MAHARSHI DAYANAND UNIVERSITY, ROHTAK
SCHEME OF STUDIES & EXAMINATIONS
B.TECH. (Biotechnology) 4th Year
SEMESTER –7th w.e.f. 2021-22

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Schedule (Marks)				Duration of Exam (Hours)
				L	T	P			Internal Assessment	External Examination	Practical	Total	
1	Professional Core Course	PCC-BT-401G	Intellectual Property Rights (IPR) & Regulatory	3	1	0	4	4	25	75	-	100	3
2	Professional Core Course	PCC-BT-403G	Nano-Biotechnology	3	1	0	4	4	25	75	-	100	3
3	Professional Elective Course	Refer to Annexure-1	Professional Elective-IV	3	1	0	4	4	25	75	-	100	3
4	Professional Elective Course	Refer to Annexure-2	Professional Elective-V	3	1	0	4	4	25	75	-	100	3
5	Professional Elective Course	Refer to Annexure-3	Professional Elective-VI	3	1	0	4	4	25	75	-	100	3
6	Open Elective Course	Refer to Annexure-4	Open Elective-III	3	0	0	3	3	25	75	-	100	3
7	Professional Core Course	LC-BT-403-G	Nano-Biotechnology Lab	0	0	3	3	1.5	25	-	25	50	3
8	Professional Elective Course	Refer to Annexure-1	Lab Course based on PEC-IV	0	0	3	3	1.5	25	-	25	50	3
9	Professional Elective Course	Refer to Annexure-2	Lab Course based on PEC-V	0	0	3	3	1.5	25	-	25	50	3
10	Summer Training	PTT-407G	Summer Training							…	Refer *Note- 1	Summer Training	PTT-407G
			Total	18	5	9	**32**	**27.5**	**225**	**450**	**75**	**750**	

*Note 1. The evaluation of the Practical Training - I will be based on seminar, viva-voce, report submitted by student. According to performance, the students are awarded grades A, B, C, F. The student who is awarded 'F' grade is required to repeat Practical Training.

MAHARSHI DAYANAND UNIVERSITY, ROHTAK
SCHEME OF STUDIES & EXAMINATIONS
B.TECH. (Biotechnology) 4th Year
SEMESTER –8th w.e.f. 2021-22

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Schedule (Marks)				Duration of Exam (Hours)
				L	T	P			Internal assessment	External examination	Practical	Total	
1		PS-BT-402G	Project (Biotech. Industrial or Biotech In-house project or Bio-entrepreneurship/ Start-Ups	0	0	18	18	9	100	-	200	300	-
TOTAL CREDIT								**9**	**100**	**-**	**200**	**300**	

Note: The students are required to undergo Industrial Training or Institutional Project Work of duration not less than 4 months in a reputed organization or concerned institute. The students who wish to undergo industrial training, the industry chosen for undergoing the training should be at least a private limited company. The students shall submit and present the midterm progress report at the Institute. The presentation will be attended by a committee. Alternately, the teacher may visit the Industry to get the feedback of the students. The final viva-voce of the Industrial Training or Institutional Project Work will be conducted by an external examiner and one internal examiner appointed by the Institute. External examiner will be from the panel of examiners submitted by the concerned institute approved by the Board of Studies in Engg. & Technology. Assessment of Industrial Training or Institutional Project Work will be based on seminar, viva-voce, report and certificate of Industrial Training or Institutional Project Work obtained by the student from the industry or Institute. The internal marks distributions for the students who have undergone Industrial Training consist of 25 marks from the industry concern and 75 marks by the committee members consisting of faculty members of concerned department of the parent institute.

The teachers engaged for in-house projects shall have a workload of 1 hour per week per group of 2 students.

