SHIVAJI UNIVERSITY, KOLHAPUR - 416004,
MAHARASHTRA
PHONE:EPABX-2609000, www.unishivaji.ac.in, bos@unishivaji.ac.in
शिवाजी विद्यापीठ, कोल्हापूर -४१६००४,महाराष्ट्र
दूरध्वनी-ईपीएबीएक्स -२६०९०००, अभ्याससमंडळे विभाग दुरध्वनी ०२३१—२६०९०९४
०२३१—२६०९४८७

Estd. 1962
"A++" Accredited by
NAAC (2021)
With CGPA 3.52

SU/BOS/Science/104 **Date: 11/03/2025.**

To,

The Director
School of Nanoscience and Technology,
Shivaji University, Kolhapur.

Subject: Regarding Minor Change syllabi of B.Sc.- M.Sc. in Nanoscience and Technology as per NEP-2020 (2.0) degree programme under the Faculty of Science and Technology.

Ref: SU/BOS/Science/880/ Date: 28/12/2023 Letter.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the Minor Change in syllabi, nature of question paper and equivalence of B.Sc.- M.Sc. in Nanoscience and Technology as per NEP-2020 (2.0) degree programme under the Faculty of Science and Technology.

	B.Sc.- M.Sc. in Nanoscience and Technology as per NEP-2020 (2.0)
1	B.Sc.- M.Sc. in Nanoscience and Technology (5 Years Integrated), Part I & II

This syllabus, nature of question shall be implemented from the academic year 2025-2026 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website www.unishivaji.ac.in,NEP-2020@suk(Online Syllabus).

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Dy Registrar
Dr. S. M. Kubal

Copy to:

1	The Dean, Faculty of Science & Technology	5	Appointment Section A & B
2	Director, Board of Examinations and Evaluation	6	I.T.Cell /Computer Centre
3	The Chairman, Respective Board of Studies	7	Eligibility Section
4	B.Sc.-M.Sc. Exam Section	8	Affiliation Section (T.1) (T.2)
9	IQAC Cell		

Shivaji University, Kolhapur

Accredited by NAAC with 'A++' Grade

NATIONAL EDUCATION POLICY (NEP-2020)
Syllabus for
B. Sc.-M. Sc. in Nanoscience and Technology,
(5 Years Integrated) Program,
Part-I

Syllabus to be implemented from the academic year 2023-24 (July 2023) onwards

Implementation: The implementation gradually as mentioned below –

B.Sc.-M. Sc. in Nanoscience and Technology (5 Years Integrated) Program

a) **B.Sc.-M. Sc. (5 Years Integrated) Part – I from the Academic year 2023-24**
b) B.Sc. -M. Sc. (5 Years Integrated) Part – II from the Academic year 2024-25
c) B.Sc. -M. Sc. (5 Years Integrated) Part – III from the Academic year 2025-26
d) B.Sc. -M. Sc. (5 Years Integrated) Part – IV from the Academic year 2026-27
e) B.Sc. -M. Sc. (5 Years Integrated) Part – V from the Academic year 2027-28

Programme: B.Sc.-M.Sc. in Nanoscience and Technology (5 Years Integrated) (NST)

Course code Abbreviations

Sr. No.	Name	Short form
1	Major	DMJ/MJ
2	Minor	DMN/MN
3	Generic Elective Course	GEC
4	Interdisciplinary Course	IDC
5	Discipline Course	DSC
6	Open Elective Course	OE
7	Ability Enhancement Course (English)	AECC
8	Indian Knowledge System	IKS
9	Field Projects	FP
10	Community Engagement Practice	CEP
11	Co-Curricular Courses	CC
12	Research Project	RP
13	Value Education Courses (Env.Sci)	VEC
14	Vocational Skill course	VSC
15	Skill Enhancement Courses	SEC
16	Discipline Specific Elective Course	DSE
17	Multidisciplinary	MDC
18	Value Added Course (Maths +Biology)	VAC
19	Major Mandatory	MM
20	Major Elective	ME
21	Research Methodology	RM

B.Sc.-M.Sc. in Nanoscience and Technology (5 Years Integrated) (NST)

List of course with the codes

Sr. No.	Name of the Course	Course Code
1	Physics	01
2	Chemistry	02
3	Biotechnology	03
4	Mathematics	04
5	Electronics	05
6	English	06
7	Nanoscience	07
8	Nanoscience and Technology	08
9	Statistics	09
10	Environmental Science	10
11	Biology	11
12	Nanobiotechnology	12

B. Sc. - M. Sc. Nanoscience and Technology (5 years integrated) - Part-I, SEM-I and SEM-II

Sr. No.	Paper Code	Title of the Paper
		SEM I
1	NSTU0325MJL201A1	Mechanics
2	NSTU0325MJL202A1	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons
3	NSTU0325MJL203A1	Cellular Foundation of Life
4	NSTU0325MDCL204A1	Differential Calculus
5	NSTU0325MNL205A1	Analog Electronics
6	NSTU0325AECCL206A1	English
7	NSTU0325VACL204A1	Fundamentals of Mathematical Computing and Calculus - I
8	NSTU0325VACL211A1	Fundamental Understanding of Life Sciences - I
9	NSTU0325MJP201A1	**Laboratory Course – I** (Mechanics)
10	NSTU0325MJP202A1	**Laboratory Course – II** (Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons)
11	NSTU0325MJP203A1	**Laboratory Course – III** (Cellular Foundation of Life)
12	(NSTU0325SECP204A1) + (NSTU0325SECP205A1)	**Laboratory Course – IV** (Differential Calculus +Analog Electronics)
		SEM II
13	NSTU0325MJL201B1	Electricity and Magnetism
14	NSTU0325MJL202B1	Chemical Energetics, Equilibria &Functional Organic Chemistry
15	NSTU0325MJL203B1	Chemical Foundation of Life Sciences
16	NSTU0325MDCL204B1	Differential Equations
17	NSTU0325MNL205B1	Linear and Digital Integrated Circuits
18	NSTU0325AECCL206B1	English
19	NSTU0325VACL204B1	Fundamentals of Mathematical Computing and Calculus - II
20	NSTU0325VACL211B1	Fundamental Understanding of Life Sciences -II
21	NSTU0325MJP201B1	**Laboratory Course – I** (Electricity and Magnetism)
22	NSTU0325MJP202B1	**Laboratory Course – II** (Chemical Energetics, Equilibria &Functional Organic Chemistry)
23	NSTU0325MJP203B1	**Laboratory Course – III** (Chemical Foundation of Life Sciences)
24	(NSTU0325SECP204B1) + (NSTU0325SECP205B1)	**Laboratory Course – IV** (Differential Equations + Linear and Digital Integrated Circuits)

