Rayat Shikshan Sanstha's

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA

(An Autonomous college)

Reaccredited by NAAC with 'A+' Grade

Bachelor of Science

Part - III

Nanoscience and Technology

Syllabus

to be implemented w. e. f. June, 2023

Structure of the Course:

Semester -V

	Theory				Practical			
	Paper Code	**No. of lectures/ Week**	**Clock Hours/ week**	**Credits**	**Paper Code**	**No. of lectures/ Week**	**Clock Hours/ week**	**Credits**
1.	BNTT-501	3	3	2	BNTP-508	4	4	2
2.	BNTT-502	3	3	2	BNTP-509	4	4	2
3.	BNTT-503	3	3	2	BNTP-510	4	4	2
4.	BNTT-504	3	3	2	BNTP-511	4	4	2
5.	BNTT-505	3	3	2				
6.	SECC-BNTT-507	2	2	1	SECC BNTP-512	4	4	2
7.	AECC-2	2	2	2				
	Total of SEM V	19	19	13		20	20	10
Total No. of Credits for Semester V = 23								

Semester-VI

	Theory				Practical			
	Paper Code	**No. of lectures/ Week**	**Clock Hours/ week**	**Credits**	**Paper Code**	**No. of lectures/ Week**	**Clock Hours/ week**	**Credits**
1.	BNTT-601	3	3	2	BNTP-608	4	4	2
2.	BNTT-602	3	3	2	BNTP-609	4	4	2
3.	BNTT-603	3	3	2	BNTP-610	4	4	2
4.	BNTT-604	3	3	2	BNTP-611	4	4	2
5.	BNTT-605	3	3	2				
6.	SECC-BNTT-607	2	2	1	SECC BNTP-612	4	4	2
7.	AECC-2	2	2	2				
	Total of SEM VI	19	19	13		20	20	10
Total No. of Credits for Semester VI = 23								
Total No. of Credits for Semester V+VI=46								

Structure and Titles of the Course of B.Sc. III course

Semester V

Sr. No	Course Code	Title of the Course
1.	BNTT-501	Mathematical Physics, Classical Mechanics and Quantum Mechanics
2.	BNTT-502	Organic and Inorganic Chemistry
3.	BNTT-503	Fundamentals of Enzymology and Nanoenzymology
4.	BNTT-504	Science at Nanoscale: Synthesis of Nanomaterials
5.	BNTT-505	Environmental Science
6.	SECC-BNTT-507	Skill Enhancement compulsory paper-Scientific Paper Writing
7.	AECC-2	English
8.	BNTP-508	Physical Science Lab
9.	BNTP-509	Chemical Science Lab
10.	BNTP-510	Biotechnology Lab
11.	BNTP-511	Nanoscience Lab
12.	SECC-BNTP -512	Project

Semester VI

Sr. No	Course Code	Title of the Course
1.	BNTT-601	Solid State Physics, Nuclear Physics
2.	BNTT-602	Physical and Organic Chemistry
3.	BNTT-603	Molecular Biology and Genetic Engineering
4.	BNTT-604	Science at Nanoscale: Properties of Nanomaterials
5.	BNTT-605	Nanomedicine
6.	SECC-BNTT-607	Skill Enhancement compulsory paper-Scientific Paper Writing
7.	AECC-2	English
8.	BNTP-608	Physical Science Lab
9.	BNTP-609	Chemical Science Lab
10.	BNTP-610	Biotechnology Lab
11.	BNTP-611	Nanoscience Lab
12.	SECC-BNTP -612	Project

B.Sc. III Semester V

BNTT - 501: Mathematical Physics, classical Mechanics and Quantum mechanics

(Lectures: 45, Credit- 2)

Course objectives: Students should:

1] Learn basic calculus for classical and quantum mechanics.

2] Study complete numbers.

3] Study infinite series for the quantum mechanical approach.

4] Study classical mechanics and its application

5] Learn rigid body motion.

6] Study quantum mechanical behavior of the particle

Credits (Total Credits 2)	Semester V BNTT-501 Mathematical Physics, classical Mechanics and Quantum mechanics	No. of hours per unit /credits
UNIT – I	**Partial Differential Equation**	**(13)**
	Introduction to differential equations, Method of separation of variables for solving second order partial differential equations, Form of two-dimensional Laplace differential equation in Cartesiancoordinates and its solution. **Integral calculus and infinite series** Integration in vector field, line and surface integrals revision, double integrals, area, moments and centers of masses, double integration in polar form. Infinite series, Fourier series. Practice exercise.	
UNIT – II	**Complex Analysis**	**(10)**
	Revision of complex numbers and their graphical representation: Geometrical representation, Equal complex numbers, Addition, Subtraction, Multiplication and Division of complex number by geometry. **Matrices and Determinants.** Introduction, types of matrices, matrix inverse, determinants, transformation on matrices, special matrices, symmetric asymmetric matrices, orthogonal matrices, unitary matrices, practice exercise.	
UNIT - III	**Dielectric and Semiconductors**	**(12)**
	Dielectric Materials, Parallel plate with Dielectrics, Polar Dielectrics, Non-polar Dielectrics, Expression for dielectric constant, Electric dipole, dipole moment and polarization, Types of polarization, Frequency dependence of dielectric constant, Expression for polarization P, Clausius - Mossotti Equation.	
UNIT - IV	**Operators in Quantum Mechanics**	**(10)**

	Definition of an operator, Position operator (x), Linear momentum operator (p),Commutation relation in quantum mechanics, Commutation relation between x and p, Kineticenergy operator (T), Hamiltonian operator (H), Parity operator (π), Angular momentum operator (L) – components of angular momentum operator in Cartesian coordinate system, Ladder operators, Eigenvalues of L and L^2 (use equations for L^2 and L in spherical polar coordinates.	

Course Outcomes: Student should be able to

Unit - I: After completion of the unit students will be able to:

1] Understand basic differentiation.

2] Understand partial differential equations used in study of classical mechanics.

3] Generalize functions and their importance with practical approach.

4] Develop better understanding of infinite series.

Unit - II: After completion of the unit students will be able to:

1] Understand importance of complete numbers.

2] Solve problems regarding complex numbers.

3] Solve various problems using matrices.

4] Understand different methods of solving mathematical problems.

Unit - III: After completion of the unit Students will be able to:

1] Understand differences between Newtonian mechanics and Lagrangian mechanics.

2] Solve problems using Lagrangian mechanics.

3] Understand applications of techniques of calculus of variation.

Unit - IV: After completion of the unit Students will be able to:

1] Identify different operators and their operations on function.

2] Understand change in functions after using various operators.

References:

1] Schaum's Advanced calculus, Robert C. Wrede, Murray Spiegel, Tata McGraw Hill publication, 3rd edition, 2010

2] A First course in Differential Equations with Modeling Applications, Dennis G. Zill, RichardStratton,10th edition,2013.

3] Partial Differential Equations, Gupta Malik and Mittal, Pragati Publication,11th edition, 2010

4] Differential Equations, Ramachandra Rao, H. R. Anuradha, Universities press 1996

5] Transforms and Partial Differential Equations, Dr. Manish Goyal, N. P. Bali, Laxmi Publications Pvt Limited, 2009

6] Differential Equations, N. Ch. S. N. Iyengar, Anmol Publications PVT. LTD.October2002.

7] Mathematical Physics, B. S. Rajput, Pragati Publication 8th edition ,1978 Mathematical Methods for Physicists, Arfken, Weber, Elsevier 2005.

8] Mathematical Methods for Scientists and Engineers, McQuarrie, Viva Books 2003.

9] Mathematical Physics, H. K. Das, Rama Varma. S. Chand and company Pvt LTd 7threvisededition, 2014 .

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BNTP-508: Physical Science Lab
(Credits: 02)

Course objective: Student should:

1] Learn practical approach to theoretical formulation.
2] Study properties of atom using spectroscopy
3] Use different software's used for solving quantum mechanical problems.
4] Determine surface tension.

