UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION M.TECH (BIOCHEMICAL ENGINEERING)

Table of Contents

FIRST SEMESTER EXAMINATION

L	T	P	Credits
15	3	12	24

Theory Papers						
Paper ID	**Paper Code**	**Tile**	**L**	**T**	**P**	**Credit**
204501	BCT-501	Advanced Bioreaction engineering	3	1	0	4
204503	BCT 503	Advanced Bioseparation Technology	3	1	0	4
204505	CT-505	Advanced system engineering	3	1	0	4
Elective courses						
204511	BCT-511	Design of Experiment And Analysis Of Engineering Data	3	0	0	3
204513	#BCT-513	Advanced Enzyme Engineering	3	0	0	3
204515	BCT- 515	Fermentation Technology	3	0	0	3
Practical/Viva Voce						
204553	BCT-553	Advanced Bioprocess engineering lab	0	0	6	3
204555	BCT- 555	Advanced Computational Lab	0	0	6	3
		Total	**15**	**3**	**12**	**24**

NOTE: Students can select TWO electives either offered by the department mentioned above or from the list of offered electives from other departments.

#subject to availability of resource person

Paper ID	Paper	L	T	P	Credit
204501	BCT-501 Advanced Bioreaction engineering	3	1	0	4

UNIT I: **16 (Hrs)**

Thermodynamics and rate concept of biological systems; Bioreactor configurations - Batch, Continuous stirred- tank, Tubular, Plug flow, packed bed, Air lift, Fluidized bed, Continuous reactors with cell recycles and wall growth, Trickle bed Bioreactors, Fluidized bed Bioreactor, Upflow anaerobic sludge blanket bioreactor, other membrane bioreactors.

UNIT II: **10 (Hrs)**

Kinetic expression; Monod's equation and its generalization, Continuous (single and multistage), Continuous (single)cell recycle and fed batch cultures operations, kinetics Bioreactor design and optimum operations – Mixing characteristics; Residence time distribution (RTD) in bioreactors and non-ideality, Concentration distribution and Temperature distribution.

UNIT III: **10 (Hrs)**

Introduction, General design information, Design of bioreactors, Basic function of a bioreactor Design, Mass and energy balance, Materials of construction for bioprocess plant, Mechanical design of process equipment, Utilities for biotechnology production plants.

UNIT IV: **10 (Hrs)**

Basic concept of Scale-up of bioreactors and the Bioprocesses from upstream to downstream, Case Studies

Text Books:

1. Principles of Fermentation Technology, Salisbury, Whitaker and Hall, Aditya Text Pvt. Ltd.
2. Bioprocess Engineering: basic concepts, Michael L. Shuler and Fikret Kargi

References Books:

1. Biochemical Engineering Fundamentals, J.E. Baily and D.F. Oillis, McGraw Hill.
2. Biochemical Engineering S. Aiba, A.E. Humphery and N.F. Millis.

Paper ID	Paper	L	T	P	Credit
204503	BCT-503 Advanced Bioseparation Technology	3	1	0	4

UNIT-I **10 (Hrs)**

Introduction: Industrial biochemical Processes, Basic Separation Techniques, Introduction to Bioseparation. Thermodynamics of Separation Operations: Phase Equilibria, Liquid Activity-Coefficient Models, Thermodynamic Activity of Biological Species.

UNIT-II **12 (Hrs)**

Enhanced distillation and supercritical extraction: Use of Triangular Graphs, Extractive distillation, Salt distillation, Pressure –swing distillation, Homogeneous Azeoptropic distillation, Heterogeneous Azeoptropic distillation, Supercritical-fluid extraction.

UNIT-III **12 (Hrs)**

Solid Phase separation Process: Industrial examples, Sorbents, equilibrium considerations, kinetics and transport considerations, solid phase separation techniques, slurry and fixed bed adsorption system, continuous and countercurrent adsorption systems, chromatographic separation, electrophoresis.

UNIT-IV **8 (Hrs)**

Mechanical separation of phases: Separation-device selection, Industrial particle-separator devices, design of particle separator, design of solid –liquid cake filtration devices based on pressure gradients, centrifuge devices for solid-liquid separations, wash cycle, mechanical separations in biotechnology.