The following shall be the courses of the studies under the NEP-2020 pattern

B. Sc. - M. Sc. Nanoscience and Technology (5 years integrated) - Part-I, SEM-I and SEM-II
NEP-2020 PATTERN (2023-24)

SEMESTER-I (Duration – 6 Months)																			
Sr. No.	Course Title	Teaching Scheme						Examination Scheme											
								Theory								Practical/SEC			
		Theory			Practical/SEC			Theory			Internal			Total		Total			
		No. of lectures	Hours	Credits	No. of Lectures	Hours	Credits	Max.	Min.	Hours	Max.	Min.	Hours	Max.	Min.	Max.	Min.	Hours
1	Mechanics	4	4	4	4	4	2	80	28	3	20	7	1	100	35	50	18	4
2	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	4	4	4	4	4	2	80	28	3	20	7	1	100	35	50	18	4
3	Cellular Foundation of Life	4	4	4	4	4	2	80	28	3	20	7	1	100	35	50	18	4
4	Differential Calculus	4	4	4	4	4	2	80	28	3	20	7	1	100	35	50	18	4
5	Analog Electronics	4	4	4				80	28	3	20	7	1	100	35			
6	English	2	2	2	-	-	-	40	14	1.5	10	4	0.5	50	18	-	-	-
7	Fundamentals of Mathematical Computing and Calculus – I **Or** Fundamental Understanding of Life Sciences - I	2	2	2	-	-	-	40	14	1.5	10	4	0.5	50	18	-	-	-
	Total	**24**	**24**	**24**	**16**	**16**	**8**	**-**			**-**	**-**	**-**	**600**	**-**	**200**		**-**

	SEMESTER-II (Duration 6 months)																	
Sr. No.	Course Title	Teaching Scheme						Examination Scheme										
								Theory								Practical/SEC		
		Theory			Practical/SEC			Theory			Internal			Total		Total		
		No. of lectures	Hours	Credits	No. of Lectures	Hours	Credits	Max.	Min.	Hours	Max.	Min.	Hours	Max.	Min.	Max.	Min.	Hours
1	Electricity and Magnetism	4	4	4	4	4	2	80	28	3	20	7	1	100	35	50	18	4
2	Chemical Energetics, Equilibria &Functional Organic Chemistry	4	4	4	4	4	2	80	28	3	20	7	1	100	35	50	18	4
3	Chemical Foundation of Life Sciences	4	4	4	4	4	2	80	28	3	20	7	1	100	35	50	18	4
4	Differential Equations	4	4	4	4	4	2	80	28	3	20	7	1	100	35	50	18	4
5	Linear and Digital Integrated Circuits	4	4	4				80	28	3	20	7	1	100	35			
6	English	2	2	2	-	-	-	40	14	1.5	10	4	0.5	50	18	-	-	-
7	Fundamentals of Mathematical Computing and Calculus – II **Or** Fundamental Understanding of Life Sciences -II	2	2	2	-	-	-	40	14	1.5	10	4	0.5	50	18	-	-	-
	Total	**24**	**24**	**24**	**16**	**16**	**8**	**-**	**-**	**-**	**-**	**-**	**-**	**600**	**-**	**200**	**-**	**-**
	Grand Total	**48**	**48**	**48**	**32**	**32**	**16**							**1200**		**400**	**-**	**-**

Note:- Practical examination will be conducted semester wise.

SHIVAJI UNIVERSITY, KOLHAPUR

School of Nanoscience and Biotechnology

B. Sc. –M.Sc. in Nanoscience and Technology,

(5 Years Integrated) Programme, Part – I, Semester- I,

Title of the Paper:- MECHANICS

(Theory: 60 Lectures)

Course Learning Outcomes:

After going through the course, the student should be able to

- Learn the vectors, vector calculus. These basic mathematical structures are essential in solving problems in various branches of Physics.
- Understand laws of motion and their application to various dynamical situations, notion of inertial frames and concept of Galilean invariance. He / she will learn the concept of conservation of energy, momentum, angular momentum and apply them to basic problems.
- Understand the analogy between translational and rotational dynamics, and application of both motions simultaneously in analyzing rolling with slipping.
- Acquire basic knowledge of nanophysics like hydrophobic and superhydrophobic nanostructured surfaces, motion at nanoscale, frequency and elasticity of nanoscale matters.

Unit No.	Topics	Total Lectures
Unit I	**1. Vector Algebra and Elementary Calculus** Revision– (Vector Algebra: Components of Vectors and Unit Vector, Addition and Subtraction of Vectors), Scalar product, Vector product and their properties, Scalar triple product and its physical significance, Properties of scalar triple product, Vector triple product, properties of vector triple product. Derivatives of a vector with respect to a parameter (velocity and acceleration), Problems. **2. Laws of Motion:** Frames of reference, Newton's Laws of motion (with proof), Problems.	**11**
Unit II	**1. Conservation Theorems:** **Single particle:** Conservation theorem for linear momentum of a particle, Conservation theorem for angular momentum of a particle, work-energy theorem, Conservation theorem for energy of a particle, Problems.	**16**

	System of particles: Center of mass, Conservation theorem for linear momentum, Conservation theorem for angular momentum, Conservation theorem for energy, Problems. **2. Rotational Motion:** Angular velocity, Angular momentum, Torque, Kinetic energy of rotation, Moment of Inertia, Moment of inertia of a spherical shell about its diameter, Moment of inertia of solid cylinder about its axis of symmetry, Problems.	
Unit III	**1. Gravitation:** Newton's Law of Gravitation, Motion of a particle in a central force field (motion in a plane, angular momentum is conserved, areal velocity is constant), Kepler's Laws (statement only), Satellite in circular orbit and applications, Geosynchronous orbits, Weightlessness, Basic idea of global positioning system (GPS), Problems. **2. Oscillations:** Simple harmonic motion, Differential equation of SHM and its solutions, Kinetic and Potential Energy, Total Energy and their time averages, Damped oscillations (Def. only), Forced oscillations (Def. Only), Frequency of nanoscale matters, Problems.	**16**
Unit IV	**1. Elasticity: (9 Lectures)** (Revision Hooke's law, Stress-strain diagram, Definition of elastic constants (Y, η, K and σ)), Bending of beam, bending moment, Cantilever (without considering weight of cantilever), Beam supported at both the ends (without considering weight of beam), Torsional oscillation and torsional couple per unit twist, Work done in twisting a wire, Torsional pendulum-Determination of rigidity modulus and moment of inertia, Determination of Y, η and σ by Searles method, Elasticity of nanoscale matters, Problems. **2. Surface Tension: (6 Lectures)** Surface tension (definition), Molecular theory of surface tension, Angle of contact, Young equation and wettability, Relation between surface tension, excess of pressure and radius of curvature, Experimental determination of surface tension by Jaeger's method, factors affecting surface tension, Applications of surface tension, Hydrophobic and superhydrophobic nanostructured surface, Problems.	**17**