Credits (Total Credit 02)	SEMESTER-V BNTT 508- Physical Science Practical Lab	No. of hours per unit/credits
	1] Resonance pendulum	
	2] Diffraction using auxilary slit	
	3] Absorption spectrum of a liquid ($KMnO_4$ solution)	
	4] S. T. of mercury by ripples method	
	5] Doubled Pendulum	
	6] Coupled Pendulum	
	7] Viscosity using Searle's method	
	8] Problems on Lagrangian mechanics	
	9] Scilab Expt. 1 (problem from Quantum Mechanics)	
	10] Scilab Expt. 2 (problems from Quantum Mechanics)	
	11] Structure analysis: secondary, tertiary and quaternary structure, bond angle, bond length, different interactions Ras-Mol, Kinemag.	

Course outcomes:

After completion of experiments, Students will be able to

1] Use various instruments.
2] Apply theoretical knowledge.
3] Understand effects of earth's magnetic field.
4] Calculate quantum mechanical problems using scilab.

Reference Book:

1] Practical Physics by Gordon Rogers Cambridge University Press, 2019
2] Department of Science Faculty of Science and Technology National Institute of Education PHYSICS Practical Handbook.2017.
3] The Art of Experimental Physics by David F. Edwards ; Spinger, 2017
4] Wilson, Jerry D. Physics Laboratory Experiments. Houghton Mifflin, 2016

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BNTT - 502: Organic & Inorganic chemistry

Course Objectives: Students should:

1] Study various types of reagents used in organic synthesis.
2] Study various types of name reaction and its mechanism.
3] Study Electrophilic addition to >C=C< and Electrophilic addition to Carbon-Carbon triple $(-C \equiv C-)$ bond.
4] Study concept of acid and base, also study its strength, principle, and application.
5] Study Nuclear and radiochemistry.
6] Study of Coordination chemistry inorganic mechanism & Crystal field theory (CFT)

Credits (Total Credits 2)	**Semester V BNTT - 502 Organic and inorganic chemistry**	**No. of hours per unit /credits**
UNIT - I	**Reagents and Name reaction in organic synthetic.**	**(12)**
	a] Reagents Preparation and Applications of following reagents. Lithium aluminium hydride LiAlH4,Raney Nickel. Osmium tetroxide, Selenium dioxide (SeO2). Dicyclohexyl Carbodiimide(DCC). Diazomethane, 2,3 Dichloro -5,6- Dicyno-1,4 benzoquinone (DDQ). **b] Name Reactions** Statement, General Reaction, Mechanism and Synthetic applications: Diels –Alder reaction. Meerwein–Ponndorf -Verley reduction. Hofmann rearrangement. Wittig reaction. Wagner- Meerwein rearrangement. Baeyer - Villiger oxidation, Dakin reaction.	
UNIT - II	**Electrophilic addition to double >C=C< & triple (>C ≡ C<) (bond**	**(12)**
	Electrophilic addition to >C=C< 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 of1,2-diols). Hydroboration-oxidation (formation of alcohol) Hydrogenation (formation of alkane). Ozonolysis (formation of aldehydes & ketones). **b] Electrophilic addition to Carbon - Carbon triple (–C ≡ C –) bond.** Introduction. Examples of addition reactions. Mechanism of electrophilic additionto –C ≡ C –bond. Addition of halogens. Addition of halogen acids Addition of hydrogen. Addition of water. Formation of metal acetylides	
UNIT - III	**Acids & Bases and Nuclear & Radiochemistry**	**(10)**

	a] Acids and Bases Introduction to theories of Acids and Bases-Arrhenius concept, Bronsted-Lowry concept, Lewis Concept, Hardand Soft Acid sand Bases.(HSAB Concept), Classification of acids and bases as hard, soft Pearson's HSAB concept. Acid–Base strength and hardness-softness. Applications and limitations of HSAB principle. **b] Nuclear & Radiochemistry** Radioactivity, Nuclear decay & stability of atomic nucleus. Nuclear reactions & Chemical reactions Classification of Nuclear reaction. Q value of Nuclear reactions. Radiation Chemistry interaction of radiation with matter. Principle of tracer technique & applications	
UNIT - IV	**Coordination Chemistry Inorganic Reaction mechanism** Introduction, Classification of Mechanism: Association, dissociation, interchange, and the rate determiningsteps.SN1 and SN2 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. b) Crystal field theory (CFT) Introduction: Shapes of d-orbitals, Basic assumptions of CFT. Crystalfield splitting of d-orbitals of metal ion in octahedral, tetrahedral, square planar complexes and John-Teller distortion.	**(11)**

Course Outcomes:

Unit - I: After completion of unit, Students are able to

1] Understand Basic concept of reagent, Preparation and physical of reagents.
2] Understand Mechanism of reagents, Applications of reagents.
3] Understand Statement, General Reaction, Mechanism and Synthetic applications of Name reaction.

Unit - II: After completion of unit, Students are able to

1] Solve Examples of addition reactions and understand Mechanism of electrophilic addition to >C=C< bond, orientation & reactivity,
2] Understand Hydroxylation &Hydrogenation
3] Understand Mechanism of electrophilic addition to "Ca" C" bond.
4] Understand Addition of halogens. Addition of halogen acids Addition of hydrogen.
5] Addition of water

Unit - III: After completion of unit, Students are able to

1] Define and solve examples of Acids and Bases.
2] Understand Classification of acids and bases, Hard and Soft Acids and Bases. (HSAB Concept)
3] Define Nuclear and radiochemistry classification of nuclear reactions.
4] Understand radiation chemistry and interaction of radiation with matter.

Unit - IV: After completion of unit, Students are able to

1] Understand Coordination Chemistry Inorganic Reaction mechanism.
2] Understand Mechanism of substitution in octahedral complexes. Tran's effect and its theories,Applications of Trans effect.
3] Understand Shapes of d-orbitals, Basic assumptions of CFT, CFT of d-orbitals of metal ion.
4] Understand Limitations of CFT, Merits and demerits of MOT

References

1] Organic Reaction Mechanisms by V K Ahluwalia, RK Parashar Naurosa Publishing House;3rd Edition 2009.
2] Organic Chemistry by Morrison & Boyd, Pearson Education India. 7thEdn, 2010
3] Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren,2nd Edition, Oxford Publisher, 2014.

4] Principles of Inorganic Chemistry; By Puri, Sharma & Kalia, Vishal publication. Co.,33rd ed., 2017.
5] Inorganic Chemistry Gulati Shikha, Sharma Gulati JL and Manocha, Shagun, 1stEdn.,CBS Publishers & Distributors , (2017)
6] Valency and Bonding. Weinhold, F.; Landis, C. Cambridge. (2005) pp. 96–100.
7] "Principles of inorganic Chemistry", B. R. Puri . L. R. Sharma and K. C. Kali Mile.Stone Publishers and Distributor, Delhi, 31st edition, 2013.
8] Inorganic Chemistry: Shriver and Atkins, Oxford 4th edition. (2003)
9] Nuclear Chemistry - B.K. Sharma

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BNTP - 509: Chemical Science Lab

Credit: 02

Course Objectives: Students should

1] Perform Gravimetric estimation from the given solution.
2] Learn Preparation of various compounds.
3] Determine the percentage purity.
4] Analyzing Commercial Sample.
5] Determine Qualitative analysis.
6] Learn Organic Estimations: Qualitative analysis.
7] Learn Organic Estimations: Quantitative analysis.
8] Study Organic preparation.
9] Study Organic preparation of derivatives

