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

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

Ref.No.SU/BOS/Science/ 274 **Date: 03/05/2025.**

To,

The Principal,
All Concerned Affiliated Colleges/Institutions
Shivaji University, Kolhapur

The Head/Co-ordinator/Director
All Concerned Department (Science)
Shivaji University, Kolhapur.

Subject: Regarding revised syllabi of degree programme under the Faculty of Science and Technology as per NEP-2020 (2.0).

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 revised syllabi, nature of question paper and equivalence of degree programme under the Faculty of Science and Technology as per NEP-2020 (2.0).

1.	B.C.A. Part II
2.	B.Sc.-M.Sc. Part III Nano Science and Technology
3.	B.A./B.A.B.Ed Part II Geography
4.	B.Sc.-M.Sc. Part II Artificial Intelligence & Machine Learning

This syllabus, nature of question and equivalence 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 (Online Syllabus)

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2025 & March/April 2026. These chances are available for repeater students, if any.

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

Thanking you,

Yours faithfully,

Dy Registrar
Dr. S. M. Kubal

Encl: As above

for Information and necessary action

Copy to:

1	Dean, Faculty of Science & Technology	6	Appointment Section A & B
2	Director, Board of Examinations and Evaluation	7	I.T.Cell /Computer Centre
3	Chairman, Respective Board of Studies	8	Eligibility Section
4	B.A.,OE-II & B.Sc.-M.Sc. Exam Section	9	Affiliation Section (T.1) (T.2)
5	Internal Quality Assurance Cell (IQAC Cell)	10	P.G. Seminar Section

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-III, (NEP 2.0)

Syllabus to be implemented from the academic year
2025-26
(July 2025) onwards

Implementation: The implementation gradually as mentioned below –

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

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 ()	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), Env. Studies]	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. in Nanoscience and Technology (5 Years Integrated), Part-II, SEM-V and SEM-VI

Sr. No.	Paper Code	Title of the Paper
		SEM V
1	NSTU0325MJL401E1	Classical Mechanics, Classical Electrodynamics and Quantum Mechanics
2	NSTU0325MJL402E1	Inorganic and Organic Chemistry
3	NSTU0325MJL403E1	Fundamentals of Enzymology and Nanoenzymology
4	NSTU0325MNL407E1	Physics and Chemistry at Nanoscale
5	NSTU0325MJL402E2	Active Inorganic, Organic Compounds and Industries
6	NSTU0325MJP401E1	**Laboratory Course – I** (Classical Mechanics, Classical Electrodynamics and Quantum Mechanics)
7	NSTU0325FPP402E1	**Laboratory Course – II** (Inorganic and Organic Chemistry)
8	NSTU0325MJP403E1	**Laboratory Course – III** (Fundamentals of Enzymology and Nanoenzymology)
9	NSTU0325MNP407E1	**Laboratory Course – IV** (Physics and Chemistry at Nanoscale)
		SEM VI
10	NSTU0325MJL401F1	Solid State Physics and Nuclear and Particle Physics
11	NSTU0325MJL402F1	Physical Chemistry
12	NSTU0325MJL403F1	Molecular biology and genetic engineering
13	NSTU0325MNL407F1	Physical and Chemical Properties of Nanomaterials
14	NSTU0325MJL402F2	Polymer Chemistry
15	NSTU0325MJP401F1	**Laboratory Course – I** (Solid State Physics and Nuclear and Particle Physics)
16	NSTU0325MJP402F1	**Laboratory Course – II** (Physical Chemistry)
17	NSTU0325MJP403F1	**Laboratory Course – III** (Molecular biology and genetic engineering)
18	NSTU0325MNP407F1	**Laboratory Course – IV** (Physical and Chemical Properties of Nanomaterials)

The following shall be the courses of the studies under the NEP-2020 pattern (NEP 2.0)

B. Sc. - M. Sc. in Nanoscience and Technology (5 years integrated) - Part-III, SEM-V and SEM-VI

NEP-2020 PATTERN (2025-26)

SEMESTER-V																			
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	Classical Mechanics, Classical Electrodynamics and Quantum Mechanics	4	4	4	1	4	2	80	28	3	20	7	1	100	35	50	18	4
2	Inorganic and Organic Chemistry	4	4	4	1	4	2	80	28	3	20	7	1	100	35	50	18	4
3	Fundamentals of Enzymology and Nanoenzymology	4	4	4	1	4	2	80	28	3	20	7	1	100	35	50	18	4
4	Physics and Chemistry at Nanoscale	4	4	4	1	4	2	80	28	3	20	7	1	100	35	50	18	4
5	Active Inorganic, Organic Compounds and Industries	4	4	4	-	-	-	80	28	3	20	7	1	100	35	-	-	-
	Total	**20**	**20**	**20**	**4**	**16**	**8**	**-**			**-**	**-**	**-**	**500**	**-**	**200**		**-**
	SEMESTER-V																		

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	Solid State Physics and Nuclear and Particle Physics	4	4	4	1	4	2	80	28	3	20	7	1	100	35	50	18	4
2	Physical Chemistry	4	4	4	1	4	2	80	28	3	20	7	1	100	35	50	18	4
3	Molecular biology and genetic engineering	4	4	4	1	4	2	80	28	3	20	7	1	100	35	50	18	4
4	Physical and Chemical Properties of Nanomaterials	4	4	4	1	4	2	80	28	3	20	7	1	100	35	50	18	4
5	Polymer Chemistry	4	4	4	-	-	-	80	28	3	20	7	1	100	35			
	Total	**20**	**20**	**20**	**4**	**16**	**8**	**-**			**-**	**-**	**-**	**500**	**-**	**200**		**-**
	Grand Total	**40**	**40**	**40**	**8**	**32**	**16**							**1000**		**400**	**-**	**-**

Note:- Practical examination will be conducted SEMESTER vise.

SHIVAJI UNIVERSITY, KOLHAPUR
School of Nanoscience and Biotechnology

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

Classical Mechanics, Classical Electrodynamics and Quantum Mechanics

(Theory: 60 Lectures) Marks -100 (80+20) (Credits: 04)

Course Learning Outcomes:

The student should be able to understand

- Lagrangian and the Hamiltonian formulations of classical mechanics and their applications in appropriate physical problems.
- The fundamental concepts of Charged Particles Dynamics.
- The interpretation of wave function of quantum particle and probabilistic nature of its location.
- Operators in Quantum Mechanics and their applications in appropriate physical problems

Unit No.	Topics	Total Lectures
Unit I	**Lagrangian Formulation** Constraints, Degrees of freedom, Generalized coordinates, Principle of virtual work, D'Alembert's principle, Lagrange's equation from D'Alembert's principle, Applications of Lagrange's equation to a particle in space, Atwood's machine and a bead sliding on uniformly rotating wire under force free condition.	
Unit II	**Techniques of Calculus of Variation** Hamilton's principle, Deduction of Hamilton's principle from D'Alembert's principle, Deduction of Lagrange's equation from Hamilton's principle, Applications - shortest distance between two points in a plane, Brachistochrone problem. **Charged Particles Dynamics**	**14**

	Poisson's and Laplace's equations and their physical significance, Laplace's equation in one dimension and its solutions, Motion of charged particle - in uniform electric field E, magnetic field B, Crossed uniform electric field E and magnetic field B.	
Unit III	**Matter Wave** Wave particle duality, De-Broglie hypothesis of matter waves, Derivation of wavelength of matter wave, Concept of wave packet, Relation between group velocity - phase velocity and group velocity-particle velocity, Davisson and Germer experiment, Uncertainty principle (statements only): position–momentum and energy- time, Application of uncertainty principle-non existence of free electrons in the nucleus **Schrodinger's Wave Equation** Wave function and its physical interpretation, Condition of physically acceptable wave function, Normalized and orthogonal wave function, Schrödinger time dependent and time independent (steady state) wave equations in 1D and 3D, Probability current density(continuity equation), Eigen values and Eigen functions, Expectation values of dynamic variables.	**18**
Unit IV	**Operators in Quantum Mechanics** Definition of an operator, Position operator (x), Linear momentum operator (p), Commutation relation in quantum mechanics, Commutation relation between x and p, Kinetic energy operator (T), Hamiltonian operator (H), Parity operator (π), Angular momentum operator (L) – components of angular momentum operator in Cartesian coordinate system, Ladder operators, Eigen values of Lz and L2 (use equations for L2 and Lz in spherical polar coordinates). **Applications of Schrodinger Equation** Particle in a rigid box (infinite potential well) in one dimension and three dimensions, Step potential- reflection and transmission coefficients, Potential barrier- tunneling effect (qualitative treatment), One dimensional simple harmonic oscillator (operator method)-energy levels, zero point energy, Schrodinger equation for Hydrogen	**18**

	atom in spherical polar coordinates, Separation of radial and angular parts, Solution of radial part of Schrodinger's equation - Energy Eigen values.	