Text Books:

1. Seader J.D. and Henley J.E., Separation Process Principles: Chemical and Biochemical Operation, John Wiley & Sons, 2010.

Reference Books:

1. Douglas M, Ruthven, Principles of adsorption and adsorption process, John Wiley & Sons, 1984,
2. Juan A. Asenjo, Separation Process in Biotechnology, CRC Press, 1990
3. Mark McHugh, Val Krukonis, Supercrical fluid extraction: Principles and practice, Elsevier, 2013.
4. Taylor R and Krishna R., Multicomponent Mass Transfer, John Wiley & Sons, 1993

Paper ID	Paper	L	T	P	Credit
14505	**CT-505 Advanced system engineering**	3	1	0	4

UNIT-I **(05 Hrs)**

Introduction to process engineering and optimization, Formulation of various process optimization problems and their classification, Basic concepts of optimization – convex and concave function, necessary and sufficient conditions for stationary points, optimization of one dimensional problems.

UNIT-II **(8 Hrs)**

Unconstrained multi variable optimization – direct search methods, indirect first and second order methods; linear programming and its application: Simplex, Big M & Two Phase methods.

UNIT-III **(10 Hrs)**

Constrained multi level optimization – necessary and sufficient for constrained optimum, quadratic programming (Wolfe's Method and Beale's Method), Generalized Reduced gradient method, optimization of stage and discrete processes, Dynamics Programming, Integer and Mixed Integer Programming (Gomory's algorithm and Branch & Bound technique)

UNIT-IV **(07 Hrs)**

Neural Network: Fundamentals of Neural Network, Back Propagation Network, Simulated annealing. Use of Neural networking in industries, Genetic Algorithm: Fundamentals of genetic algorithm, Genetic Modeling.

Books & Reference:

1. T.F. Edgar and D.M. Himmelblau "Optimization of Chemical Proceses", McGraw Hill Internationaleditions.
2. Rao S S, "Engineering Optimization" New Age
3. Sharma JK. "Operations Research", Macmillian.
4. Bart Kosko, "Neural Network and Fuzzy systems", PHI
5. Rajasekaran R. and Vijaylakshmi GA, "Neural Networks, Fuzzy systems and Genetic algorithm", PHI.
6. G.S. Beveridge and R.S. Schekhter "Optimization theory and practice, McGraw Hill New York.
7. G.V. Rekhlaitis, A. Ravindran and K.M. Ragidell "Engineering Optimization Methods applications, John Wiley, NewYork.
8. James A Anderson, "An Introduction to Neural Networks", Eastern Economy Edition.
9. George J Klier, "Fuzzy sets and Fuzzy Logic", PHI.

Paper ID	Paper	L	T	P	Credit
204511	BCT-511 Design of Experiment and Analysis of Engineering Data	3	0	0	3

Graphical methods of model selection from experimental data. Two variable empirical equations. Liner, logarithmic and semi logarithmic plots. Modified linear, logarithmic and semilogarithmic plots. Reciprocal plots. Equations for lumped data. Elongated "s" curves. Three variables empirical equations. Sterns methods. Multivariable empirical equations. Dimensionless numbers.

Nomography: Introduction. Logarithmic charts. Equations of the form F1(x)+F2(y)=F3(z), F1(x)+F2(y)=F3(z), 1/ F1(x)+1/F2(y)=1/F3(z) and line coordinate charts.

Statistical Analysis: Tests for Fluctuations in process variables. Test for deviation of the variables from standard conditions. Selection of theoretical model to fit the data.

Design of experiments: Factorial design of experiments. Detection of significant variables in the absence and in the presence of experimental errors. 2k factorial design. Fractional factorial design. Box-Wilson method. Estimation of quantitative significance of the variables. Response surface analysis: Interpretation of results. Taguchi, ANNOVA, and RSM related softwares.