Credits (Total Credit 02)	SEMESTER-V BNTP-509- chemical science lab Course	No. of hours per unit /credits
	A] INORGANIC CHEMISTRY	
	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 (dimethyl glyoximeto) nickel (II) from the given solution containing nickel sulphate, ferrous ammonium sulphate and free Sulphuric acid.G6. Gravimetric estimation of aluminium as aluminium oxinate potassium tris (8-hydroxy quinol a to) 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 given in 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 trioxala to aluminate (III). P2. Preparation of Tetra ammine copper (II) chloride. P3. Preparation of tris (thiourea) copper (I) sulphate.P4. Preparation of potassium trioxala to 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 trioxala to 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 titratable acidity in the given sample of milk or lassi. V8. Determination of percentage purity of boric acid using supplied sodium hydroxide. (Standard succinic or oxalic acid solution to be prepared to standardise the given sodium hydroxide solution.) V9. To determine the amount of HCl in given	
	B] ORGANIC CHEMISTRY **I] Qualitative analysis** Separation of binary mixture and Identification of one component. (**At least 08 mixtures)** Nature 1] Solid – Solid: 4 mixtures 2] Solid – Liquid: 2 mixtures 3] Liquid – Liquid: 2 mixtures **1] Solid – Solid Mixtures:** One mixture from each the following types should be given: i] Acid + Phenol ii] Acid + Base iii] Acid + Neutral iv] Phenol + Base v] Phenol+ Neutral vi] Base + Neutral **2] Solid – Liquid Mixtures:** One mixture from each the following types should be given: i] Neutral + Neutral ii] Acid + Neutral **3] Liquid – Liquid Mixtures:** One mixture from each the following types should be given: i] Neutral + Neutral ii] Base + Neutral should be	

	Given. Following compounds should be used for preparation of mixtures i] Acids: Benzoic acid, Phthalic acid, Salicylic acid, Cinnamic acid, Aspirin, Oxalic acid. ii] Phenols: - naphthol, - naphthol. iii] Bases: o-nitroaniline, m-nitroaniline, p-nitroaniline, aniline, o-toluidine and N, dimethylaniline. Neutrals: Anthracene, acetanilide, m-dintrobenzene, chloroform, carbon tetrachloride, acetone, nitrobenzene, ethyl acetate, ethyl benzoate, bromobenzene, urea and thiourea	
	NB: 1) For Solid-Liquid and Liquid-Liquid mixtures avoid detection of type of mixture. Instead, the weightage is given to detection of nature and separation of mixture. 2) Separation and qualitative analysis of the binary Mixtures should be carried out on microscale using microscale kits. **II] 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 bromination method. **Note: Double burette method should be used for titration.** **III] 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. **IV] Preparation of Derivatives: (Any two)** 1. Picrate derivative (naphathalene and á-naphthol). 2. Iodoform (Acetone). 3. Osazone of Carbohydrates (Glucose). 4. Oxalate derivative (of Urea). 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, Butar aldehyde, 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.	

Course outcomes:

After completion of the Experiment, Students will be able to

1] Know Importance of chemical safety and Lab safety while performing experiments in laboratory
2] Learn measuring skills in practical.
3] Understand theoretical concepts by performing experiments.
4] Develop awareness of minimizing errors. 5. Handle various instruments

Reference Books:

1] Elementary Practical Organic Chemistry, Part 1: Small scale Preparations, Vogel, A. I. Pearson (2011)
2] Practical Organic Chemistry, Mann, F.G. & Saunders, B.C. Pearson Education (2009)
3] Practical Organic Chemistry, Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A. R. 5th Ed., Pearson (2012)
4] Comprehensive Practical Organic Chemistry Preparation and Quantitative Analysis, Ahluwalia, V.K. & Aggarwal, R. University Press (2000).
5] Comprehensive Practical Organic Chemistry: Qualitative Analysis, Ahluwalia, V.K. & Dhingra, S. University Press (2000).
6] Practical Organic Chemistry, Mann, F.G. & Saunders, B.C. Pearson Education (2009)
7. Practical Organic Chemistry, Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell,
7] Qualitative Inorganic Analysis, Svehla, G. Vogel's Pearson Education, 2012.
8] Quantitative Chemical Analysis, Mendham, J. Vogel's Pearson, 5th Ed., Pearson (2012)

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BNTT - 503: Fundamentals of Enzymology and Nano-enzymology
(Lectures - 45, Credit – 2)
Course

Course Objectives: Student will be able to:

1] Understand basic concept of enzyme.
2] Study types of enzymes.
3] Study Enzyme kinetics.
4] Study Electrophoresis techniques like PAGE.
5] Study the chromatographic techniques.
6] Study application of Nano-enzymes.

Credits (Total Credits 2)	Semester V BNTT-503 Fundamentals of Enzymology and Nanoenzymology	No. of hours per unit /credits
UNIT - I	**Classification and Properties**	**(10)**
	Introduction: Definition, Basic terminologies, Classification, Nomenclature and Physico- chemical properties of enzymes, IUB system. Concepts of active site, binding site, enzyme- substrate complex, activation energy, Transition State Theory. Effects of pH, temperature and substrate concentration on enzyme activities.	
UNIT - II	**Enzyme Kinetics**	**(12)**
	Enzyme Kinetics: Introduction: Michaelis - Menten Equation form and derivation, steady state enzyme kinetics, Significance of Vmax and Km Enzyme activity: Specific activity, turnover number Enzyme inhibition: types of inhibitors-competitive, noncompetitive and uncompetitive, feedback inhibition. Enzyme immobilization: Methods and Significance	
UNIT - III	**Biochemical technique**	**(15)**
	Introduction: Sub-cellular fractionation, Methods of lysis for plants, animals and microbial cells 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	**Concept of nanoenzymes**	**(10)**
	Nanozymes in bionanotechnology, Natural enzymes, artificial enzymes, nanoenzymes, Various nanomaterial based nanoenzymes, Applications of nanoenzymes for sensing and imaging, nucleic acid sensing, asaptasensors, for immunoassay, for detection of cells and bacteria, for imaging, Nanoezymes for therapeutics.	

Course Outcomes: Student should be able to

Unit-I: After completion of the unit Students will be able to:

1] Understand basic classification of Enzymes.

2] Understand the Properties of Enzymes

Unit-II: After completion of the unit Students will be able to:

1] Understand Enzyme kinetics for Enzyme activity.

2] Understand enzyme inhibition and immobilization.

Unit-III: After completion of the unit Students will be able to:

1] Understand the DNA and RNA separation through Electrophoresis.

2] Understand various chromatographic techniques.

Unit-IV: After completion of the unit Students will be able to :

1] Understand application of nanoenzyme.

2] Understand the types of nanoenzymes.

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,1995
3] Biochemistry by David Rawn,Joanna Cotler Books,1983
4] Biochemistry Donald Voet Judith Voet. 4th edition Paperback ,2018
5] Fundamentals Of Enzymology, by Nicholas C. Price3rd Edition Paperback 2009
6] Wilson and walkers principles and techniques of biochemistry and molecular biology by hofmann 8ed (sae), pb 2018
7] Enzyme Nanoparticles: Preparation, Characterisation, Properties and ApplicationsBook by Chandra S. Pundir,2015.
8] Nanozymes Sci. China LifeSci. created by learning from nature,Zhang, R., Fan, K. & Yan, X. (2020).
9] Nanozymes: Next Wave of Artificial Enzymes. Springer Briefs in Molecular Science.
10] doi:10.1007/978-3-662-53068-9.Wang, X., Guo, W., Hu, Y., Wu, J., & Wei, H. (2016).

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BNTP - 510: Biotechnology lab- Lab Course
(Credits: 02)

Course Objectives: Student will be able to
1] Study the inhibitory action on enzymes.
2] Study the activity of enzymes.
3] Study the inhibitory action on enzymes.
4] Study about bioinformatics.

Credits (Total Credit 02)	**SEMESTER-V** **BNTP-510 - Biotechnology lab Course-**	**No. of hours per unit/credits**
	1] Qualitative estimation of starch by iodine and Benedict test	
	2] Identification and quantitation of activity of alphaamylase/ beta 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 optimum temperature	
	8] Determination of Km and Vmax Determination of Competitive, non-competitive inhibitors	
	9] Getting an amino acid sequence, nucleotide sequence and BLAST	
	10] Multiple sequence alignment	
	11]Structure analysis: secondary, tertiary and quaternary structure, bond angle, bond length, different interactions Ras-Mol, Kinemag.	
	12] Separation of proteins by SDS PAGE	
	13]Separation of proteins by Native PAGE	

Course outcomes-Students should be able to

After completion of experiments, Students will be able to

1] Understand the activity of enzyme.
2] Understand the inhibitor of enzyme.
3] Understand the activator of enzyme.
4] Understand the bioinformatics techniques.
5] Use RasMol software to study protein structure

References-

1] Wilson and walkers principles and techniques of biochemistry and molecular biology by hofmann 8ed (sae), pb 2018
2] Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith
3] Biochemical Methods 2nd ed. by S.Sadasivam and A. Manickam
4] A Textbook of Practical Biochemistry by David PlummerMcGraw Hill Education; 3 edition, 2017.
5] Laboratory Mannual in Biochemistry by S. Jayaraman.APC, 3rd edition, 2018.