Reference Books:

1. Classical Mechanics, Goldstein Herbert, Narosa Publi. / Pearson Edu. 2018
2. Classical Mechanics, Gupta, Kumar and Sharma, Pragati Praka.2012
3. Introduction to Classical Mechanics, Nikhil Ranjan Roy, S Chand Publ. 2016
4. Introduction to Classical Mechanics, Takwale R.G., Puranik P. S., Tata McGraw 1979
5. Classical Mechanics, Panat P. V., Narosa Publi. 2016
6. Atomic physics, J B Rajam S Chand
7. Concepts of Modern Physics, Arthur Beiser, McGraw Hill
8. Classical Electrodynamics, Puri S.P., Tata McGraw/Alpha Science 2011
9. Classical Electrodynamics, Jackson J. D., Wiley India , 2007
10. Electromagnetics, Laud B. B., New Age Interna. 2011
11. Modern Physics, R. Murugeshan, 1997, S. Chand and Company Ltd.
12. Atomic Physics, J B Rajam, S Chand and Co.
13. Perspectives of Modern Physics, Arthur Beiser, McGraw Hill International Editions.
14. Concepts of Modern Physics, Arthur Beiser, Ahobhit Mahajan, S. Rai Choudhury, Sixth Edition, Tata McGraw Hill Education Private Ltd.
15. Modern Physics, S. L. Kakani and Shubhra Kulkarni, 2006, Viva books Private Ltd.
16. Modern Physics, D. L. Sehgal, K. L. Chopra and N. K. Sehgal, Reprint 1995, Sultan Chand & sons. 17. Introduction to Modern Physics, F. K. Richtmyer, E. H. Kennard, John N. Cooper, Sixth Edition, Tata McGraw Hill Education Private Ltd
18. A Text book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, 2nd Edn.,2010, Tata McGraw Hill,
19. Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
20. Quantum Mechanics Theory and Applications, A. K. Ghatak and S. Lokanathan, Third Edn.1995, Macmillan India Ltd.
21. Quantum Mechanics Theory and applications, Ajoy Ghatak, S. Lokanathan, 5th Ed,2017, Trinity. 22. Quantum Mechanics, Chatwal and Anand, Reprint 2010, Himalaya Publishing house.
23. Quantum Mechanics, Gupta, Kumar, Sharma, Thirtieth Edn., 2011, Jai Prakash Nath Publications. 24. Advanced Quantum Mechanics, SatyaPrakash, Reprint 2011, KedarNath Ram Nath Meerut.
25. Advanced Quantum Mechanics, B. S. Rajput, Ninth Edn., 2009, Pragati Prakashan.
26. Quantum Mechanics, B. N. Srivastava, Reprint 2011, Pragati Prakashan.
27. Quantum Mechanics, P. J. E. Peebles, 2003, Prentice Hall of India.
28. Quantum Mechanics, S. P. Singh,M. K. Bagade, Kamal Singh, S. Chand & company Ltd, New Delhi

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

Laboratory Course I
(Classical Mechanics, Classical Electrodynamics and Quantum Mechanics)
(Practical: 60 Lectures) 50 (Credits: 02)

1. Resonance pendulum
2. Y by Koenig's method
3. Cardinal points by Newton's method
4. Diffraction at a Single Slit
5. Diffraction at cylindrical obstacle
6. Spherical aberration
7. Schuster's method and optical leveling of spectrometer
8. Absorption spectrum of a liquid (KMnO4 solution)
9. C program to arrange the given set of numbers in ascending/descending order Or C program to find largest/smallest number from a given set of numbers
10. Scilab Expt. 1 (problem from Quantum Mechanics)
11. Determination of Plank's constant by using LED

Note: (Any 8 experiments from the above list)

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

Inorganic and Organic Chemistry

(Theories of Acids, Bases, Chemistry of f-Block Elements, Metal Bondings in Transition Metal Complex and Co-ordination Chemistry, Organic Reagents, and Reactions)
Theory: 60 Lectures and Marks -100 (80+20) (Credits: 04)

Course Learning Outcomes:

CO1: Understanding of the concepts of acids, bases and different solvents and chemistry of f- Block Elements

CO2: Increased knowledge about metal-ligand bonding in transition metal complexes and co-ordination chemistry

CO3: Conceptual knowledge about reagents and reactions in organic synthesis reactions

CO4: Conceptual knowledge about electrophilic addition reactions to C-C multiple bonds and their practical significance

Unit No.	Topics	Total Lectures
Unit I	**Acids, Bases and Non aqueous Solvents and Chemistry of f- Block Elements** **Acids, Bases and Non aqueous Solvents [10]** Introduction to theories of Acids and Bases-Arrhenius concept, Bronsted-Lowry concept, Lewis Concept, Lux-Flood Concept (definition and examples), Hard and Soft Acids and Bases. (HSAB Concept), Classification of acids and bases as hard, soft and borderline. Pearson's HSAB concept. Acid–Base strength and hardness-softness. Applications and limitations of HSAB principle. Acid base theory's link to nanomaterial synthesis. Chemistry of non-aqueous solvents. Introduction, definition and characteristics of solvents. Classification of solvents. Physical properties and Acid-Base reactions in Liquid Ammonia (NH_3) and Liquid Sulphur Dioxide (SO_2). Use of solvents for common nanomaterials synthesis. **Lanthanides & Actinides [5]** **Lanthanides**	**15**

	Importance and position in periodic table. Rare earth element based nanomaterials and their applications in various fields. **Actinides** Position in periodic table. Electronic configuration. General methods of preparation of transuranic elements. Neutron capture – followed by β decay. Accelerated projectile bombardment. Heavy ion bombardment. IUPAC nomenclature of the super heavy elements with atomic number (Z) greater than 100.	
Unit II	**Metal Ligand bonding in Transition Metal Complexes and Co-ordination Chemistry** **Crystal field theory (CFT) & Molecular orbital theory (MOT). [10]** CFT introduction: Shapes of d-orbitals, Basic assumptions of CFT. Crystal field splitting of d-orbitals of metal ion in octahedral, tetrahedral, square planar complexes and John-Teller distortion. Factors affecting the Crystal field splitting. High spin and low spin octahedral complexes w.r.t. Co (II). Crystal Field stabilization energy (CFSE), Calculation with respect to octahedral complexes only. Limitations of CFT. MOT introduction, MOT of octahedral complexes with sigma bonding such as $[Ti(H_2O)_6]^{3+}$,$[CoF_6]^{3-}$, $[Co(NH_3)_6]^{3+}$.Merits and demerits of MOT. **Coordination Chemistry: Inorganic Reaction mechanism [5]** Introduction, Classification of Mechanism: Association, dissociation, interchange and the rate determining steps. S_N1 and S_N2 reactions for inert and labile complexes. Mechanism of substitution in cobalt (III) octahedral complexes. Trans effect and its theories. Applications of trans effect in synthesis of Pt (II) complexes.	**15**
Unit III	**Reagents and Reactions in Organic Synthesis and Retrosynthesis** **Reagents [5]** Preparation and Applications of following reagents**.** Lithium aluminium hydride $LiAlH_4$ and Sodium borohydride ($NaBH_4$). Raney Nickel. Osmium tetraoxide. Selenium dioxide (SeO_2). Dicyclohexyl Carbodiimide (DCC). Diazomethane. Introduction to nanoparticle catalyzed organic synthesis reactions. **Reactions [5]**	**15**

	Statement, General Reaction, Mechanism and Synthetic applications: Diels - Alder reaction. Meerwein –Pondorff-Verley reduction.Hofmann rearrangement. Wittig reaction. Wagner- Meerwein rearrangement. Baeyer Villiger oxidation. Problem based on above reactions. **Retrosynthesis [5]** Introduction. Recapitulation of basics of reaction mechanism and reagents. Terms used- Target molecule (TM), Disconnection, Synthons, Synthetic equivalence, Functional group interconversion (FGI), one group disconnection (w. r. t. suitable examples). Retrosynthetic analysis and synthesis of target molecules: Cinnamaldehyde, Cyclohexene, para methoxy acetophenone, Paracetamol.	
Unit IV	**Electrophilic addition to >C=C< and −C≡C− bonds** **Addition to Carbon-Carbon double (>C=C<) bond [6]** Introduction. Examples of addition reactions. Mechanism of electrophilic addition to >C=C< bond, orientation & reactivity, Hydrohalogenation. Anti-Markovnikoff's addition (peroxide effect). Rearrangements (support for formation of carbocation). Addition of halogens. Addition of water. Addition of hypohalous acids (HO-X). Hydroxylation (formation of 1,2-diols). Hydroboration-oxidation (formation of alcohol). Hydrogenation (formation of alkane). Ozonolysis (formation of aldehydes & ketones). **Addition to Carbon-Carbon triple (−C≡C−) bond [5]** Introduction. Examples of addition reactions. Mechanism of electrophilic addition to −C≡C− bond. Addition of halogens. Addition of halogen acids. Addition of hydrogen. Addition of water. Formation of metal acetylides. **Named Reactions [4]** Diels -Alder reaction. Meerwein –Pondorff-Verley reduction. Hofmann rearrangement. Wittig reaction. Wagner- Meerwein rearrangement. Baeyer Villiger oxidation.	**15**

References:

1. Concise Inorganic Chemistry (ELBS, 5th Edition) – J. D. Lee.
2. Inorganic Chemistry (ELBS, 3rd Edition) D. F. Shriver, P. W. Atkins, C. H.Lang Ford, Oxford University Press, 2nd Edition.