List of Electives for B. Tech. Biotech. 7th Semester

Annexure-I

Professional Elective-IV

Choose any one subject from list

S. No.	Course Code	Course Title
1	PEC-BT-405-G	Genome Editing
2	PEC-BT-407-G	Bioinformatics & Computational Biology
3	PEC-BT-409-G	Rational Drug Discovery
4	PEC-BT-411-G	Solid Waste Management and Upcycling

Annexure-II

Professional Elective-V

Choose any one subject from list

S. No.	Course Code	Course Title
1	PEC-BT-413-G	Gene Expression & Transgenics
2	PEC-BT-415-G	Genomics and Proteomics
3	PEC-BT-417-G	Biosimilars Technology
4	PEC-BT-419-G	Stem Cell Technology

Annexure-III

Professional Elective-VI

Choose any one subject from list

S. No.	Course Code	Course Title
1	PEC-BT-421-G	Precision Medicine & Wellness
2	PEC-BT-423-G	Biochips and Microarray Technology
3	PEC-BT-425-G	Environment Policy and Legislation
4	PEC-BT-427-G	Entrepreneurship & Start-ups in Biotechnology

Annexure-IV

Open Elective Courses

Choose any one subject from list

S. No.	Course Code	Course Title
1	OEC-BT-401-G	Food and Nutrition Technology
2	OEC-BT-403-G	Biosensors
3	OEC-BT-405-G	Bioterrorism and National Security
4	OEC-BT-407-G	Block Chain Technology
5	OEC-BT-409-G	Environmental Pollution and Control
6	OEC-CSE-430-G	Computer Communications

Course Code	PCC-BT-401-G
Course Title	IPR & Regulatory
Number of Credits	4 (L: 3, T: 1, P: 0)
Course Category	Professional Core Course
Continuous Assessment (C.A.)	25
End Semester Assessment (E.S.A.)	75

Course Objective(s):

- To disseminate knowledge on patents, patent regime in India and abroad and registration aspects
- To make students aware about current trends in IPR and Govt. supports in promoting IPR
- To classify the role of regulatory committees in controlling the risk

UNIT I

INTELLECTUAL PROPERTY RIGHTS: Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967,the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994 India`s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies.

UNIT II

BIOSAFETY-REGULATORY FRAMEWORK FOR GMOS IN INDIA & AT INTERNATIONAL LEVEL: Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBSC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Seed Policy (2002), Prevention Food Adulteration Act (1955), The Food Safety and Standards Bill (2005), Plant Quarantine Order (2003), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007).

UNIT-III

NATIONAL ENVIRONMENT POLICY (2006): Rules for the manufacture, use/import/export and storage of hazardous microorganisms/genetically engineered organisms or cells (Ministry of Environment and Forests Notification, (1989).

Convention of Biological Diversity (1992) – Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol.

Understand the legal steps involved in progressing a new drug to market. Grasping the current regulatory acts and safety norms of the modern pharmaceutical industries.

UNIT IV

BIOETHICS: Patenting live microorganism, Human Genome project and ethical issues,

Animal cloning, human cloning and their ethical issues, Experimenting on animals.

Public education of producing transgenic organism, legal and socioeconomic impacts of biotechnology, testing drugs on human volunteers, Hazardous materials used in biotechnology, their handling and disposal.

Text Books/References:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
3. V Sreekrishna, 2017. Bioethics and Biosafety in Biotechnology by New Age International publishers.

E-resources:

1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
2. World Intellectual Property Organization. (2004). WIPO Intellectual Property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub _489.pdf

Course Outcomes:

- The students shall get an adequate knowledge on patent and copyright. This provides further way for developing their idea or innovations.
- Identify the role of regulatory committees in controlling the risk.
- Students should get enough information on ethical issues linked to research on animal models, transgenics, clinical trials.
- Students to consider Intellectual Property (IP) as a career option as IP Counsel/Patent Examiner/Patent agent.