Books & Reference:

1. Mokhtar S. Bazara & C.M.Shetty; Non linear Programming, Theory & Algorithums; John Wiley & Sons.
2. Stephan G.N., Ariela Sofer; Linear & nonlinear programming, McGraw Hill.
3. T.F. Edgar and D.M.Himmelblan " Optimization of Chemical Processes", McGraw Hill International editions.
4. G.S.Beveridge and R.S.Schekhter " Optimization theory and practice, McGraw Hill, New York.
5. G.V. Rekhlaitis, A.Ravindran and K.M. Ragidell "Engineering Optimization Methods & applications, John Wiley, New York.

Paper ID	Paper	L	T	P	Credit
204513	BCT-513 Advanced Enzyme Engineering	3	0	0	3

UNIT I: **8 (Hrs)**

Enzyme Introduction and Scope, regulation and control of enzyme in microorganisms.

UNIT II: **8 (Hrs)**

Enzyme kinetics -Single and multiple substrate systems, Inhibition kinetics - substrate, product and inhibitors, effect of pH, temperature, Allosteric regulation of enzymes, Deactivation of kinetics.

UNIT III: **8 (Hrs)**

Large scale production and purification of enzyme; Cofactors and their role in enzyme activity; Immobilization of enzyme and whole cells, External and diffusional mass transfer limitation, Effectiveness factor and modulus.

UNIT IV: **16 (Hrs)**

Process design and operation strategies for immobilized enzyme reactors; Stabilization of enzyme, synzymes, Immobilization of multiple enzyme system; Application of enzyme - Industrial, Analytical and Medical.

Text Books:

1. Enzyme Technology, M.F. Chaplin and C. Bucke, Cambridge University Press.
2. Enzyme Biochemistry, Biotechnology, Clinical Chemistry, Trevor Palmer.
3. Enzyme Kinetics: Behavior and analysis of rapid Equilibrium and steady state Enzyme Systems, I.H. Segel, Wiley-Interscience.

Reference Books:

1. Enzyme: A Practical Introduction to structure, Mechanism and data analysis, R.A. Copeland, John Wiley & Sons Inc.
2. Biotechnological Innovations in Chemical Synthesis, R.C.B. Currell, V.D. Mieras, Biotol Partners staff, Butterworth Heinemann

Paper ID	Paper	L	T	P	Credit
204515	BCT-515 Fermentation Technology	3	0	0	3

UNIT I **6 (Hrs)**

Selection of industrially important cultures; Isolation of pure culture & genetic improvement of industrial microorganisms with applications.

UNIT II **6 (Hrs)**

Process technology for the production of primary metabolites, Baker's yeast, Single Cell Protein, ethanol.

UNIT III **10 (Hrs)**

Biosynthesis and fermentative production of antibiotics – penicillin, semi-synthetic penicillin, streptomycin, tetracyclines, chloramphenicol; Microbial production of antifungal antibiotics; Metabolic regulations in industrial fermentation; microbial production of amino acids-lysine, glutamic acid, microbial transformation of steroids; microbial production of vitamin-β-carotene, vitamin B12, vitamin B6.

UNIT IV **8 (Hrs)**

Recombinant DNA Technology for production of protein (insulin), vaccine (hepatitis), monoclonal antibodies (Herceptine).

UNIT V **4 (Hrs)**

Microbial assay techniques for estimation of antibiotics and vitamins. Application of antibiotics in animal nutrition and food preservation, mycotoxins and microbial insecticides.

UNIT VI **8 (Hrs)**

Use of microbes in mineral beneficiation; Production of biodegradable polymers, biofertilizers, microbial exopolysaccharides – xanthan, gellan etc.

Text Books:

1. Biotechnology, A Text book of Industrial Microbiology, W. Crueger and A. Crueger, Sinauer Association.
2. Principles of Fermentation Technology, Stanbury, Whitaker and Hall, Aditya Text Pvt. Ltd.

Reference Books:

1. Bioprocess Engineering: basic concepts, Michael L. Shuler and Fikret Kargi
2. Bioprocess Engineering, B. K. Lydersen , K.L. Nelson B.K. Lydersen and N.D'Elia, John Wiley and sons Inc.