3. Basic Inorganic Chemistry: Cotton and Wilkinson.
4. Advanced Inorganic Chemistry (4^{th} Edn.) Cotton and Wilkinson.
5. Concepts and Models of Inorganic Chemistry: Douglas and Mc. Daniel. 3^{rd} Edition. John Wiley publication.
6. Structural principles in inorganic compounds. W. E. Addison.
7. Theoretical principles of Inorganic Chemistry – G. S. Manku.
8. Theoretical Inorganic Chemistry by Day and Selbine.
9. Co-ordination compounds. SFA Kettle.
10. Essentials of Nuclear Chemistry by H. J. Arnikar.
11. Nuclear Chemistry by M. N. Sastri.
12. Organometallic Chemistry by R. C. Mahrotra, A. Sing, Wiley Eastern Ltd.New Delhi.
13. Inorganic Chemistry by A. G. Sharpe, Addision – Wisley Longman – Inc.
14. Principles of Inorganic Chemistry by Puri, Sharma and Kalia, Vallabh Publication. Pitampur Delhi.
15. Text book of Inorganic Chemistry by K. N. Upadhyaya Vikas Publishing House –New Delhi.
16. Inorganic Chemistry 3rd Edn G. L. Miessler and D.A. Tarr, pearson publication.
17. Co-ordination compounds by Baselo and Pearson.
18. UGC Inorganic chemistry by H.C. Khera, Pragati Prakashan
19. UGC Advanced Inorganic Chemistry by Agarwal and Keemtilal, Pragati Prakashan
20. Advanced Organic Chemistry : Reactions, Mechanisms and structure by – Jerry March.
21. Reagents for Organic Synthesis by Louis F. Fieser , Mary Fieser -1967.
22. A Text book of Practical Organic Chemistry including Qualitative Organic Analysis by A. I.Vogel.
23. Mechanism and Structure in Organic Chemistry. April,1963 By Edwin S.Gould.
24. A text book of Organic Chemistry by Arun Bahl, B.S.Bhal Eighteenth Revised edition 2006.
25. A guidebook to mechanism in Organic Chemistry sixth Edition by Peter Syke.
26. Organic Synthesis: The Disconnection Approach by Stuart Warren.
27. Organic Synthesis Through Disconnection Approach by P. S. Kalsi
28. Fundamentals of Organic Synthesis the Retrosynthetic Analysis by Ratan Kumar Kar
29. Organic Reactions and Their Mechanisms P. S. Kalsi 3rd Revised edition.
30. Advanced organic Chemistry by B.S. Bahl & Arun Bhal (Reprint in 1997)
31. Organic Chemistry by Morrison and Boyd 6thedition.
32. Organic Chemistry Vol II Stereochemistry and the Chemistry of Natural Products (5th ed) by I. L.Finar.
33. Organic Chemistry Natural Products Vol I, by O. P. Agrawal

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

Laboratory Course II
(INORGANI CHEMISTRY)
(Practical: 60 Lectures) 50 (Credits: 02)

I) Gravimetric Estimations (G).

N. B. Any **two** experiments from G1 to G3 and any **one** experiment from G4 & G6.

G1. Gravimetric estimation of iron as ferric oxide (Fe_2O_3) from the given solution containing ferrous ammonium sulphate, copper sulphate and free sulphuric acid.

G2. Gravimetric estimation of zinc as zinc pyrophosphate from the given solution containing zinc sulphate, ferrous ammonium sulphate and free sulphuric acid.

G3. Gravimetric estimation of barium as barium sulphate ($BaSO_4$) from the given solution containing barium chloride, ferric chloride and free hydrochloric acid.

G4. Gravimetric estimation of barium as barium chromate ($BaCrO_4$) from the given solution containing barium chloride, ferric chloride and free hydrochloric acid.

G5. Gravimetric estimation of nickel as bis (dimethylglyoximato) nickel (II) fromthe given solution containing nickel sulphate, ferrous ammonium sulphateand free Sulphuric acid.

G6. Gravimetric estimation of aluminium as aluminium oxinate potassium tris (8-hydroxy quinolato) aluminium (III) from the given solution containing potash alum, copper sulphate and free sulphuric acid.

[For the gravimetric experiments, stock solution should be given in the range of10 to 15 cm^3 and asked to dilute to 100 cm^3 (or the stock solution should be givenin the range of 20 to 30 cm^3 and asked to dilute to 250 cm^3). Use 50 cm^3 of this diluted solution for estimation.]

II. Inorganic Preparations (P).

N. B. At least **two** preparations from the following with **percentage yield**: **P1.** Preparation of potassium trioxalato aluminate (III).

P2. Preparation of Tetra ammine copper (II) chloride. **P3.** Preparation of tris(thiourea) copper (I) sulphate.

P4. Preparation of potassium trioxalato ferrate (III).

P5. Preparation of chloropenta-ammine cobalt (III) chloride.

P6. Preparation of ammonium diamminetetrathiocynatochromate (III) (Reineck's salt).

P7. Preparation of Potassium hexa nitro coblatate (III). **P8**. Preparation of ammonium trioxalato chromate (III). **P9**. Preparation of hexathiourea plumbus (II) nitrate.

A) Percentage Purity N. B.: Any one from the following.

V1. Determination of percentage purity of ferrous ammonium sulpahte.

V2. Determination of percentage purity of tetrammine copper (II) sulphate.

V3. Determination of percentage purity of potassium (trioxalato-aluminate) (III).

B) Analysis of Commercial Sample.

N. B. Any **one** from the following:

V5. Determination of percentage of Calcium in the given sample of milk powder or lime.

V6. Determination of amount of aluminum in the given solution of potash alum.

V7. Determination of titrable acidity in the given sample of milk or lassi.

V8. Determination of percentage purity of boric acid using supplied sodiumhydroxide. (Standard succinic or oxalic acid solution to be prepared to standardise thegiven sodium hydroxide solution.)

V9. To determine the amount of HCl in given of commercial samples.

C) Ion exchange method.

N. B. Any **one** from the following.

V10. Determination of amount of sodium present in the given solution of commonsalt using cation exchange resin (By Acid Base titration).

V11. Determination of amount of magnesium in the given solution containing (Mg^{2+} and Zn^{2+}) using anion exchange resin and standard solution of EDTA.

V12. Determination of amount of zinc in the given solution containing (Mg^{2+} andZn^{2+}) using anion exchange resin and standard solution of EDTA.

Reference Books:

1. A text book of quantitative Inorganic Analysis - A. I. Vogel.
2. Text book of Quantitative Inorganic Analysis - Kolthoff and Sandell.
3. Experimental Inorganic Chemistry - Palmer W. G.
4. Advanced Practical Inorganic Chemistry - Adams and Raynor.
5. Manual in Dairy Chemistry - I.C.A.R. Sub-Committee on Diary Education.
6. Chemical methods for environmental analysis - R. Ramesh and M. Anbu.

B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – III, Semester- V,
Fundamentals of Enzymology and Nanoenzymology
(Theory: 60 Lectures) Marks -100 (80+20) (Credits: 04)

Course Learning Outcomes:

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

- Understand the fundamentals concepts of biological catalysis, enzymes, their types mechanisms
- Learn the techniques of purification of protein/ enzymes and chromatography, Understand the concept of nanomaterials as enzymes, their types, mechanisms and applications

Unit No.	Topics	Total Lectures
Unit I	**UNIT I** **Introduction:** Definition, Basic terminologies, Classification, History of biological catalysis, and Physico-chemical properties of enzymes, IUB system. Concepts of **the** active site, binding site, enzyme-substrate complex, models of enzyme substrate binding, activation energy, Transition State Theory, cofactor, coenzymes.	**15**
Unit II	**UNIT II** Catalysis as remarkable property of enzyme, specificity as remarkable property of enzyme, Regulation as remarkable property of enzyme. Enzyme nomenclature and classification, trival names, enzyme commission numbers, **Enzyme Kinetics: Introduction:** Michaelis - Menten Equation-form and derivation, steady state enzyme kinetics, Significance of V_{max} and K_m **Enzyme activity**: Specific activity, turnover number **Enzyme inhibition**: types of inhibitors-competitive, non-competitive and uncompetitive, feedback inhibition.	**15**
Unit III	**UNIT III** **Biochemical Techniques** **Introduction**: Sub-cellular fractionation, Methods of lysis for plants, animals and microbial cells	**15**

	Centrifugation: Basic principle, Types and Importance **Electrophoresis:** SDS and Native PAGE, Staining techniques **Chromatographic Techniques**: Ion exchange, Gel filtration chromatography, Partition chromatography, Affinity chromatography, Paper chromatography, Thin Layer Chromatography.	
Unit IV	**UNIT IV** **Concept of nanoenzymes:** Nanozymes in bionanotechnology, Natural enzymes, artificial enzymes, nanoenzymes, Various nanomaterial based nanoenzymes, Applications of nanoenzymes for sensing and imaging, nucleic acid sensing, as aptasensors, for immunoassay, for detection of cells and bacteria, for imaging, Nanozymes for therapeutics	**15**

References:

1. Lehninger's Principles of Biochemistry by D.L. Nelson and M.M. Cox, CBS Publications, 2000
2. Biochemistry by Lubert Stryer, 4th Edition
3. Biochemistry by David Rawn
4. Garrett and Grisham - Biochemistry 2nd Edition
5. Biochemistry by J. L. Jain
6. Biochemistry by Roger Harper
7. Principles of protein structure by Shulz and Schirmer
8. Fundamentals of Enzymology by Royer
9. Fundamentals of Enzymology Price and Stevens
10. Enzymes Dixon and Webb
11. Immobilized Biocatalysts W. Hartneir
12. Computational Biochemistry, By: C. Stan Tsai, A John Wiley & Sons, Inc., publication
13. Xiaoyu Wang, Yihui Hu and Hui Wei, ***Inorg. Chem. Front.***, 2016,**3**, 41-60
14. Zhang, R., Fan, K. & Yan, X. Nanozymes: created by learning from nature. *Sci. China Life Sci.* (2020). https://doi.org/10.1007/s11427-019-1570-7
15. Wang, X., Guo, W., Hu, Y., Wu, J., & Wei, H. (2016). *Nanozymes: Next Wave of Artificial Enzymes. SpringerBriefs in Molecular Science.* doi:10.1007/978-3-662-53068-9

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

Laboratory-course III
(Fundamentals of Enzymology and Nanoenzymology)
(Practical: 60 Lectures) 50 (Credits: 02)