Note: *Students are not familiar with vector calculus. Hence all examples involve differentiation either in one dimension or with respect to the radial coordinate.*

Reference Books:

1. University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. Addison-Wesley
2. Mechanics Berkeley Physics course,v.1: Charles Kittel, et. Al. 2007, Tata McGraw-Hill
3. Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley eastern Ltd, New Delhi
4. Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press
5. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole
6. Physics – S.G. Starling and Woodal Longmams and Green Co. Ltd.
7. Elements of properties of matter – D.S. Mathur, Shamlal Charitable trust New Delhi
8. A text book of properties of matter–N.S. Khare and S. Kumar. Atmaram and sons New Delhi
9. Concepts of Physics –Vol.1 H.C. Verma -Bharati Bhavan Publishers
10. The big ideas of Nanoscale Science & Engineering- S. Stevens and M. Sutherland, CRC Press

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- I,

Laboratory Course – I
MECHANICS
(Theory: 60 Lectures)

Course Learning Outcomes:

After going through the course, the student should be able to,

- Extend the skills of handling various apparatus like micrometer screw gauge, vernier calliper and travelling microscope.
- Extend the skills and practical use of different types of pendulum.
- Aware of emerging needs in nanophysics and incorporate them into their practical ideas.

Sr. No.	Name of experiment
1	Measurements of length (or diameter) using Vernier caliper, Screw gauge and Travelling microscope.
2	To determine the Moment of Inertia of a Flywheel
3	To determine the Moment of Inertia of a Bifilar pendulum
4	To determine the Moment of inertia of a disc using auxiliary annular ring.
5	Young's modulus of material of Bar by vibration
6	To determine g by Bar Pendulum
7	To determine g by Kater's Pendulum
8	Poisson's ratio of rubber using rubber tube.
9	To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g.
10	Surface tension of liquid using Jaeger's Method.

Reference Books:

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.

2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

4. College Practical Physics – Khanna and Gulati (S. Chand and Co. Ltd, Delhi)

5. Practical Physics – Gupta and Kumar (Pragati Prakation Meerat)
6. Advanced Level Practical Physics – J.M. Nelcon, J.M. Ogloom (EIBS).
7. A Text Book of Practical Physics - Shrinivasan and Balasubramanyam.
8. Engineering Practical Physics- S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.

B. Sc. –M.Sc. in Nanoscience and Technology,

(5 Years Integrated) Programme, Part – I, Semester- I,

TITLE OF THE PAPER: - ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS
(Theory: 60 Lectures)

Unit No.	Topics	Total Lectures
Unit I	**Atomic Structure:** *Review of: Bohr's theory and its limitations*, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. Surface area of atoms and nanoscale materials. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Radial and angular nodes and their significance.Radial distribution functions and the concept of the most probable distance with special reference to '1s' and '2s' atomic orbital's. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbital's, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Rules for filling electrons in various orbital'. Electronic configurations of the atoms. Stability of half-filled and completely filled orbital's, concept of exchange energy. Relative energies of atomic orbital's, Anomalous electronic configurations.	**14**
Unit II	**Chemical Bonding and Molecular Structure:** ***Ionic Bonding***: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born- Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent	**16**

	compounds, bond moment, dipole moment and percentage ionic character. ***Covalent bonding***: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds. ***MO Approach***: Rules for the LCAO method, bonding and antibonding. MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches. Nano Perspective of bondings: Bonding considerations at nanoscale.	
Unit III	**Fundamentals of Organic Chemistry:** ***Physical Effects, Electronic Displacements***: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. ***Reactive Intermediates***: Carbocations, Carbanions and Carbon free radicals. ***Stereochemistry:*** Basic concept of stereochemistry. Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; and E / Z Nomenclature (for upto two C=C systems)	**18**

Unit IV	**Aliphatic Hydrocarbons:** ***Alkanes:*** (Upto 5 Carbons). *Preparation*: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions*: Free radical Substitution: Halogenation. Concept of Nanocatalysis. ***Alkenes:*** (Upto 5 Carbons) *Preparation*: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis-alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions*: cis addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti- Markownikoff's addition) Hydration, Ozonolysis. ***Alkynes:*** (Upto 5 Carbons) *Preparation*: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions*: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$ and oxidation with hot alk. $KMnO_4$. Nanoscale carbon materials (carbonaceous materials-Bucky ball, graphene oxide, carbon nanotubes)	**12**

Reference Books:

1. Lee, J.D.Concise Inorganic ChemistryELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L.Basic Inorganic Chemistry, 3rd Ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
5. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
6. McMurry, J. E. Fundamentals of Organic Chemistry, 7thEd. Cengage Learning India Edition, 2013.
7. Sykes, P.A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
8. Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
9. Finar, I. L. Organic Chemistry (Vol. I & II), E.L.B.S.
10. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.

11. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
12. Introduction to Nanoscience and Nanotechnology, Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore, CRC Press.

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- I,

Laboratory Course – II
(ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS)

(Practical: 60 Lectures)

Section A: Inorganic Chemistry - Volumetric Analysis:

1. To prepare standard 0.1 N KMnO4 solution and to determine the strength of given oxalic acid solution.
2. To determine quantity of Fe (II) ions from the given solutions by titrating it with 0.1 N K_2Cr2O7 solution by using internal indicator
3. To estimate amount of Cu (II) ions by iodometric titration by using Na2S2O3 solution.
4. To standardize supplied EDTA solution by titrating with 0.01 M ZnSO4 solution and to estimate amount of calcium from given solution by using Erio-T as an indicator.
5. Quality control-To determines percentage purity of the given sample of soda ash Na_2CO_3 by titrimetric method.
6. Estimation of amount of Acetic acid from the given vinegar sample by titrimetric method
7. Chromatography : Separation and identification of cations by Paper Chromatographic technique from the following mixtures:
   a) $Ni^{2+} + Cu^{2+}$
   b) $Ni^{2+} + Co^{2+}$

Section B: Organic Chemistry:

1. Estimation of aniline. (by bromination method)
2. Estimation of acetamide.
3. Estimation of Aspirin.
4. Organic Qualitative Analysis: Detection of physical constant, type, functional group, elements, and Confirmatory test.

