Rayat Shikshan Sanstha's

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA

(AN AUTONOMOUS COLLEGE)

Reaccredited by NAAC with 'A+' Grade

Bachelor of Science

Part - II

Nanoscience and Technology

Syllabus

to be implemented w. e. f. June, 2022

Structure of the Course:

2) Semester -III

	Theory				Practical			
	Paper Code	**No. of lectures/ Week**	**Clock Hours/ week**	**Credits**	**Paper Code**	**No. of lectures/ Week**	**Clock Hours/ week**	**Credits**
1.	BNTT-301	2	2	2				
2.	BNTT-302	2	2	2	BNTP-311	4	4	2
3.	BNTT-303	2	2	2				
4.	BNTT-304	2	2	2	BNTP-312	4	4	2
5.	BNTT-305	2	2	2				
6.	BNTT-306	2	2	2	BNTP-313	4	4	2
7.	BNTT-307	2	2	2				
8.	BNTT-308	2	2	2	BNTP-314	4	4	2
9.	BNTT-309	2	2	2				
10.	BNTT-310	2	2	2	BNTP-315	4	4	2
11.	BNTT-AECC-2	2	2	2				
	Total of SEM III	22	22	22		20	20	10
Total No. of Credits for Semester III = 32								

3)Semester-IV

Sr. No.	Theory				Practical			
	Paper Code	**No. of lectures/ Week**	**Clock Hours/ week**	**Credits**	**Paper Code**	**No. of lectures/ Week**	**Clock Hours/ week**	**Credits**
1.	BNTT -401	2	2	2				
2.	BNTT -402	2	2	2	BNTP-411	4	4	2
3.	BNTT -403	2	2	2				
4.	BNTT -404	2	2	2	BNTP-412	4	4	2
5.	BNTT -405	2	2	2				
6.	BNTT -406	2	2	2	BNTP-413	4	4	2
7.	BNTT -407	2	2	2				
8.	BNTT -408	2	2	2	BNTP-414	4	4	2
9.	BNTT -409	2	2	2				
10.	BNTT -410	2	2	2	BNTP-415	4	4	2
11.	BNTT - AECC-2	2	2	2				
	Total of SEM IV	22	22	22		20	20	10
Total Credits= Sem-III & IV =64								

Student contact hours per week- 42 hrs

Total Marks for B. Sc-II (Including environmental Science) = 1600

AECC 2- Ability Enhancement Compulsory Course (BNTT -AECC-2 & BNTT -AECC-2) Environmental Science

Separate passing is mandatory for Theory, Internal and Practical.

Practical Examination will be conducted at semester end for 50 Marks per DSC course (subject). Passing Criteria -minimum 40%

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

Semester III

Sr. No	Course Code	Title of the Course
1.	BNTT-301	Thermal Physics
2.	BNTT-302	Optic, Lasers and Crystallography
3.	BNTT-303	Physical Chemistry
4.	BNTT-304	Organic Chemistry
5.	BNTT-305	Biomolecules and General Microbiology I
6.	BNTT-306	Biomolecules and General Microbiology II
7.	BNTT-307	Statistical Methods for Nano Sciences-I
8.	BNTT-308	Statistical Methods for Nano Sciences-II
9.	BNTT-309	Electronic Instrumentation
10.	BNTT-310	Measurement Techniques
11.	BNTT- AECC-2	Environmental science
12.	BNTP -311	Physical Science Lab
13.	BNTP -312	Chemical Science Lab
14.	BNTP -313	Biotechnology Lab
15.	BNTP -314	Computational Methods Lab
16.	BNTP -315	Instrumentation Lab

Semester IV

Sr. No	Course Code	Title of the Course
1.	BNTT-401	Classical Mechanics
2.	BNTT-402	Modern Physics
3.	BNTT-403	Inorganic Chemistry
4.	BNTT-404	Analytical Chemistry
5.	BNTT-405	Nanobiology I
6.	BNTT-406	Nanobiology II
7.	BNTT-407	Statistical Methods for Nanoscience-III
8.	BNTT-408	Statistical Methods for Nanoscience-IV
9.	BNTT-409	Analytical Instrumentation I
10.	BNTT-410	Analytical Instrumentation II
11.	BNTT -AECC-2	Environmental science
12.	BNTP -411	Physical Science Lab
13.	BNTP -412	Chemical Science Lab
14.	BNTP -413	Biotechnology Lab
15.	BNTP -414	Computational Methods Lab
16	BNTP -415	Instrumentation Lab

B.Sc. II: Evaluation structure
Semester III and IV

Course	ESE	Internal Exam		Submission		Practical			Total
		ISE-I	ISE-II	Home assignment	Case Study	Course	Exam	Journal	
BNTT-301	40	5	5	5	5	BNTP 411	25	5	150
BNTT-302	40	5	5	5	5				
BNTT-303	40	5	5	5	5	BNTP 412	25	5	150
BNTT-304	40	5	5	5	5				
BNTT-305	40	5	5	5	5	BNTP 413	25	5	150
BNTT-306	40	5	5	5	5				
BNTT-307	40	5	5	5	5	BNTP 414	25	5	150
BNTT-308	40	5	5	5	5				
BNTT-309	40	5	5	5	5	BNTP 415	25	5	150
BNTT-310	40	5	5	5	5				
BNTT-AECC-2	30	-	-	-	-	Project	20	-	50
Total	430	50	50	50	50		145	25	800

This evaluation scheme is same for semester IV

Semester – III

BNTT - 301: Thermal Physics

Course Objectives: Student will be able to:

1) Understand properties of ideal and real gases.
2) Understand of laws of thermodynamics.
3) Get comprehensive idea of thermal conductivity, diffusion etc.
4) Learn about importance of entropy.

Credits (Total Credits 2)	Semester III BNTT-301 Thermal Physics	No. of hours per unit/credits
UNIT - I	**Kinetic Theory of Gases Ideal and Real Gas**	**(09)**
	Interpretation of temperature, Andrew experiment and curve, critical constants, Relation between critical constants and Vander Waal's constant), Principle of thermometry, types of thermometers, Platinum resistance thermometer.	
UNIT - II	**Transport Phenomena**	**(07)**
	Mean free path, transport of momentum (viscosity), Energy (conduction) and mass (Diffusion), law of equipartition of energy (no derivation) and its application to specific heat of gases; mono-atomic and diatomic gases.	
UNIT - III	**Thermodynamics – I**	**(07)**
	Thermodynamical state, Thermodynamic equilibrium, zeroth law of thermodynamics, first law and internal energy, conversion of heat into work, various thermodynamical processes (application of first law): general relation between Cp and Cv, work done during isothermal and adiabatic processes, reversible and irreversible processes	
UNIT - IV	**Thermodynamics - II**	**(07)**
	Second law of thermodynamics (different statements), Carnot's reversible engine, Carnot's cycle, efficiency of Carnot's engine, Carnot's theorem), Entropy, entropy changes in reversible and irreversible processes, entropy-temperature diagram, third Law of thermodynamics	

Course Outcomes: Student should be able to

1) Define behavior of real and ideal gases
2) Explain laws of thermodynamics, concept of entropy, thermodynamical state and equilibrium conditions
3) Calculate critical constant for real gases.
4) Calculate thermal conductivity of materials.

References-

1. Treaties on Heat and Thermodynamics, Brijlal and Subramanyam, (Delhi: S. Chand and Co. Ltd, 2010)
2. Heat and Thermodynamics, Zemansky M. W. and Dittman R., (India: The McGraw Hill company, 7th edition 2007.
3. Thermal Physics, Garg S, Bansal. R and Ghosh C, (India: Tata McGraw hill Publishing, Co. Ltd, 2nd Edition 2013)
4. Mathematical Physics of Black Body Radiation- Claes Johnson, Icarus I Ducation 2012
5. Introduction to Quantum Mechanics, Griffith David J. (Cambridge: Cambridge University Press; August16,2018)
6. Mechanics wave motion, heat, Sears Francis, (Addison-Wesley Publishing Company (1958).
7. Kinetic theory of gases- Earle H. Kennary (New York : McGraw Hill company, First Edition, 1901)

Course: BNTT - 302: Optics, Lasers and Crystallography

Course Objectives: Student will be able to

1. Get fundamental knowledge of interference and diffraction pattern of waves.
2. Understand properties and applications of LASER
3. Learn Optical fiber system
4. Understand crystal structure

Credits (Total Credits 2)	**SEMESTER-III** **BNTT 302- Optics, Lasers and Crystallography**	**No. of hours per unit/credits**
UNIT - I	**Interference of light**	**(06)**
	Interference in thin films: parallel and wedge- shaped films, Michelson's interferometer and its applications to measure (i) Wavelength of light (ii) Refractive index of thin film, construction and working of Fabry-Perot interferometer, superiority of F-P interferometer over Michelson's interferometer	
UNIT - II	**Diffraction of light**	**(06)**
	Fraunhofer diffraction: multiple slits and diffraction grating, Fresnel diffraction: half period zones, zone plate, Fresnel diffraction pattern of a straight edge, a slit and wire using half-period zone analysis	
UNIT - III	**Crystallography**	**(08)**
	Crystal structure (Elementary idea), lattice and basis, Unit cell, fundamental type of lattices, miller indices, lattice planes, simple cubic, FCC and BCC lattices, reciprocal lattices, Brags law, powder method of X ray diffraction, analysis of cubic crystal structure	

UNIT - IV	Optical fibers	(10)
	A) Principle and structure, type of optical fibers, numerical aperture (definition only) and pulse dispersion in step index fiber, fiber optic communication system (quantitative treatment only), advantages of optical fibers B) **Laser system:** Absorption, spontaneous and stimulated emission, Einstein coefficients (only definitions), population inversion, optical and electrical pumping, properties of lasers, Ruby laser, Helium- Neon laser, uses of laser, idea of holography (qualitative treatment only).	