No	Practical
1	Qualitative estimation of starch by iodine and Benedict test
2	Identification and quantification of activity of α amylase/ β amylase/cellulase/amyloglucosidase/invertase/alkaline phosphatase salivary/microbial/animal/plant source].
3	Determination of specific activity
4	Determination of activity in presence of activators.
5	Determination of activity in presence of inhibitors
6	Determination of optimum pH
7	Determination of K_m and V_{max} Determination of Competitive, non-competitive inhibitors
8	Demonstration of enzyme like activity (peroxidase/catalase/oxidase) of metal nanoparticles

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

Phy & Chem. at Nanoscale: Physics and Chemistry at Nanoscale

(Theory: 60 Lectures) Marks -100 (80+20) (Credits: 04)

Unit No.	Topics	Total Lectures
Unit I	**Introduction to Nanoscience** Introduction to Nanoscale, Nanomaterials, Nanoscienceand Nanotechnology. Nanoscience effects: Quantum size effects, Quantum confinement effect, Bhorexciton radius, surface area to volume ratio etc.The development of nanoscale science: scaling up approach, scaling down approach, Generations of nanotechnology/ Nanotechnology Timeline: Pre-18thCentury, 19thCentury, 20thCentury, 21stCentury. Classification of nanomaterials:0D,1D,2D and 3D and types of nanomaterials (QDs, QW, CNT's, Bucky Balls, etc.) Nanocomposites:Types of nanocomposites and applications.Nano and Nature: Lycurgus Cup, stained glass windows, Damascus saber blades, Nanoscopiccolours (Butterfly wings), Bioluminescence (fireflies), Tribology, Nano tribology (Gecko's Sticky Feet, Nasturtium Leaf-Lotus effect etc.) in nature.Brief applications of nanomaterials / Consumer products: Television, Energy, Automobile, Textile, Space, Defense and Engineering etc	**15**
Unit II	**Making of nanostructures: Top down** Overview of top down nanofabrication processes. Mechanical methods: Mechanical grinding (ball milling), Lithographic methods: Types of lithography techniques i.e. photolithography, electron beam lithography, X-ray lithography, Nano-imprint lithography. Thin film technologies: Thermal methods: Thermal evaporation, e-beam evaporation. Plasma methods: DC and RF Magnetron Sputtering, High-energy methods: Pulsed Laser Deposition etc. Advantages and disadvantages of Top down approaches.	**15**
Unit III	**Making of nanostructures: Bottom up**	**18**

	Overview of bottom up nanofabrication processes.Growth mechanism: nucleation and growth of nanomaterials: Ostwald Ripening, sintering. **Vapor – phase synthesis:** Chemical vapor deposition (CVD): Types of CVD process, Atomic Layer Deposition, Molecular beam epitaxy (MBE), Inert gas condensation, Spray Pyrolysis, Flame pyrolysis. **Liquid-phase synthesis:** Colloidal methods: Metal and semiconducting nanoparticles, Solution precipitation, Electrodeposition, Sol-gel technique: Introduction. Sol-gel process: synthesis of Aerogel, Xerogel, sol-gel coating processes.Hydrothermal synthesis, Dip coating, spin coating, flow coating etc.Template synthesis of nano pattering.Advantages and Disadvantages of Top down approaches.	
Unit IV	**Visualization and manipulation tools** Microscopy: Basics, Working principle and applications. Optical microscopy, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM). Difference between SEM and TEM.Scanning Probe Microscope (SPM) techniques: Scanning Tunneling Microscopy (STM) and Atomic force microscopy. Optical Tweezers: Basics, Working principles and applications.	**12**

Reference Books:

1. Introduction to Nanoscience and Nanotechnology, G. Hornyak, H. Tibbals, J. data, J. Moore.

2. Nanotechnology: Principles and Practices by S. K. kulkarani

3. Nanotechnology: Technology Revolution of 21st Century by Rakesh Rathi, published by S.Chand.

4. Introduction to Nanoscience, by Stuart Lindsay.

5. Introduction to Nanomaterials and nanotechnology by Vladimir Pokropivny, RynnLohmus, Irina Hussainova, Alex Pokropivny and Sergey Vlassov

6. Nanomaterials by A.K. Bandyopadhyay; New Age International Publishers.

7. Nanotechnology by Mark Ratner and Daniel Ratner, Pearson Education.

8. Nano Essentials- T.Pradeep/TMH

9. Bharat Bhusan, “Springer Handbook of Nanotechnology”, springer, Newyork, 2007 10. Hari Singh Nalwa, “Encyclopedia of Nanotechnology”, USA 2011.

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

Laboratory-course IV
(Physics and Chemistry at Nanoscale)
(Practical: 60 Lectures) 50 (Credits: 02)

1. Synthesis of TiO_2 nanotubes by electrochemical anodization
2. Synthesis of silver nanoparticles by chemical method
3. Synthesis of TiO_2 nanoparticles by using ball-milling method
4. Synthesis of Fe_2O_3 by sol-gel method
5. Synthesis of ZnO nanorods by hydrothermal method
6. Synthesis of carbon quantum dots by chemical method
7. Synthesis of Graphene oxide by modified Hummers method
8. Synthesis of Polyaniline nanofibers by CBD method
9. Synthesis of nanofibers by electrospinning method
10. Electrodeposition of Cu
11. Determination of average particle size by frequency distribution curve
12. Surface area to volume ratio of nanosphere and nanowires using TEM image.
13. Transparent conducting oxides by spray pyrolysis method
14. Graphene by CVD
15. Preparation of superhydrophobicnanocoatings by spin coating method
16. Environmental Sampling methods and analytical preparations
17. Air pollution monitoring and analysis
18. Determination of total alkalinity and acidity of a water sample.
19. Chemical Oxygen Demand, Dissolved Oxygen and Biological Oxygen Demand
20. Total Hardness, Sulphates, Nitrates and Chlorides
21. Physical Properties of Minerals, ore and Rocks
22. Optical properties of Minerals and Study of crystal systems
23. Photogrammetry, Interpretation of Aerial Photographs / Digital Image Processing
24. Data capturing through GPS and Study of GIS softwares

Note : Any 10 experiment

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

Active Inorganic, Organic Compounds and Industries
Theory: 60 Lectures and Marks -100 (80+20) (Credits: 04)

Course Learning Outcomes:

CO 1: Understanding and uses of natural products & synthetic pharmaceuticals

CO 2: Knowledge about Iron and Steel industry

CO 3: Knowledge about Sugar industry and related useful byproducts

CO 4: Understanding of significance of industries in production of heavy chemicals

Unit No.	Topics	Total Lectures
Unit I	**. Bio-inorganic Chemistry, Natural Products and Pharmaceuticals [25]** **Bio-inorganic Chemistry [7]** Introduction. Essential and trace elements in biological process.Metalloporphyrins with special reference to hemoglobin and myoglobin.Biological role of alkali and alkaline earth metal ions with special referenc to Na^+ , K^+ and Ca^{2+} **Natural Products [10]** **Terpenoids:** Introduction, Occurrence, Isolation, General Characteristic, Classification. General Methods for structure determinations. Isoprene rule. Analytical evidences and synthesis of Citral. **Alkaloids:** Introduction, Occurrence, Isolation, Classification, Properties.General Methods for structure determination. Analytical evidences and synthesis of Nicotine. **Pharmaceuticals [8]** Introduction. Classification. Qualities of ideal drug. Synthesis and uses of ethambutal, phenobarbitone, isoniazide, benzocaine, Chloramphenicol, paludrine. Drug action of sulpha drugs.	**25**

Unit II	**Iron and Steel [10]** Occurrence and ores of iron. Definition of the Terms- Ore, Mineral, Slag, Flux, Gangue, Matrix, Calcinations, Reduction, Roasting, Smelting and Leaching. Extraction of iron by Blast furnace. Steel: Definition and types.Conversion of cast iron into steel by Bessemer process. L. D. process. Heat treatment on steel.	**10**
Unit III	**Sugar Industry [10]** Introduction. Manufacture of cane sugar in India: Extraction of juice, Clarification, Concentration, crystallization, centrifugation and other details of industrial process. Byproducts of sugar industry.Manufacture of Ethyl Alcohol from Molasses: by Fermentation.	**10**
Unit IV	**Manufacture of Industrial Heavy Chemicals [15]** Introduction. Manufacture of Ammonia (NH_3), Physico-chemical principles. Manufacture by Haber's process. Manufacture of Sulphuric acid (H2SO4). Physico-chemical principles. Manufacture by Contact process. Manufacture of Nitric acid (HNO_3). Physico-chemical principles. Manufacture by Ostwald's process (Ammonia oxidation process). Manufacture of Sodium carbonate(Na_2CO_3) (Washing soda). Physico-chemical principles. Manufacture by Solvay process.	**15**

References:

1. Industrial Chemistry- B. K. Sharma
2. Chemical process industries – Shrieve & Brink
3. Industrial chemistry – Kent
4. Industrial chemistry – Rogers
5. Industrial chemistry – R. K. Das
6. Mechanical chemistry – Burger
7. Nanotechnology: Principles and Practices – Sulbha Kulkarni
8. The Petroleum chemicals industry by R. F. Goldstine, e & Fn London
9. Fundamentals of petroleum chemical technology by P Below.
10. Petro Chemicals Volume 1 and 2 ; A Chauvel and Lefevrev ; Gulf Publishing company
11. Organic Chemistry Vol II Stereochemistry and the Chemistry of Natural Products (5^{th} ed) by I. L.Finar.
12. Organic Chemistry Natural Products Vol I, by O. P. Agrawal
13. Industrial Chemistry-B. K. Sharma, Goyal publishing house, Mirut

14. Shreeves chemical process industries 5th Edition, G.T. Oustin, McGraw Hill
15. Riegel`s hand book of Industrial chemistry, 9th Edition, Jems A. Kent
16. Industrial chemistry –R. K. Das, 2nd Edition, 1976.
17. Synthetic drugs by M. S. Yadav, Campus book international
18. Organometallic Chemistry by R. C. Mahrotra A. Sing, Wiley Eastern Ltd. New Delhi.
19. Inorganic Chemistry by A. G. Sharpe, Addision-Wisley Longman – Inc.
20. Principles of Inorganic Chemistry by Puri, Sharma and Kalia, Vallabh Publication. Pitampur Delhi.
21. Text book of Inorganic Chemistry by K. N. Upadhyaya Vikas Publishing House-New Delhi.
22. Inorganic Chemistry 3rd edn G. L. Miessler and D. A. Tarr, pearson publication

SHIVAJI UNIVERSITY, KOLHAPUR

School of Nanoscience and Biotechnology
B. Sc. –M.Sc. in Nanoscience and Technology,
(5 Years Integrated) Programme, Part – III, Semester- VI,

Solid State Physics and Nuclear and Particle Physics
(Theory: 60 Lectures) Marks -100 (80+20) (Credits: 04)

Course Learning Outcomes:

At the end of the course, the student is expected to learn and assimilate the following.