Identification of Organic Compounds (at least eight) (four containing at least one extra element- N, S, Cl. Br, I)

a) Acids: Oxalic acid, Benzoic acid, cinnamic acid
b) Phenols: Beta-Naphthol, Resorcinol
c) Base: Aniline, p-Nitroaniline
d) Neutral: Acetone, Acetanilide, Chloroform, m-Dinitrobenzene, Thiourea, Bromobenzene

Reference Books:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. 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.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- I,

Title of the Paper: - CELLULAR FOUNDATION OF LIFE

(Theory: 60 Lectures)

Unit No.	Topics	Total Lectures
Unit I	The origin of first cell, Prokaryotic Cell: Introduction, history and origin, classification, Present–day prokaryotes. A typical bacterial cell: Ultra-cellular structure: Bacterial plasma membranes, Bacterial cell walls, Bacterial cell envelope layers outside the cell wall, Bacterial cytoplasm, Bacterial external structures, Bacterial cell growth and reproduction. Eukaryotic Cell: The origin of eukaryotes, A typical eukaryotic cell, Eukaryotic cell envelopes, The development of multicellular organisms. Comparison of bacterial and eukaryotic cells.	**15**
Unit II	Cellular Organelles: Plasma Membrane: History, Ultra structure, and chemical composition of plasma membrane (Lamellar-models, micellar models and fluid mosaic model). Functions of plasma membrane. Mitochondria: History and structure of mitochondria, biogenesis and functions of mitochondria (Respiratory chain complex and Electron transport mechanism). Chloroplasts: Structure and function, genomes, biogenesis. Endoplasmic Reticulum, Ribosome, Golgi Bodies: History, structure, functions and importance. Lysosomes, Centrioles, Microtubules: History, structure, functions and Importance. Nucleus: History, structure, functions and importance. Chromosomes: History, types and functions of chromosomes, Giant chromosomes, Polytene chromosome and Lampbrush chromosome. Comparison of plant and animal cells. Introduction to Cell cycle, Apoptosis and Cancer.	**15**
Unit III	Cell membrane and Cytoskeleton: Structure and function of microtubules, Microfilaments, Intermediate filaments, Extracellular Matrix: Chemical composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, regulation of receptor	**15**

	expression and function, Transport systems: Active and Passive.	
Unit IV	Biological Nanostructures: Cellular Nano-machines and building blocks of life, Phospholipid membrane: Natural biological assembly at the Nano-Scale. Biological Nano-Motors: Kinesin and Dynein. Ion Channels: Nano-Pores of High Specificity. Amyloid Fibrils as Self-Assembled Nano-Scale Bio-Assemblies.	**15**

SUGGESTED READING FOR CELL BIOLOGY

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- I,

Laboratory Course – III

(CELLULAR FOUNDATION OF LIFE)

(Theory: 60 Lectures)

PRACTICALS

1. Introduction to some common instruments and apparatus useful in Biotechnology laboratory.
2. Study the effect of temperature and organic solvents on semi permeable membrane.
3. Demonstration of dialysis.
4. Study of plasmolysis and de-plasmolysis.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Cell division in onion root tip.
7. Permanent slide preparation.
8. Isolation of chloroplast from plant leaves.
9. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

Suggested Reading for Biotechnology Lab

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- I,

Title of the Paper: - DIFFERENTIAL CALCULUS

(Theory: 60 Lectures)

Unit No.	Topics	Total Lectures
Unit I	Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of function of one variable, Successive differentiation, Leibnitz's theorem.	**15**
Unit II	Rolle's theorem, Lagrange's Mean Value theorem, Cauchy's Mean Value Theorem, Maclaurin's series of sin x, cos x, e^x, log(l+x), $(l+x)^m$, Indeterminate forms.	**15**
Unit III	Partial differentiation, Composite function, Chain Rule and Total Derivative, Euler's theorem on homogeneous functions, Maxima and Minima of functions of two variables.	**15**
Unit IV	(A) Numerical Differentiation(i) Introduction, Definition(ii) Numerical differentiation using Newton's forward difference interpolation formula, (iii) Newton's backward difference interpolation formula, (iv) Sterling's Central difference interpolation formula, (v) Newton's divided difference formula. (B) Complex Numbers (i) Rectangular, polar and exponential forms of complex numbers, (ii) De-Moivre's Theorem, (iii) Powers, roots and log of complex numbers	**15**

Books Recommended:

1. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.
3. Finite differences and Numerical Analysis, H.C. Saxena , S.Chand and Company.
4. Complex Numbers, Algebra and Geometry: G. V. Kumbhojkar and H. V. Kumbhojkar,
5. Jamnadas and Com. Bombay, 1982

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- I,

Laboratory Course – IV

(DIFFERENTIAL CALCULUS)

Practical: 30 Lectures

1. Examples on Newtons forward difference formula
2. Examples on Newtons backward difference formula
3. Examples on Central Difference formula
4. Examples on Differentiation at non-tabular values
5. Lagranges method for undetermined multipliers
6. Jacobian-I
7. Jacobian-II
8. Numerical Methods for solution of Linear equations; Gaussian elimination Method
9. Numerical Methods for solution of Linear equations; Gauss Jordan Method Numerical Methods for solution of Linear equations; Gauss Seidel Method

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- I,

Title of the Paper:- ANALOG ELECTRONICS

Theory: 60 Lectures

Course Learning Outcomes:

After going through the course, the student should be able to

- Understand the concepts of Voltage source, Current source, the network theorems and the two–port network parameters with an ability to analyze the electronic circuits using network theorems and find out/calculate two-port network parameters**.**
- Describe the construction and working of different types of diodes, BJT, JFET & UJT. Also Comprehend the I-V characteristics of them.
- Illustrate about rectifiers and transistor amplifiers & its biasing. Also calculate the parameter's values and compare the performances of them.
- Memorizes the concepts of feedback and feedback amplifiers and Design the oscillators.

Unit No.	Topics	Total Lectures
Unit I	**Circuit Analysis:** Passive and Active Elements, Introduction to Resistor, Capacitor, Inductor, Memristor and Transformer. Concept of Voltage and Current Sources. Kirchhoff's Current Law, Kirchhoff's Voltage Law. Principle of Duality. Superposition Theorem. Thevenin's Theorem. Norton's Theorem. Maximum Power Transfer Theorem.	**14**
Unit II	**Junction Diode and its applications:** Semiconductor theory, PN junction diode (Ideal and practical)- constructions, Formation of Depletion Layer, Diode Equation and I-V characteristics. Idea of static and dynamic resistance. Introduction to microelectronics and nanoelectronics, types of micro and nanoelectronic devices, Zener diode, Reverse saturation current, Zener and avalanche breakdown. Qualitative idea of Schottky diode, Photo diode and Light Emitting Diode (LED). Rectifiers- Half wave rectifier, Full wave rectifiers (center tapped and bridge), circuit diagrams, working and waveforms, ripple factor and efficiency. Filters- shunt capacitor filter, series inductor filter, its role in power supply, output waveform, and working. Regulation - Line and load regulation, Zener diode as voltage regulator.	**18**