Course outcomes-Students should be able to

1) Explain interferometer & uses of various interferometer.
2) Define diffraction and conditions for diffraction
3) Analyse structure of crystal using X-ray diffraction
4) Define Absorption, spontaneous and stimulated emission.

References

1) Text book of optics for B.Sc. Classes, BrijLal and Subrahmanyam N. (New Delhi :S. Chand& Company Ltd,2006)
2) Fundamentals of Optics, F A Jenkins and H E White, McGraw-Hill, 1976.
3) Optics, Ghatak Ajay, (New Delhi: Tata McGraw- Hill Publishing Company Ltd., 2nd Edition,1992).
4) Laser and nonlinear optics, Laud B. B., (New Delhi: New Age International Publisher, 3rd Edition, 2011)
5) Optics and atomic Physics, Satya Prakash, (Meerut: Pragati Prakashan,1st edition, 2017)
6) Solid state physics, Kittle. Charles, (India: Wiley and sons' publications, 7th Edition, 1996)
7) Physics of light and optics, Peatros Justine, Ware Micheal, (Hawai: Brigham Young University, 2013)
8) Introduction to Optics, (India: Pearson Education,3rd edition, 2006)
9) Optical fiber communication, Bagad V S, (Pune: Technical Publications, 2009)
10) Solid state physics, Wahab. M., (New Delhi: Narosa Publishing House, 3rdEdition,2015)

BNTP - 311: Physical Science Practical- Lab Course -XI

Course Objectives: Student will be able to

1) Understand concept of optics.

2) Understand wave mechanics and Thermodynamics.
3) Understand thermal conductivity.
4) Understand use of temperature transducer,

Credits (Total Credit 02)	SEMESTER-III BNTP- 311-Physical Science Practical Lab Course-XI	No. of hours per unit/credits
	1) To study the Schuster's method of optical levelling	
	2) Calibration of spectrometer	
	3) Measurement and identification of spectral lines	
	4) Diffraction due to cylindrical obstacle	
	5) Absorption spectrum of $KMnO_4$ solution	
	6) To determine Thermal conductivity of a bad conductor by Lee's method	
	7) To determine crystal structure of given sample using X-ray diffraction pattern	
	8) To determine the coefficient of thermal conductivity of copper by Searle's method.	
	9) To determine wavelength of given laser light using Diffraction grating	
	10) To study divergence of laser beam 11) Study of transducer- To study the variation of thermo-emf across the two junctions of thermocouple with temperature	
	12) Fresnel's bi-prism	

Course outcomes-Students should be able to

1) Operate spectrometer
2) Operate transducer and calculate parameters.
3) Determine unknown wavelength of light.
4) Calculate divergence of LASER beam

References-

1) Advanced practical physics for students L., and H. T. Flint, (London: Methuen & Co., Ltd,1962)
2) Practical physics Gupta, S.L., and V. Kumar.,. (Meerut: Pragati, Prakashan, 27th Edition. 1973)
3) An advanced course in practical Physics Chattopadhyay, D., and P. C. Rakshit. (Calcutta: New Central Book,2007)
4) Experimental college physics; a laboratory manual White, Marsh W., and Kenneth V. Manning, (New York: McGraw-Hill Publication,1954)

BNTT - 303: Physical Chemistry

Course Objectives: Student will be able to:

1) Understand properties of ideal and real Solutions
2) Get knowledge of Clausius – Clapeyron equation and its importance
3) Understand equivalent and molar conductivity etc.
4) Learn about importance of Carnot's cycle and Efficiency

Credits (Total Credits 2)	**Semester III BNTT-303 Physical Chemistry**	**No. of hours per unit/credits**
UNIT - I	**Solutions**	**(06)**
	a) Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature composition curves of ideal and non-ideal solutions. Distillation of solutions. Fractional distillation, distillation of immiscible liquid, b) Kinetic Theory of Gases: Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation	
UNIT - II	**Phase Equilibrium**	**(08)**
	Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water) and two component systems involving eutectics, congruent and incongruent melting points.	
UNIT - III	**Conductance**	**(08)**
	Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility.	
UNIT - IV	**Electrochemistry**	**(08)**

	Second law of thermodynamics (different statements), Carnot's reversible engine, Carnot's cycle, efficiency of Carnot's engine, Carnot's theorem), Entropy, entropy changes in reversible and irreversible processes, entropy-temperature diagram, third Law of thermodynamics	

Course outcomes: Student should be able to

1) Analyze behavior of Raoult's Law for Ideal and Non ideal Solution
2) Explain Gibbs Phase Rule and its thermodynamic derivation
3) Calculate Transference number
4) Calculate efficiency of Carnot's engine

References-

1) Physical Chemistry, Atkins and de Paula, (Oxford University Press, 10th Edition 2014)
2) Physical Chemistry, Berry, Rice and Ross (Oxford University Press, 2nd Edition 2000)
3) Methods in Physical Chemistry, Schäfer, Schmidt, Rolf Schäfer, Peter C. Schmidt, (Wiley-VCH Verlag GmbH & Co. K Ga A, 2012)
4) Electrochemical Methods: Fundamentals and Applications Allen J. Bard, Larry R. Faulkner, (John Wiley and Sons, 2nd edition, 2000)
5) The Laws of Thermodynamics: A Very Short Introduction, Peter Atkins (Oxford University Press, USA Published April 19th 2010)
6) Physical Chemistry, Ira N. Levine (McGraw-Hill Science, August 29th , 2001)

BNTT - 304: Organic Chemistry

Course Objectives: Student will be able to:

1) Understand various Functional Groups
2) Learn methods of Preparation of amines
3) Study Preparation methods for Alcohol
4) Learn about reactions of aldehyde and Ketone

Credits (Total Credits 2)	**Semester III BNTT-304 Organic Chemistry**	**No. of hours per unit/credits**
UNIT - I	**Carboxylic Acids and their derivatives**	**(06)**
	Functional group: Introduction of functional group, Carboxylic acids (aliphatic and aromatic) Preparation: Acidic and Alkaline hydrolysis of esters. Reactions: Hell – Vohlard – Zelinsky Reaction. Carboxylic acid derivatives (aliphatic) Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their inter conversion	

UNIT - II	**Amines and Diazonium Salts**	**(08)**
	Amines (Aliphatic and Aromatic): Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, and Hofmann Bromamide reaction. Reactions: Hofmann vs. Saytzeff elimination, Carbylamines test, Heinsberg test, Schotten – Baumann Reaction. Electrophilic substitution. Diazonium salts: Preparation: from aromatic amines. Reactions: conversion to benzene, phenol, dyes (methyl orange)	
UNIT - III	**Alcohol and Phenols**	**(08)**
	Preparation of alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. Reactions: With sodium, HX (Lucas test), esterification, oxidation. Oppeneauer oxidation Diols oxidation of diols. Phenols: (Phenol case) Preparation: Cumene hydroperoxide method from diazonium salts.	
UNIT - IV	**Aldehyde and ketone**	**(08)**
	Aliphatic and aromatic: (Formaldehyde, acetaldehyde, acetone and benzaldehyde) Preparation: from acid chlorides and from nitriles. Reactions – Reaction with HCN, ROH, NaHSO3. Iodoform test. Aldol Condensation, Wittig reaction. Clemensen reduction and Wolff Kishner reduction.	

Course outcomes: Student should be able to

1) Understand reactions in Carboxylic acid
2) Explain Hofmann vs. Saytzeff elimination
3) Define reactions of alcohol and phenol
4) Explain Aldol Condensation and Wittig reaction

References-

1) Advanced Organic Chemistry Francis A. Carey, Richard A. Sundberg (Paperback Springer ,5th Edition, 2007.)
2) Organic Chemistry Jonathan Clayden, Nick Geeves, Stuart Warren (Oxford University Press 2nd Edition, 2012)
3) Name Reactions and Reagents in Organic Synthesis Bradford P. Mundy, Michael G. Ellerd, Frank G. Favaloro (Wiley- Interscience 2nd Edition, March 2005)
4) Organic reaction mechanism V. K. Ahulwalia (Narosa publication, Alpha Science International, Ltd January 30th 2011)
5) Organic Chemistry Paula Y. Bruice (Prentice Hall 6th Edition, 2010)
6) Organic Chemistry, Clayden, Greeves, Warren and Wothers (Oxford University press 7th edition. 2001)
7) Advanced Organic Chemistry, Jerry March (Willy publications 5th edition. 2001)
8) Organic Chemistry by Morrison & Boyd, (Pearson Education India. 7th Edition,2010

BNTP - 312: Chemical Science Practical- Lab Course -XII

Course Objectives: Student will be able to

1)Understand concept of Cell constant
2) Understand Potentiometric titration.
3)Understand Organic Qualitative Analysis
4)Understand Organic Estimation and Preparation Method

Credits (Total Credit 02)	SEMESTER-III BNTP-312-Chemical Science Practical Lab Course-XII	No. of hours per unit/credits
	1)Determination of cell constant	
	2)Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid	
	3)conductometric titrations- Strong acid vs. strong base ii)Weak acid vs. strong base	
	4)Potentiometric titrations: i) Strong acid vs. strong base ii) Weak acid vs. strong base iii) Potassium dichromate vs. Mohr's salt	
	5)Phase Equilibria Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.	
	6)Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.	
	7)Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.	
	8) Organic Qualitative Analysis: i) Acids: Salicylic acid, phthalic acid, aspirin, cinnamic acid, Succinic acid, Oxalic acid, ii) Phenol: β napthol, p-nitro phenol, m-nitro phenol. iii) Base: p-nitro aniline, o-nitro aniline, m-nitro aniline, diphenyl amine. iv) Neutrals: Acetamide, ethyl methyl ketone, Acetophenone, Benzophenone, Benzaldehyde, methyl acetate, chloro benzene, bromo benzene, Nitrobenzene, m-dinitrobenzene, naphthalene, thiourea.	
	9) Organic Estimation: 1) Estimation of Acetone 2) Estimation of Aspirin	
	10) Organic Preparations: 1) Preparation of p– nitroacetanilide 2) Preparation of Dihydropyrimidone 3) Preparation of Benzoic acid 4) Preparation of Benzamide	

Course outcomes-Students should be able to

1) Operate Conductometer
2) Explain concept of Potentiometer and its working
3) Determine Melting Point and Qualitative analysis.
4) Estimate the amount of Aspirin .