- A brief idea about crystalline and amorphous substances, about lattice, unit cell, miller indices, reciprocal lattice, concept of Brillouin zones and diffraction of X-rays by crystalline materials
- At knowledge of different types of magnetism from diamagnetism to ferromagnetism and hysteresis loops and energy loss.
- Secured an understanding about the dielectric and ferroelectric properties of materials.
- Understanding above the band theory of solids and must be able to differentiate insulators, conductors and semiconductors.
- Understand the basic idea about superconductors and their classifications.
- To carry out experiments based on the theory that they have learned to measure the magnetic susceptibility, dielectric constant, trace hysteresis loop. They will also employ to four probe methods to measure electrical conductivity and the hall set up to determine the hall coefficient of a semiconductor.
- Learn the ground state properties of a nucleus – General Properties of Nuclei and Nuclear Model

Unit No.	Topics	Total Lectures
Unit I	**1. Crystal Structure** Solids: amorphous, polycrystalline and crystalline materials; lattice, basis, unit cell- primitive, non-primitive unit cell, symmetry operations, symmetry elements of cube, Bravais lattice in two and three dimensions, Miller indices, Miller indices and inter-planer spacing, Simple crystal structures: SC, BCC, FCC and HCP (Co-ordination number, atomic radius, atoms per unit cell and packing fraction) **2. X-Ray Diffraction**	**18**

	Reciprocal lattice and its properties, Brillouin zone, Diffraction of Xrays by crystals, Ewald construction, Bragg's law in reciprocal lattice, Experimental methods in X-ray diffraction (Laue method, rotating crystal method, powder photograph method), Analysis of cubic crystal by powder method.	
Unit II	**1. Magnetic Properties of Matter** Classical Langevin theory of diamagnetic and paramagnetic materials, Quantum mechanical treatment of paramagnetism, Curie's law, Weiss theory of ferromagnetism and ferromagnetic domains, Explanation of B-H curve, Hysteresis and energy loss. **2. Superconductivity** Idea of superconductivity, Critical temperature, Critical magnetic field, Meissner effect, Type-I and Type-II superconductors, London equation and penetration depth, Isotope effect, Application (magnetic levitation)	**16**
Unit III	**Elementary Band Theory of Solids** Concept of density of states, Bloch theorem (statement only), Kroning– Penny model, Origin of energy gap, Velocity of electrons according to band theory, Effective mass of an electron, Distinction between metals, semiconductors and insulators, Hall Effect - Hall voltage and Hall Coefficient.	**8**
Unit IV	**1. General Properties of Nuclei and Nuclear Model** Constituents of nucleus and their intrinsic properties, Quantitative facts about size, mass, charge density (matter energy), binding energy, average binding energy and its variation with mass number, Liquid drop model approach, Semi empirical mass formula, Magic numbers. **2. Particle Accelerator** Need of accelerators, Cyclotron- construction, working, theory and its limitations, Principle of phase stable orbit, Synchrocyclotron - construction and working, Synchrotrons- electron synchrotron and proton synchrotron, Betatron - principle, construction and working condition, expression of energy gain.	**18**

Reference Books:

1. Introduction to Solid State Physics, Charles Kittle, 8th Ed.,2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prenice-Hall of India
3. Introduction to Solid, Leonid V.Azaroff, 2004, Tata Mc-Graw Hill
4. Solid State Physics, Neil W. Aschroft and N. David Mermin, 1976, Cengage Learning
5. Solid State Physics, Rita John,2014, Mc-Graw Hill
6. Solid State Physics, Adrianus J. Dekker, Macmillan Publishers India Ltd.
7. Solid State Physics, M.A.Wahab, 3rd Ed.,2018,Narosa Publishing House Pvt. Ltd.
8. Solid State Physics, S.O.Pillai, 5th Ed., New Age International(P) Ltd., Publishers.
9. Fundamentals of Solid State Physics, Saxena-Gupta-Saxena, (Pragati Prakashan Meerut)
10. Solid State Physics, R. L. Singhal
11. Solid State Physics, C.M. Kachhava (Tata McGraw Hill Publication)
12. Elements of X-ray diffraction, B.D. Cullity and S. Stock
13. Solid state electronic devices, B. G. Streetman & S.K. Banerjee,5th Ed. PHI Learning Delhi.
14. Introductory nuclear Physics, Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
15. Concepts of nuclear physics, Bernard L. Cohen. (Tata McGraw Hill, 1998).
16. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004)
17. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
18. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
19. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
20. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
21. Theoretical Nuclear Physics, J.M. Blatt &V. F. Weisskopf (Dover Pub. Inc., 1991)
22. Nuclear Physics by John Lilley, The Manchester Physics Series – Willy
23. Nuclear Physics by S. B. Patel, New age international (p) lit. Publishers New Delhi.
24. Modern Physics by R. Murugeshan, S. Chand & company Ltd, Ram Nagar New Delhi

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

(5 Years Integrated) Programme, Part – III, Semester- VI,

Laboratory Course I

(Solid State Physics and Nuclear and Particle Physics)

(Practical: 60 Lectures) : 50 (Credits: 02)

1. Determination of lattices constant using the given XRD powder pattern
2. Self-Inductance by Owen's Bridge
3. Measurement of BH, BV and θ using Earth Inductor /Hysteresis by magnetometer method
4. Resistance of B.G. by half deflection method
5. Absolute capacity of condenser
6. I-V characteristics of Solar Cell
7. Band gap energy of semiconductor using p-n junction diode
8. e/m of Electron by Thomson's Method
9. Study of divergence of LASER beam and measurement of wavelength of LASER using plane diffraction grating
10. Study of quantum tunneling effect using tunnel diode
11. Obtaining Biprism fringes without lateral shift and Measurement of distance between two coherent sources in Biprism experiment
12. Polar graph using photocell/photovoltaic cell

Note: (Any 10 Experiments from the above list)

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

Physical Chemistry
(Elements of Quantum Mechanics, Chemical Kinetics, Thermodynamics, Chemistry of Solutions, Solid State Chemistry, Electrochemistry, Spectroscopy and Photochemistry)

Theory: 60 Lectures and Marks -100 (80+20) (Credits: 04)

Course Learning Outcomes:

CO 01: Understanding of elementary quantum mechanics, thermodynamics and chemical kinetics principles.

CO 02: Knowledge about Solid State Chemistry, Solutions, Phase Equilibria and Distribution Law.

CO 03: Knowledge about Electrochemistry and Photochemistry. Practical applications of spectroscopic techniques.

CO 04: Understanding of basic and applied physical chemistry concepts to qualitative and quantitative analysis.

Unit No.	Topics	Total Lectures
Unit I	**Elementary quantum mechanics, Thermodynamics and Chemical Kinetics Elementary quantum mechanics [06]** Introduction, Drawbacks of classical mechanics, Black body radiation, Photoelectric effect, Compton effect, Duel nature of matter and energy: De Broglie hypothesis. The Heisenberg's uncertainty principle. Concept of energy operators (Hamiltonian). Derivation of Schrodinger wave equation, well behaved function. Physical interpretation of the ψ and ψ^2. Particle in a one dimensional box. Numerical problems. **Thermodynamics [07]** Introduction. Free energy: Gibbs function (G) and Helmholtz function (A), Criteria for thermodynamic equilibrium and spontaneity. Relation between ΔG and ΔH: Gibbs-Helmholtz equation. Phase equilibria:	**20**

	Clapeyron – Clausius equation and its applications. Thermodynamics derivation of law of mass action, Van't – Hoff isotherm and isochore. Fugacity and activity concepts. Partial molar quantities, Partial molar volume, Concept of chemical potential, Gibbs- Duhem equation. Numerical problems. **Chemical Kinetics and Catalysis [07]** Introduction. Simultaneous reactions such as: Opposing reaction: (Derivation of rate equation for first order opposed by first order expected). Side reaction. Consecutive reactions. Chain reaction. Explosive reaction (Derivation of rate equation and Numerical problems are not expected). **Catalysis:** Introduction. Classification of catalytic reaction- Homogenous and Heterogeneous. Types of Catalysis. Characteristics of catalytic reactions. Mechanism of catalysis. Intermediate compound formation theory. Adsorption theory. Industrial applications of catalysis.	
Unit II	**Solid State Chemistry, Solutions, Phase Equilibria and Distribution Law** **The Solid State [06]** Introduction: Space lattice, lattice sites, lattice planes, unit cell. Laws of crystallography: Law of constancy of interfacial angles, Law of rational indices. Symmetry and Symmetry elements in crystals, Centre of Symmetry, Plane of Symmetry, Axis of symmetry and Law of crystal symmetry. **Solutions [05]** Introduction. Ideal solutions, Raoult's law, Vapour pressure of ideal and non-ideal solutions of miscible liquids. Composition of liquid and vapour, vapour pressure and boiling point diagrams of miscible liquids. Distillation of miscible liquid pairs. Type I: Systems with intermediate total vapour pressure (i.e. System in which b.p. increases regularly – Zeotropic). Type II: Systems with a maximum in the total vapour pressure (i.e. System with a b.p. minimum – Azeotropic). Type III: Systems with a minimum in the total vapour pressure (i.e. System with a b.p. Maximum – Azeotropic). Solubility of partially miscible liquids.	