Paper ID	Paper	L	T	P	Credit
204553	BCT-553 Advanced Bioprocess engineering lab	3	0	0	3

1. Study on protein separation by iron oxide nanoparticles.
2. Study on antibacterial activities of iron oxide nanoparticles against Escherichia coli.
3. Study on in-vitro drug release kinetics using cystamine coated of iron oxide nanoparticles.
4. Determination the fermentation profile of a supplied microorganism. Computation of maximum specific growth rate, growth yield, generation time and maintenance coefficient.
5. Determination of thermal death point and Thermal death time of microorganism for design of an autoclave.
6. Comparative studies of ethanol production using different substrates in batch and Continuous culture/ fed batch culture.
7. Determination of MWCO of membrane and estimation of membrane permeability of different MWCO membrane.
8. Separation of protein from aqueous solution using ultrafiltration and prediction of permeate flux.
9. Separation of polysaccharides from aqueous solution using ultrafiltration and prediction of permeate flux.
10. To separate and identify the amino acids in a mixture by thin layer chromatography
11. Adsorption of methylene blue on biomass.
12. Identify and separate the components of a given mixture of carbohydrates by paper chromatography and calculate the RF value for each component. Learning

Paper ID	Paper	L	T	P	Credit
204555	BCT-555 Advanced Computational Lab	0	0	6	3

Students will be required to do Exercises and to write computer program as well as gain experience in the use of commercially available software such as MATLAB or any simulation software for bioprocess.

SECOND SEMESTER EXAMINATION

L	T	P	Credits
14	2	16	22

Theory Papers						
Paper ID	**Paper Code**	**Tile**	**L**	**T**	**P**	**Credit**
14502	CT502	Computer Aided process Design	3	1	0	4
204502	BCT-502	Bioprocess Instrumentation And Control	2	1	0	3
Elective courses						
204522	BCT-522	Metabolic Engineering	3	0	0	3
204524	BCT-524	Application of membranes in Bioprocess Engineering	3	0	0	3
204526	BCT-526	Bioremediation/Biotransformation	3	0	0	3
204528	#BCT-528	Bioprocess Safety And Management In Industries	3	0	0	3
Practical/Viva Voce						
204554	BCT-554	Minor Project	0	0	16	8
		Total	**14**	**2**	**16**	**24**

NOTE: Students can select THREE electives either offered by the department mentioned above or from the list of offered electives by other departments

#Subject to availability of resource person

Paper ID	Paper	L	T	P	Credit
14502	**CT-502 Computer Aided process Design**	3	1	0	4

Process and cost models, Role & application of mathematical models in process design and optimization, Process synthesis, modelling and development. **(8 Hrs)**

Process flow sheeting. Dynamic modelling and simulation of chemical/ biochemical process with/without recycle. Use of generic software for steady unsteady state material, momentum & energy balance flow sheet simulation, software development for design of process equipment & flowsheet. **(8 Hrs)**

Introduction to design of Separation network, Reactor-Separator network, Flow sheet optimization. **(8 Hrs)**

Process design under uncertainty: Accommodating to future developments; Anticipating the future, Accommodating to linear demand forecast, Non zero initial demand, sizing new chemical plants in a dynamic, economy, Accounting for uncertainty in Data; engineering on safe side, The propagation of uncertainty through designs, Failure tolerance; introduction, Catastrophic results from minor events, preliminary flowsheet review, theory of reliability & its application, Engineering around variation; variability, effects of storage on pulsed supply, analysis of queing theory, intersystem variation, economically optimal utilization, adapting to a variable power supply. **(12 Hrs)**

Course Objectives:

- Train students for various process design problems in industries using computer tools available like ASPENTECH.
- To make students capable for development of the software in process designing.

Books & Reference:

1. Alexander C. Dimian, Integrated Design and Simulation of Chemical Processes, Elsevier,
2. Seider W.D. and Seader J.D., Process Design Principles, John wiley & sons, inc.
3. Rudd and Watson; strategy of process engineering, John wiley & sons, inc. Babu
4. B.V. Basu, Process Plant Simulation,
5. Oxford Luyben, W.L. Process Modelling, Simulation and Control, McGraw Hill Book Co., 1990.
6. Hussain Asgher, Chemical Process Simulation, wiley eastern Ltd., New Delhi, 1986

Paper ID	Paper	L	T	P	Credit
204502	BCT-502 Bioprocess Instrumentation and Control	2	1	0	3

UNIT I **(8 Hrs)**

Biochemical process variables and their measurements; Control principles and their application in bioreactors. On-line, in-line and off-line sensors in Bioreactor.