Unit III	**Bipolar Junction Transistor:** Theory and working of BJT, Basic configurations (CB, CE & CC), Characteristics of transistor in CE and CB configurations, Regions of operation (active, cut off and saturation), applications as an amplifier and switch. Current gains α and β. Relations between α and β. dc load line and Q point. Introduction to Nano Transistor. **Amplifiers:** Transistor biasing and Stabilization circuits- Fixed Bias and Voltage Divider Bias. Thermal runaway, stability and stability factor S. Input and Output impedance, Current and Voltage gains.	**15**
Unit IV	**Cascaded Amplifiers:** Coupling Methods (RC & DC), Two stage RC Coupled Amplifier and its Frequency Response. Feedback in Amplifiers: Concept of feedback, negative and positive feedback, advantages of negative feedback (Qualitative only). Sinusoidal Oscillators: Barkhausen criterion for sustained oscillations. Phase shift and Colpitt's oscillator. Determination of Frequency and Condition of oscillation. **Unipolar Devices:** JFET & MOSFET. Construction, working and I-V characteristics (output and transfer), Pinchoff voltage. UJT, basic construction, working, equivalent circuit and I-V characteristics.	**13**

Reference Books:

1. Electric Circuits, S. A. Nasar, Schaum's outline series, Tata McGraw Hill (2004)
2. Electrical Circuits, M. Nahvi & J. Edminister, Schaum's Outline Series, Tata McGraw-Hill (2005)
3. A Text Book of Applied Electronics -R. S. Sedha, Revised Edition 2014, S. Chand Publication
4. Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press
5. Network, Lines and Fields, J.D.Ryder, Prentice Hall of India.
6. Electronic Devices and Circuits, David A. Bell, 5th Edition 2015, Oxford University Press.
7. Electronic Devices and Circuits, Allen Mottershead, Goodyear Publishing Corporation.
8. Electronic Circuits: Discrete and Integrated, D.L. Schilling and C. Belove, Tata McGraw Hill
9. Electrical Circuit Analysis, Mahadevan and Chitra, PHI Learning
10. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press. J. J. Cathey, 2000
11. Solved Problems in Electronics, Schaum's outline Series, Tata McGraw Hill (1991)

B. Sc. –M.Sc. in Nanoscience and Technology,

(5 Years Integrated) Programme, Part – I, Semester- I,

Laboratory Course – IV

(DIFFERENTIAL CALCULUS +ANALOG ELECTRONICS)

(DIFFERENTIAL CALCULUS)

Practical: 30 Lectures

1. Examples on Newtons forward difference formula
2. Examples on Newtons backward difference formula
3. Examples on Central Difference formula
4. Examples on Differentiation at non-tabular values
5. Lagranges method for undetermined multipliers
6. Jacobian-I
7. Jacobian-II
8. Numerical Methods for solution of Linear equations; Gaussian elimination Method
9. Numerical Methods for solution of Linear equations; Gauss Jordan Method Numerical Methods for solution of Linear equations; Gauss Seidel Method

(ANALOG ELECTRONICS)

Theory: 30 Lectures

Course Learning Outcomes:

After going through the course, the student should be able to

- Choose the appropriate equipment and measuring instruments to supply and measure electrical quantities. Verify the network theorems and operation of electronic circuits.
- Perform experiments for better understanding the behaviour of semiconductor devices and examine the I-V characteristics of them to calculate various device parameters' values. Also Design & construct the oscillator.

ANY FIVE EXPERIMENTS SHOULD BE COMPLETED FROM THE FOLLOWING BESIDES

1. To familiarize with basic electronic components (R, C, L, diodes, transistors), digital Multimeter, Function Generator and Oscilloscope.

2. Verification of (a) Thevenin's theorem and (b) Norton's theorem.

3. Verification of the Maximum Power Transfer Theorem

4. Study of the I-V Characteristics of (a) p-n junction Diode, and (b) Zener diode.

5. Study of (a) Half wave rectifier and (b) Full wave rectifier (FWR).

6. Study the effect of (a) C- filter and (b) L-filter on the output of FWR

7. Study of the Zener diode as voltage regulator.

8. Study output and transfer I-V characteristics of common emitter transistor.

9. Study of the output and transfer I-V characteristics of common source JFET.

10. Study of Fixed Bias and Voltage divider bias configuration for CE transistor.

11. Study of the (a) RC Phase Shift Oscillator (b) Colpitts oscillator.

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- I,

Title of the Paper:- Fundamentals of Mathematical Computing and Calculus - I

Theory: 30 Lectures

Unit No.	Topics	Total Lectures
Unit I	Review of Real number systems and algebraic operations, solutions of polynomial equations, review of trigonometric functions, Introduction to complex numbers, introduction to functions, Graphs of functions	**15**
Unit II	Limits and Continuity, of functions of one variable, geometrically understanding the concepts of limits and continuity, introduction to differentiation of a function of one variable, physical significance of concept of differentiation, formulae of differentiation, properties of differentiation	**15**

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- I,

Title of the Paper:- Fundamental Understanding of Life Sciences - I

Theory: 30 Lectures

Unit	Topics	Lectures
I	**Understanding of the Life:** Concept and characteristics of life, theory of origin of life, cell theory, understanding the diversity of life, three-domain system, six kingdom system, major and minor living organisms, classification of organisms based on cellular structures. World microbes and viruses.	15
II	**Growth and development of live forms:** Cell cycle, Types of cell division, Significance of meiosis and mitosis, Cell death. Growth, types of growth, phases of growth, growth curves, growth rates. Sexual and asexual reproduction in plants.	15

Suggested reading resources:

- Verma P. S. and Agarwal V. K. 2018. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand Limited.
- 11^{th} and 12^{th} Standard Biology Textbooks

SHIVAJI UNIVERSITY, KOLHAPUR

School of Nanoscience and Biotechnology

B. Sc. –M.Sc. in Nanoscience and Technology,

(5 Years Integrated) Programme, Part – I, Semester- II,

Title of the Paper:-ELECTRICITY AND MAGNETISM

(Theory: 60 Lectures)

Course Learning outcomes:

After going through the course, the student should be able to

- Acquire basic knowledge of physics behind the vector analysis, electrostatics, a. c. circuits, magnetism, electromagnetic wave propagation, electromagnetic induction.
- Understand the various applications of the concepts related with electricity and magnetism.
- Aware of basic concepts from nanophysics like electrostatic at nanoscale, memristor circuits at nanoscale, spintronics and nanoelectrodynamics.

