ख़्वाजा मुईनुद्दीन चिश्ती भाषा विश्वविद्यालय, लखनऊ, उत्तर प्रदेश (भारत)
Khwaja Moinuddin Chishti Language University, Lucknow, U.P. (India)
U.P. STATE GOVERNMENT UNIVERSITY,
(Recognised Under Section 2(f) & 12(B) of the UGC Act, 1956 & B.Tech. Approved by (AICTE)

FACULTY OF ENGINEERING & TECHNOLOGY

KHWAJA MOINUDDIN CHISHTI LANGUAGE UNIVERSITY, LUCKNOW, UTTAR PRADESH

B.TECH. BIOTECHNOLOGY

Curriculum Structure

FOURTH YEAR
(VII Semester)

Subject – Green Biotechnology and Pollution Abetment

Course Outcome (CO): -	
CO 1:	Understand the principles of biodegradation of xenobiotic compounds, including factors affecting biodegradation and microbial degradation of hydrocarbons.
CO 2:	Evaluate biotransformations and biocatalysts, including enzyme mechanisms, biocatalyst advantages, and the application of isolated enzymes versus whole cell systems.
CO 3:	Apply bioremediation and biorestoration techniques for environmental cleanup, including soil and sludge treatment, phytoremediation, and reforestation strategies using microbes and mycorrhizae.
CO 4:	Explore eco-friendly bioproducts from renewable sources, such as composting, biofuels, biofertilizers, and biopesticides, and assess the role of biotechnology in environmental protection and sustainability.

Course Content:

Unit I: Biodegradation of Xenobiotic Compounds: Xenobiotic compounds–Definition, examples and sources. Biodegradation- Introduction, effect of chemical structure on biodegradation, recalcitrance, co metabolism and biotransformation. Factors affecting biodegradation, microbial degradation of hydrocarbons.

Unit II: Biotransformations and Biocatalysts: Basic organic reaction mechanism- Common prejudices against enzymes, advantages & disadvantages of biocatalysts, isolated enzymes versus whole cell systems, biocatalytic application, catalytic antibodies; stoichiometry.

Unit III: Bioremediation and Biorestoration: Introduction and types of bioremediation, bioremediation of surface soil and sludge, bioremediation of subsurface material, In situ and Ex-situ technologies, phytoremediation- restoration of coal mines a case study. biorestoration: reforestation through micropropagation, use of mycorrhizae in reforestation, use of microbes for improving soil fertility, reforestation of soils contaminated with heavy metals.

Unit IV: Eco-Friendly Bioproducts from Renewable Sources: Fundamentals of composting process: scientific aspects and prospects of biofuel production: bioethanol, biohydrogen and biodiesel; biofertilizers and biopesticides.

Unit V: Biotechnology in Environment Protection: Current status of biotechnology in environment protection and its future, release of genetically engineered organisms in the environment.

Text Books/References:

1. Environmental Processes I-III, J. Winter, 2nd ed., Wiley Publications
2. Introduction to Wastewater Treatment- R. S. Ramalho, Academic Press.
3. Elements of Water Pollution Control Engineering – O.P. Gupta, Khannabooks.
4. Energy Technology – O.P. Gupta, Khannabooks, 2018.
5. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd.

Subject – Chemoinformatics and Medical Chemistry

Course Outcome (CO): -	
CO 1:	Students will able to investigate chemicals and materials that are not practical for laboratory analysis.
CO 2:	Students will able to develop individual model molecules or the behaviors of chemical compounds within the natural world.
CO 3:	Students will able to create and/or work with databases to catalog, categorize, organize, and search the structures of chemicals.
CO 4:	Students will able to employ computational chemistry to simplify problems and make calculations that are used in laboratory experimentation.

Course Content

Unit I: Chemistry & Information technology: Overview of Rational Drug Design, Ligands and Targets, *in-silico* representation of chemical information.

Unit II: Chemical Databases: Data Mining, Chemical/biochemical data collation, retrieval, analysis & interpretation, Molecular Drawing and Interactive Visualization: Building molecules on a computer, Molecular Modeling.

Unit III: Computer-Aided Drug Design: Overview, Structural Homology Modeling Tools, Docking Tools and Screening Tools.

Unit IV: Chemical data science: Artificial intelligence in chemistry, Simulation methods for molecules and materials. Stereochemistry and mechanism, coordination chemistry for drug design, *in silico* tools for medicinal chemistry (docking, MD, *de novo* drug design).