UNIT II **(12 Hrs)**

Physical And Chemical Parameters In Bioreactors ,Theory of electrode processes and their applications; Measurement and control of pH, temperature, dissolved oxygen, aeration and agitation, redox potential, foam, etc

UNIT III **(12 Hrs)**

Introduction to biosensors; Transduction principles used in biosensors; Characteristics of biosensors; Biosensors based on amperometric, potentiometric, thermistor FET, fiber optics and bioluminescence, Microbial biosensors

UNIT IV **(10 Hrs)**

Fundamentals of digital process control; Use of computer in control and optimization of microbiological processes. Computer Interfaces and peripheral devices; Data logging, Data analysis, Process control\

Text Books:

1. Advanced Instrumentation, Data Interpretation and Control of Biotechnological Processes, J. F. Van Impe, Kluwer Academic.

Reference Books:

1. Principles of Fermentation Technology, Stanbury, Whitaker and Hall, Aditya Text Pvt. Ltd.
2. Biochemical Engineering S. Aiba, A.E. Humphery and N.F. Millis.

Paper ID	Paper	L	T	P	Credit
204522	BCT-522 Metabolic Engineering	3	0	0	3

UNIT I **(8 Hrs)**

Overview of molecular biology and cellular metabolism, different models for cellular reactions, Metabolic regulation network at enzyme level and whole cell level. Basic concepts of Metabolic Engineering.

UINIT II **10 (Hrs)**

Modeling of metabolic networks- stoichiometry, kinetics, mass balance for steady state, mass balance for transient case.

UNIT III **6 (Hrs)**

Metabolic flux analysis- linear programming, cell capability analysis, Genome Scale Flux analysis. Methods for experimental determination of metabolic fluxes- isotope labeling.

UNIT IV **4 (Hrs)**

Metabolic control analysis- nonlinear programming.

UNIT V **14 (Hrs)**

Synthesis and design of metabolic networks - integer programming, mixed-integer nonlinear programming, Case studies – ethanol production, amino acid biosynthesis, other metabolisms in bacteria and yeast.

Text Books:

1. Metabolic Engineering: Principles and Methodologies. Edited by G. Stephanopoulos, A.A. Aristidou, J. Neilson (1988) Academic Press, San Diego, CA.
2. Metabolic Engineering Edited by S.Y. Lee & E.T. Papoutsakis (1999) Marcel Dekker, New York, pp.423.

Reference Books:

1. Biochemistry by J.M. Berg, J.L. Tymockzo and Lubert Stryer (2002) Fifth edition, W.H. Freeman, New York.
2. Understanding the control of Metabolism by David Fell (1997) Portland Press.
3. Metabolism at a Glance by J.G. Salway (1994) Blackwell Scientific Publications, Oxford.

Paper ID	Paper	L	T	P	Credit
204524	BCT-524 Application of membranes in Bioprocess Engineering	3	0	0	3

Membrane processes: Microfiltration, Ultrafiltration, Nanofiltration and Reverse osmosis; Membrane configuration, Criterion of selection of suitable membrane; Factors affecting membrane fouling; Flux enhancement techniques; Cleaning protocol; Concept of integrated membrane process; Process design and energy requirement. **10 (Hrs)**

Models predicting process throughput and permeate quality: Pore blocking model; surface- renewal model, concentration polarization model, gel layer model; osmotic pressure model and resistance in series model etc. **15 (Hrs)**

Applications of membrane and above models: Purification and concentration of protein, enzymes etc.; Dairy industry; Sugar refining; Fruit juice processing; Treatment of plant extract; Alcoholic beverages etc. **10 (Hrs)**

Affinity ultrafiltration and membrane bioreactor. **5 (Hrs)**

References:

1. Membrane in Bioprocessing: Theory and Applications, J.A. Howell, V. Sanches, R.W. Field, Chapman & Hall Inc, London, U.K.
2. Membrane Processes, R. Rautenbach and R. Albrecht, John Wiley & Sons Ltd.
3. Ultrafiltration and Microfiltration Hand book, Munir Cheryan, Second Edition, TECHNOMIC publishing Company Ltd.
4. Microfiltration and Ultrafiltration: Principles and Applications, Principles and applications, Leos J. Zeman, Andrew L. Zydney, Marcel Dekker, New York.