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BNTT - 504: Science at nanoscale: Synthesis of Nanomaterials
(Lectures: 45, Credit- 2)

Course Objectives: Student will be able to:

1] Study the basic knowledge of nanoscience and technology
2] Study the different types of nanomaterials
3] Study the top down method for synthesis of nanomaterials
4] Study the thin film technology
5] Study the Bottom up method for nanoparticle's synthesis
6] Study the principle of different microscopies.

Credits (Total Credits 2)	Semester V BNTT - 504 Science at nanoscale: Synthesis of Nanomaterials	No. of hours per unit /credits
UNIT - I	**Introduction to nanoscience**	**(13)**
	Basic introduction about nanoscience and technology Nanoscience effects: Quantum size effects, Quantum confinement effect, Bohr exciton radius, surface area to volume ratio etc. The development of nanoscale science: scaling up approach, scaling down approach, Generations of nanotechnology/ Nanotechnology Timeline: Pre-18th Century, 19th Century, 20th Century, 21st Century. Nano and Nature: Lycurgus Cup, stained glass windows, Damascus saber blades, Nanoscopic colours (Butterfly wings), Bioluminescence (fireflies), Tribology, Nano tribology (Gecko's Sticky Feet, Nasturtium Leaf-Lotus effect etc.) in nature. 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.	
UNIT - II	**Top-down method: Lithography** 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	**(11)**

	methods: Thermal evaporation, e-beam evaporation. Plasma methods: DC and RF Magnetron Sputtering, High-energy methods: Pulsed Laser Deposition Physical vapor deposition method etc. Advantages and disadvantages of Top-down approaches	
UNIT - III	**Bottom-up method: Vapor – phase synthesis**	**(12)**
	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 bottom up approaches.	
UNIT - IV	**Visualization and manipulation tools**	**(09)**
	Microscopic: Basics, working, principle and application, optical microscopy, electron microscopy, scanning electrochemical microscopy(STM) and atomic force microscopy. Optical tweezers: basics, working principle and application	

Course Outcomes: Student should be able to

Unit-I: After completion of the unit Students will be able to:

1] Understand generations of nanotechnology.
2] Know nanoscopic structure present in natural materials.
3] Know dimensions-based classification of nanomaterials.
4] Study application of nanocomposites.

Unit-II: After completion of the unit Students will be able to :

1] Understand concept of synthesis of nanoparticles by using physical method.
2] Study different lithographic techniques.
3] Understand thin film technologies.
4] Understand high energy methods for thin film synthesis.

Unit-III: After completion of the unit Students will be able to:

1] Synthesize of nanoparticles by using bottom up methods.
2] Understand concept of growth mechanism of nanomaterials.
3] Understand vapor phase synthesis methods.
4] Study liquid phase synthesis methods.

Unit-IV: After completion of the unit Students will be able to:

1] Understand advantages and disadvantages of bottom up method.
2] Know basics of microscopies.
3] Understand morphology of nanomaterials.
4] Understand optical tweezers method.

References-

1] Introduction to Nanoscience and Nanotechnology, G. Hornyak, H. Tibbals, J. data, J. Moore, CRC Press, 2008
2] Nanotechnology: Principles and Practices by S. K. kulkarani, Capital publish, 3rd edition, 2014.
3] Nanotechnology: Technology Revolution by Rakesh Rathi, published by S. Chand, of 21st Century, 2009.

4] Introduction to Nanoscience, by Stuart Lindsay, 2009.
5] Introduction to Nanomaterials and nanotechnology by Vladimir Pokropivny, Rynn Lohmus, Irina Hussainova, Alex Pokropivny and Sergey Vlassov, Tartu University Press, 2007.
6] Handbook of microscopy for nanotechnologyby nan yao princeton university princeton, nj, usa zhong lin wang, Kluwer Academic Publishers, 2005.
7] Handbook of vacuum science and technology by dorothy m. Hoffman, Academic Press, 1998.

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BNTP - 511: : Nanoscience Lab Course - IV
(Credit- 2) Course -

Course Objectives: Student will be able to

1] This practical course will provide student better understanding of different techniques for synthesis of nanoparticles
2] Gain knowledge in optimization of reaction conditions for synthesis of nanomaterials
3] Know the synthesis of nanoparticle by using biological material.4] Study about the hardness of water.
5] Study about the oxygen demand of organisms.

Credits (Total Credit 02)	**SEMESTER-V** **BNTP-511 – Nanoscience lab** **Course-IV**	**No. of hours per unit/credits**
	1] Synthesis of Fe_2O_3 by Solvothermal method	
	2] Synthesis of silver nanoparticles by chemical method	
	3] Synthesis of TiO_2 nanoparticles by using sol-gel method	
	4] Synthesis of Fe_2O_3 by sol-gel method	
	5] Synthesis of ZnO nanorods by hydrothermal method	
	6] Synthesis of Graphene oxide by modified Hummers method	
	7] Synthesis of Polyaniline nanofibers by CBD method	
	8] Synthesis of CdS nanoparticles by SILAR method	
	9] Synthesis of Nickel ferrite by hydrothermal method	
	10] Preparation of superhydrophobic nanocoatings by spin coating method.	
	11] Synthesis of silver nanoparticles by using plant material.	
	12] Synthesis of silver nanoparticles by using fungi.	
	13] Synthesis of silver nanoparticles by using bacteria.	
	14] Environmental Sampling methods and analytical preparations	

	15] Air pollution monitoring and analysis	
	16] Determination of total alkalinity and acidity of a water sample.	
	17] Determination of Chemical Oxygen Demand.	
	18] Determination of Dissolved Oxygen and Biological Oxygen Demand	
	19] Determination total Hardness, Sulphates, Nitrates and Chlorides	

Course outcomes-

After completion of experiments, Students will be able to

1] Know principle and working of various synthesis method.
2] Have an idea about the growth mechanism of nanomaterials.
3] Use different nanoparticles synthesis methods.
4] Understand the synthesis of nanoparticle by using plants, fungi.
5] Understand the alkalinity and acidity of water.
6] Understand the Dissolved Oxygen and Biological Oxygen Demand

References:

1] Instrumental Analysis Lab manual, M. J. Prushan. CHM 311, 2018.
2] Introduction to Nanotechnology Charles P. Poole Jr. and Franks. J. Qwens John Wiley and Sons. (2003)
3] Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology.,
4] Ehud Gazit Imperial college Press 2007
5] Springer Handbook of Nanotechnology,Bharat Bhushan ,Springer Verlag.(2007).
6] Nanofabrication towards biomedical application: Techniques, tools, Application and impact Challa S., S. R. Kumar, J. H. Carola, John Wiley and sons.2006

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BNTT - 505(Elective): Environmental Science
(Lectures - 45, Credit - 2)

Course objectives: Students should:

1] Study the basic source of water and air pollution.
2] Study the Act's for water and Soil pollution.
3] Study the biosynthesis of nanoparticles from plants, fungi and Microorganisms.
4] Study the Applied Nano-Technology.
5] Study the type of Environmental Sensors

Credits (Total Credits 2)	Semester V BNTT - 505 Environmental science	No. of hours per unit/credits
UNIT - I	**Water and Soil pollution**	**(10)**
	Environmental pollutants in water & soil, hazardous and toxic wastes, waste water characteristics and parameters. Traditional water Treatment, nanomaterial Contamination in Aqueous Environmental, Ground water pollution, sources, effects, control, Current Nanotechnology for water treatment: Activated Carbon-A Simple Traditional Nanotechnology, Membranes separation Technology. The Environment (Protection) Act,1986, the Water (Prevention and Control of Pollution) Act, 1974.	
UNIT - II	**Air pollution & Nano-toxicology**	**(12)**

	Toxicity due to airborne Nanomaterials, Engineered nanomaterial's in the environment and Health Effects of Nanoparticles through Air, Absorption and pulmonary deposition of Nanoparticles, Elimination of dusts deposited in the lungs, Nanoparticles absorption mechanisms from air, Effects of ultrafine dusts. Gas Separation: Advanced Membrane Technology, Chemical Sensing and Detection. The Air (Prevention and Control of Pollution) Act, 1981.	
UNIT - III	**Applied Nano-Technology**	**(12)**
	The Environmental and Applied Nano-Technology Traditional Methods of Detecting, Environmental Contaminants, Type of Environmental Sensors, Sensing of chemical pollutants (Gas sensors: Introduction), basic sensing mechanism, application of TiO2, Solar Energy and Nanotechnology, Important characteristics and environmental applications of Mesoporous materials.	
UNIT - IV	**Green Nanotechnology**	**(11)**
	Definition and principles of Green Chemistry and it's significance, Biosynthesis of nanoparticles from plants, fungi & microorganisms and their application. Energy efficient resources and materials in Nanotechnology, Biological Sensors and Detectors and their applications Future aspects and importance of Nanotechnology in environmental conservation.	