Practical references-

1) Inquiry-based Experiments in Chemistry Valerie Ludwig Lechtanski (Oxford University Press, 2000)
2) Laboratory Manual for Principles of General Chemistry, J A Beran (John Wiley & Sons, 6th Edition 2000)
3) Dean's Handbook of Organic Chemistry by John A. Dean; George W. Gokel Publication Date: 2004
4) A. Senior Practical Physical Chemistry, Khosla, B. D.; Garg, V. C. & Gulati, (R. Chand & Co. New Delhi 2011).
5) Comprehensive Practical Organic Chemistry, Ahluwalia, V. K. & Renu (Agarwal Orient Black Swan 2004)

BNTT- 305: Biomolecules and General Microbiology

Course objective: Student will be able to

1) Understand structure and functions of important biomolecules.
2) Study nutrient media for bacterial isolation.
3) Learn different culture techniques for isolation of bacteria.

Credits (Total Credits 2)	**Semester III** **BNTT-305** **Biomolecules and General Microbiology - I**	**No. of hours per unit/credits**
UNIT - I	**Carbohydrates**	**(08)**
	Monosaccharides, Disaccharides, Polysaccharides, Classification. Introduction to: Structural Polysaccharides, Storage Polysaccharides, Complex Polysaccharides, Nanoligno cellulosic material	
UNIT - II	**Lipids and Nucleic Acid**	**(08)**
	Lipid Classification, Fatty Acids, Triacylglycerols, Glycerophospholipids, Sphingolipids Cholesterol. Storage Lipids, Lipids as Signals, Cofactors, and Pigments. **Applications of Nano-capsules:** Nano-capsule for efficient delivery of pesticides, fertilizers and other agrochemicals, Liposomal nano- capsules in food Science and agriculture	
UNIT - III	**Microbial Nutrients**	**(07)**

	Culture media: Synthetic or defined media, complex media, types of media, selective media, differential media. Common nutrient requirements, requirements for carbon, hydrogen, and oxygen, types of microorganisms based on nutritional requirements.	
UNIT - IV	**Pure Culture Techniques**	**(07)**
	Isolation of pure cultures, spread plate, streak plate, pour plate method. colony morphology and growth. Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.	

Course Outcomes: Students should able to

1) Explain structures of different carbohydrates, classification of carbohydrates.
2) Classify lipids, structures of different lipids, functions of lipid in biological system.
3) Classify micro-organism's based on their nutrient media, carbon and energy source.

References

1) Lehninger's- Principles of Biochemistry, D. L. Nelson and M. M. Cox , (CBS Publications, 7th edition, United Kingdom, 2017)
2) Biochemistry, Jermey berg, Lubert Stryer, (W.H. Freeman and Company, 5th Edition, Dallas, TX, United States, 1975)
3) General Microbiology, Stanier, Adelberg and Ingraham, (The Macmillan Press Ltd, Hong Kong, 1976. 4th Edition)
4) Cell biology, genetics, molecular biology, evolution and ecology, Verma and Agarwal,(S. Chand and company, New Delhi, 2006. 4th edition)
5) Molecular Cell Biology, Lodish et al (W.H. Freeman & Company, New York, United states, 2006. 5th edition)

BNTT - 306: Biomolecules and General Microbiology

Course objective: Student will be able to

1) Learn structure and functions of biological nanostructures.
2) Understand concept of microbial growth and its characteristics.
3) Understand bacterial reproduction and their control.

Credits (Total Credits 2)	**Semester III** **BNTT-306** **Biomolecules and General Microbiology – II**	**No. of hours per unit/credits**

UNIT - I	**Proteins**	**(08)**
	Overview of amino acids and protein, Peptide bond, Primary, Secondary, Tertiary and Quaternary Structures. Fibrous protein, globular proteins. Protein Stability, Protein folding and denaturation.	
UNIT - II	**Enzymes and Vitamins**	**(08)**
	Enzymes: Classification, Overview of structure, function and mechanism of actions of enzymes Vitamins and Minerals: Importance and role of vitamins, Types of vitamins, water soluble and fat-soluble vitamins. Minerals, micro nutrients, macronutrients, roles and functions, disorders of mineral deficiency.	
UNIT - III	**Microbial growth**	**(07)**
	Microbial growth, Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. The influence of environmental factors on growth: solutes and water, activity, pH temperature oxygen concentration pressure radiation	
UNIT - IV	**Bacterial Reproduction**	**(07)**
	Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria. Control of Microorganisms: By physical, chemical and chemotherapeutic Agents **Fermentation:** Definition, basic concepts of fermentation traditional fermentations (wine, beer), contemporary fermentations (vinegar and citric acid, antibiotics). Fermentation for Nanomaterial isolation.	

Course Outcomes: Student should be able to**:**

1) Explain formation of proteins with the help of amino acids.
2) Define role of vitamins and minerals in biological system.
3) Prepare different cultures for microbial growth.
4) Calculate growth of reproduction of micro-organisms.

References:

1) Lehninger's- Principles of Biochemistry, D. L. Nelson and M. M. Cox , (CBS Publications, United Kingdom, 7th edition 2017)
2) Biochemistry, Jermey berg, Lubert Stryer, W.H. Freeman and Company, 5th Edition, Dallas, TX, United State, 1975.
3) General Microbiology, Stanier, Adelbergand Ingraham,(The Macmillan Press Ltd, Hong Kong , 4th Edition, 1976)
4) Cell biology, genetics, molecular biology, evolution and ecology, Verma and Agarwal, (S. Chand and company, New Delhi, 2006, 4th

edition)
5) Molecular Cell Biology, Lodish et al. (W.H. Freeman & Company, New York, United states, 5th edition 1992)
6) Biochemistry -U. Satyanarayanan & U. Chakrapani, (Elsevier-India, , 5th edition 2008.)

BNTP - 313: Biotechnology Lab Course -XIII (Credits: 02)

Course objective: Student will be able to

1) Study different staining techniques of bacteria.
2) Learn the biochemical isolation of bacteria and characterization of bacteria
3) Study preparation of media and sterilization techniques.
4) Understand separation of amino acids by paper chromatography.

Credits (Total Credit 02)	**SEMESTER-III BNTP-313 Biotechnology Lab Course XIII**	**No. of hours per unit/credits**
	1. Isolation of bacteria & their biochemical characterization	
	2. Staining methods: simple staining, Gram staining, negative staining, hanging drop.	
	3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.	
	4. Determination of bacterial cell size by micrometry	
	5. Enumeration of microorganism - total & viable count. Separation of Amino acids by paper chromatography. Qualitative tests for Carbohydrates, lipids and proteins	
	6. Determination of total amino acid concentration by ninhydrin method	
	7. Estimation of protein concentration by Biuret method or Lowry method.	
	8. Estimation of reducing sugar concentration by DNSA method.	
	9. To study the growth curve of *E.coli* bacteria.	
	10. Estimation total sugar concentration by Phenol-H2SO4 method	
	11. Estimation total sugar concentration by Anthrone method	

Course Outcomes: Students should be able to:

1) Isolate and characterize bacteria
2) Calculate qualitative estimation of biomolecules.

3) Develop technique of paper chromatography, different staining.
4) Prepare nutrient media for bacterial isolation.

References:

1) Practical Biochemistry: An Introductory Course, (England Publisher: London, 1972)
2) A Textbook of Practical Biochemistry, S. Jayaraman. (APC; 2018)
3) Laboratory Manual in Biochemistry, S. Jayaraman, (New Age, 3rd edition)

BNTT - 307: Statistical Methods for Nano Sciences I

Course Objectives: Student will be able to:

1) Understand techniques of data collection
2) Understand techniques of interpretation.
3) Get knowledge of various measures of central tendencies & interrupt them.
4) Imbibe appropriate statistical techniques to solve problems in real life.

Credits (Total Credits 2)	**Semester III** **BNTT - 307: Statistical Methods for Nano Sciences I**	**No. of hours per unit/credits**
UNIT - I	**Meaning and scope of Statistics**	**(07)**
	Meaning and scope of statistics in industry and physical sciences, population and sample, census method, sampling method. Primary and Secondary data, ungrouped and grouped data, qualitative data (attributes) and quantitative data (variables).	
UNIT - II	**Scales of Measurement**	**(08)**
	Data Presentation: Frequency distribution, Diagrammatic & graphical presentation with real applications- Pie diagram, line diagram. Simple & multiple bar diagram, Histogram, Frequency curve, Ogive Curve, Boxplot.	
UNIT - III	**Concept of Central Tendency**	**(09)**
	Concept of central tendency, criteria for good measures of central tendency. Arithmetic mean (A.M.), Geometric mean (G.M.), Harmonic mean (H.M.) and their properties. Computations of A.M., G.M., H.M., for grouped and ungrouped data. Comparison between averages in accordance with requirements of good average.	
UNIT - IV	**Concept of Positional Averages**	**(06)**
	Concept of positional averages. Median, mode and their properties, Computations of medianand mode for ungrouped and grouped data.	

Course Outcomes: Students should be able to:

1) Define different data types.
2) Explain scales of measurement, graphical tools.
3) Calculate Mathematical Averages (A.M., G.M., H.M.)
4) Compute positional Averages (Median, Mode).