Paper ID	Paper	L	T	P	Credit
204526	BCT-526 Bioremediation/ Biotransformation	3	0	0	3

UNIT I **8 (Hrs)**

Bioremediation/ Biotransformation processes and their developments, Current remediation processes in practices, Benefits of bioremediation

UNIT II **10 (Hrs)**

The soil environment, Fate and Transport of contaminants in soils and water bodies

UNIT III **16 (Hrs)**

Chemical Transformations, Microbial Ecology and Metabolism, Bioremediation of common chemical compounds, *In-situ* bioremediation process strategies.

UNIT IV **8 (Hrs)**

Solid phase bioremediation, Slurry phase bioremediation, Vapour phase bioremediation, Natural attenuation with processes used

Text Books:

1. Eweis, Ergas, Chang and Schroeder, Bioremediation Principles, WCB Mc Graw Hill
2. Alexander M., 1999, Biodegradation and Bioremediation, 2nd edition, Academic Press, USA.

Reference Book(s):

1. Ajay Sing, O.P. Ward, 20204, Biodegradation and Bioremediation, 2nd edition, Academic Press, USA.

Paper ID	Paper	L	T	P	Credit
204528	BCT-528 Bioprocess Safety and Management in Industries	3	0	0	3

UNIT I **6 (Hrs)**

Introduction, Bioprocess Engineering Information Transfer and Management Practices, Need for Bioprocess Safety and management Systems, Bioprocessing Incidents and Releases, An Overview of Bioprocessing Industries, Historical Developments, Good Manufacturing Practice.

UNIT II **12 (Hrs)**

Genetic Advancements, Food Science and Food Process Technology Advancements, Microbiological Advancements, Future Bioprocess Technology Developments and their Risk, Bioprocess Lifecycle, Discovery and Development Phase –laboratory and Pilot Plant for Scaleup, Upstream and Downstream Inoculation, Seed and Production Biosafety, Containment and Production Risks, Fermentation and Cell culture.

UNIT III 8 **(Hrs)**

Use of Biosafety Cabinets, Fume Hood, Laminar Flow Equipment, Facilities Design and Equipment Design for Different Safety Levels, Cleaning, Inactivation, maintenance and sterilization; Air and Gas Emission Pattern in The Lab; Disinfection, Sterilization and Decontamination of Waste, Product Handling and Product Safety Information, Material Disposal and Disposable Process technology, Risk Related to Aerosol Production.

UNIT IV 8 **(Hrs)**

Develop and Document a system to manage Biosafety hazards, Bioprocess Hazard Information,Transportation and Shipping of Hazardeous Material, Incidents and Releases, Management Practices and Programs, Management safety models, Biosafety Training for Workforce, A Generic procedure for Initial Bioprocess Incidents and Response, Applying Behavior based safety to Bioprocesses.

UNIT V 8 **(Hrs)**

Identifying Bioprocess Hazards, Emergency Response Procedures, Effects of Emerging Technology on Bioprocessing Risk Management, Radiation Safety Awareness, Understanding the Reporting System and its Importance.

Text Book:

1. Guidelines for Process safety in Bioprocess Manufacturing, By CCPS, USA.
2. Biosafety in Microbiological and Biomedical Laboratories,2009,5th Edition, HHS Publication

Paper ID	Paper	L	T	P	Credit
204554	BCT-554 Minor Project	0	0	16	8

The student should select an existing experimental rig from U.G. Labs. Analyze the existing experiment being performed. Suggest modification for better performance.

If required, update the existing manual.

Suggest new experiment that may be carried out on existing or modified set up or entirely new set up. Or small research project.