Course Outcomes:

Unit - I: After completion of the unit, Students will be able to:

1] Understand source of water pollution.

2] Know the Act's for water pollution.

Unit - II: After completion of the unit, Students will be able to:

1] Understand source of Air pollution.

2] Know the Act's for Air pollution.

Unit - III: After completion of the unit, Students will be able to:

1] Understand Applied Nano-Technology

2] Understand Type of Environmental Sensors

Unit - IV: After completion of the unit, Students will be able to:

1] Understand Biosynthesis of nanoparticles from plants.

2] Understand Biosynthesis of nanoparticles from fungi.

References:

1] A Reference handbook of Nanotoxicology by M.Zafar Nyamadzi, Gunter Oberdörster, Eva Oberdorster and Jan Oberdorster, Environmental Health Perspectives, Volume, 113 Number 7 , July 2005.

2] Waste water Engineering- treatment, Disposal and reuse, Metcalf and Eddy, Inc., Tat McGraw Hill, 1999

3] Environmental applications of nanomaterials: synthesis, sorbents and sensors, 2nd edition, Glen E Fryxell, Guozhonga Cao, Imperial College Press.

4] Nanotechnology for Environmental Engineering, Springer International Publishing, Ratul Kumar DasVinayak Laxman PachapurLinson Lonappan Volume 1 / 2016 - Volume 4 / 2019.

5] Environmental Chemistry, A.K. De, Wiley Eastern Ltd, New Delhi, 2003

6] Water and waste water analysis (Handbook of methods in environmental studies Col.1 by S. K. Maiti, ABD Publication, Delhi, ISBN-978-81-8577-34-07

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SECC-BNTT 507: Skill Enhancement Compulsory Course
Scientific and Technical Writing - I
(Lectures:15, Credit:01)

Course Objectives: Students should

1] Motivate towards research.
2] Study to write research paper.
3] Learn to present their project work.

Credits (Total Credits 2)	Semester V BNTT - 507 Skill enhancement compulsory course scientific course	No. of hours per unit/credits
UNIT - I	**Types of Writing**	
	Scientific articles, research papers and proposals **Composition:** Title, paragraph writing, Introduction, Writing main body, figures and tables, referencing, plagiarism, Abstracts, summary writing	
UNIT - II	**Style**	
	Objectivity, clarity, formality, hedging, signposting	
	Assignment - I : Present any paper from Nature Nanotechnology or Nature Journal.	

Course Outcomes:

After completion of this course students will be able to

1] Understand types of scientific writing
2] Understand concept of plagiarism checking
3] Understand Abstracts, summary writing.
4] They are able to present paper.

References

1] Practical handbook for scientific and technical writers, Z. Svobodova et al. L, Da Vinci Program, European Commission
2] The fine art of technical writing by C. R. Perry, Create space publisher.

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SECC-BNTP- 512: Project Work Credit: 02

Semester – VI

B.Sc. Part - III Semester -VI

BNTT - 601: Solid state physics, Nuclear Physics

(Lectures - 45, Credit - 2)

Course objectives: Students should:

1] Study atomic structure's
2] Learn properties of matter and its application
3] Understand band structure ofsolids.
4] Learn crystal imperfections.
5] Learn properties of nucleus.

Credits (Total Credits 2)	**Semester VI BNTT-601 Solid state physics nuclear physics**	**No. of hours per unit /credits**
UNIT - I	**Atomic Structures**	**(05)**
	Revision of Rutherford, Bohr atomic model, The hydrogen spectrum, Somerfield's relativistic atom model, elliptical orbits of hydrogen, vector atommodel, The Pauli's Exclusion principle.	
Unit: II	**Properties of matter**	**(16)**
	Introduction, classical free electron theory of metals, quantum theory of free electrons, classical. Wave equation, Schrodinger's wave equation and its importance, electrical. Conductivity from quantum mechanical. Consideration thermal Conductivity. Crystal imperfection Introduction, Point defects, Vacancies, Schottky defect sand Frankel defects, Compositional defect, Electronic defect, Line imperfection, Screwdis location, Burger vector, Surface imperfections, Grain boundaries, Twin boundaries, Stacking defects.	
Unit: III	**Elementary Band Theory of Solids**	**(08)**
	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.	
Unit: IV	**General Properties of Nuclei and Nuclear model**	**(16)**
	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. Particle Physics Particle interactions, Classification of elementary particles, Symmetries and conservation laws-energy, momentum, angular momentum and parity, Baryon number, Lepton number, Concept of quark model	

Course Outcomes:

Unit – I: After completion of the unit, Students will be able to :

1] Understand atomic structure.
2] Understand experiments done by scientists to define closest structure of atom and drawbacks of their theories.

Unit – II: After completion of the unit, Students will be able to:

1] Understand Types of matter
2] Analyze effects of pressure, temperature etc on the formation of matter and its properties.
3] Solving problems related to thermal, electrical properties
4] Understand Change in properties of solids due to defects
5] Calculate number of vacancies created in solid structures.

Unit – III : After completion of the unit, Students will be able to:

1] Band structures in solids
2] Differences between metals, semiconductor and insulators
3] Analyze Hall effect.

Unit – IV: After completion of the unit, Students will be able to:

1] Get knowledge of Intrinsic Nuclear properties
2] Calculate binding energy
3] Understand various particles present in nucleus
4] Understand Importance of nuclear particles

References:

1] Introduction to Solid State Physics, Charles Kittle,Wiley India Pvt. Ltd, 8th Ed.,2004.
2] Elements of Solid State Physics, J.P. Srivastava, ,Prenice-Hall of India, 2nd Ed., 2006
3] Introduction to Solid, Leonid V.Azaroff,,Tata Mc-Graw Hill, 3rd edition 2004
4] Solid State Physics, Neil W. Aschroft and N. David Mermin, Cengage Learning,1st edition
5] Solid State Physics,Rita John,,Mc-Graw Hill, 2014.
6] Solid State Physics, Adrianus J. Dekker, Macmillan Publishers India Ltd 1970.
7] Solid State Physics, M.A.Wahab,Narosa Publishing House Pvt. Ltd, 3rd Ed.,2018,
8] Solid State Physics, S.O.Pillai,, NewAge International(P) Ltd., Publishers, 5th Ed2009.
9] Fundamentals of Solid State Physics, Saxena-Gupta-Saxena, Pragati Prakashan Meerut, 2015.

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BNTP-608: Physical Science Lab

(Credits: 02)

Course objective: Student should:

1] Determine properties of solids.
2] Learn to analyze hysteresis curve.
3] Determine hall effect.
4] Determine surface tension.

Credits (Total Credit 02)	SEMESTER-VI BNTP 608- Physical Science Practical Lab	No. of hours per unit/credits
	1] Measurement of resistivity of given thin film using two probe method.	
	2] Thermal conductivity of metal using Searle's apparatus.	
	3] Hysteresis using CRO.	
	4] Surface tension of mercury.	
	5] Study of bandgap energy using semiconductor diode.	
	6] IV characteristics of solar cell.	

