of initial and boundary value problems, Heat conduction in solids (one dimensional problems in infinite & semi infinite domain).

Reference Books:

1. Lokenath Debnath and Dambaru Bhatta, Integral Transforms and their Applications, CRC Press Taylor & Francis.
2. I. N. Sneddon, Use of Integral Transforms, Tata-McGraw Hill.

3. L. Andrews and B. Shivamogg, Integral Transforms for Engineers, Prentice Hall of India.

Course: Number Theory and its applications II (Elective B)
Course Code: USMT6B4/ UAMT6B4

Unit I: Quadratic Reciprocity (15 L)

Quadratic residues and Legendre Symbol, Gauss's Lemma, Theorem on Legendre Symbol $\left(\frac{2}{p}\right)$, the result: If p is an odd prime and a is an odd integer with $(a,p)=1$ then $\left(\frac{a}{p}\right)=(-1)^t$ where $t=\sum_{k=1}^{\frac{p-1}{2}}\left[\frac{ka}{p}\right]$, Quadratic Reciprocity law. Theorem on Legendre Symbol $\left(\frac{3}{p}\right)$. The Jacobi Symbol and law of reciprocity for Jacobi Symbol. Quadratic Congruences with Composite moduli.

Unit II: Continued Fractions (15 L)

Finite continued fractions. Infinite continued fractions and representation of an irrational number by an infinite simple continued fraction, Rational approximations to irrational numbers and order of convergence, Best possible approximations. Periodic continued fractions.

Unit III: Pell's equation, Arithmetic function and Special numbers (15 L)

Pell's equation $x^2-dy^2=n$, where d is not a square of an integer. Solutions of Pell's equation (The proofs of convergence theorems to be omitted). Arithmetic functions of number theory: $d(n)$ (or $\tau(n)$,) $\sigma(n), \sigma_k(n), \omega(n))$ and their properties, $\mu(n)$ and the Möbius inversion formula. Special numbers: Fermat numbers, Mersenne numbers, Perfect numbers, Amicable numbers, Pseudo primes, Carmichael numbers.

Reference Books:

1. Niven, H. Zuckerman and H. Montogomery; An Introduction to the Theory of Numbers; John Wiley & Sons. Inc.
2. David M. Burton; An Introduction to the Theory of Numbers; Tata McGraw-Hill Edition.
3. G. H. Hardy and E.M. Wright; An Introduction to the Theory of Numbers; Low priced edition; The English Language Book Society and Oxford University Press, 1981.
4. Neville Robins; Beginning Number Theory; Narosa Publications.
5. S. D. Adhikari; An introduction to Commutative Algebra and Number Theory; Narosa Publishing House
6. N. Koblitz; A course in Number theory and Crytopgraphy. Springer.
7. M. Artin; Algebra. Prentice Hall.
8. K. Ireland, M. Rosen; A classical introduction to Modern Number Theory. Second edition, Springer Verlag.

9. William Stalling; Cryptology and network security.

Course: Graph Theory and Combinatorics (Elective C)
Course Code: USMT6C4 /UAMT6C4

Unit I: Colorings of graph (15L)

Vertex coloring- evaluation of vertex chromatic number of some standard graphs, critical graph. Upper and lower bounds of Vertex chromatic Number- Statement of Brooks theorem. Edge colouring- Evaluation of edge chromatic number of standard graphs such as complete graph, complete bipartite graph, cycle. Statement of Vizing Theorem. Chromatic polynomial of graphs- Recurrence Relation and properties of Chromatic polynomials. Vertex and edge cuts, vertex and edge connectivity and the relation between vertex and edge connectivity. Equality of vertex and edge connectivity of cubic graphs. Whitney's theorem on 2-vertex connected graphs.

Unit II: Planar graph (15L)

Definition of planar graph. Euler formula and its consequences. Non planarity of $K_5; K_(3; 3)$. Dual of a graph. Polyhedran in $\mathbb{R}^3$ and existence of exactly five regular polyhedron- (Platonic solids) Colorabilty of planar graphs- 5 color theorem for planar graphs, statement of 4 color theorem. flows in Networks, and cut in a network- value of a flow and the capacity of cut in a network, relation between flow and cut. Maximal flow and minimal cut in a network and Ford-Fulkerson theorem.

Unit III: Combinatorics (15L)

Applications of Inclusion Exclusion Principle- Rook polynomial, Forbidden position problems. Introduction to partial fractions and Newton's binomial theorem for real power series, series expansion of some standard functions. Forming recurrence relation and getting a generating function. Solving a recurrence relation using ordinary generating functions. System of Distinct Representatives and Hall's theorem of SDR.

Recommended Books.

1. Bondy and Murty; Grapgh Theory with Applications.
2. Balkrishnan and Ranganathan; Graph theory and applications.
3. Douglas B. West, Introduction to Graph Theory, 2nd Ed., Pearson, 2000
4. Richard Brualdi; Introduction to Combinatorics.

Additional Reference Book.