Unit No.	Topics	Total Lectures
Unit I	**Vector Analysis**: Introduction, Del operator, gradient of scalar field and its physical significance, divergence of vector field and its physical significance, curl of vector field and its physical significance, line integral, surface integral, volume integral (definitions only), Statements of Gauss divergence theorem, Stoke's theorem and Greens symmetrical theorem. Problems.	**15**
Unit II	**Electrostatics:** Electrostatic Field, electric flux, Gauss's theorem of electrostatics, Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere, Calculation of electric field from potential, Capacitance of an isolated spherical conductor, parallel plate, spherical and cylindrical condenser, Energy per unit volume in electrostatic field, Dielectric medium, Polarization vector, Displacement vector, Gauss's theorem in dielectrics, Parallel plate capacitor completely filled with dielectric. Electrostatic at nanoscale, Problems.	**15**
Unit III	**1. A.C. Circuits:** Complex numbers and their application in solving a. c. series LCR circuit using j operator and phasor diagram. Resonance in LCR series circuit,	**15**

	Sharpness of resonance (qualitative treatment only), Q-factor (definition only), Resonance in LCR Parallel circuit, complex Impedance, Reactance, Admittance, and Susceptance, A.C. Bridge - Owen's Bridge, Memristor circuits at nanoscale, Problems. **2. Electromagnetic Induction:** Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils, Energy stored in magnetic field, Problems. **3. Ballistic Galvanometer:** Construction and working of B. G., expression for charge flowing through ballistic galvanometer, Correction for damping in galvanometer, Constants of ballistic galvanometer, Problems.	
Unit IV	**1. Magnetism:** Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current, Divergence and curl of magnetic field, Magnetic vector potential, Ampere's circuital law, Problems. **2. Magnetic materials and their Properties:** Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Hysteresis and hysteresis curve, diamagnetic, paramagnetic, ferromagnetic, ferrimagnetic and anti-ferromagnetic materials. Introduction to spintronics, Problems.	**15**

Reference Books:

1. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
2. Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
3. Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
4. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
5. D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.
6. Electricity and Magnetism – Khare and Shrivastav.
7. Foundations of Electromagnetic Theory – Rritz and Milford.
8. University Physics 9th edition – Young and Freedman.
9. Concepts of Physics Vol-2 H. C. Verma
10. The big ideas of Nanoscale Science & Engineering- S. Stevens and M. Sutherland, CRC Press.

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- II,

Laboratory Course – I
(ELECTRICITY AND MAGNETISM)

Practical: 60 Lectures

Course Learning outcomes:

After going through the course, the student should be able to

- Extend the skills of handling multimeter, battery eliminator and frequency generator.
- Extend the skills and practical use of sonometer, ballistic galvanometer and different types of LCR circuits.

Sr. No.	Name of experiment
1	To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2	To compare capacitances using De'Sauty's bridge
3	Measurement of field strength B and its variation in a Solenoid (Determine dB/dx)
4	Impedance of series LCR circuit.
5	To study the series LCR circuit and Determine its (a) Resonant Frequency, (b) Quality Factor
6	To study a parallel LCR circuit and Determine its (a) Anti-resonant frequency
7	Frequency of A. C. mains by sonometer using magnetic wire
8	Frequency of A. C. mains by sonometer using non-magnetic wire
9	Verification of Thevenin's Theorem
10	Determine internal resistance of a battery using maximum power transfer theorem

Reference Books:

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. College Practical Physics – Khanna and Gulati (S. Chand and Co. Ltd, Delhi)

5. Practical Physics – Gupta and Kumar (Pragati Prakation Meerat)
6. Advanced Level Practical Physics – J.M. Nelcon, J.M. Ogloom (EIBS)
7. A Text Book of Practical Physics - Shrinivasan and Balasubramanyam
8. Engineering Practical Physics- S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- II,

Title of the Paper:- CHEMICAL ENERGETICS, EQUILIBRIA &FUNCTIONAL ORGANIC CHEMISTRY

(Theory: 60 Lectures)

Unit No.	Topics	Total Lectures
Unit I	**Chemical Energetic:** Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermo-chemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Introduction to nanoscale thermodynamics. **Chemical Equilibrium:** Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^{o} , Le Chatelier's principle. Relation ships between Kp, Kc and Kx for reactions involving ideal gases.	**18**
Unit II	**Ionic Equilibria:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applicationsof solubility product principle.	**12**
Unit III	**Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.** ***Aromatic hydrocarbons:*** Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzenesulphonic acid. Reactions: (Case benzene): Electrophilic substitution: nitration,	**16**

	halogenation andsulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene).Side chain oxidation of alkyl benzenes. ***Alkyl and Aryl Halides*** ***Alkyl Halides*** (Upto 5 Carbons) Types of Nucleophilic Substitution (SN^1, SN^2 and SN^i) reactions. *Preparation*: from alkenes and alcohols. *Reactions*. hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ethersynthesis: Elimination vs substitution. ***Aryl Halides*** *Preparation*: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. *Reactions* (Chlorobenzene): Aromatic nucleophilic substitution (replacement by —OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2 H_3 (or $NaNH_2$, H_3). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.	
Unit IV	**<u>Alcohols, Phenols and Ethers (Upto 5 Carbons)</u>** ***Alcohols:*** *Preparation*: Preparation of 1°, 2°and 3°alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. *Reactions*: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO4, acidic dichromate, conc. HNO3). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement. ***Phenols:*** (Phenol case) *Preparation*: Cumene hydroperoxide method, from diazonium salts.Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction, Gattermann-Koch Reaction, Schotten – Baumann Reaction. ***Ethers (aliphatic and aromatic)***: Cleavage of ethers with HI. Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde) *Preparation*: from acid chlorides and from nitriles. Reactions — Reaction with HCN, ROH, $NaHSO_3$. NH_2-G	**18**

	derivatives. Iodoform test. AldolCondensation, Cannizzaro's reaction, Wittigreaction, Benzoin condensation. Clemensenreduction and Wolff Kishner reduction.Meerwein-Pondorff Verley reduction. Introduction to functionalization of nanomaterial.+	

Reference Books:

1. Graham Solomon, T W., Fryhle, C.B. & Dnyder, S.A.Organic Chemistry,JohnWiley & Sons (2014).
2. McMurry, J.E. Fundamentals of Organic Chemistry, 7thEd. Cengage Learning India Edition, 2013.
3. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, NewDelhi (1988).
4. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
6. Bahl, A. & Bahl, B. S. Advanced Organic Chemistry, S. Chand, 2010.
7. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
8. Castellan, G.W. Physical Chemistry 4thEd. Narosa (2004).
9. Kotz, J.C., Treichel, P.M. & Townsend, J. R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
10. Mahan, B. H. University Chemistry 3'dEd. Narosa (1998).
11. Petrucci, R. H. General Chemistry 5thEd. Macmillan Publishing Co.: New York (1985).
12. Introduction to Nanoscience and Nanotechnology, Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore, CRC Press.

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- II,

Laboratory Course – II

(CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY)

(Practical: 60 Lectures)

Section A: Physical Chemistry

Thermochemistry

1. Determination of equivalent weight of Mg by Eudiometer.
2. Study of specific reaction rate of hydrolysis of methyl acetate in presence of HCl.
3. Determination of heat of ionization of weak acid by using polythene bottle.
4. Determination of heat capacity of calorimeter for different volumes.
5. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
6. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
7. Determination of enthalpy of hydration of copper sulphate.
8. Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

b) Preparation of buffer solutions:

(i) Sodium acetate-acetic acid.

(ii) Ammonium chloride-ammonium hydroxide.