References-

1) Fundamentals of Statistics, A.M. Goon, M. K. Gupta, B. Das Gupta, (The World Press Private Ltd., Calcutta, 4th Edition, 1968)
2) Fundamental of Statistics S. C. Gupta, (Himalaya Publishing House, Mumbai ,7th Edition, 2018)
3) Mathematical Statistics E. Freund, 1985, (Pearson Publication, Prentice Hall, London. 8th Edition)
4) Basic Statistics B. L. Agarwal, 2013, (New Age International Private Ltd., Delhi. 6th Edition)

BNTT - 308: Statistical Methods for Nano Sciences II

Course Objectives: Student will be able to:

1) understand various techniques in statistical data.
2) Compute various techniques and interrupt them.
3) Compute various measures, dispersion, moments, skewness, kurtosis.
4) Compute various measures of central tendencies & interrupt them.

Credits (Total Credits 2)	**Semester III** **BNTT - - 308: Statistical Methods for Nano Sciences II**	**No. of hours per unit/credits**
UNIT - I	**Measures of Dispersion**	**(12)**
	Concept of dispersion, requirements of a good measure of dispersion, measures of dispersion, absolute and relative measures of dispersion. Range, mean deviation, standard deviation and their relative measures. Variance, coefficient of variation and its use. Concepts of measures of skewness and kurtosis.	
UNIT - II	**Correlation**	**(06)**
	Concept of correlation, Bivariate data, scatter diagram, Karl Pearson's coefficient of correlation, Spearman's Rank Correlation coefficient.	
UNIT - III	**Regression**	**(05)**
	Regression: concept, lines of regression, least square method, regression coefficients, relation between correlation and regression coefficients.	

UNIT - IV	Multiple and Partial Correlation and Regression	(07)
	Concept of multiple linear regression, Plane of regression, Yule's notation, fitting of regression plane by method of least squares. Definition of partial regression coefficients and their interpretation. Residual: definition, order, properties. Concept of multiple and partial correlation.	

Course Outcomes: Students should be able to:

1) Calculate Dispersion
2) Explain Co- relation and calculate with various methods
3) Define-regression and their computation.
4) Define Concept of multiple linear regression, fitting of regression.

References-

1) Fundamentals of Statistics, A.M. Goon, M. K. Gupta, B. Das Gupta, (The World Press Private Ltd., Calcutta, 4th Edition, 1968)
2) Fundamental of Statistics S. C. Gupta, (Himalaya Publishing House, Mumbai ,7th Edition, 2018)
3) Mathematical Statistics E. Freund, (Pearson Publication, Prentice Hall, London. , 8th Edition, 1985)
4) Basic Statistics B. L. Agarwal, (New Age International Private Ltd., Delhi. , 6th Edition, 2013,)
5) Fundamentals of Mathematical Statistics, S. C. Gupta, V. K. Kapoor, (Sultan Chand and Sons, 10th Edition New Delhi, 2000).

BNTP - 314 Computational Methods Practical - Lab Course-XIV

Course Objectives: Student will be able to

1) Get familiar with presentation of data using graph.
2) Assess relation between two variable and model it in mathematical form.
3) Understand different measures of dispersions.
4) Understand Moments, Skewness and Kurtosis.

Credits (Total Credit 02)	SEMESTER-III BNTP- 314-Computational Methods Practical Lab Course-XIV	No. of hours per unit/credits
	1)Graphical presentation of the frequency Distribution-I	
	2)Graphical presentation of the frequency Distribution-II	
	3)Measures of central tendency (Grouped Data)	

	4)Measures of central tendency (Ungrouped Data)	
	5)Measures of Dispersion (Grouped Data)	
	6)Measures of Dispersion (Ungrouped Data)	
	7)Moments, Skewness and Kurtosis (Ungrouped Data)	
	8)Moments, Skewness and Kurtosis (Grouped Data)	
	9)Correlation and regression	
	10)Multiple Correlation	
	11)Partial Correlation	
	12)Multiple Regression	

Course outcomes-Students should be able to

1) Analyse given data using appropriate method.
2) Compute correlation between variable and also transform
3) Compute Measures of Dispersion
4) Compute Moment, Skewness and Kurtosis

References-

1) Fundamentals of Statistics, A.M. Goon, M. K. Gupta, B. Das Gupta, (The World Press Private Ltd., Calcutta, 4th Edition, 1968)
2) Fundamental of Statistics S. C. Gupta, (Himalaya Publishing House, Mumbai ,7th Edition, 2018)
3) Mathematical Statistics E. Freund, (Pearson Publication, Prentice Hall, London. 8th Edition, 1985)
4) Basic Statistics B. L. Agarwal, (New Age International Private Ltd., Delhi. 6th Edition, 2013,)

BNTT - 309: Electronic Instrumentation

Course Objectives: Student will be able to:

1) Learn working principle, operation and characteristics of different transducers.
2) Study about selecting transducers.
3) Understand various signal conditioning systems and data acquisition systems.

Credits (Total Credits 2)	**Semester III BNTT-309 Electronic Instrumentation**	**No. of hours per unit/credits**
UNIT - I	**Transducers**	**(02)**

	General Block diagram of Instrumentation system, Classification of transducers, selecting of transducer, Electrical Transducers and their parameters	
UNIT - II	**Sensors and Transducers**	**(12)**
	Electro acoustic transducers: microphone and speaker. Force/Pressure transducers: resistance pressure transducer, strain gauge, and load cell. Temperature Transducers: Thermistor, Thermocouple and RTD, Fiber Optical sensors, Smart sensors.	
UNIT - III	**Signal Conditioner**	**(07)**
	Introduction to Instrumentation Amplifier and active filters. Voltage to frequency convertors (V/F), frequency to voltage convertors (F/V).	
UNIT - IV	**Data Acquisition System**	**(09)**
	Block diagram of DAS, objective of DAS, single channel and multichannel Data Acquisition System, computer-based data acquisition system and data loggers.	

Course outcomes: Student should be able to

1) Classify types of transducers.
2) Define Principle, Construction and working of various types of transducers.
3) Use signal conditioning in instrumentation.
4) Analyze concept of Data Acquisition System.

References-

1) Electronic Instrumentation, Kalsi H. S. (India: Tata McGraw Hill ,2006)
2) Electronic Instrumentation and Measurement Techniques, Cooper W.D. and. Helfrick, A. D, (New York: Prentice- Hall ,2005).
3) Nakra B. C., Chaudry K, Instrumentation Measurement and analysis, (India: Tata McGraw Hill)
4) Instrumentation Devices and Systems, (R. Sarma and V. S.ManiIndia: Tata McGraw Hill (1998).
5) Elements of Electronic Instrumentation and Measurement, Joseph J Carr, (India: Pearson Education (2005)
6) Electronic Instrumentation and Measurements, David A. Bel, (New York: Prentice Hall.2013).
7) "Electronic Measurements and Instrumentation", Oliver and Cage, (India: Tata McGraw Hill)
8) "Measurement and Instrumentation Principles", Morris Alan S (Elsevier Buterworth Heinmann-2008

BNTT - 310: Measurement Techniques

Course Objectives: Student will be able to:

1) Learn about units, standards, error analysis and characteristics of measurement systems.
2) Study basic concepts and definitions in measurement.
3) Understand various AC and DC bridge configurations for relevant parameter measurement.
4) Imbibe importance of various instruments in Measurement.

Credits (Total Credits 2)	**Semester III BNTT-310 Measurement Techniques**	**No. of hours per unit/credits**
UNIT - I	**Principle of Measurements: Measurement and error**	**(06)**
	Static and dynamic characteristics of an instrument, error in the measurements and types of static error, dynamic response of an instrument, significant figure and rounding off the numbers, statistical analysis **System of units of measurement:** fundamental and derived units, international system of units, other system of units. **Standard of measurements:** classification of standard, standard for mass, length and volume, electrical standard, international standards**.**	
UNIT - II	**Resistance measurement**	**(10)**
	Voltmeter-Ammeter method and Whetstone Bridge method, measurement of low resistance: Kelvin's bridge method. **Inductance measurement:** Maxwel 's bridge, **capacitance measurement** :Schering Bridge, **frequency measurement:**Wien bridge, **Voltage and Current measurement:** Introduction, basic DC ammeter, basic DC voltmeter	
UNIT - III	**Digital Instruments**	**(06)**
	Introduction, Digital Frequency Meter, Digital Measurement of Time, Q-meter, complex impendence measurement meters and digital LCR Q-meter.	
UNIT - IV	**Oscilloscopes**	**(08)**
	Cathode Ray Tube, Vertical and Horizontal Deflection Systems, Delay lines, Probes and Transducers, Specification of an Oscilloscope. Oscilloscope measurement Techniques, Special Oscilloscopes – Storage Oscilloscope, Sampling Oscilloscope. Spectrum Analyzer.	

Course outcomes: Student should be able to

1) Define Static and dynamic characteristics of an instrument.
2) Measure Resistance, Inductance, Capacitance, Frequency.
3) Use Digital Instruments such as digital multimeter, frequency meter,
4) Explain functioning of CRO

References-

1) Electronic Instrumentation, Kalsi H. S. (India: Tata McGraw Hill ,2006)
2) Electronic Instrumentation and Measurement Techniques, Cooper W.D. and. Helfrick, A. D, (New York: Prentice- Hall ,2005).
3) Nakra B. C., Chaudry K, Instrumentation Measurement and analysis, (India: Tata McGraw Hill)
4) Instrumentation Devices and Systems, (R. Sarma and V. S.ManiIndia: Tata McGraw Hill (1998).
5) Elements of Electronic Instrumentation and Measurement, Joseph J Carr, (India: Pearson Education (2005)
6) Electronic Instrumentation and Measurements, David A. Bell, (New York: Prentice Hall.2013).
7) "Electronic Measurements and Instrumentation", Oliver and Cage, (India: Tata McGraw Hill)
8) "Measurement and Instrumentation Principles", Morris Alan S (Elsevier Buterworth Heinmann-2008

BNTP - 315 Instrumentation Practical - Lab Course- XV

Course Objectives: Student will be able to

1) Study the characteristics of various types of transducers
2) Understand the working of instrumentation amplifier.
3) Study the various types of data converters

Credits (Total Credit 02)	SEMESTER-III BNTP- 315 Instrumentation Practical's Lab Course-XV	No. of hours per unit/credits
	1) Study of Uncertainty & Errors	
	2) Study of instrumentation amplifier	
	3) Study of Load Cell	
	4) Study of LVDT	
	5) Study of Thermistors	
	6) Study of LDR	
	7) Study of Photodiode	

	8) Study of Phototransistor	
	9) Study of Analog to Digital Converter	
	10) Study of Digital to Analog Converter	
	11) Study of Fiber optic sensor	
	12) Study of Uncertainty & Errors	

Course outcomes- Students should be able to

1) Calculate parameters using transducers
2) Explain working of signal conditioners
3) Define working of Data converters.