1. Behzad and Chartrand; Graph theory.
2. Choudam S. A.; Introductory Graph theory; 3 Cohen, Combinatorics.

Course: Operations Research (Elective D)
Course Code: USMT6D4 / UAMT6D4

Unit I: Linear Programming-I (15L)

Prerequisites: Vector Space, Linear independence and dependence, Basis, Convex sets, Dimension of polyhedron, Faces.
Formation of LPP, Graphical Method. Theory of the Simplex Method- Standard form of LPP, Feasible solution to basic feasible solution, Improving BFS, Optimality Condition, Unbounded solution, Alternative optima, Correspondence between BFS and extreme points. Simplex Method – Simplex Algorithm, Simplex Tableau.

Unit II: Linear programming-II (15L)
Simplex Method – Case of Degeneracy, Big-M Method, Infeasible solution, Alternate solution, Solution of LPP for unrestricted variable. Transportation Problem: Formation of TP, Concepts of solution, feasible solution, Finding Initial Basic Feasible Solution by North West Corner Method, Matrix Minima Method, Vogel's Approximation Method. Optimal Solution by MODI method, Unbalanced and maximization type of TP.

Unit III: Queuing Systems (15L)
Elements of Queuing Model, Role of Exponential Distribution. Pure Birth and Death Models; Generalized Poisson Queuing Model. Specialized Poisson Queues: Steady- state Measures of Performance, Single Server Models, Multiple Server Models, Self- service Model, Machine-servicing Model.

Reference for Unit III:

1. G. Hadley; Linear Programming; Narosa Publishing, (Chapter 3).
2. G. Hadley; Linear Programming; Narosa Publishing, (Chapter 4 and 9).
3. J. K. Sharma; Operations Research; Theory and Applications, (Chapter 4, 9).
4. J. K. Sharma, Operations Research, Theory and Applications.
5. H. A. Taha, Operations Research, Prentice Hall of India.

Additional Reference Books:

1. Hillier and Lieberman, Introduction to Operations Research.
2. Richard Broson, Schaum Series Book in Operations Research, Tata McGrawHill Publishing Company Ltd.

Course: Practicals (Based on USMT601 / UAMT601 and USMT602 / UAMT602)
Course Code: USMTP07 / UAMTP07
Suggested Practicals (Based on USMT601 / UAMT601):

1. Limit continuity and derivatives of functions of complex variables.
2. Steriographic Projection , Analytic function, finding harmonic conjugate.
3. Contour Integral, Cauchy Integral Formula ,Mobius transformations.

4. Taylors Theorem , Exponential , Trigonometric, Hyperbolic functions.
5. Power Series , Radius of Convergence, Laurents Series.
6. Finding isolated singularities- removable, pole and essential, Cauchy Residue theorem.
7. Miscellaneous theory questions.

Suggested Practicals (Based on USMT602 / UAMT602)

1. Examples of rings (commutative and non-commutative), integral domains and fields
2. Units in various rings. Determining characteristics of rings.
3. Prime Ideals and Maximal Ideals, examples on various rings.
4. Euclidean domains and principal ideal domains (examples and non-examples)
5. Examples if irreducible and prime elements.
6. Applications of division algorithm and Eisenstein's criterion.
7. Miscellaneous Theoretical questions on Unit 1, 2 and 3.

Course: Practicals (Based on USMT603 / UAMT603 and USMT6A4 / UAMT6A4 OR USMT6B4 / UAMT6B4 OR USMT6C4 / UAMT6C4 OR USMT6D4 / UAMT6D4)
Course Code: USMTP08 / UAMTP08

Suggested practicals Based on USMT603 / UAMT603:

1 Continuity in a Metric Spaces

2 Uniform Continuity, Contraction maps, Fixed point theorem

3 Connected Sets , Connected Metric Spaces

4 Path Connectedness, Convex sets, Continuity and Connectedness

5 Pointwise and uniform convergence of sequence functions, properties

6 Point wise and uniform convergence of series of functions and properties

7 Miscellaneous Theory Questions.

Suggested Practicals based on USMT6A4 / UAMT6A4

1 Find the Laplace transform of differential and integral equations.

2 Find the inverse Laplace transform by the partial fraction method.

3 Find the Fourier integral representation of given functions.

4 Find the Fourier Sine / Cosine integral representation of given functions.

5 Solve higher order ODE using Laplace transform.

6 Solve one dimensional heat and wave equation using Laplace transform. Solve initial and boundary value problems using Fourier transform.

7 Miscellaneous Theory Questions.

Suggested Practicals based on USMT6B4 / UAMT6B4

1 Legendre Symbol.

2 Jacobi Symbol and Quadratic congruences with composite moduli.

3 Finite continued fractions.

4 Infinite continued fractions.

5 Pell's equations and Arithmetic functions of number theory.

6 Special Numbers.

7 Miscellaneous Theoretical questions.

Suggested Practicals based on USMT6C4 / UAMT6C4

1 Coloring of Graphs

2 Chromatic polynomials and connectivity.

3 Planar graphs

4 Flow theory.

5 Application of Inclusion Exclusion Principle, rook polynomial. Recurrence relation.

6 Generating function and SDR.

7 Miscellaneous theoretical questions.

Suggested Practicals based on USMT6D4 / UAMT6D4
All practicals to be done manually as well as using software TORA / EXCEL solver.