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed.

Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

(a) Bromination of Phenol/Aniline

(b) Benzoylation of amines/phenols

(c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

Reference Books

1. 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.

2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

4. Practical book of Physical Chemistry: Nadkarni, Kothari & Lawande.

5. Experimental Physical Chemistry: A. Findlay.

6. Systematic Experimental Physical Chemistry: S. W. Rajbhoj, Chondhekar. (Anjali Publication.)

7. Experiments in Physical Chemistry: R. C. Das and B. Behra. (Tata Mc Graw Hill)

8) Advanced Practical Physical Chemistry: J. B. Yadav (Goel Publishing House.)

9) Practical Physical Chemistry: B. D. Khosala. (R. Chand & Sons)

7) Experiments in Chemistry: D. V. Jahagirdar.

10) A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis: A.I. Vogel (Third Ed.) (ELBS)

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- II,

Title of the Paper: - CHEMICAL FOUNDATION OF LIFE SCIENCES

(Theory: 60 Lectures)

Unit No.	Topics	Total Lectures
Unit I	**UNIT I: UNDERSTANDING OF THE LIFE:** **The Chemical Foundation of Life** Prelude to The Chemical Foundation of Life, Atoms, Isotopes, Ions, and Molecules - The Building Blocks, Water Biomolecules (Compounds of Carbon with a Variety of Functional Groups), Small Molecules of Cells, Macromolecules of Cells, Organisms's Transform Energy and Matter from Their Surroundings Concept and characteristics of life, Elements of life systems	**15**
Unit II	**UNIT II: BIOMOLECULES OF LIFE-I**: **Carbohydrates:** Monosaccharides, Disaccharides, Polysaccharides, Classification. Introduction to: Structural Polysaccharides (Cellulose and Chitin), Storage Polysaccharides (Starch and Glycogen), Complex Polysaccharides (Glycosaminoglycans, Glycoproteins, Proteoglycans) **Proteins:** Overview of amino acids and protein, Peptide bond, Primary, Secondary, Tertiary and Quaternary Structures. Fibrous protein, globular proteins. Protein Stability, Protein folding and denaturation.	**15**
Unit III	**UNIT III: BIOMOLECULES OF LIFE-II**: **Lipids:** Lipid Classification, Fatty Acids, Triacylglycerols, Glycerophospholipids, Sphingolipids Cholesterol. Storage Lipids, Lipids as Signals, Cofactors, and Pigments. **Nucleic acids:** Deoxyribose nucleic acid (DNA) Ribonucleic acid (RNA) Components of Nucleic acids, Nucleotides, Purines and Pyrimidines, Structure and types of nucleic acids, Nucleic acids as a Nano-technological template	**15**

	Vitamins and Minerals: Importance and role of vitamins, Types of vitamins, water-soluble and fat soluble vitamins. Minerals, micro nutrients, macronutrients, roles and functions, disorders of mineral deficiency.	
Unit IV	**UNIT III: ENZYMES AND BIOPOLYMERS** **Enzymes: Introduction and Functions** Overview--proteins as catalysts, Catalytic activity of enzymes, mechanism of catalysis, coenzymes, Enzyme characteristics and properties, Enzyme nomenclature/classification **Biopolymers** Definition of biopolymers and types of biopolymers, Definition of bioplastics and types of bioplastics. Description of certain biopolymers like starch, cellulose, chitosan, gelatin, alginate, keratin, fatty acids, lipids, aliphatic polyesters (PLA, PHB).	**15**

SUGGESTED READING

1. David L. Nelson and Michael M. Cox. Lehninger Principles of Biochemistry 4th edition. W H Freeman & Co.
2. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
3. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition Lippincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- II,

Laboratory Course – III

(CHEMICAL FOUNDATION OF LIFE SCIENCES)

Practical: 60 Lectures

1. Preparation of buffers.
2. Separation of Amino acids by paper chromatography.
3. Qualitative tests for Carbohydrates, lipids and proteins.
4. Principles of Colorimetry:
    a. Verification of Beer's law, estimation of protein.
    b. To study relation between absorbance and % transmission..
5. Determination of total amino acid concentration by ninhydrin method.
6. Estimation of protein concentration by
    a. Biuret method
    b. Lowry method.
7. Estimation of reducing sugar concentration by DNSA method.
8. Estimation total sugar concentration by
    a. Phenol-H2SO4 method
    b. Anthrone method.

Suggested Reading

1. Practical Biochemistry: An Introductory Course by Fiona Frais.
2. Textbook of Practical Biochemistry by David Plummer.
3. Laboratory Mannual in Biochemistry by S. Jayaraman.

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- II,

Title of the Paper:- DIFFERENTIAL EQUATIONS

(Theory: 60 Lectures)

Unit No.	Topics	Total Lectures
Unit I	First order exact differential equations. Integrating factors, rules to find an integrating factor.First order higher degree equations solvable for x, y, p.	**15**
Unit II	**(A) Applications of differential equations:** Newton's law of Cooling, Kirchoff's law of electrical circuits, motion under gravity, simple harmonic motion. (B) **Numerical Solution of Ordinary Differential Equations of first order and first degree:** Introduction, (ii) Solution by Picard's method, (iii) Taylor's series method, (iv) Euler's method, (v) Modified Euler's method, (vi) Runge-Kutta second and fourth order Method	**15**
Unit III	Methods for solving higher-order differential equations, Solving a differential equation by reducing its order. Linear homogenous equations with constant coefficients, Linear non-homogenous equations.	**15**
Unit IV	The method of variation of parameters. The Cauchy-Euler equation, Simultaneous differential equations, Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations	**15**

Books Recommended:

1. Shepley L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, International Edition.
3. Introductory Methods of Numerical Analysis, S.S. Sastry, 3rd edition, Prentice Hall of India, 1999.

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- II,

Title of the Paper:- LINEAR AND DIGITAL INTEGRATED CIRCUITS

(Theory: 60 Lectures)

Course Learning Outcomes:

After going through the course, the student should be able to

- Recognize the DC and AC characteristics of operational amplifiers and design the linear and nonlinear applications-oriented circuits using Op-Amp.
- Represent and convert the numbers in powers of base. Reduce/simplify Boolean expressions using the knowledge of basic logic gates, Boolean algebra & techniques.
- Analyze and design the simple combinational and sequential logic circuits.
- Understand the construction and working principles of digital logic families.