	Maximum solution temperature type: Phenol – water system. Minimum solution temperature type: Triethyl amine – water system. Maximum and minimum solution temperature type: Nicotine – water system. Distillation of partially miscible liquid pairs. Vapour pressure and distillation of immiscible liquids, steam distillation. **Phase Equilibria** [05] Introduction. Gibbs phase rule: Phase rule equation and explanation of terms involved in the equation. Phase diagram, true and metastable equilibria. One component systems: Water system. Sulphur system with explanation for polymorphism. Two component systems: Eutectic system: (Ag – Pb system); Desilverisation of lead. Freezing mixture: (KI –H_2O system). Formation of compound with congruent melting point ($FeCl_3$ – H_2O). Three component solid-liquid system: Development of triangular phase diagram: (Acetic acid – Chloroform –water system). **Distribution law [05]** Introduction, solute, solvent and solution, miscible and immiscible liquids. Nernst distribution law and its limitations. Modification of distribution law with respect to change in molecular state of solute (association and dissociation of solute in one of the solvent). Applications of the distribution law: Process of extraction (derivation expected). Determination of solubility of solute in particular solvent. Determination of molecular weight of solute in different solvents. Numerical problems.	
Unit III	**Electromotive force** Convention: Reduction potentials to be used) Introduction. Thermodynamics of electrode potentials, Nernst equation for electrode and cell potentials in terms of activities. E.M.F. series. Types of electrodes: Description in terms of construction, representation, half-cell reaction and emf equation for: Metal – metal ion electrode. Amalgam electrode. Metal – insoluble salt electrode. Gas – electrode. Oxidation – Reduction electrode. Reversible and Irreversible cells. Chemical cells without transference. Concentration cells with and without transference. Liquid – Liquid junction potential: Origin,	**8**

	elimination and determination. Equilibrium constant from cell emf, Determination of the thermodynamic parameters such as ΔG, ΔH and ΔS. Applications of emf measurements: Determination of pH of solution using Hydrogen electrode. Solubility and solubility product of sparingly soluble salts (based on concentration cells). Numerical problems.	
Unit IV	**Spectroscopy and Photochemistry** **Spectroscopy [10]** Interaction of electromagnetic radiations with atoms and molecules. Interaction of radiation with matter, Electromagnetic spectrum, Energy level diagram. Electronic Spectra (UV-Vis), Modes of electronic transitions. Rotational spectra of diatomic molecules: Rigid rotor model, moment of inertia, energy levels of rigid rotor, selection rules, Intensity of spectral lines, determination of bond length, isotope effect. Vibrational spectra of diatomic molecules: Simple Harmonic oscillator model, Vibrational energies of diatomic molecules, Determination of force constant, Hook's Law for Calculation of vibrational frequency, overtones. Raman spectra: Concept of polarizability, pure rotational and pure Vibrational Raman spectra of diatomic molecules, selection rules. Comparative study of IR and Raman spectra, rule of mutual exclusion- CO_2 molecule. Magnetic Resonance (NMR and ESR). Magnetic and nonmagnetic nuclei, Chemical shift: definition, measurement, calculation, Factors affecting Chemical shift, Shielding & deshielding. Numerical problems. **Photochemistry** [06] Introduction, Difference between thermal and photochemical processes. Laws of photochemistry: i) Grotthus - Draper law ii) Lambert law iii) Lambert – Beer's law iv) Stark-Einstein law. Quantum yield, Reasons for high and low quantum yield. Factors affecting Quantum yield. Photosensitized reactions – Dissociation of H_2, Photosynthesis. Photodimerisation of anthracene. Jablonski diagram depicting various processes occurring in the excited state: Qualitative description of fluorescence and phosphorescence. Chemiluminescence, Electroluminescence and Bioluminescence. Numerical problems.	**16**

Reference Books:

1. Physical Chemistry by G. M. Barrow, International student Edn, Mc GrawHill.
2. University General Chemistry by C.N.R. Rao, Macmillan.
3. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
4. The Elements of Physical Chemistry by P. W. Atkins, Oxford.
5. Principles of Physical Chemistr yby S.H.Maron,C.H. Prutton,4th Edition.
6. Nuclear and Radiochemistry by Friedlander, Kennedy and Miller, John Wiley and Sons. Wiley International edition.
7. EssentialsofNuclearChemistrybyH.J.Arnikar,4th edition. Wiley Eastern.
8. Principles of Physical Chemistry by Puri, Sharma, Pathania, Shobhanlal Nagin chand and Company, Jalandar.
9. Instrumental methods of chemical analysis by Chatwal and Anand, 5th Edition, Himalaya Publication.
10. Fundamentals of molecular spectroscopy by C.N.Banwell–Tata McGraw-Hill.
11. Quantum Chemistry including molecular spectroscopy by B. K.Sen,Tata Mc Graw – Hill.
12. Text Book of Physical Chemistry by S. Glasstone, MacmillanIndia Ltd.
13. Elements of Physical Chemistry by D. Lewis and S. Glasstone (Macmillan).
14. Principles of Physical Chemistry by Maron and Lando (Amerind).
15. Electrochemistry by S.Glasstone.
16. Physical Chemistry by W. J.Moore.
17. Basic Chemical Thermodynamics by V. V. Rao (Macmillan).
18. Essential of Physical Chemistry, Bahl and Tuli (S.Chand).
19. Text Book of Physical Chemistry, Soni andDharmarha.
20. Advanced Physical Chemistry Gurdeep Raj GOELPublishing House, 36th Edition.

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

Laboratory Course II
(ORGANIC CHEMISTRY)
(Practical: 60 Lectures) : 50 (Credits: 02)

Qualitative analysis
Separation of binary mixture and Identification of one component. (At least 08 mixtures)
Nature 1) Solid – Solid : 4 mixtures
Solid – Liquid : 2 mixtures
Liquid – Liquid : 2 mixtures
Solid – SolidMixtures:
One mixture from each the following types should be given:
Acid+Phenol ii) Acid + Base
iii) Acid+Neutral iv) Phenol +Base
v) Phenol+Neutral vi) Base +Neutral
Solid – LiquidMixtures
Mixture of type Neutral + Neutral or Acid + Neutral should be given.
Liquid – Liquid Mixtures
Mixture of type Neutral + Neutral or Base + Neutral should be Given. Following compounds should be used for preparation ofmixtures
Acids: Benzoic acid, Phthalic acid, Salicylic acid, Cinnamic acid, Aspirin, Oxalic acid.
Phenols: α-naphthol, β-naphthol.
Bases:o-nitroaniline, m-nitroaniline, p-nitroaniline, aniline, o-toluidine and N, N-dimethylaniline.
Neutrals: Anthracene, acetanilide, m-dintrobenzene, chloroform, carbon tetrachloride, acetone, nitrobenzene, ethyl acetate, ethyl benzoate, bromobenzene, urea and thiourea.
NB : For Solid-Liquid and Liquid-Liquid mixtures avoid detection of type of mixture. Instead the weightage is given to detection of nature and separation ofmixture.
Separation and qualitative analysis of the binary Mixtures should be carried out on microscale using microscale kits.

I) Quantitative analysis: Organic Estimations :(Any two)

1. Estimation of sucrose
2. Saponification value of oil.
3. To determine the amount of acid and amide present in the given mixture of acid and amide.
4. Determination of Molecular weight of monobasic/dibasic acid by volumetric method.
5. Estimation of unsaturation –to estimate the percentage purity of given olefinic compound by brominationmethod.

Note: Double burette method should be used for titration.

II) Organic Preparations: (Any two)

1. Multicomponent reaction - Preparation of Dihydropyrimidone.
2. Radical coupling reaction - Preparation of 1,1,2 bis-2naphthol.
3. Base catalyzed Aldol condensation- Preparation of Dibenzal propanone.
4. Diels Alder reaction- Reaction between Furan and Maleic acid
5. Benzil- Benzilic acid rearrangement reaction
6. Oxidation reaction – Preparation of Methyl phenyl sulfone.

III) Preparation of Derivatives: (Any two)

1. Picrate derivative (naphathalene and α-naphthol).
2. Iodoform (Acetone).
3. Osazone of Carbohydrates (Glucose).
4. Oxalate derivative (ofUrea).
5. Nitrate derivative of Urea
6. 2,4-Dinitro phenyl hydrazone (carbonyl compounds)
7. Oxime derivatives (carbonyl compounds)

Or

Determination of structure of organic compound from given NMR spectra. Ethanol, Ethyl acetate, Benzyl alcohol, Propanoic acid, Butaraldehyde, Ethyl benzoate, Isopropyl benzene, Propyl ether, n-pentane, Propene, Diethyl amine, 2-chloro butane.