Practical references-

1) Electronic Instrumentation, Kalsi H. S. (India: Tata McGraw Hill ,2006)
2) Electronic Instrumentation and Measurement Techniques, Cooper W.D. and. Helfrick, A. D, (New York: Prentice- Hall ,2005).
3) Nakra B. C., Chaudry K, Instrumentation Measurement and analysis, (India: Tata McGraw Hill)
4) Instrumentation Devices and Systems, R. Sharma and V. S. Mani (India: Tata McGraw Hill 1998).
5) Elements of Electronic Instrumentation and Measurement, Joseph J Carr, (India: Pearson Education (2005)
6) Electronic Instrumentation and Measurements, David A. Bel, (New York: Prentice Hall.2013).
7) "Electronic Measurements and Instrumentation", Oliver and Cage, (India: Tata McGraw Hill)
8) "Measurement and Instrumentation Principles", Morris Alan S (Elsevier Buterworth Heinmann-2008

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SEMESTER- IV

Course- BNTT 401- Classical Mechanics

Course Objectives: Student will be able to

1) Study Lagrange mechanics and its application.
2) Learn methods of calculation of variation.
3) Study methods for calculating total energy of the moving object.
4) Learn concept of degrees of freedom and its applications

Credits (Total Credits 2)	SEMESTER-IV BNTT-401 Classical Mechanics	No. of hours per unit/credits
UNIT - I	**Lagrangian Formulation**	**(10)**
	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**	**(06)**
	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	
UNIT - III	**Theory of radiation**	**(07)**
	Black body radiation, spectral distribution, concept of energy density, derivation of Planck's law, deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan Boltzmann law and Wien's displacement law from Planck's law, phase space, macrostate and microstate	
UNIT - IV	**Classical Dynamics of Particles**	**(07)**
	Planck's constant and light as a collection of photons; photoelectric effect and Compton effect; De Boglie wavelength; Davisson Germer experiment, failure of Rutherford model, Bohr's Quantization rule, Wave Particle duality, Heisenberg uncertainty principle.	

Course Outcomes: Student should be able to

1) Explain concept of degrees of freedom.
2) Define technique of calculation of variational principle.
3) Solve Lagrange equation to find energy of a motion of an object.
4) Find energy density of radiation.

References.

1. Classical Mechanics Gupta, Kumar and Sharma, (Maharashtra: Pragati Prakashan .2012)
2. Introduction to Classical Mechanics Roy Nikhil Ranjan, (Pune: S Chand

Publication. 2016)
3. Introduction to Classical Mechanics Takwale R.G., Puranik P. S, (India: Tata McGraw 1979)
4. Classical Mechanics, Panat P.V, (New Delhi: Narosa Publication ,2016) .
5. Concepts of Modern Physics, Beiser Arthur, (India: Tata McGraw Hill Education Privet Ltd., 6th Edition,2003)
6. Classical Electrodynamics Puri S. P, (India: Tata McGraw Hill Publishing Company Limited, 2011)
7. Classical Electrodynamics, Jackson J. D., (India: Wiley, 2007)

Course – BNTT 402- Modern Physics

Course Objectives: Student will be able to

1) Get comprehensive idea of quantum mechanics and its application
2) Learn about operators and use of operators
3) Study methods for calculating total energy, momentum in quantum mechanics
4) Learn concept of radioactivity and reaction mechanism

Credits (Total Credits 2)	**SEMESTER-IV BNTT-402 Modern Physics**	**No. of hours per unit/credits**
UNIT - I	**Schrodinger Equation and its formalism**	**(08)**
	Matter wave and wave amplitude, Schrödinger equation (non-relativistic particles), momentum and energy, physical interpretation of wave function, normalization of wave function, Probability, Probability current densityin1-D	
UNIT - II	**Applications of Schrödinger Equation**	**(06)**
	1-D infinitely rigid box- energy eigenvalues, Eigen functions and normalization, Quantum mechanical tunneling- Step potential (Quantitative) and potential barrier(qualitative).	
UNIT - III	**Operators in Quantum Mechanics**	**(09)**
	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)	

UNIT - IV	**Radio activity and nuclear fission and fusion**	**(07)**
	Alpha-Decay, Beta Decay, Energy released in reaction, Pauli's Predictions of Neutrino, Gamma ray emission, Mass deficit, relativity and generation of energy, emission of neutron, Fusion and thermonuclear reactions.	

Course outcomes: Student should be able to

1) Calculate Schrödinger equation for particles (matter wave).
2) Define eigen function and eigen values.
3) Identify different operators and their operations on function
4) Explain decaying process of alpha, beta particles, fusion reactions.

References

1) Fundamentals of physics Halliday Resnik, (India: Wiley India edition 8th Edition, 2012)
2) Fundamentals of modern physics, Nolan Peter J, (Physics Curriculum & Instruction, 1st edition, 2006)
3) Modern Physics Tipler W.H. (New York: Freeman and Company, 6th edition, 2012)
4) Modern Physics S. L. Kakani and Shubhra Kulkarni, (Hyderabad: Viva books Private Ltd2006)
5) Modern Physics Sehgal D. L, Chopra K. L. and Sehgal N. K. (New Delhi: Chand & sons, Reprint 1995,)
6) Introduction to Modern Physics, Richtmyer F. K., Kennard, E. H. John N. Cooper, (India: Tata McGraw Hill Education Private Ltd,6thEdition,1969)
7) A Text book of Quantum Mechanics, (India: Tata McGraw Hill, 2nd Edition.,2010)
8) Quantum Mechanics, Schiff Leonard I., (India: Tata McGraw Hill3rdEdition. 2010.)
9) Concepts of Modern Physics, Rai Choudhury, (India: Tata McGraw Hill Education Private Ltd, Sixth Edition.)

BNTT-411 Physical Science Practical's – Lab course -XVI

Course objectives: Student will be able to

1) Study experiments based on quantum mechanics.
2) Learn about operators and use of operators in Sci-lab and Mat-lab software.
3) Study methods of calculating Planks constant.
4) Learn concept of photoelectric effect and its calculation.

Credits (Total Credit 02)	**SEMESTER-IV BNTT-411 Physical Science Practical's –Lab course XVI**	**No. of hours per unit/credits**
	1) To determine value of Planck's constant using LEDs of at least 4 different colours.	
	2) Verification of Stefan's law of radiation	
	3) To show the tunnelling effect in tunnel diode using I-V characteristics.	
	4) Determine I-V characteristics of Solar Cell.	
	5) To determine the wavelength of laser source using diffraction of single slit.	
	6) Determination of Value of 'h' using Photo diode	
	7) Determination of Intensity of light by Lux meter	
	8) To determine 'e' by Millikan's oil drop method	
	9) To study the photoelectric effect: variation of photocurrent versus intensity and wavelength of light	
	10) Sci-lab Expt. 1 (problem from Quantum Mechanics)	
	11) Sci-lab Expt. 2 (problem from Quantum Mechanics)	
	12) Sci-lab Expt. 3 (problem from Lagrange formulation)	

Course outcomes- Students should be able to

1) Define tunnelling effect
2) Determine value of plank constant
3) Calculate efficiency of Solar cell
4) Calculate value of a Planks constant

Practical references:

1) Advanced practical physics for students L., and H. T. Flint, (London: Methuen & Co., Ltd,1962)
2) Practical physics Gupta, S. L., and V. Kumar (Meerut: Pragati Prakashan,27th Edition.1973)
3) An advanced course in practical physics. Chattopadhyay, D., and P. C. Rakshit. (Calcutta: New Central Book,2007)
4) Experimental college physics; a laboratory manual White, Marsh W., and

Kenneth V. Manning, (New York: McGraw-Hill Publication,1954)

Course- BNTT 403- Inorganic Chemistry

Course Objectives: Student will be able to

1) Study Position of elements in periodic table.
2) Learn methods of preparation of Transuranic elements.
3) Study ligand, co-ordination number.
4) Learn concept of catalysis and its applications

Credits (Total Credits 2)	**SEMESTER-IV BNTT-403 Inorganic Chemistry**	**No. of hours per unit/credits**
UNIT - I	**Chemistry of elements of first transition series**	**(06)**
	Position of elements in periodic table: characteristics of d-block elements with special reference to i) Electronic structure ii) Oxidation states, iii) Magnetic character iv) coloured ions v) Complex formation	
UNIT - II	**Study of f-block elements**	**(08)**
	Lanthanides: Introduction of f-block elements, Occurrence, Positions of Lanthanides in the Periodic Table, Electronics Configurations, Lanthanide contraction, Oxidation states, Magnetic properties. Actinides: Position in periodic table, Electronic configuration, Oxidation States. General methods of preparation of Transuranic elements. i) Neutron capture – followed by β decay. ii) Accelerated projectile bombardment. iii) Heavy ion bombardment.	
UNIT - III	**Coordination Chemistry**	**(08)**
	Introduction - Definition and formation of co-ordinate covalent bond in BF_3 -NH_3, $[NH_4]^+$ and H_2O. Distinguish between double salt and complex salt, Werner's theory-Postulates. The theory as applied to cobalt amines. Definition of ligand, co-ordination number, coordination sphere, effective atomic number. IUPAC nomenclature of coordination compounds.	
UNIT - IV	**Catalysis**	**(08)**
	Introduction, Classification of catalytic reactions – Homogeneous and Heterogeneous. Types of catalysis, Characteristics of catalytic reactions, Mechanism of catalysis. i) Intermediate compound formation. ii) Adsorption	

Course Outcomes: Student should be able to

1) Analyze characteristics of d-block elements.
2) Define electronic Configurations of Lanthanide.
3) Explain concept of Co-ordination Sphere.
4) Differentiate between types of catalysis, Characteristics of catalytic reactions

References.