Unit V: Organic reaction mechanism, Logic in organic synthesis, QSAR, pharmacological screening, chemistry of drug action, Pharmaceutical Preformulation, Solid State Pharmaceutics, Drug metabolism, pharmacokinetics, pharmacodynamics.

Practical

1. *in silico* selection of compound from an NCI library against a target protein.
2. Docking, energy minimization and MD simulation of Cyclosporine-CyclophilinA complex
3. Structure based drug design against a target protein such HIV-1 protease using crystal structure from Protein Data Bank
4. Analysis of PK and PD data of a drug candidate
5. Organic synthesis of a stereo-selective small compound and its purification

Text Books/References:

1. Muthukumarasamy Karthikeyan and Renu Vyas. Practical chemoinformatics. Springer, soft-cover ISBN 9788132234913, 2014.
2. Silverman, Richard B., and Mark W. Holladay. The organic chemistry of drug design and drug action. Academic Press, 2014.
3. Bajorath, Jurgen. Chemoinformatics for Drug Discovery. John Wiley & Sons, 2013.
4. Cramer, C.J., Essentials of Computational Chemistry, 2nd Ed., John Wiley & Sons Ltd., 2004.
5. Essentials of Foye's Principles of Medicinal Chemistry – 2016.
6. An Introduction to Medicinal Chemistry, by Graham L. Patrick.
7. Medicinal Chemistry by Ashutosh Kar.

Subject – Data analysis and simulation

Course Outcome (CO): -	
CO 1:	students will be able to gain insights such as correlation and basic analysis using data visualization. get accustomed with deep learning techniques and their applications in biological and healthcare data.
CO 2:	Students can present their research results in probabilistic terms using statistical significance.
CO 3:	Students can build and train machine learning models and evaluate them.

CO 4:	Student will get accustomed with deep learning techniques and their applications in biological and healthcare data.

Course Content:

Unit 1: Data preprocessing and visualization: Types of data, dealing with missing data, data visualization: Scatter Plot, histogram, group plots, box plots etc., dimensionality reduction.

Unit 2: Data analysis: Statistical analysis, hypothesis testing, significance of p-value, chi square, T-test, ANOVA, Bayesian Probability.

Unit 3: Mining Frequent Patterns: Associations and Correlations, Classification.

Unit 4: Machine learning: Supervised, unsupervised, logistic regression, SVMs, decision trees, clustering and model evaluation.

Unit 5: Artificial neural networks: Types of ANN, case studies for the application of deep learning in biology and health care research.

Text Books/References:

1. Introduction to Machine Learning using Python, Jeeva Jose, Khanna Publishing House, 2019.
2. Data Mining: Concepts and Techniques by Jiawei Han, Jian Pei, Micheline Kamber, Elsevier; Third edition 2007.
3. Deep Learning by Ian Goodfellow, Yoshua Bengio, MIT Press 2017.
4. Data Visualization – A Practical Introduction by Kieran Healy, Princeton University Press 2019.
5. Deep Learning – Rajiv Chopra, Khanna Publishing House, 2019.

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Professional Electives
(Semester VII)

Subject – (PE 304) Waste Management & Upcycling

Course Outcome (CO): -	
CO 1:	The students shall get an adequate knowledge on waste and its sustainable management.
CO 2:	Students should get enough knowledge on safety guidelines of waste management.
CO 3:	Students in groups shall develop concepts in managing waste of their institutions.
CO 4:	Students should get experiential learning with a waste management company in the vicinity.

Course Content:

Unit I

Waste management: The definition of waste, and its classification in the context of EU legislation, policy and other drivers for change, including the planning and permitting regime for the delivery of waste management solutions

Liquid waste collection, treatment and disposal systems: Segregation and mixing schemes; Pre-treatment and its role in the industrial wastewater management; Overview of wastewater treatment technologies and development of wastewater treatment schemes; Operation and maintenance of effluent treatment plants; and Case study of an industrial wastewater management system.

Air Pollution management and treatment: Overview of industrial emissions; Air pollution control systems and overview of air pollution control technologies; Development of schemes for the collection, treatment and discharge industrial emissions;

Unit II

Technologies for Waste treatment technologies: waste incineration and energy from waste, pyrolysis and gasification, anaerobic digestion, composting and mechanical biological treatment of wastes, managing biomedical waste.

Unit III

Health considerations in the context of operation of facilities, handling of materials and impact of outputs on the environment; Advances in waste recycling and recovery technologies to deliver added value products; Landfill engineering and the management of landfill leachate and the mining of old landfills.