THIRD SEMESTER EXAMINATION

L	T	P	Credits
6	0	36	24

Elective courses						
Paper ID	**Paper Code**	**Tile**	**L**	**T**	**P**	**Credit**
204611	BCT- 611	Nano-biotechnology	3	0	0	3
204613	BCT-613	Immunotechnology	3	0	0	3
204615	BCT-615	#Genomics & Proteomics	3	0	0	3
Practical/Viva Voce						
204651	BCT-651	Major Project (Part-I)	0	0	30	15
204653	BCT-653	Industrial training/Project Seminar*	0	0	6	3
		Total	**6**	**0**	**36**	**24**

***NUES**

NOTE: Students can select TWO electives either offered by the department mentioned above or from the list of offered electives by other departments

#Subject to availability of resource person

Paper ID	Paper	L	T	P	Credit
204611	BCT-611 Nano- biotechnology	3	0	0	3

UNIT-I

Overview and fundamental Principles of Nano biotechnology- History Perspective of Integration of biology, Chemistry, and material science. Opportunities and promises of nano biotechnology. Functional Principles of Nanobiotechnology – Structure and functional properties of Biomaterials bimolecular sensing, Molecular recognition and flexibility of biomaterial.

UNIT-II

Protein and DNA based Nanostructures- Protein based nanostructures building blocks and templates- Proteins are transducer and amplifiers of bimolecular recognition events – Nanobioelectronic devices and polymer nanocontainers- Microbial production of inorganic nanoparticles –Megnetosomes . DNA based nanostructure –Topographic and Electrostatic Properties of DNA and Proteins –Hybrid conjugates of Gold nanoparticles-DNA

UNIT III

Nanomaterials used in biotechnology- Nanoparticles, carbon nanotubes , Quantum dots and buckyballs interface with biological micromolecules. Biological perspectives of nano materials – impact of nanomaterials in biological processes tolerance by immune system and toxicity . Nucleic acid Engineering –Modification of DNA for nano- technological applications. Nanostructure assembly using DNA. Large scale nano particle manufacturing and its particle characterization.

UNIT-IV

Nanotechnology in Biomedical and pharmaceutical industry – Nanoparticles in bone substitute and dentistry and dentistry-Implants – Prosthesis- Reconstructive Intervention and surgery – Nanorobotics in surgery Photodynmics Therpy – Nanosensor in diagnosis – Protein Engineering – Drug delivery –Therapeutic applications.

UNIT –V

Nanotechnology in Agriculture and food technology – Insecticides developments using Nanotechnology and nanofertilizers. Nanotechnology in food Processing, food safety and bio security, toxin and contaminant detection, smart packaging .

UNIT-VI

Biosensing applications of nano biotechnology – Nano –biosensing –Biosenssor and nanobiosensor -basics. Design and types of nano bio sensors. DNA aptamer for Nano biosensing and drug discovery.

Paper ID	Paper	L	T	P	Credit
204613	BCT-613 Immunotechnology	3	0	0	3

UNIT I: **10 (Hrs)**

Phylogeny of immune system, Types of immunity clonal nature of immune response. Organization and structure of lymphoid organs. Antibody structure and function. Major histocompatibility: Complex BCR and TCR, generation of antibody diversity, Complement system.

UNIT II: **10 (Hrs)**

Cells of immune system Hematopoeisis and differentiation, antigen processing and presentation, activation of B and T lymphocytes, cytokines and their role in immune regulation , T cell regulation and MHC restriction, immunological tolerance. Tumor immunology, Transplantation immunology, immunotherapy.

UNIT III: **8 (Hrs)**

Cell mediated toxicity, Hypersensitivity, AutoimmUNITy, Vaccine: General consideration, ideotype network hypothesis, synthetic vaccine.

UNIT IV: **6 (Hrs)**

Product of Hybridoma, Monoclonal antibody and Fab fragments

UNIT V: **8 (Hrs)**

Immuno diffusion, immuno-electrophoresis, ELISA, RIA, fluorescence activated cell sorter (FACS), Hybridoma Technology and its application.

Text Books:

1. Immunology by J. Kubey Fence Creek Publishing (Blackwell).
2. Immunology by Ivan Riott.

Reference Books:

1. Basic immunology, A.K. Abbas and A. H. Lichtman, Saunders W.B. Company.
2. Immunology, Roitt, Mosby- Yearbook Inc.
3. Immunology, W.L. Anderson, Fence Creek Publishing (Blackwell).