1) Concise Inorganic chemistry, J. D. Lee (Wiley India Editor 5th edition 2008)
2) Synthesis of Inorganic Materials, U. Schubest and N. Husing (Wiley VCH, 2000)
3) Advanced Inorganic Chemistry: F.A. Cotton, G. Wilkinson, C.A. Murillo, M. Bochmann 6^{th} Edition. 2003)
4) Inorganic Chemistry**:** Shriver and Atkins, (UK: Oxford 4th edition 2003).
5) "d- and f- block Chemistry", C. J. Jones, Tutorial Chemistry Texts, E. W. Abel (Ed.), Royal Society of Chemistry, Cambridge (2001).
6) Organo transition Metal Chemistr**y**, Anthony F. Hill, Royal Society of Chemistry, Tutorial Chemistry Text, 2002.
7) Homogeneous Catalysis: Mechanisms and Industrial Applications, S. Bhaduri and D. Mukesh, Wiley, New York, 2000
8) Homogeneous Catalysis**:** Understanding the Art, P.W.N.M. van Leeuwen, Kluwer Academic Publishers, 2003
9) Catalysis: Principles and Applications, B. Vishwanathan, S. Sivasankar and A. V. Ramaswamy (Narosa Pub. House, New Delhi, 2004)

Course- BNTT 404- Analytical Chemistry

Course Objectives: Student will be able to

1) Study Distillation techniques.
2) Learn methods of Sterilization and disinfection.
3) Study Basic Principle of Chromatography.
4) Learn concept of Volumetric analysis

Credits (Total Credits 2)	**SEMESTER-IV BNTT-404 Analytical Chemistry**	**No. of hours per unit/credits**
UNIT - I	**Purification and Separation Method**	**(06)**

	Distillation techniques- Distillation of liquid mixtures, Types of distillation, Types of columns and packing, Condensers, Vacuum distillation, Spinning-band distillation, Steam distillation, Kiigelrohr distillation, Isopiestic or isothermal distillation, recrystallization techniques, Filtration	
UNIT - II	**Water Analysis**	**(08)**
	Introduction, hardness, Sterilization and disinfection of water; Chemical methods and physical methods of sterilization. Measurement of water quality by chemical and physical examination: Colour Taste, Turbidity, Alkalinity, Suspended solids, Hydrogen ion concentration, Acidity, Chemical Sensors Introduction, definitions, Classification of chemical sensors, descriptions of chemical sensors, electrochemical sensors, potentiometric sensors, voltametric chemical sensors	
UNIT - III	**Chromatography**	**(08)**
	Introduction, Basic Principle of Chromatography, Classification of Chromatography Paper Chromatography- Principle, Methodology, sample loading, choice of solvent, development- location of spots, determination of Rf value, Applications, advantages and disadvantages thin layer chromatography; Principle, preparation of TLC plate, methodology-sample loading, development, detection of spot, Rf value, Applications, advantages and disadvantages	
UNIT - IV	**Quantitative Analysis**	**(08)**
	Theoretical principle involved in quantitative analysis – Volumetric analysis General principle involve in volumetric analysis ii) Standardization of solution Primary & Secondary std; Preparation of std soln. Gravimetric analysis i) Definition & types of gravimetric analysis ii) Precipitation technique with respect to theory iii) Digestion iv) Nucleation v) Co & post precipitation vi) Filtration & washing vii) Drying &Ignition.	

Course outcomes: Student should be able to

1) Define Types of distillation.
2) Explain chemical methods and physical methods of sterilization.
3) Determination of Rf value.
4) Define Types of gravimetric analysis and Volumetric analysis

References.

1) Industrial chemistry by B. K. Sharma, (Goel Publishing Housing, 1st edition 2011)
2) Principles of Environmental Chemistry, James E. Girard Jones and Bartlett. (2nd Ed.2009)
3) Systematic Experiment in Chemistry Arun Sethi (New Age International Publisher. 2006)
4) Vogels Textbook of Quantitative Inorganic Analysis J. Bassett, R. C. Denney.
5) Basic Concepts of Analytical Chemistry**.** Khopkar, S. M. (New Age, International Publisher, 2009.Additional Reading).
6) Dean's Analytical Chemistry by Pradyot Patnaik (Publication Date: 2004)
7) Instrumental Methods Of Chemical Analysis By (author) Gurdeep R Chatwal Sham K. (Anand Himalaya Publishing House 01 Aug 2016)

BNTT-412 Chemical Science Practical's – Lab course -XVII

Course objectives: Student will be able to

1) Study experiments based on Semi-micro qualitative analysis
2) Learns Lambert Beer's Law and use of Colorimetry.
3) Study methods Gravimetric estimation.
4) Learn concept of rate of reaction through chemical kinetics.

Credits (Total Credit 02)	**SEMESTER-IV BNTT-412 Chemical Science Practical's –Lab course XVII**	**No. of hours per unit/credits**
	1)Semi-micro qualitative analysis using H2S of mixtures - not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following: Cations : NH4+, Pb2+, Ag+, Bi3+, Cu2+, Cd2+, Sn2+, Fe3+, Al3+, Co2+, Cr3+, Ni2+, Mn2+, Zn2+,Ba2+, Sr2+, Ca2+,K+ Anions : CO32– , S2–, SO2–, S2O32–, NO3–, CH3COO–, Cl–, Br–, I–, NO3–,SO42-, PO43-, BO3- ,C2O4, F-(Spot tests should be carried out wherever feasible)	
	2)Estimate the amount of nickel present in a given solution as bis (dimethylglyoximato) nickel (II) or aluminium as oximate in a given solution gravimetrically	
	3)Estimation of (i) Mg2+ or (ii) Zn2+ by complexometric titrations using EDTA.	
	4)Gravimetric estimation of Barium.	
	5)Gravimetric estimation of iron.	
	6)Preparation of ferrous ammonium sulphate.	
	7)Preparation of tetra ammino copper (II)sulphate.	
	8) Estimation of total hardness of a given sample of water	

	by complexometric titration.	
	9)Thin layer chromatography.	
	10)Colorimeter (anyone) a) Draw calibration curve (absorbance at λ max vs. concentration) for various concentrations of a given coloured compound (KMnO4/ CuSO4) and estimate the concentration of the same in a given solution. b) Determine the composition of the Fe3+salicylic acid complex solution by colorimetric method.	
	11)Chemical Kinetics a) To study the hydrolysis of methyl acetate in presence of HCl and H2SO4 and to determine the relative strength of acids. b) To study the effect of acid strength (0.5 M and 0.25 M HCl) on hydrolysis of an ester. C)To study the kinetics of the reaction between K2S2O8 and KI in solution with unequal initial concentration of the reactants	

Course outcomes- Students should be able to

1)Calculate Semi-micro qualitative analysis.
2)Determine amount of Compound in gravimetric estimation
3)Calculate the relative strength of acids.
4)Calculate value of Absorbance

Practical references:

1)Qualitative Inorganic Analysis, Svehla, G. Vogel's,2012. Pearson Education
2)Quantitative Chemical Analysis Pearson Mendham, J. Vogel's,2009.
3)A Senior Practical Physical Chemistry D.; Garg, V. C. & Gulati, R. Chand & Co.: New Delhi (2011).

BNTT- 405: Nanobiology - I

Course objective: Student will be able to

1) Study role of microbe in Nanotechnology.
2) Learn nanomaterial synthesis by biological methods.
3) Understand different concepts of immunology and vaccination
4) Understand methods of Vaccines and Vaccinations

Credits (Total Credits 2)	**Semester IV BNTT- 405 Nanobiology – I**	**No. of hours per unit/credits**
UNIT - I	**Role of Microbes in Nanotechnology**	**(08)**

	Microbial synthesis of nanomaterials - Concepts and introduction Bacteria mediated nanomaterials synthesis – Methodology, Mechanism and applications, Fungi mediated nanomaterials synthesis – Methodology, Mechanism and applications, Advantages of microbial/biogenic nanomaterials synthesis methods	
UNIT - II	**Nanomaterials Synthesis**	**(07)**
	Yeast mediated nanomaterials synthesis – Methodology, Mechanism and applications, Plant mediated nanomaterials synthesis – Methodology, Mechanism and applications, Antimicrobial activity of nanomaterials- concept of MIC, MBC, and possible mechanisms of the antimicrobial activities, Isolation and enrichment of metaltolerant microorganism.	
UNIT - III	**Concepts of Immunology**	**(08)**
	T lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T- cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, B cell receptors, monoclonal antibodies, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination. Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS	
UNIT - IV	**Vaccines & Vaccination**	**(07)**
	Vaccines & Vaccination– adjuvants, cytokines, DNA vaccin recombinant vaccines, bacterial vaccines, viral vaccines, vaccines other infectious agents, passive & active immunization. Introducti to immunodiagnostics – RIA, ELISA. Protocols for nano drug administration for Oral administratic Nasal administration and Ocular administration, Nanomaterial used in diagnostic and therapeutic application	

References :

1) Kuby's Immunology, Goldsby RA, Kindt TJ, Osborne BA. (W. H. Freeman and Company, New York.. 6th edition, 2007.)
2) NANO: The Essentials, T. Pradeep Mc Graw, (McGraw-Hill Education, India, 2008.)
3) Synthesis of Nanoparticles and nanomaterial synthesis by biological approaches, (Abdullaeva, _Springer publication ,2017)
4) Immunology, Sharon, Kuby, Judith A Owen; Jenni Punt, (A Stanford; 7th edition, W.H. Freeman, , New York, 2013.)
5) General Microbiology, Roger Y. Stanier, Edward A. Adelberg, John L Ingraham,

(Macmillan 4th edition, 1976.)