Unit No.	Topics	Total Lectures
Unit I	**Operational Amplifier** (Black box approach): Difference amplifier, Block diagram of an Operational Amplifier, Characteristics of an Ideal and Practical Operational Amplifier (IC 741), Open and closed loop configuration, Frequency Response, CMRR and Slew Rate of Op-Amp. (7 Lectures) **Applications of Op-Amps:** Inverting Amplifier with concept of Virtual Ground, Non-inverting Amplifier, Voltage Follower, Summing and Difference Amplifier, Differentiator, Integrator, Comparator. (9 Lectures)	**16**
Unit II	**Number System and Codes:** Decimal, Binary, Octal and Hexadecimal number systems, base conversions. Representation of signed and unsigned numbers, BCD and ASCII codes. Binary and Hexadecimal arithmetic; addition, subtraction by 2's complement method. (9 Lectures)	**14**

	Logic Gates and Boolean algebra: Logic Gates- OR, AND, NOT, NOR, NAND, XOR and XNOR. Positive and Negative logic, Universality of NAND and NOR gates, Basic postulates and fundamental theorems of Boolean algebra, De Morgan's Theorems, tristate gate. (5 Lectures)	
Unit III	**Combinational Logic Analysis and Design:** Standard representation of logic functions (SOP and POS), Karnaugh map minimization techniques (up to 4 variables for SOP). (5 Lectures) **Arithmetic Circuits:** Binary Addition. Half and Full Adder. Half and Full Subtractor, 4-bit binary Adder/Subtractor. (4 Lectures) **Data processing circuits:** Multiplexers, De-multiplexers, Decoders, Encoders. (4 Lectures)	**13**
Unit IV	**Sequential Circuits**: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. Master-slave JK Flip-Flop. (10 **Lectures**) **Digital Logic Families:** Logic levels, propagation delay time, power dissipation, fan-out and fan-in, noise margin, logic families and their characteristics- DTL, TTL, CMOS and ECL. **(5 Lectures)**	**17**

Reference Books:

1. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
2. Operational Amplifiers and Linear ICs, David A. Bell, 3rd Edition, 2011, Oxford University Press.
3. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
4. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
5. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
6. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning.
7. Digital Fundamentals, Thomas L. Flyod, Pearson Education Asia (1994).
8. Modern Digital Electronics, R. P. Jain, Tata McGraw Hill
9. Schaum's Outline of Digital Principles, R. L. Tokheim, Tata McGraw- Hill (1994)

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- II,

Laboratory Course – IV

(DIFFERENTIAL EQUATIONS + LINEAR AND DIGITAL INTEGRATED CIRCUITS)

DIFFERENTIAL EQUATIONS

Practical: (30 Lectures)

1. Examples on Picards Mathod
2. Examples on Eulers Mathod
3. Examples on Eulers Modified Mathod
4. Examples on Taylors series method
5. Examples on Runge-Kutta Method
6. Applications of Differential equations: Orthogonal Trajectories
7. Examples on Newtons Law of cooling
8. Examples on Basic Electrical Circuits
9. Laplace Transform-I
10. Laplace Transform -II
11. Laplace Transform-III
12. Inverse Laplace Transform
13. Applications of Laplace Transform to solve Differential Equations

LINEAR AND DIGITAL INTEGRATED CIRCUITS

Practical: (30 Lectures)

Course Learning Outcomes:

After going through the course, the student should be able to

- Design and construct the circuits using Op-Amp for basic linear and non-linear applications.
- Design and test the different types of combinational and sequential logic circuits. Compose the application oriented digital circuits and test it.

ANY FIVE EXPERIMENTS SHOULD BE COMPLETED FROM THE FOLLOWING

1. Study of inverting amplifier and non-inverting amplifier using Op-amp (741,351) for dc voltage of given gain.

2. Study the application of Op-Amp. as an Adder.

3. Study the application of Op-Amp. as a Subtractor.

4. To investigate the use of an op-amp as an Integrator.

5. To investigate the use of an op-amp as a Differentiator

5. Study of Basic and Derived Logic Gates.

6. To design a combinational logic system using logic gate ICs for a specified Truth Table.

7. To construct and verify Half Adder and Full Adder using logic gates.

8. To construct and verify Half Subtractor and Full Subtractor using logic gates.

9. Study of 4-bit binary adder and subtractor using Full adder IC.

10. Study of Multiplexers and De-multiplexers.

11. To build and Study of Clocked RS, D-type and JK Flip-Flops.

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- II,

Title of the Paper:- Fundamentals of Mathematical Computing and Calculus - II

Theory: 30 Lectures

Unit No.	Topics	Total Lectures
Unit I	Introduction of Differential equations, The role of integration in solving differential equations, Notion of integration as an antiderivative, geometric interpretation of integration, Study of formulae of integration	**15**
Unit II	Properties of integration, integration by parts, Integration by substitution, Integration by partial fraction, Concept of definite integration, Solutions of differential equations by using variable separable method, Solutions of differential equations by using substitutions	**15**

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – I, Semester- II,

Title of the Paper:- Fundamental Understanding of Life Sciences -II

Theory: 30 Lectures

Unit	Topics	Lectures
I	**Immunology, Diseases and Disorders:** Overview of immune system, innate and adaptive immunity, cells and organs of immune system, Introduction to the concept of antigen, antigenicity, immunogenicity, Antibody. Human Health and Diseases, Correlation between diseases and health. .com	15
II	**Fundamental understanding of building blocks of life:** Proteins as building blocks of living structure, Amino acids and their types, Proteins and their structures (primary, secondary, tertiary and quaternary structures), Carbohydrates: Aldohexoses, aldoketoses, Monosaccharides, disaccharides, polysaccharides, starch, glycogen. Structural carbohydrates, Lipids and fatty acids, their types and function	15

Suggested reading resources:

- Verma P. S. and Agarwal V. K. 2018. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand Limited.
- 11^{th} and 12^{th} Standard Biology Textbooks
- Lehninger Principles of Biochemistry
- Biochemistry by Lubert Stryer

NATURE OF QUESTION PAPER

B. Sc. –M. Sc. Nanoscience and Technology (5 Years Integrated Course)

All Questions are compulsory

Time duration (3 hours) **Total Marks: 80**

Q. 1. Select the correct answers: MCQ **1 x 8 = 8**

i) ii)

iii) iv)

v) vi)

vii) viii)

Q. 2. Write short notes on: **2 x 4 = 8**

a) b)

c) d)

Q. 3. Answer any six of the following: **4 x 6 = 24**

a)

b)

c)

d)

e)

f)

g)

h)

Q.4. Answer any five of the following: **8 x 5 = 40**

a)
b)
c)
d)
e)
f)

NATURE OF QUESTION PAPER

B. Sc. –M. Sc. Nanoscience and Technology (5 Years Integrated Course)

All Questions are compulsory

Time duration (1.5 hours) **Total Marks: 40**

Q. 1. Select the correct answers: MCQ **1 x 4 = 4**

i)

ii)

iii)

iv)

Q. 2. Write short notes on: **2 x 2 = 4**

a) b)

Q. 3. Answer any two of the following: **4 x 2 = 8**

a)

b)

c)

Q.4. Answer any three of the following: **8 x 3 = 24**

a)
b)
c)
d)