Paper ID	Paper	L	T	P	Credit
204615	BCT-615 Genomics & Proteomics	3	0	0	3

GENOMICS

UNIT I: 7 (Hrs)

Introduction to Genome and Gene structure, Structural organization of prokaryotic and eukaryotic genome. Genome assembly and annotation, Basis of population genomics, Contents of genomes, Repetitive DNA. Bioinformatics for the analysis of sequence data.

UNIT II: 7 (Hrs)

Genome expression in Prokaryotes and Eukaryotes, Transcriptomics; RNA Contents, Gene variation and single nucleotide polymorphism, Genetic Markers; Microsatellite DNA markers, RAPD RFLP, DNA sequencing methods, PCR, Microarray: DNA micro array marker, random primers, and computational methods.

UNIT III: **7 (Hrs)**

Genome sequence techniques and application, Functional genomics, metagenomics,The human genome project and the human genetic map. Human disease genes.

PROTEOMICS

UNIT IV: 8 (Hrs)

Introduction to proteomics Protein structure: secondary structural elements, super-secondary structure, domains, mechanism of protein folding. Formation of oligomers. Salting in and Salting out, Protein engineering principles.

UNIT V: 6 (Hrs)

Fundamental methods used in proteomics, Relationship between protein structure and function. Post translational protein modification, Proteome analysis, Protein - protein interactions, Two hybrid interaction screening, Fundamental of system biology.

UNIT VI: 7 (Hrs)

Proteome databases, Use of computer simulations and knowledge-based methods in the protein design process. De-novo design; making use of databases of sequence and structure.

Text Books & References

1. Brown T. A. 2007, Genomes 3. Garland Science Publishing, New York.
2. Dunham, I., 2003. Genome Mapping and sequencing. Horizon Scientific.
3. Lewin B. 2003. Genes VIII. Oxford University Press. Oxford.
4. R.M.Twyman, Principles of Proteomics, BIOS Scientific Publishers, 20204.
5. P.Michael Conn, Handbook of Proteomic Method. Humana Press, Totowa, New Jersey, 2003.
6. Recombinant DNA (Second edition), James D. Watson and Mark Zoller.
7. The Human Genome 2001, Nature Vol. 409.
8. The Drosophila Genome. 2000, Science Vol. 267.
9. The Caenorhabditis elegans genome 1998. Science Vol. 282.
10. The Arabidopsis Genome 2000 Nature vol. 408. 10. Primrose, S. B., and R. M. Twyman . 2006. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA.
11. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G. Veres. 20204. Genetics from Genes to Genomes. McGraw Hill.

Paper ID	Paper	L	T	P	Credit
204651	BCT-651 Major Project Part-I	0	0	30	15

The student should select any one of the topics offered from the department or select one, on his own, duly approved from the department. As part of the project work, candidate should give oral presentation of the work at least one in a semester **(CT - 653**). The candidate is required to submit the detailed synopsis of the work that he would complete in the part-II **(CT - 652)** along with the report of the work already completed.

Paper ID	Paper	L	T	P	Credit
204653	BCT-651 Industrial training/Project Seminar*	0	0	6	3

Based on industrial training at the end of 1st year of 6-8 week duration, candidate should give oral presentation of the work or seminar on any contemporary research area through self-study.

***NUES**

FOURTH SEMESTER EXAMINATION

L	T	P	Credits
0	0	36	18

Practical/Viva Voce						
Paper ID	**Paper Code**	**Tile**	**L**	**T**	**P**	**Credit**
204652	BCT-652	Major Project (Part-II)	0	0	30	15
204652	BCT-654	Project Seminar*	0	0	6	3
		Total	**0**	**0**	**36**	**18**

***NUES**

Paper ID	Paper	L	T	P	Credit
204652	BCT-652 Major Project Part-II	0	0	30	15

Students has to continue the work of CT-651, Major Project Part-I, and complete the work and submit the thesis for evaluation after giving Project Seminar (BCT - 654).

Paper ID	Paper	L	T	P	Credit
204654	BCT-654 Project Seminar*	0	0	6	3

As part of the project work, candidate should give oral presentation of the work atleast one in a semester

***NUES**