Course Code	PCC-BT-403-G
Course Title	Nano Biotechnology
Number of Credits	4 (L: 3, T: 1, P: 0)
Course Category	Professional Core Course
Continuous Assessment (C.A.)	25
End Semester Assessment (E.S.A.)	75

Course Objective(s): This course is designed to make students understand the intersection of nanotechnology and biology. It will also acquaint students with nano- devices of biomedical applications. Students will know about the use of nanotechnology in diagnostic biology and learn about health and environmental impacts of nanotechnology.

UNIT-I

Introduction & Background: Introduction to Nanotechnology, Historical Background advances in nanotechnology, its future prospects & applications in different fields such as: agriculture, healthcare, instrumentation, textile, food industry, cosmetics etc. Ethical issues in nanotechnology.

Unit-II

Techniques used in Nanotechnology: UV-Visible Spectroscopy, Particle Size Analyzer, X-Ray Diffraction, Fourier Transform Infrared Spectroscopy, Scanning Electron Microscopy, Transmission Electron Microscopy.

Unit-III

Synthesis Methods of Nanomaterials: Green & Chemical synthesis of various nanomaterials such as Gold, Silver, Zinc Oxide, Tin Oxide, Iron nanoparticles with characterization techniques. Chemical Synthesis of Carbon Nanotubes: Single Walled & Multi Walled Carbon Nanotubes along with characterization techniques.

Unit-IV

Role of Nanotechnology: in Disease diagnosis such as Cancer Detection & Therapy. Nanotechnology used in drug delivery systems. Materials used for the fabrication of nanodevices. Lab-on-chip, Micro fluidics devices and their properties.

Text Books/References:

1. Fundamentals and applications of nanomaterials by Guo Z and Tan L, Artech house (2009).
2. Nanobiotechnology by Balaji S, MJP Publishers (2010).
3. Nanobiotechnology: concepts, applications and perspectives by Niemeyer CM and Mirkin CA, Wiley-VCH (2004).
4. Introduction to Nanoscience by Lindsay SM, Oxford University Press (2010).

Course Outcomes: Students will know about the use of nano material and nano technology in basic biology and biomedical and agro applications. They will also learn how to design and fabricate nano materials and nano devices.

Course Code	PEC-BT-405-G
Course Title	Genome Editing
Number of Credits	4 (L: 3, T: 1, P: 0)
Course Category	Professional Elective Course
Continuous Assessment (C.A.)	25
End Semester Assessment (E.S.A.)	75

Course Objective(s):

The course will provide the technical details and applications of modern tools for precision gene targeting and editing. The course will also provide information about targeted gene silencing.

UNIT-I

Overview of traditional methods: homologues recombination for gene knockout. RNAi system, Cre-LoxP and Flp-FRT systems.

UNIT-II

Engineered enzyme systems: Zinc finger nucleases (ZFNs), transcription-activator like effector nucleases (TALEN), meganucleases and the clustered regularly interspaced short palindromic repeats (CRISPR/Cas9) system. Design of sgRNA. Multiplex Automated Genomic Engineering (MAGE).

UNIT-III

Applications in Targeted gene mutation, Gene therapy, creating chromosome rearrangement, Study gene function with stem cells

UNIT-IV

Transgenic animals, Endogenous gene labeling, targeted transgene addition, GM plants. Ethics, safety and risk of targeted gene editing.

Text Books/References:

1. CRISPR Gene Editing, Methods and Protocols, Editors: Luo, Yonglun (Ed.)
2. Genome Editing and Engineering, From TALENs, ZFNs and CRISPRs to Molecular Surgery. Edited by Krishnarao Appasani.
3. Progress in Molecular Biology and Translational Science Vol 149-Genome Editing in Plants. Edited by Donald P. Weeks and Bing Yang. Academic Press.
4. Precision Medicine, CRISPR, and Genome Engineering, Moving from Association to Biology and Therapeutics, Editors: Tsang, Stephen H. (Ed.). Springer.

Course Outcomes:

- The students will learn the concept of synthetic biology and its widespread applications in research and industry.
- They will be able to assemble DNA and genes into biological circuits to make a biosensor or even engineer organisms.
- The students will also appreciate that biological systems are highly dynamic and not static and can be manipulated by various design strategies.