	7] Polar graph using photocell.	
	8] Study of temperature transducer.	
	9] Hall effect	
	10] Determination of density and mobility of charge in p-germanium	

Course outcomes:

After completion of experiments, Students will be able to

1] Understand methods for analyzing properties of solids.
2] Measure thermal conductivity.
3] Measure hall voltage and charge density using Hall effects instrument.
4] Understand effects of intensity of light on current and voltage of solar cell.
5] Measure magnetic susceptibility of materials.
6] Handle various instruments with ease.

Reference Books :

1] 2017, Department of Science Faculty of Science and Technology, National Institute of Education Physics Practical Handbook.
2] Ketterson. B. J. September 2016.The Physics of Solids. Oxford University.
3] Matthew E. Cross, Emma V. E. Plunkett. June 2014. Physics, Pharmacology and Physiology for Anaesthetists

BNTT - 602: Physical &Organic chemistry

Course Objectives: Students should:

1] Study Chemical bonding and basis of reactivity.
2] Study concepts of aromaticity.
3] Learn Structure and stability of reactive intermediates.
4] Study Aliphatic Nucleophilic substitutions reaction& Elimination reaction.
5] Study the al reactions in chemical kinetics, Simultaneous reactions, Opposing reaction, and Sidereaction. Consecutive reactions, Chain reaction, explosive reaction.
6] Study the catalysis, classification of catalytic reaction and industrial applications of catalysis

Credits (Total Credits 2)	Semester VI BNTT - 602 Physical and organic chemistry	No. of hours per unit/credits
UNIT - I	**Reaction Mechanism: Structure and Reactivity**	**(15)**

	A. Types of reactions, Chemical bonding and basis of reactivity- Chemical bond, delocalization, conjugation, resonance, hyper conjugation, tautomerism, inductive effects. B. Aromaticity: Structural, thermochemical, and magnetic criteria for aromaticity, including NMR characteristics of aromatic systems. Benzenoid and non-benzenoid compounds, Huckel'S rule, antiaromaticity, Application to carbocyclic and heterocyclic systems, anulenes, azulenes, tropyliumcations, metallocenes , current 2 C. Structure and stability of reactive intermediates, carbenes, nitrenes, carbocations, carbanions and free radicals.	
UNIT - II	**Aliphatic Nucleophilic substitutions: Elimination Reactions**	**(15)**
	A) Aliphatic Nucleophilic substitutions: The S_N2, S_N1 and S_N reactions with respects to mechanism and stereochemistry. Nucleophilic substitutions at an alylic, aliphatic trigonal, benzylic, aryland vinylic carbons. Reactivity effect of substrate structure, effect of attackingnucleophiles, leaving groups and reaction medium. S_N reactions at bridge head carbon, competition between S_N1 and S_N2, Ambident nucleophiles, Neighbouring Group Participation. **B)** Elimination Reactions: The E1, E2 and E1cB mechanisms. Orientation in Elimination reactions. Hoffman Versus Saytzeff elimination, competition between substitution and elimination reactions, Reactivity: effects of substrate structures, attacking base, the leaving group, the nature of medium on elimination reactions.	
UNIT - III	**Chemical Kinetics and Catalysis**	**(07)**
	Chemical Kinetics 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. Characteristicsof catalytic reactions. Mechanism of catalysis. Intermediate compound formation theory. Adsorption theory. Industrial applications of catalysis.	
UNIT - IV	**Photochemistry**	**(08)**
	Introduction, Difference between thermal and photochemical processes. Laws of photochemistry: i] Grotthus - Draper law ii] Lambert law iii] Lambert – Beer's law (with derivation) iv]Stark-Einsteinlaw. Quantum yield, Reasons for high and low quantum yield. Factors affecting Quantum yield. Photosensitized reactions – Dissociation ofH2, Photosynthesis. Photo dimerisation of anthracene. Jablonski diagram depicting various processes occurring in the excited state:	

Course Outcomes :

Unit - I: After completion of the unit, Students will be able to

1] Understand organic reaction mechanism with respect to structure and reactivity.

2] Know concepts of aromaticity.
3] Know structure and stability of reactive intermediates.

UNIT - II: After completion of the unit, Students will be able to

1] Understand formation of various types of Aliphatic Nucleophilic substitutions.
2] Understand to compare SN_2, SN_1 and SN reactions with respects to mechanism and stereochemistry.
3] Know ambient nucleophiles, Neighboring Group Participation

Unit - III: After completion of the unit, Students will be able to :

1] Understand all reactions in chemical kinetics,
2] Understand derivation of rate equation.
3] Understand Catalysis classification and mechanism.
4] Understand industrial applications of catalysis

Unit - IV: After completion of the unit, Students will be able to :

1] Understand the difference between thermal and photochemical processes, Laws of photochemistry
2] Understand relation between Photosensitized reactions, Photosynthesis.

Reference Books :

1] Organic Reaction Mechanisms by V K Ahluwalia, R K Parashar 2nd edition 2004
2] Organic Reaction Mechanisms by V K Ahluwalia, R K Parashar Naurosa Publishing House; 3rd Edition 2009.
3] Organic Chemistry by Morrison & Boyd, Pearson Education India. 7th Edn,2010
4] Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren,2nd Edition, Oxford Publisher, 2014.
5] Textbook of Physical chemistry, P. L. Sony, O. P. Dharmarha, U.N. Das by Sultan Chand and S.publication.2003
6] Principle of physical chemistry Puri Sharma, Patania by Vishal publishings. Co.44th edition
7] Physical Chemistry by G. M. Barrow, International student Edition, Mc GrawHill.
8] Physical Chemistry by Ira N. Levine Published by McGraw-Hill Science August 29th2001
9] Physical Chemistry by David W. Ball Publishe by Brooks Cole d August 20th 2002
10] Physical Chemistry – P.W.Atkins, Oxford University press, 8th edition, 2006

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BNTP - 609: Lab Course II: Chemistry (Credit- 2)

Course Objectives: Students should

1] Perform accurate quantitative measurements with and understanding of the theory and use contemporary chemical instrumentation,
2] Interpret experimental result and perform the calculation
3] Learn to present scientific and technical information resulting from laboratory experimentation in both written and oral formats.

4] Study non instrumental experiments.
5] Study instrumental experiments.

Credits (Total Credit 02)	SEMESTER-VI BNTP-609 - Chemistry lab Course-	No. of hours per unit/credits
	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 thesolubility 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. N.B. i] 8to10mlof1Nacidsolutiontobegivenbyexaminerin100ml volumetric flask & student should dilute it to 100 ml and10mlof this solution is taken for titration. ii] Experiment is carried out by taking pilot run from 1 to 10ml and then final run taking 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's equation.	

	3. Determination of standard electrode potential of Zn / Zn++, Cu / Cu++, Ag/Ag+ (Any two). 4. Estimate the amount of Cl-, Br- and I- in given unknown halide mixture by titrating it against standard AgNO3solution. 5. Titration of ferrous ammonium sulphate using K2Cr2O7 solution and to calculate redox potential of Fe++, Fe+++ system.	
	B] Conductometry (Any two). N.B. i] 8to10mlof1Nacidsolutiontobegivenbyexaminerin100ml volumetric flask & student should dilute it to 100 ml and10mlof this solution is taken for titration. 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 monochloro acetic acid (cellconstant to be given). 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 ë” of strong electrolyte (NaCl or KCl) and to verify Onsager equation.	
	C] Refractometry. (Any One) 6] To determine the percentage composition of unknown mixtureby a graphical method and by composition law (Densities of pure liquids A& B begiven). 7] To determine the molar refractivity of methyl acetate, ethyl acetate, n-hexane and carbon tetrachloride and calculate the refraction equivalents of C, H and Cl atoms.	
	D] Colorimetry (Any Two). 1. To verify Lambert – Beer’s law using CuSO4solution. 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 permanganatein acidic medium calorimetrically.	
	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.	

Course Outcomes:

After completion of the Experiment, Students will be able to

1] Learn measuring skills in practical.
2] Understand theoretical concepts by performing experiments.
3] Develop awareness of minimizing errors.
4] Handle various instruments.