Course Outcomes: Students should be able to:

1) Find mechanism of nanoparticle synthesis by bacteria.
2) Analyze mechanism of formation of antibodies and metal tolerance of micro-organisms.
3) Explain receptors of lymphocytes.
4) Explain mechanism of vaccination.

BNTT- 406: Nanobiology II

Course objective: Student will be able to

1) Study basic things of Nanotechnology.
2) Understand concept and applications of Nanochips.
3) Learn concept and applications of Nanomedicine.
4) Study disease treatment with the help of Nanomedicine**.**

Credits (Total Credits 2)	**Semester IV BNTT-406 Nanobiology II**	**No. of hours per unit/credits**
UNIT - I	**The Canvas of Nano and Nanochips**	**(09)**
	The Canvas of Nano: Nano and nature, Nano –The Beginning, Applications of nano in biology. Nanochips**:** Nanoparticles and quantum dots as molecular labels. Diagnostic Nanochips, lab on chip (microfluidic technology) and microelectromechanical systems (MEMS). Nanoprobes for analytical applications.	
UNIT - II	**Nano-diagnostics**	**(07)**
	Nanotechnology in molecular imaging. Materials for use in diagnostic and therapeutic applications. Diagnosis using nanomaterials, Nanoparticles for bioanalytical applications, Nanoparticles for MRI, X Ray, ultrasonography, gamma ray imaging.	
UNIT - III	**Nano-biosensor**	**(06)**
	Biosensor and nano-biosensor basic concepts, characterization, perception, Different types of nano-biosensors; Nano-biosensors for medical diagnostics.	
UNIT - IV	**Nanomedicine**	**(08)**
	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 nano-systems in use. Nanodrug administration nano-devices for drug delivery and theragnostic. Introduction to the potentials, applications and challenges of nanomedicine. Nanomedicine and tissue engineering, nano-bio	

	machines and nanorobots.	

Course Outcomes: Students should be able to

1) Defferentiate concept and applications of Nanotechnology
2) Define mechanism of nanoparticles for bioanalytical applications.
3) Explain Disease diagnostic by nanotechnology.
4) Analyse nanoparticles for different diagnostics technique.

References:

1) NANO: The Essentials, T. Pradeep Mc Graw, (McGraw-Hill Education, India, 2008)
2) Synthesis of Nano-particles and nano-material synthesis by biological approaches, (Abdullaeva , Springer publication, 2017.
3) Nano Materials; A.K. Bandyopadhyay (New Age International-, 2007)
4) Environmental ,Glen E. Fryxell; (Kindle Edition, Imperial College Press, 2nd edition 2012.)

BNTP - 413: Biotechnology Lab Course-XVIII

Course Objectives: Student will be able to

1) Learn to Count leucocytes in blood.
2) Study technique of double diffusion.
3) Study different techniques of ELISA.
4) Understand drug diffusion on agar plates

Credits (Total Credit 02)	**SEMESTER-IV BNTP-413 Biotechnology Lab (Credits: 02)–Lab course XVIII**	**No. of hours per unit/credits**
	1. Differential leucocytes count	
	2. Total leucocytes count	
	3. Total RBC count	
	4. Double diffusion.	
	5. Antigen capture ELISA	
	6. Antibody capture ELISA	
	7. Synthesis of silver nanoparticles from plant.	
	8. Synthesis of silver nanoparticles from bacteria	
	9. Synthesis of silver nanoparticles by green root method.	
	10. Antibacterial activity of silver nanoparticles	

	11. To study Drug Diffusion	
	12. Demonstration of design of nano-diagnostics device.	

Course outcomes: - Students should be able to

1) Determine the concentration of leucocytes in blood.
2) Develop technique of double diffusion., antigen capture ELISA
3) Synthesize nano particles using bacteria, plants etc.

Reference Books:

1) Immunocyte chemical Methods and Protocols, Lorette C. Javois (1st_ Springer Science & Business Media, Secaucus, NJ, United States, 1994.)
2) Immunocyte chemistry: Theory and Practice, Larsson, L. I. CRC, Boca, Raton, FL;1988.
3) A Textbook of Practical Biochemistry, David Plummer McGraw, 3rd edition, Hill Education; India,2017.

Course- BNTT 407: Statistical Methods for Nano-Sciences –III

Course Objectives: Student will be able to

1) Understand basic concepts of probability.
2) Learn between random and non-random experiments.
3) Study probabilities of various events.
4) Learn some univariate probability distribution.

Credits (Total Credits 2)	**SEMESTER-IV** **BNTT-407: Statistical Methods for Nanoscience's –III**	**No. of hours per unit/credits**
UNIT - I	**Sample space and events**	**(06)**
	Concept of experiment with random outcome, sample space, finite and countably infinite sample space, discrete sample space, events, types of events, power set. Simple examples on events.	
UNIT - II	**Probability**	**(09)**
	Classical (a priori) definition of probability of an event, axiomatic definition of probability. Theorems on probability: i) $P(\Phi) = 0$, ii) $P(A^c) = 1 - P(A)$ iii) $P(A \cup B) = P(A) + P(B) - P(A \cap B)$, iv) If A is subset of B then $P(A) \leq P(B)$ $0 \leq P(A \cap B) \leq P(A) \leq P(A \cup B) \leq P(A) + P(B)$ simple examples. Conditional probability and independence of events: Independence of two events, properties and	

	examples. Definition of conditional probability, Bayes theorem and applications. Simple examples.	
UNIT - III	**Univariate Probability distribution and Mathematical Expectation**	**(06)**
	Discrete random variable, probability mass function (p. m. f.), cumulative distribution function(c. d. f.), properties of c. d. f., and examples. Definition of expectation of random variable, properties of expectation, expectation of function of random variable, definition of mean and variance of univariate distribution, Examples.	
UNIT - IV	**Some Standard discrete probability distribution**	**(09)**
	Univariate probability distributions: Definitions of discrete uniform distribution, Bernoulli distribution, Binomial distributionPoisson distribution Mean and variance of these distributions, important properties of these distributions. Applications of these distributions.	

Course outcomes: Student should be able to

1) Explain sample space, power set and identify and different types of event.
2) Explain classical and axiomatic definition of probability
3) Analyze Cumulative Distribution Function
4) Explain different univariate probability distribution

References-

1) Statistical Methods, Gupta S.P. ,2014, (Sultan Publication, 7th Edition)
2) Basic Statistics, S. C. Gupta, V. K. Kapoor, (Sultan Chand and Sons, 2000)
3) Fundamentals of Mathematical Statistics, 10th Edition, New Delhi.

Course- BNTT 408: Statistical Methods for Nano-Sciences –IV

Course Objectives: Student will be able to

1) Knowledge of basic concepts of probability.
2) Understand concept of testing of hypothesis
3) Learn testing hypothesis
4) Understand the Exact sampling distribution and its normal approximation

Credits (Total Credits 2)	**SEMESTER-IV** **BNTT- 408: Statistical Methods for Nano-sciences –IV**	**No. of hours per unit/credits**
UNIT - I	**Sampling**	**(05)**

	Basic terminology used in sampling technique, Concept of sampling for finite population: SRS, SRSWR, SRSWOR, Stratified, systematicSampling, Sampling error (This syllabus is used for higher education)	
UNIT - II	**Exact Sampling Distributions:**	**(10)**
	Chisquare distribution: definition, chisquare variate as the sum of square of n i. i. d. S.N.V., statement of p. d. f., mean, variance, additive property, normal approximation and examples. t distribution: definition, nature of probability curve, statement of mean and variance, normal approximation, examples. F-distribution: definition, interrelationship between normal, chi-square, t and F Distribution.	
UNIT - III	**Random Sampling**	**(07)**
	Notion of random sample from probability distributions, statistic, sampling distribution of statistic. Critical region, idea of one & two tailed test, type I and II errors, level of significance, p – value. Large sample tests: Statement of Central Limit Theorem (CLT) for i. i. d. r. v. s, construction of test statistic and identification of its probability distribution a) Test for proportion: i) H_O: $P = P_O$ ii) Ho: $P_1 = P_2$ b) Tests for means: i) H_O: $\mu = \mu_O$ ii) Ho: $\mu_1 = \mu_2$	
UNIT - IV	**Test Statistics:**	**(08)**
	Small sample tests: If $X_1, X_2, \ldots\ldots, X_n$ is a r. s. from (μ,σ^2)then and S^2 are Independently distributed (without proof), construction of test statistic and identification of distribution of test statistic. a) T tests for means: i) H0 : $\mu = \mu_O$(σ unknown) b) i) Ho: $\mu_1 = \mu_2$ ($\sigma_1 = \sigma_2$unknown) unpaired test. ii) Ho: $\mu_1 = \mu_{2b}$ (paired t test), iv) H0: $\rho=\rho_o$	

Course outcomes: Student should be able to

1) Explain Sampling (SRS, SRSWR, SRSWOR, Stratified)
2) Calculate Exact sampling distributions
3) Explain concepts of Hypothesis, Critical region, Types of errors.
4) Develop test statistic to test hypothesis.