Unit IV

Interface of waste and resource management and civil engineering in the context of sustainable waste management in global cities and developing countries; and Use of decision support tools including multi-criteria analysis, carbon foot-printing and life- cycle analysis, as appropriate.

Unit V

Waster Upcycling, waste reuse, Waste down cycling, waste upcycling a social enterprise, Case study in each area. Innovative technologies for sustainable waste management.

Text Books/References:

1. O.P. Gupta, "Elements of Solid & Hazardous Waste Management", Khanna Publishing House, New Delhi, 2019.

2. George Tchobanoglous et.al., "Integrated Solid Waste Management", McGraw-Hill Publishers, 1993.

3. B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, "Waste Management", Springer, 1994.

Subject – (PE 401) Gene Expression and Transgenics

Course Outcome (CO): -	
CO 1:	Design and utilize various recombinant protein expression vectors with tags for efficient protein production and purification in multiple host systems.
CO 2:	Develop strategies for the over-expression of integral membrane proteins using bacterial, yeast, insect, mammalian, and plant cell systems.
CO 3:	Implement advanced techniques for cell-free protein expression, chloroplast transformation, and adherence to GMP and GLP standards for protein production.
CO 4:	Apply knowledge of transgenic animals in diverse fields such as medical research, toxicology, and biotechnology, including the creation and ethical considerations of humanized animal models.

Course Content:

Unit I: Overview of recombinant protein expression vectors and promoters: Vectors with tags His, GST, MBP, GFP, Cleavable tag and non-cleavable tags, Vectors for tag free protein expressions.

Unit II: Over-expression of integral membrane proteins. Over- expression in E. coli, B. subtilis, Corynebacterium, Pseudomonas fluorescens, yeasts like S. cerevisiae and Pichia pastoris. insect cell lines like Sf21, Sf9 and BTI-TN-5B1-4, Mammalian cell line like Chinese Hamster ovary (CHO) and Human embryonic kidney (HEK), Plant single cell.

Unit III: Chloroplast transformation and protein expression in chloroplasts. Cell free protein Expression-Cell free extracts from E. coli, rabbit, wheat germ, insects. Purification of tagged and tag-free proteins. GMP and GLP requirements.

Unit IV: Use of transgenic animals. History, safety and ethics of transgenic animals. Methods for creation of transgenic animals-DNA microinjection, Embryonic stem cell-mediated gene transfer, Retrovirus-mediated gene transfer.

Unit V: Use transgenic animals in medical research, in toxicology, in mammalian developmental genetics, in molecular biology in the pharmaceutical industry, in biotechnology, in aquaculture and in xenografting. Humanised animal models.

Text Books/References:

1. Gene Expression Systems, Using Nature for the Art of Expression. Edited by Joseph M. Fernandez and James P. Hoeffler.

2. Regulation of Gene Expression, By Perdew, Gary H., Vanden Heuvel, Jack P., Peters, Jeffrey M. Springer.

3. Prokaryotic Gene Expression. Edited by Simon Baumberg. Oxford Press

4. Transgenic Animal Technology,3rd Edition, A Laboratory Handbook by Carl Pinkert. Elsevier.

Subject – (PE 407) Precision Medicine & Wellness

Course Outcome (CO): -	
CO 1:	Apply genomics, transcriptomics, proteomics, and metabolomics to understand and analyze disease conditions and biomarker identification.
CO 2:	Utilize knowledge of the Human Genome Project and Cancer Genome Project for disease state validation and biomarker discovery.
CO 3:	Conduct genetic and non-genetic variations analysis, genetic screening, and diagnosis, including prenatal and newborn testing for Mendelian diseases.
CO 4:	Implement pharmacogenomic testing for personalized drug therapy, tumor profiling, and risk assessment while considering ethical and legal implications in precision medicine.

Course Content:

Unit I: Use of genomics, transcriptomics, proteomics and metabolomics in understanding disease condition.

Unit II: Biomarker identification and validation of a disease state. Human Genome project. Cancer genome project.

Unit III: Different types of genetic and non- genetic variations, Genetic screening and diagnosis: prenatal carrier testing and newborn screening for Mendelian diseases.

Unit IV: Pharmacogenomic testing for drug selection, dosing and predicting adverse effects of commonly prescribed drugs, Tumor profiling, Patient data and clinical decisions.

Unit V: Risk assessment through omics approach. Ethical, legal, and social implications of health privacy and policy laws for precision medicine. Ayurveda system of Prakriti and Agni.