References:

1] Senior Practical Physical Chemistry, Khosla, B. D.; Garg, V. C. & Gulati, R. Chand & Co. New Delhi (2011).
2] Comprehensive Practical Organic Chemistry, Ahluwalia, V. K. & Renu Agarwal Orient Black Swan (2004)
3] Experiments in Physical Chemistry Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. McGraw-Hill: New York 8th Ed. (2003).
4] Experimental Physical Chemistry Halpern, A. M. & McBane, G. C. W.H. Freeman & Co. New York 3rd Ed.; (2003).

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BNTT - 603: Molecular biology and genetic engineering
(Lectures: 45, Credits: 02)

Course Objectives: Student will be able to:

1] Study the structure of DNA.
2] Study the prokaryotic and eukaryotic replication.
3] Study the process of Transcription.
4] Study the process of translation.
5] Study the PCR technique.
6] Study the recombinant DNA Technology.

Credits (Total Credits 2)	Semester VI BNTT-603 Molecular biology and genetic engineering	No. of hours per unit/credits
UNIT – I	**Nucleic acid**:	**(12)**
	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, Semidiscontinuous 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, Mismatch Repair, the SOS Response, Double-Strand Break Repair Identification of Carcinogens.	
Unit : II	**Transcription** :	**(12)**
	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	
Unit :III	**Nucleic Acids and Allied Techniques**	**(15)**
	Isolation of DNA from plants, animals and microbial sources, Isolation of plasmid DNA, 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 (Tiand Ri plasmids) Construction of cDNA libraries, Cloning librariesApplications of Recombinant DNA Technology: Transgenics and their applications in Medicine, Agriculture and Veterinary science	
Unit : IV	**Nanoparticles for nucleic acid delivery**	**(07)**
	Nanoparticles for DNA delivery, Nanoparticles for mRNA deliver, Nanoparticles for gene editing. Lipid based nanoparticles, Gold nanoparticles based delivery, Chitosan nanoparticles based delivery, solid lipid nanoparticles based delivery, and composite nanoparticles based delivery	

Course Outcomes: Student should be able to

Unit - I: After completion of the unit, Students will be able to:

1] Get knowledge of Genetic Material.
2] Understand Replication process for cell division.

Unit - II: After completion of the unit, Students will be able to:

1] Understand about the RNA synthesis.
2] Understand protein synthesis from RNA.

Unit - III: After completion of the unit, Students will be able to:

1] Understand various blotting technique.
2] Understand PCR reaction for DNA amplification.

Unit - IV: After completion of the unit, Students will be able to:

1] Understand use of nano in molecular biology.
2] Understand use of nanoparticles in m RNA delivery system.

References:

1] Molecular Biology of the Cell by Bruce Alberts
2] Genetic Engineering: An Introduction to Gene Analysis and Exploitation in Eukaryotes,
3] S. M. Kingsman, Blackwell Scientific Publications, Oxford, 1998
4] Route Maps in Gene Technology, M.R. Walker, and R. Rapley, Blakwell Science, Oxford, 1997

5] Molecular cloning, vol. I, II, III, Sambrook J, Fritsch E. F. and Maniatis 2nd edition, Cold spring harbor laboratory press, New York. (1989)
6] Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 S.L. Berger and A. R. Kimmel, Academic Press Inc, San Diego, 1996
7] DNACloning: Apractical approach D.M. Glover and D.B. Hames, RL Press, Oxford,
8] 1995
9] Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
10] Methods in Enzymology Gene Expression Technology, Vol. 185 D.V. Goedel, Academic Press Inc., San Diego, 1990
11] DNA Science: A First Course in Recombinant Technology, D.A. Mickloss and G.A. Freyer, Cold Spring Harbor Laboratory Press, New York, 1990

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BNTP- 610: Lab Course IV: Molecular biology and genetic engineering (Credits: 02)

Course Objectives: Student will be able to

1] Learn the DNA Isolation process.
2] Perform DNA separation by using electrophoresis.
3] Perform transformation in bacteria.
4] Study the separation of protein.
5] Perform DNA amplification by using PCR.

Credits (Total Credit 02)	SEMESTER-VI BNTP-610 - Biotechnology lab Course	No. of hours per unit/credits
	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] Demonstration of DNA sequencer	

Course outcomes-Students should be able to

After completion of experiments, Students will be able to

1] Know the DNA Isolation process.
2] Understand DNA separation by using electrophoresis.
3] Perform transformation in bacteria.
4] Understand the separation of protein.
5] Perform DNA amplification by using PCR.

References

1] Methods in Molecular Biology by Sambrook and Russel
2] Practical Biochemistry: An Introductory Course by Fiona Frais
3] Methods in Enzymology Vol. I by S.P. Colowick and N.O. Kaplan eds.
4] Basic Biochemical Methods by R.R. Alexander and J.M. Griffith, 2nd edition.
5] Biochemical Methods by S. Sadasivam and A. Manickam, 2nd edition.
6] Hawk's Physiological Chemistry by Bernard L Oser
7] ATextbook of Practical Biochemistry by David PlummerMcGraw Hill Education; 3 edition, 2017.
8] Laboratory Mannual in Biochemistry by S. Jayaraman.APC, 3rd edition, 2018.

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BNTT - 604: Science at nanoscale: Properties of Nanomaterials
(Lectures: 45, Credit- 2)

Course Objectives: Students should:

1] Study the physical properties of nanomaterials.
2] Study the mechanical properties of nanomaterials.
3] Study the electrical properties of nanomaterials.
4] Study the optical properties of nanomaterials 5] Study the magnetic properties of nanomaterials.

Credits (Total Credits 2)	Semester VI BNTT-604 Science at nanoscale: Properties of nanomaterials	No. of hours per unit/credits
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.	**(10)**
Unit : II	**Electronic Properties of Nanomaterials :**	**(12)**

	Density of states of 3D, 2D, 1D and 0D dimensional nanostructures. Clusters of metals and semiconductors, nanowires. Size-induced metal-insulator-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.	
Unit :III	**Optical properties of Nanomaterials**	**(11)**
	Interaction of light with matter: Absorption- Emission. Direct and indirect band gap transitions, radiative-non radiative process, photoluminescence. Surface Plasmon: Interaction of light with metal, scattering, extinction. Difference between Surface Plasmon Resonance (SPR) and Localized Surface Plasmon Resonance (LSPR). Origin of color generation from metal nanoparticles, Size and Shape dependent optical properties of metal nanoparticles. Applications of nano-plasmonics. 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 supercapacitor, batteries etc.	
Unit : IV	**Magnetic properties of nanomaterials:**	**(11)**
	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, superparamagnetic, 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). Application of nanomaterials based on magnetic properties	

Course Outcomes:

Unit - I: After completion of the unit, Students will be able to :

1] Get knowledge of physical properties of nanomaterials.
2] Know hardness of nanomaterials by using nanoindentation.
3] Get knowledge of mechanical properties of nanomaterials.
4] Understand thermodynamics of nanomaterials.

Unit - II : After completion of the unit, Students will be able to :

1] Get knowledge of electrical properties of nanomaterials.
2] Know concept of density of states.
3] Understand concept of quantum confinement.
4] Understand tunnel diodes.

Unit - III: After completion of the unit, Students will be able to :

1] Get knowledge of optical properties of nanomaterials.
2] Understand concept of Surface Plasmon Resonance.
3] Get knowledge of optical properties of core-shell nanomaterials.
4] Understand concept of quantum dots.

Unit - IV : After completion of the unit, Students will be able to :

1] Get knowledge of magnetic properties of nanomaterials.
2] Understand superparamagnetism.
3] Understand Exchange coupling in magnetic multilayers.
4] Know applications of nanomaterials in magnetism.