1 LPP formation, graphical method and simple problems on theory of simplex method

2 LPP Simplex Method

3 Big-M method, special cases of solutions.

4 Transportation Problem

5 Queuing Theory; single server models

6 Queuing Theory; multiple server models

7 Miscellaneous Theory Questions.

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(8) Scheme of Evaluation

Scheme of Examination (75:25)

The performance of the learners shall be evaluated into two parts.

- Internal Assessment of 25 percent marks for each paper.
- Semester End Examination of 75 percent marks for each paper.

I. **Internal Evaluation of 25 Marks:**

T.Y.B.Sc. :

(i) One class Test on unit I of 20 marks of duration one hour to be conducted during Practical session.
Paper pattern of the Test:
Q1: Definitions/ Fill in the blanks/ True or False with Justification (04 Marks).
Q2: Multiple choice 5 questions. (10 Marks: 5×2)
Q3: Attempt any 2 from 3 descriptive questions. (06 marks: 2×3)

(ii) Active participation in routine class: 05 Marks.

OR

Students who are willing to explore topics related to syllabus, dealing with applications historical development or some interesting theorems and their applications can be encouraged to submit a project for 25 marks under the guidance of teachers.

T.Y.B.A. :

(i) One class Test on unit I of 20 marks to be conducted during Tutorial session.
Paper pattern of the Test:
Q1: Definitions/ Fill in the blanks/ True or False with Justification (04 Marks).
Q2: Multiple choice 5 questions. (10 Marks: 5×2)
Q3: Attempt any 2 from 3 descriptive questions. (06 marks: 2×3)

(ii) Journal : 05 Marks.

OR

Students who are willing to explore topics related to syllabus, dealing with applications historical development or some interesting theorems and their applications can be encouraged to submit a project for 25 marks under the guidance of teachers.

II. **Semester End Theory Examinations :** There will be a Semester-end external Theory examination of 75 marks for each of the courses USMT501/UAMT501, USMT502/UAMT502, USMT503 and USMT5A4 OR USMT5B4 OR USMT5C4 OR USMT 5D4 of Semester V and USMT601/UAMT601, USMT602/UAMT602, USMT603 and USMT6A4 OR USMT6B4 OR USMT 6C4 OR USMT 6D4 of semester VI to be conducted by the University.

1. Duration: The examinations shall be of $2\frac{1}{2}$ Hours duration.
2. Theory Question Paper Pattern:

a) There shall be FOUR questions. The first three questions Q1, Q2, Q3 shall be of 20 marks, each based on the units I, II, III respectively. The fourth question Q4 shall be of 15 marks based on the entire syllabus.

b) All the questions shall be compulsory. The questions Q1, Q2, Q3, Q4 shall have internal choices within the questions. Including the choices, the marks for each question shall be 30-32.

c) The questions Q1, Q2, Q3, Q4 may be subdivided into sub-questions as a, b, c, d & e, etc and the allocation of marks depends on the weightage of the topic.

III. **Semester End Practical Examinations :**
There shall be a Semester-end practical examinations of three hours duration and 100 marks for each of the courses USMTP05/UAMTP05, USMTP06/UAMTP056 of Semester V and USMTP07/UAMTP07, USMTP08/UAMTP08 of semester VI.

In semester V, the Practical examinations for USMTP05/UAPTP05 and USMTP06/UAMTP06 are conducted by the college.

In semester VI, the Practical examinations for USMTP07/UAMTP07 and USMTP08/UAMTP08 are conducted by the University.
Question Paper pattern:

Paper pattern: The question paper shall have two parts A, B.
Each part shall have two Sections.

Section I Objective in nature: Attempt any Eight out of Twelve multiple choice questions. ($8 \times 3 = 24$ Marks)

Section II Problems: Attempt any Two out of Three. ($8 \times 2 = 16$ Marks)

Practical Course	Part A	Part B	Marks out of	duration
USMTP05/UAMTP05	Questions from USMT501/UAMT501	Questions from USMT502/UAMT502	80	3 hours
USMTP06/UAMTP06	Questions from USMT503/UAMT503	Questions from USMT504/UAMT504	80	3 hours
USMTP07/UAMTP07	Questions from USMT601/UAMT601	Questions from USMT602/UAMT602	80	3 hours
USMTP08/UAMTP08	Questions from USMT603/UAMT603	Questions from USMT604/UAMT604	80	3 hours

Marks for Journals and Viva:
For each course USMT501/UAMT501, USMT502/UAMT502, USMT503/UAMT503, USMT504/UAMT504, USMT601/UAMT601, USMT602/UAMT602 USMT603/UAMT603, and USMT604/UAMT604:

1. Journals: 5 marks.

2. Viva: 5 marks.

Each Practical of every course of Semester V and VI shall contain 10 (ten) problems out of which minimum 05 (five) have to be written in the certified journal.

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