References-

1) Fundamental of Mathematical Statistics Kapoor V. K. and Gupta S. C. (New

Delhi. 2008, 11th Edition)
2) An Introduction to probability andStatistics, K., Saleh A. K. and Md. Ehsan, (Wiley India, Third Edition ,2015)
3) B. L. Agarwal, 2003, Programmed Statistics, (New Age International Publishers, Second Edition)
4) A first course on parametric inference, Kale B. K., (Alpha Science International. 2005,)

BNTT-414 Computational Methods Practical's – Lab course -XVIV

Course objectives: Student will be able to

1) Assess relation between three variable and model it in mathematical form.
2) Get Knowledge of chi-square, F distribution
3) Understand small and large data using testing of hypothesis
4) Learn attributes and to create simulated data set.

Credits (Total Credit 02)	**SEMESTER-IV BNTT-415 Computational Methods Practical's –Lab course XVIV**	**No. of hours per unit/credits**
	1)Simple random sampling for variable	
	2)Simple random sampling for attribute.	
	3)Stratified random sampling.	
	4)Application of Chi-square Distribution	
	5)Application of Student –T Distribution	
	6)Application of F-Distribution	
	7)Large Sample Test	
	8)Small Sample Test	
	9)Applications of Probability	
	10)Applications of Bayse Theorem	
	11)Applications of Binomial Distribution	
	12)Applications of Poisson Distribution	

Course outcomes- Students should be able to

1) Analyse real life situations using testing of hypothesis.
2) Draw simulated data set from given population.
3) Analyse applications of distributions.
4) Compute Measures of Dispersion

Practical references

1) Fundamentals of Statistics, A.M. Goon, M. K. Gupta, B. Das Gupta, (The World Press Private Ltd., Calcutta, 4th Edition, 1968)

2) Fundamental of Statistics S. C. Gupta, (Himalaya Publishing House, Mumbai ,7th Edition, 2018)
3) Mathematical Statistics E. Freund, (Pearson Publication, Prentice Hall, London., 8th Edition, 1985)
4) Basic Statistics B. L. Agarwal, (New Age International Private Ltd., Delhi. , 6th Edition, 2013,)

BNTT - 409: Instrumentation III: Analytical Instrumentation-I

Course Objectives: Student will be able to:

1) Understand the materials are characterized by various spectroscopy
2) Study the basic knowledge of the spectroscopy
3) Get knowledge of spectroscopy techniques.

Credits (Total Credits 2)	Semester IV BNTT-409 **Analytical Instrumentation-I**	No. of hours per unit/credits
UNIT - I	**Ultraviolet Spectroscopy**	**(08)**
	Introduction, nature of electromagnetic radiation, electromagnetic spectrum, brief review of atomic and molecular theory. Ultraviolet Spectrophotometry: Instrumentation, radiation sources, detectors, readout module, filters, monochromators and performance, grating system for single beam and double beam UV spectrophotometry.	
UNIT - II	**Visible Spectrophotometry**	**(08)**
	Instrumentation, radiation sources, detectors, readout module, filters, monochromators and performance, grating system for single beam and double beam Vis Spectrophotometry.	
UNIT - III	**Fluorescence Spectrophotometry**	**(07)**
	Introduction, Theory of Fluorescence: Principle, working and construction, instrumentation for fluorescence measurement: Sources, Monochromator and Detectors.	
UNIT - IV	**Phosphorescence Spectrophotometry**	**(07)**
	Introduction, Theory of Phosphorescence: Principle, working and construction,instrumentation for Phosphorescence measurement: Sources, Monochromator and Detectors.	

Course outcomes: Student should be able to

1) Define concept of electromagnetic spectrum.
2) Use UV Spectrophotometry for band gap measurement.
3) Explain principle and construction of fluorescence spectrophotometry
4) Calculate electronic properties using phosphoresce spectroscopy .

References-

1) UV-Visible Reflection Spectroscopy of Liquids Jukka Räty Kai-Erik Peiponen Toshimitsu Asakura ISBN 978-3-540-45093-1 (eBook) DOI 10.1007/978-3-540-45093-1 (Springer series in optical Sciences)
2) Analytical absorption spectrophotometry in the visible and ultraviolet the principles. Sommer *Professor of Analytical Chemistry J. E. Purkyne University Brno, Czechoslovakia.* ISBN 0-444-98882-3
3) Fundamentals of UV-visible spectroscopy Hewlett-Packard publication number12-5965-5123E
4) Ultraviolet and Visible Spectroscopy Edited by. Helmut Giinzler, Alex Williams Copyright OWILEY-VCH Verlag GmbH,2001.
5) An Introduction to Fluorescence Spectroscopy PerkinElmer 2000
6) Principles of Fluorescence Spectroscopy, Joseph R. Lakowicz, (Springer Science+ Business Media, LLC. Third Edition, 2006)
7) Fluorescence and phosphorescence spectroscopy, Stephen G. Schulman (Pergamon press).

BNTT - 410: Instrumentation IV: Analytical Instrumentation-II

Course Objectives: Student will be able to:

1) Study the characterization techniques.
2) Learn about crystalline size of materials by using X-Ray Diffraction.
3) Imbibe principle of SEM, TEM and AFM microscopies.

Credits (Total Credits 2)	**Semester IV** **BNTT-409** **Analytical Instrumentation-II**	**No. of hours per unit/credits**
UNIT - I	**Infrared Spectroscopy**	**(09)**
	Introduction, Theory of IR spectroscopy, Instrumentation, radiation sources, detectors, readout module. Advantages, applications, interpretation of Infrared (IR) spectra. **Raman Spectroscopy**: Introduction, Theory of Raman spectroscopy, Instrumentation, radiation sources, detectors, readout module, application.	
UNIT - II	**X-Ray Diffraction (XRD)**	**(06)**

	Introduction, Theory of XRD, Production of X-rays and X-ray spectra, instrumental units: sources, X –ray tube, crystal monochromators, detectors for measurement of X- ray radiation. X-ray spectroscopy- Principle, absorption, emission and diffraction of X-rays, Braggs Law, and applications.	
UNIT - III	**Atomic Absorption and Emission Spectroscopy**	**(08)**
	Atomic Absorption Spectrometry (AAS): Introduction, Theory of AAS, Instrumentationfor Atomic Absorption Spectrometry, Nebulizer and atomizer. **Atomic Emission Spectroscopy (AES)**: Introduction, Theory of AES, Instrumentation,spectroscopic sources, atomic emission spectrometer.	
UNIT - IV	**Microscopy**	**(07)**
	Introduction of Scanning Electron Microscopy (SEM): Construction, principle and working. Atomic Force Microscopy (AFM): Construction, principle and working. Transmission Electron Microscopy (TEM): Construction, principle and working.	

Course outcomes: Student should be able to

1) Calculate vibrational frequency using of Raman spectrometry.
2) Explain principle of XRD construction and working of XRD
3) Analyse Atomic AbsorptionSpectrometry
4) Define construction, working and principle of SEM, TEM, AFM.

References-

1. Infrared and Raman spectroscopy: principles and spectral interpretation. Larkin, Peter(Peter J.) ISBN:978-0-12-386984-5.
2. Introductory Raman Spectroscopy (Second edition) Elsevier, 2003 John R. Ferraro,Kazuo Nakamoto and Chris W. Brown ISBN:978-0-12-254105-6
3. D. Cullity-Elements of X-Ray Diffraction Second Edition. ISBN 0-201-01174-3. Elsevier,2003.
4. Atomic Force Microscopy/Scanning Tunnelling Microscopy 3, Samuel H. Cohen and Marcia L. Light body, Kluwer Academic Publishers.
5. Analytical Atomic Absorption Spectroscopy Selected Methods Jon C. Van Loon 1980 A Subsidiary of Harcourt Brace Jovanovich, Publishers.
6. Atomic Absorption Spectrophotometry *By* W. T. Elwell *And* J. A. F. Gidley 1966 Pergamon Press Ltd.
7. Microscopy for Nanotechnology, by Nan Yao. Zhong Lin Wang Kluwer

AcademicPublishers.
8. Microscopy Applications in Materials Science, Solid-state Physics and Chemistry, S.Amelinckx, D. van Dyck, J. van Landuyt , G. van Tendeloo, VCH Verlagsgesel lschaftmb H, Weinheim (Federal Republic of Germany)

BNTP - 415 Instrumentation Practical - Lab Course- XX

Course Objectives: Student will be able to

1) Gain knowledge in characterization techniques
2) Study analysis of the materials by using characterization technique.
3) Study Morphology of materials
4) Learn spectral analysis of FTIR, RAMAN, UV etc.

Credits (Total Credit 02)	**SEMESTER-IV BNTP- 415-Instrumentation Practical's Lab Course-XX**	**No. of hours per unit/credits**
	1) Data interpretation and plotting	
	2) Studies on UV-Visible spectrophotometer	
	3) Studies on X-Ray Diffractions	
	4) FT-IR spectra interpretation	
	5) FT-RAMAN spectra interpretation	
	6) Fluorescence spectra interpretation	
	7) Phosphorescence spectra interpretation	
	8) Scanning Electron Microscope image interpretation	
	9) Atomic Force Microscope image interpretation	
	10) Analysis of atomic absorption spectra	

Course outcomes- Students should be able to

1) Calculate crystal structure of materials by usingXRD.
2) Explain atomic stretching in materials by using IRspectrometer.
3) Analyse morphology of materials by using SEM, TEM andAFM images.
4) Calculate the surface area of colloidal materials by using image of SEM, TEM and AFM

Practical references-

1) Instrumental Analysis Lab Manual, M. J. Prisham, CHM 311, 2018
2) Atomic Absorption Spectrophotometry *By* W. T. Elwell *And* J. A. F. Gidley 1966 Pergamon Press Ltd.
3) Microscopy for Nanotechnology, by Nan Yao. Zhong Lin Wang Kluwer AcademicPublishers.

4) Microscopy Applications in Materials Science, Solid-state Physics and Chemistry, S.Amelinckx, D. van Dyck, J. van Landuyt , G. van Tendeloo, VCH Verlagsgesel lschaftmb H, Weinheim (Federal Republic of Germany)