References:

1] Optical properties and spectroscopy of nanomaterials Jin Zhong Zhang university of California, Wspc, 2009.
2] Nanotechnology: principles and practices by S. K. Kulkarani, Capital publish, 3rd edition, 2014.
3] An introduction to nanoscience and nanotechnology Alain Nouailhat, by ISTE Ltd and John Wiley & Sons, Inc., 2008.
4] Materials science and engineering William d. Callister, jr. David g. Rethwisch, John Wiley & Sons, Inc., 2000.
5] Microsystems and nanotechnology Zhaoyingzhouzhonglinwangliweilin, Tsinghua University Press, Beijing and Springer-Verlag Berlin Heidelberg, 2012.
6] Introduction to Nanoscience and Nanotechnology, G. Hornyak, H. Tibbals, J. data, J. Moore, CRC Press, 2008
7] Nanotechnology: Technology Revolution by Rakesh Rathi, published by S. Chand, of 21st Century, 2009.
8] Introduction to Nanoscience, by Stuart Lindsay, 2009.
9] Introduction to Nanomaterials and nanotechnology by Vladimir Pokropivny, Rynn Lohmus, Irina Hussainova, Alex Pokropivny and Sergey Vlassov, Tartu University Press, 2007.

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BNTP 611: Lab 4- Properties of nanomaterials
(Credit- 02)

Course Objectives: Students should:

1] Learn different characterization techniques
2] Study analysis of the materials by using characterization technique.
3] Study of evaluation of Paracetamol syrup.
4] Study of dissolution rate of some tablet formulations.

Credits (Total Credit 02)	**SEMESTER-VI** **BNTP-611 – Properties of nanomaterial Course**	**No. of hours per unit/credits**
	1] Structural properties of nanomaterials by XRD	
	2] Analysis of surface morphology byAFM	
	3] Structural properties by STM	
	4] Quantum size effect in nanomaterials	
	5] Use of FT-IR for functional group identification (in CNT, graphene etc.)	
	6] Photoluminescence study of nanomaterials	

	7] Determination of crystallite size using Scherrer formula	
	8] Mechanical properties of nanomaterials	
	9] Determination of average particle size by frequency distribution curve	
	10] Surface area to volume ratio of nanosphere and nanowires using TEM image.	
	11] Collection of data on various editions of IP, gross additions and deletions per edition and sources of some commonly available drugs.	
	12] Determination of saturation and Biopharmaceutics solubility of some drugs.	
	13] Preparation and evaluation of Paracetamol syrup.	
	14] Studies on dissolution rate of some tablet formulations.	
	15] Determination of degree of hydrolysis of given ester.	
	16] Synthesis of metal nanoparticles using synthetic/green route	
	17] Preparation of nanoformulation and its evaluation.	

Course Outcomes :

After completion of the unit, Students will able to:

1] Know principle and working of various characterization techniques.
2] Get knowledge about the crystal structure of materials by using XRD.
3] Understanding the structural properties by using STM.
4] Calculate the surface area of colloidal materials by using image of TEM.
5] Know about the evaluation of Paracetamol syrup.
6] Understand the dissolution rate of some tablet formulations.

References:

1] Instrumental Analysis Lab manual, M. J. Prushan. CHM 311, 2018.
2] Introduction to Nanotechnology Charles P. Poole Jr. and Franks. J. Qwens John Wiley and Sons. (2003)
3] Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology.,
4] Ehud Gazit Imperial college Press 2007
5] Springer Handbook of Nanotechnology, Bharat Bhushan ,Springer Verlag.(2007).
6] Nanofabrication towards biomedical application: Techniques, tools, Application and impact Challa S., S. R. Kumar, J. H. Carola, John Wiley and sons.2006
7] Laboratory Mannual in Biochemistry by S. Jayaraman.APC, 3rd edition, 2018.

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BNTT - 605(Elective): Nanomedicine
(Lectures - 45, Credit - 2)

Course Objectives: Students should:

1] Study the biological nanostructure.
2] Study biological polymer.
3] Study of nanoformulation.
4] Study the concept of nanodrug

Credits (Total Credits 2)	Semester VI BNTT-605 Nanomedicine	No. of hours per unit/credits
UNIT - I	**Nanobiology and Nanomedicine**	**(12)**
	Introduction to Nanobiology and Nanomedicine Nanobiology – Introduction. Biological Nanostructures and natural biological assemblies at nanoscale: Bacterial S layers, phospholipid membranes, viruses, Nucleic acids, Oligosaccharides, polysaccharides, biological polymers, Proteins. Biological nanomotors, protein assemblies: Kinesin and dynein, cilia. Bacterial flagella: structure and function; nanomotor. Ion channels: nanopores of high specificity. Bioinspired nanomaterials:DNA and peptide based. Interaction between biomolecules and nanoparticle surfaces.	
Unit : II	**Synthesis of Nanomaterials and nanoformulations**	**(13)**
	Characterization techniques for nanomaterials. Nanobioassemblies : Different types of inorganic materials used for thesynthesis of hybridnanobio Assemblies. Concept of drug and formulation/dosage form. Physicochemical and biological properties of drugs. Routes of dosage for madministration. Formulation of nanocrystals, nanoemulsions, polymeric micelles. Introduction to liposome and solid lipid nano particles (SLN). Fate of nanoformulations in body.	
Unit :III	**Nanomedicine**	**(10)**
	Applications of nano in biology. Concept of disease, Cause and molecular/cellular progression of key diseases including infectious, inherited diseases, immunological diseases and cancer. Approach to developing nanomedicines. Various kinds of nanosystems in use.	
Unit : IV	**Nanodrug**	**(10)**
	Nanodrug administration nanodevices for drug deliveryand theranostics. Polymer Nanoparticles for drug and small silencing RNA deleivery to treat cancer of different phenotypes, Mechanism of drugs delivery to tumors by polymer nanoparticles, applications and challenges of nanomedicine. Nanomedicine and tissue engineering, nanobiomachines and nanorobots.	

Course Outcomes :

Unit - I: After completion of the unit, Students will be able to:

1] Understand the concept of Biological Nanostructures.

2] Understand the Biological nanomotors.

Unit - II: After completion of the unit, Students will be able to :

1] Understand the concept of Nanobioassemblies.

2] Understand the properties of drugs.

Unit - III : After completion of the unit, Students will be able to :

1] Understand the cellular progression.

2] Understand the developing nanomedicine.

Unit - IV : After completion of the unit, Students will be able to:

1] Understand the challenges of nanomedicine.

2] Understand the concept of Nanodrug administration

References:

1] Introduction to Nanotechnology. John Wiley and Sons.,Charles P. Poole Jr. and Franks.
2] J. Qwens (2003)
3] Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology, Imperial college Press Ehud Gazit (2007)
4] Springer Handbook of Nanotechnology. Springer Verlag, Bharat Bhushan (2007)
5] Nanofabrication towards biomedical application: Techniques, tools, Application and impact, John Wiley and sons. Challa S., S. R. Kumar, J. H. Carola (2006
6] Nanomedicine, Vol. I: Basic Capabilities,Robert A. Freitas Jr (2003)
7] Biomedical Nanotechnology. Taylor and Francis. CRC press, Neelina H. Malsch (2005)
8] Nanoscience: Nanobiotechnology and Nanobiology,Patrick Boisseau, Marcel Lahmani, Springer Publishers (2009)
9] Nanoscale Technology in Biological Systems. Ralph S. Greco, Fritz B. Prinz, R. Lane Smith (Editors) CRC Press (2004) .

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SECC - BNTT - 607: Scientific and Technical Writing - II
Lectures 15: Credit 01

Course Objectives: Student should

1] Learn to read and understand research articles.
2] Learn to write research article.

Credits (Total Credits 2)	**Semester VI** **BNTT - 607** **Skill enhancement compulsory course scientific course II**	**No. of hours per unit/credits**
UNIT - I	**Language functions**	
	Agreeing disagreeing, classifying, comparing, contrasting, defining, emphasizing, generalizing, paraphrasing and quoting. **Grammar :** Adverbs, articles, numbers, passive voice, punctuation, verbtenses, word order **Words :** Abbreviations, prefixes and suffixes	
UNIT - II	**Assignment - II : Writing of research article**	

Course Outcomes:

After completion of this course, students are able to write research articles.

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SECC-BNTP-612: Project work (Credits 02)

1] Students should submit project report .
2] Certificate of paper presentation
3] Research paper presented .

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