Course Code	PEC-BT-407-G
Course Title	Bioinformatics & Computational Biology
Number of Credits	4 (L: 3, T: 1, P: 0)
Course Category	Professional Elective Course
Continuous Assessment (C.A.)	25
End Semester Assessment (E.S.A.)	75

Course Objective (s):
This course is beneficial for students to understand the principles of analyzing biological data, building models and testing hypotheses using computer science algorithms. This course is a survey of algorithms and tools in biological sequence analysis, genome-wide disease association, and precision medicine. Basic concept machine learning and its application in analysis of biological data are also included in this course. It will also introduce information technology practices in the field of biotechnology. The course will provide a basic overview of various information repositories widely used in biological sciences; and tools for searching or querying those databases. This course will build foundation of sequence alignment techniques and to find evolutionary connections. It will help students to analyze mRNA expression data and gene annotations.

Unit-I

General Introduction: To study bioinformatics and its applications.
Biological databases and tools: Nucleotide sequence databases, Protein sequence, structural and functional databases, Patent data base, *insilico* tools for rDNA technology. Data base searching: BLAST and its types, Entrez, Ensembl-Biomart.

Unit-II

Pairwise Sequence alignment: Pairwise alignment, Dynamic programing, Scoring Matrices, Gaps. Multiple sequence alignment: Dynamic and heuristic methods, Relevance to inferences about evolution, introduction to molecular phylogeny.

Unit-III

Phylogenetic analysis: Introduction, Types of Phylogenetic Trees, Methods and Applications. Boot strap.
Genome informatics: Genome sequencing technologies and analysis methods; transcription factor regulation and motif finding. Computational Epigenetics: Epigenetics and its role in transcription regulation, development, and diseases. Genomic variations and its associations: Linking genes, variations and diseases; Introduction to biomarkers and personalized medicine.

Unit-IV

Network biology and human diseases: Genome-wide association studies of human diseases, Genome editing tools and applications to human diseases. Machine learning: Classification, Regression, SVM, Decision Trees, Artificial Neural Networks, Big Data in Biology.
Molecular modeling (Homology and *Abinitio*) and validation (Procheck, verify 3 Detc), Docking, Molecular dynamics.

Text Books/References:

1. Jonathan Pevsner. Bioinformatics and Functional Genomics, 2nd Edition. ISBN: 978-0- 470-08585-1.

2. Greg Gibson and Spencer V. Muse. A Primer of Genome Science, Third Edition. ISBN: 978-0-87893-309-9.
3. Essential Bioinformatics, JinXiong, Cambridge University Press; 1st edition 2006.
4. Bioinformatics: methods and applications, S.C. Rastogi, PHI learning; 4th edition, 2013.
5. The Dictionary of Genomics, Transcriptomics and Proteomics, Günter Kahl, Willey VCH, 2015.

Course Outcomes:

After completing this course, students will be able to:

- Perform computational analyses of biological sequences, genome-wide studies and relate the results to core principles of biology;
- Use computational methods to help execute a biological research plan; analyze biological problems and data using the latest machine learning and deep learning techniques.
- Browse or retrieve gene, protein sequences and related information from biological data bases;
- Learn to align sequences using dot matrices, dynamic programming and heuristic approach;
- Understand the notion of similarity, identity and gaps in the context of sequence alignment and deduce evolutionary relationships among sequences; analyze microarray and RNA-seq gene expression data.

Course Code	PEC-BT-409-G
Course Title	Rational Drug Discovery
Number of Credits	4 (L: 3, T: 1, P: 0)
Course Category	Professional Elective Course
Continuous Assessment (C.A.)	25
End Semester Assessment (E.S.A.)	75

Course Objective(s):

This course is aimed at imparting knowledge and skill to understand the

1. Drug discovery process
2. Rational methods to identify and design molecules for new medications greatly shortening the discovery phase of drug development by computational methods.