NB: All preparations should be carried out by considering green Chemistry approach

1. Preparation of derivative should be carried out on small scale. The starting compound should not be given more than one gram.
2. Calculation of percentage practical yield in preparation is must.
3. Recrystallization of crude product and its melting point.
4. The product should be confirmed by TLC.
5. Assign reactions with mechanism.

References:

1. Practical Organic Chemistry by – A.I.Vogel.
2. Practical Organic Chemistry by – O. P.Agarwal

I. Non instrumental Experiments:

A. Any **two** of the following

i) Partition Law.

To determine the partition coefficient of CH_3COOH between H_2O and CCl_4.

ii) Viscosity.

To determine the viscosity average molecular weight of a polymer.

iii) Adsorption.

To investigate the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich & Langmuir isotherms.

iv) Solubility.

To study the effect of addition of electrolyte (NaCl or KCl) on the solubility of Benzoic acid at room temperature.

B. Chemical kinetics. (Any two)

1. The study of energy of activation of first order reaction i.e. hydrolysis of methyl acetate in

presence of 0.5 N HCl / 0.5 NH_2SO_4.

2. The study of energy of activation of second order reaction i.e. reaction between $K_2S_2O_8$ and KI (Equal concentrations).
3. The study of energy of activation of second order reaction i.e. reaction between $K_2S_2O_8$ and KI (Unequal concentrations).
4. To study the hydrolysis of methyl acetate by using its two concentrations in presence of 0.5 N HCl and hence find velocity constant of the reaction.
5. To study the effect of addition of electrolyte (KCl) on the reaction between $K_2S_2O_8$ and KI (Equal concentrations).

C. Partial molar volume.

1. To determine the partial molar volume of ethyl alcohol in a mixture of ethyl alcohol and water (Any seven mixtures be given).

II. Instrumental experiments

A. Potentiometry (Any two)

1. Titration of strong acid with strong alkali.
   ii) Experiment is carried out by taking pilot run from 1 to 10ml and then final runtaking 0.2 ml reading in the range of endpoint.
2. Preparation of buffer solution and determination of their pH (Any five buffer solutions). Theoretical
   calculation of pH values by using Henderson'sequation.
3. DeterminationofstandardelectrodepotentialofZn/Zn^{++},Cu/Cu^{++},Ag/Ag^{+}(Anytwo).
4. Estimate the amount of Cl^-, Br^- and I^- in given unknown halide mixture by titrating it against
   standard $AgNO_3$solution.
5. Titration of ferrous ammonium sulphate using $K_2Cr_2O_7$ solution and to calculate redox potential of
   Fe^{++}, Fe^{+++} system.

B. Conductometry (Any two)

1. Titration of a mixture of weak acid and strong acid with strong alkali
2. To study the effect of substituent on dissociation constant of weak acid with respect to acetic
   acid and monochloroacetic acid (cell constant to begiven).

N.B. Calculate K by using formula $K= \alpha^2.C/1- \alpha$

3. To determine the velocity constant of hydrolysis of ethyl acetate by NaOH solution by conduct
   metric method.
4. To determine the normality of citric acid in lemon by titrating it against standard 0.2 N NaOH solution by conduct metric method.
5. To determine λ_∞ of strong electrolyte (NaCl or KCl) and to verify Onsager equation.

C. Refractometry. (Any One)

1. To determine the percentage composition of unknown mixture by(i) graphical method and (ii) by composition law (Densities of pure liquids A & B be given).
2. To determine the molar refractivity of methyl acetate, ethyl acetate, n-hexane and carbon

tetrachloride and calculate the refraction equivalents of C, H and Clatoms.

D. Colorimetry (Any Two).

1. To verify Lambert – Beer's law using $CuSO_4$solution.
2. To estimate of Fe^{+++} ions by thiocynate method.
3. To estimate Fe^{+++} ions using salicylic acid by colorimetric titration.
4. To determine the order of reaction for the oxidation of alcohol by potassium dichromate and potassium permanganate in acidic medium colorimetrically.

E. pH – metry (Any One).

1. To determine the dissociation constant of monobasic acid (Acetic acid).
2. To determine the dissociation constant of dibasic acid (Malonic acid).
3. To determine hydrolysis constant of aniline hydrochloride.

Reference Books:

1. Findlay's Practical Physical Chemistry(Longman)
2. Advanced Practical Physical Chemistry by J. B. Yadav, Goel publishinghouse.
3. Practical Physical Chemistry by B. D. Khosla, V. C. Garg (R. Chand andCo.)
4. Systematic experimental Physical Chemistry by Rajbhoj, Chandekar (Anjali Publicaiton) Aurangabad.
5. Practical Physical Chemistry: Nandkumari, Kothari andLavande.
6. Practical Physical Chemistry by Gurtu (S.Chand).
7. Text Book of Qualitative Inorganic Analysis by A. I. Vogel (ELBSLongman).

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

Biotech.: Molecular biology and genetic engineering
(Theory: 60 Lectures) Marks -100 (80+20) (Credits: 04)

Course Learning Outcomes:

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

- Understand the fundamental concepts of central dogma of molecular biology, Nucleic acid as genetic material,
- Understand the fundamentals and detailed concepts of replication, transcription and translation
- Learn the techniques of nucleic acid purification and quantification
- Understand the concept of manipulation of genetic material, recombinant DNA technology and applications of recombinant DNA technology
- Learn and understand how nanomaterials can be used as vehicles for transfer of genetic materials

No	Topic	Lectures (60)
1	**UNIT I** **Nucleic acid:** History, nucleic acid as genetic material. Nucleic Acid Structure and Chemistry, nitrogenous bases, purine and pyrimidine bases Sugar–Phosphate Chain Conformations, Base Pairing, Base Stacking, Hydrophobic and Ionic Interactions. Different forms of DNA, A form, B, form, Z form. Other Functions of Nucleotides. **DNA Replication:** An Overview, Replication Forks, Role of DNA Gyrase, Semi discontinuous Replication, RNA Primers. Enzymes of Replication, DNA Polymerase I, DNA Polymerase III; Unwinding DNA: Helicases and Single-Strand Binding Protein, DNA Ligase, Primase, Topoisomerase, **Prokaryotic Replication:** *Escherichia coli,* Fidelity of Replication **Eukaryotic Replication:** The Cell Cycle, Eukaryotic Replication Mechanisms, Reverse Transcriptase, telomeres and Telomerase. Repair of DNA, Direct Reversal of Damage, Excision Repair,	**16**

	Mismatch Repair, The SOS Response, Double-Strand Break Repair Identification of Carcinogens.	
2	**UNIT II** **Transcription:** The Role of RNA in Protein Synthesis, Enzyme Induction, Messenger RNA. RNA Polymerase, Template Binding, Chain Initiation, Chain Elongation, Chain Termination Eukaryotic RNA Polymerases **Translation:** The Genetic, Nature of the Code, Codons. Transfer RNA and Its aminoacylation, Primary and Secondary Structures of tRNA, Tertiary Structure of tRNA Aminoacyl–tRNA Synthetases, Codon–Anticodon Interactions, Nonsense Suppression. **Ribosomes and Polypeptide Synthesis:** Ribosome Structure, Polypeptide Synthesis: An Overview, Chain Initiation Chain Elongation, Translational Accuracy, Chain Termination, Protein Synthesis Inhibitors: Antibiotics	**16**
3	**UNIT III** **Nucleic Acids and Allied Techniques** Isolation of DNA from plants, animals and microbial sources, Isolation of plasmid DNA, Agarose gel electrophoresis **PCR**: Introduction, Principle, Working, Uses **Blotting techniques**: Southern and Western Blotting **DNA sequencing**: Sanger's method, Maxam-Gilbert method. **Recombinant DNA Technology** **Enzymes involved:** Taq polymerase, Restriction endonucleases, Exonucleases, End modification enzymes, Ligases **Vectors:** Properties of a good vectors, Plasmids, Phages, Cosmids, Artificial vectors, Animal Virus derived vectors **Transformation:** Chemical and physical methods, Role of Agrobacteria (Ti and Ri plasmids) Construction of cDNA libraries, Cloning libraries **Applications of Recombinant DNA Technology:** Transgenics and their applications in Medicine, Agriculture and Veterinary science	**16**
4	**UNIT IV**	**12**

	Nanoparticles for nucleic acid delivery: Nanoparticles for DNA delivery, Nanoparticles for mRNA delivery, Nanoparticles for gene editing. Lipid-based nanoparticles, Gold nanoparticles based delivery, Chitosan nanoparticles based delivery, solid lipid nanoparticles based delivery, composite nanoparticles based delivery	

References:

1. Molecular Biology of the Cell by Bruce Alberts
2. Molecular biology of the Gene by Watson
3. The Cell, a molecular approach by Cooper and Hausman
4. The Cell Biology by Gerald Karp
5. Sambrook J, Fritsch E. F. and Maniatis (1989) Molecular cloning, vol. I, II, III, 2nd edition, Cold spring harbor laboratory press, New York.
6. DNA Cloning : A practical approach D.M. Glover and D.B. Hames, RL Press, Oxford, 1995
7. Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 S.L. Berger and A. R. Kimmel, Academic Press Inc, San Diego, 1996
8. Methods in Enzymology Gene Expression Technology, Vol. 185 D.V. Goedel, Academic Press Inc., San Diego, 1990
9. DNA Science: A First Course in Recombinant Technology, D.A. Mickloss and G.A. Freyer, Cold Spring Harbor Laboratory Press, New York, 1990
10. Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
11. Route Maps in Gene Technology, M.R. Walker, and R. Rapley, Blakwell Science, Oxford, 1997
12. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, S. M. Kingsman, Blackwell Scientific Publications, Oxford, 1998
13. Alvin J. Mukalel, Rachel S. Riley, Rui Zhang, Michael J. Mitchell, (2019) Nanoparticles for nucleic acid delivery: Applications in cancer immunotherapy, Cancer Letters, 458, 102-112,
14. Sharma, A. K., Gupta, L., & Gupta, U. (2017). *Nanoparticles as nucleic acid delivery vectors. Advances in Nanomedicine for the Delivery of Therapeutic Nucleic Acids, 13–42.*
15. Vaughan, H. J., Green, J. J., Tzeng, S. Y., Cancer-Targeting Nanoparticles for Combinatorial Nucleic Acid Delivery. *Adv. Mater.* 2020, 32, 1901081. https://doi.org/10.1002/adma.201901081
16. Ogris, M., & Oupicky, D. (Eds.). (2013). *Nanotechnology for Nucleic Acid Delivery. Methods in Molecular Biology.* doi:10.1007/978-1-62703-140-0
17. Xiao, Y., Shi, K., Qu, Y., Chu, B., & Qian, Z. (2018). Engineering Nanoparticles for Targeted Delivery of Nucleic Acid Therapeutics in Tumor. *Molecular therapy.*