Text Books/References:

1. National Institute of General Medical Sciences. The New Genetics. Bethesda, MD: U.S. Department of Health and Human Services.
2. Genomic and Precision Medicine, Geoffrey Ginsburg and Huntington Willard,
3. The Language of Life: DNA and the Revolution in Personalized Medicine, Francis S. Collins.

Subject – (PE 409) Tissue Engineering

Course Outcome (CO): -	
CO 1:	Understand the properties and applications of natural and synthetic polymers in biomaterials for medical use.
CO 2:	Analyze cell-polymer interactions and the characteristics of the extracellular matrix for designing effective tissue engineering scaffolds.
CO 3:	Develop and utilize various scaffold fabrication techniques, including hydrogels, porous materials, and 3D printing for tissue engineering and wound healing.
CO 4:	Explore and apply methods for regenerating complex organs and tissues, such as kidneys, bladders, tendons, and corneas, in regenerative medicine.

Course Content:

Unit I: Biomaterials: Natural and synthetic polymers.

Unit II: Basic biology: Fibrous extracellular matrix of the human body and their characteristic features, Cell-Polymer interaction.

Unit III: Methods to develop Scaffolds for Tissue engineering: hydrogel, porous scaffold, and Textile-based techniques used for medical application, Rapid prototyping/3D printing, Wound healing.

Unit IV: Organ regeneration: Cartilage, Skin, Liver, Blood Vessel

Unit V: Complex organ regeneration: . Kidney, Urinary bladder, Tendons, Ligaments, Cornea.

Text Books/References:

1. Principles of Tissue Engineering, 4th Edition, Editors: Robert Lanza, Robert Langer, Joseph Vacanti, eBook ISBN: 9780123983701, Imprint: Academic Press,

2. Tissue Engineering: Principles and Practices, 1st Edition, John P. Fisher, Antonios G. Mikos, Joseph D. Bronzino, Donald R. Peterson,CRC Press, ,ISBN 9781138077867 - CAT# K34349,

3. Biomaterials for Musculoskeletal Regeneration- Applications By Bikramjit Basu, Sourabh Ghosh, Springer, 2016, ISBN 978-981-10-3017-8.

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Open electives

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Open Elective III (Semester VII)

Subject – (OS 307) Biomaterials

Course Outcome (CO): -	
CO 1:	Students will understand the structure, properties, and classification of materials, including chemical bonding, phase diagrams, and the distinction between crystalline and amorphous materials.
CO 2:	Students will analyze the properties and applications of metals, alloys, ceramics, and glasses used in medical applications, including stainless steel, titanium alloys, and bioactive ceramics.
CO 3:	Students will explore the classification, polymerization, and applications of various polymers, including biodegradable and natural polymers, as well as composites and advanced materials like carbon nanotubes.
CO 4:	Students will gain knowledge of engineering manufacturing principles, common processes like milling and forging, and advanced fabrication techniques such as biomimetic synthesis and direct molding.

Course Content:

Unit I: Introduction to Materials, General structure and properties. Classification of common materials and applications. Chemical Bonding, Crystalline, Amorphous. Melting, Solidification, Nucleation, Phase diagrams.

Unit II: Metal and alloys in Medical application: Stainless steel, cobalt based alloys, titanium based alloys (including shape memory alloys). Ceramics and glasses-bio ceramics: Type of Ceramics and their classification, Calcinations, Annealing, Sintering, Nearly inert ceramics, bio-reactive glasses and glass ceramics, Calcium phosphate ceramics.

Unit III: Introductions to polymers: Definition, classification, Polymerization. Rubber, plastics, fibers and resins and structure-properties relationship. Biodegradable polymers; Natural polymers, Composites, Pyrolytic carbon, Carbon nanotubes. Bulk Proper, Surface properties and modification of surface properties.

Unit IV: Basic principles of engineering manufacturing, methods and applications of common manufacturing processes, milling, grinding, finishing, rolling, forging.

Unit V: Concept of biomimetic synthesis, Preparation of fiber and wire, Fabrication of Porous Materials, Direct molding Technique, Different advanced fabrication technique.

Text Books/References:

1. Biomaterials Science - An Introduction to Materials in Medicine, Buddy Ratner Allan Hoffman Frederick Schoen Jack Lemons.
2. Biomaterials: An Introduction- J. Bo.
3. Park Materials Science and Engineering- Callister
4. Materials for Medical Engineering- Euromat 99 vol-2