Methods & clinical development, *12*, 1–18. https://doi.org/10.1016/j.omtm.2018.09.002

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

Laboratory-course III
(Molecular biology and genetic engineering)
(60Lectures) Marks - 50 (Credits: 02)

No	Practical
1	Isolation of DNA from bacterial, plant and fungal sources
2	Quantitative estimation of DNA (spectrophotometer).
3	Separation of DNA by Agarose Gel Electrophoresis
4	Demonstration of PCR
5	Amplification of DNA by PCR
6	Preparation of competent cells
7	Plasmid Transformation in competent cells.
8	Isolation of plamids by miniprep method
9	Isolation of plamids by midiprep method.
10	Isolation of RNA
11	Isolation of proteins
12	Separation of proteins by SDS PAGE
13	Separation of proteins by Native PAGE
14	Demonstration of DNA sequencer

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

Physical and Chemical Properties of Nanomaterials
(Theory: 60 Lectures) Marks -100 (80+20) (Credits: 04)

Unit No.	Topics	Total Lectures
Unit I	**Physical Properties of Nanomaterials Mechanical Characterization** Plastic deformation, Toughness, Stiffness, Ductility, modulus and load carrying capability, fatigue – abrasion and wear resistance etc. Stress-Strain Curve. Hardness of nanomaterials: Nanoindentation, Nanomachines, Mechanical properties of CNT. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS). Thermodynamics of Nanomaterials: Melting point and phase transition processes at nanoscale materials. Classical thermodynamics Vs Nano thermodynamics.	**15**
Unit II	**Electronic Properties of Nanomaterials** Density of states of 3D, 2D, 1D and 0D dimensional nanostructures. Clusters of metals and semiconductors, nanowires. Size-induced metalinsulator-transition (SIMIT). Electronic transport in 1,2 and 3 dimensions. Effective mass, Drude conduction of metals - mean free path in 3D-diffusive transport and ballistic conduction. Coulomb blockade. Single electron transistors (SET), Tunnel diodes: Esaki tunneling diode (ETD), Resonant tunneling diode (RTD). Fundamentals of electrical conductivity in carbon nanotubes. CNT based transistor, electrical conductivity of nanocomposites.	**15**
Unit III	**Optical properties of Nanomaterials** Interaction of light with matter: Absorption-Emission. Direct and indirect band gap transitions, radiative - nonradiative process, photoluminescence. Surface Plasmon: Interaction of light with metal, scattering, extinction. Difference between Surface Plasmon Resonance (SPR) and Localized Surface Plasmon Resonance (LSPR).	**18**

	Origin of color generation from metal nanoparticles, Size and Shape dependent optical properties of metal nanoparticles. Applications of nanoplasmonics. Quantum dots (QDs): optical properties of QD nanomaterials. Size dependent band gap tuning: optical absorption and optical emission. Optical properties of core-shell nanomaterials. Optoelectronic applications of nanomaterials: detection, PV solar cells, photoelectrochemical cells, light emitting diodes etc.	
Unit IV	**Magnetic properties of nanomaterials** Origin of magnetism in materials, Classification into Dia-, Para- and Ferro- magnetic materials, Hysteresis in ferromagnetic materials, domains, soft and hard magnetic materials, Coercivity vs particle size, Single domain particles, superparamagnetism, Exchange coupling in magnetic multilayers (RKKY Coupling), Giant Magnetoresistance (GMR), Origin of GMR, Oscillatory exchange coupling, spin valve, Magnetic Tunnel Junction (MTJ),Spin Field Effect Transistor (SFET).	**12**

Reference Books:

1. Introduction to Nanoscience and Nanotechnology, G. Hornyak, H. Tibbals, J. data, J. Moore.
2. Nanotechnology: Principles and Practices by S. K. kulkarani
3. Nanotechnology : Technology Revolution of 21st Century by Rakesh Rathi, published by S. Chand.
4. Introduction to Nanoscience, by Stuart Lindsay.
5. Introduction to Nanomaterials and nanotechnology by Vladimir Pokropivny, RynnLohmus, Irina Hussainova, Alex Pokropivny and Sergey Vlassov
6. Nanomaterials by A.K. Bandyopadhyay; New Age International Publishers.
7. Nanotechnology by Mark Ratner and Daniel Ratner, Pearson Education.
8. Nano Essentials- T.Pradeep/TMH
9. Bharat Bhusan, “Springer Handbook of Nanotechnology”, springer, Newyork, 2007
10. Hari Singh Nalwa, “Encyclopedia of Nanotechnology”, USA 2011

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

Laboratory-course IV
(Physical and Chemical Properties of Nanomaterials)
(60Lectures) Marks - 50 (Credits: 02)

Name of the experiment

A. (Any six)

1. Structural properties of nanomaterials by XRD
2. Analysis of surface morphology by AFM
3. Photocatalytic degradation of dyes
4. Structural properties by STM
5. Quantum size effect in nanomaterials
6. Use of FT-IR for functional group identification (in CNT, graphene etc.)
7. Photoluminescence study of nanomaterials
8. Hall-effect measurement
9. Electrical resistivity of Nanorods and nanotubes
10. Size dependent Hysteresis loop study
11. Determination of crystallite size using Scherrer formula
12. Mechanical properties of nanomaterials
13. Collection of data on various editions of IP, gross additions and deletions per edition and sources of some commonly available drugs.
14. Determination of saturation and Biopharmaceutics solubility of some drugs.
15. Preparation and evaluation of Paracetamol syrup.
16. Studies on dissolution rate of some tablet formulations.
17. Determination of degree of hydrolysis of given ester.
18. Synthesis of metal nanoparticles using synthetic/green route
19. Preparation of nanoformulation and its evaluation.

B. (Any Six)

20. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).

a. Purification of monomer

b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bisisobutylonitrile (AIBN)

21. Preparation of nylon 66/6

22. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein

a. Preparation of IPC

b. Purification of IPC c. Interfacial polymerization

(Anyone from 27-31)

27. Redox polymerization of acrylamide
28. Precipitation polymerization of acrylonitrile

29. Preparation of urea-formaldehyde resin
30. Preparations of novalac resin/resold resin.
31. Microscale Emulsion Polymerization of Poly(methylacrylate).

(Anyone from 32 and 33)

32. Determination of molecular weight by viscometry: (only one)

(a) Polyacrylamide-aq.$NaNO_2$ solution

(b) (Poly vinyl proplylidine (PVP) in water

33. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
34. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
35. Determination of hydroxyl number of a polymer using colorimetric method.
36. Estimation of the amount of HCHO in the given solution by sodium sulphite method

SHIVAJI UNIVERSITY, KOLHAPUR
School of Nanoscience and Biotechnology

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

Polymer Chemistry

Theory: 60 Lectures and Marks -100 (80+20) (Credits: 04)

CO1: Understanding the fundamentals of polymers, polymerization processes, and chemical bonding in polymers

CO2: Understanding the fundamentals of kinetics of polymerization process and morphology of polymers

CO3: Understanding the concepts of determination of molecular weight of polymers and glass transition temperature

CO4: Understanding physical, thermal, flow & mechanical properties of polymers

Unit No.	Topics	Total Lectures
Unit I	**Introduction of polymer, Functionality and Importance. [12]** Relevance of polymers in daily life and in industries. Evolution of concept of macromolecules-historical prospective. Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers. Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.	**12**
Unit II	**Polymer synthesis, Structure-property relationship in polymers** **Polymerization [8]** Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques. **Crystallization and crystallinity [4]** Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point. **Nature and structure of polymers [2]** Structure Property relationships	**14**
Unit III	**Polymer Characterization [4]** Determination of molecular weight of polymers, Glass transition temperature (Tg) and determination of Tg, Polymer Solution **Determination of molecular weight of polymers [4]**	**24**

	(Mn, Mw, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index. **Glass transition temperature (Tg) and determination of Tg [8]** Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg). **Polymer Solution [8]** Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions,entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.	
Unit IV	**Industrial polymers** Monomer and polymer synthesis. Recycling techniques. Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].	**10**

Reference Books:

1. Seymour, R.B. & Carraher, C.E. Polymer Chemistry: An Introduction, Marcel Dekker, Inc. New York, 1981.
2. Odian, G. Principles of Polymerization, 4th Ed. Wiley, 2004. Billmeyer, F.W. Textbook of Polymer Science, 2nd Ed. Wiley Interscience, 1971.
3. Ghosh, P. Polymer Science & Technology, Tata McGraw-Hill Education, 1991.
4. Lenz, R.W. Organic Chemistry of Synthetic High Polymers. Interscience Publishers, New York, 1967.