Unit-I

Molecular Modelling in Drug Discovery:

Drug discovery process, Role of Bioinformatics in drug design, Methods of computer aided drug design, ligand design methods, drug design approaches, Target identification and validation, lead optimization and validation, Structure and ligand based drug design, modelling of target-small molecule interactions, Molecular simulations. Protein Modelling.

Unit-II

Quantum Mechanics and Molecular Mechanics:

Features of molecular mechanics force fields; Bond structure and bending angles – electrostatic, van der Waals and non – bonded interactions, hydrogen bonding in molecular mechanics; Derivatives of molecular mechanics energy function; Application of energy minimization.

Unit-III

Molecular Dynamics simulation methods:

Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time – dependent properties; Solvent effects in Molecular Dynamics; Conformational changes from Molecular Dynamics simulation and application.

Unit-IV

Pharmacophore and QSAR:

Pharmacophore derivation, 3D pharmacophore prediction and application in drug discovery; QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Neural Networks and Principal Components Analysis in the QSAR equations.

Text Books/References: 1. Computational methods in drug design Fred E. Cohen, Walter Hamilton Moos Publisher: ESCOM Science, 1993. 2. Molecular Modelling for Beginners - Alan Hinchliffe Publisher: John Wiley & Sons Inc, 2008. ISBN: 978-0470513149. 3. Combinatorial Library Design and Evaluation: Principles, Software, Tools, Applications in Drug Discovery – Arup Ghose, Vellarkad Viswanadhan Publisher: CRC Press, 2001. ISBN: 0-8247-0487-8. 4. Molecular Modeling Basics - Jan H. Jensen Publisher: CRC Press, 2010. ISBN 978- 1420075267. 5. 3D QSAR in Drug Design: Recent

Advances – Hugo Kubinyi, Gerd Folkers, Yvonne C. Martin Publisher: Springer Science & Business Media. ISBN: 0-306-46858-1. 6. Computational Chemistry and Molecular Modeling - K. I. Ramachandran, Gopakumar Deepa, Krishnan Namboori Publisher: Springer – Verlag Berlin Heidelberg. ISBN: 978- 3540773023.

Course Outcomes:

- Exposure to various methods of rational drug design such as modelling of protein and target-small molecule interactions, molecular docking, lead optimization,
- Combinatorial chemistry and library design, Virtual screening
- Toxicity (ADMET) property analysis, Pharmacophore and QSAR.

Course Code	PEC-BT-411-G
Course Title	Solid Waste Management and Upcycling
Number of Credits	4 (L: 3, T: 1, P: 0)
Course Category	Professional Elective Course
Continuous Assessment (C.A.)	25
End Semester Assessment (E.S.A.)	75

Course Objectives:

- To introduce fundamental aspects of types of waste and its management.
- To disseminate knowledge on various waste management technologies.
- To provide knowledge on waste management acts
- To enable students to think innovative way to develop concepts in waste management.

Unit – I

Sources, generation, classfication & composition of solid wastes. Solid waste management methods - Sanitary land filling, Recycling, Composting, Vermi composting, Incineration, energy recovery from organic waste.

Unit – 2

Solid Waste Management Plan, Waste minimization technologies, Hazardous Waste Management, Sources & Classification, physicochemical properties, Hazardous Waste Control & Treatment.

Unit – 3

Hospital Waste Management, Hazardous Waste Management & Handling rules, 1989 & 2000 (amendments)

Unit- 4

Disaster Management, Fly ash generation & utilization, Primary, secondary & tertiary & advance treatment of various effluents.
Waste Upcycling, waste reuse, Waste down cycling, waste upcycling a social enterprise, Innovative technologies for sustainable waste management.

References :

1. Solid Waste Management CPCB. New Delhi.
2. Ecotechnology for pollution control & environmental management - By R.K. Trivedi & Arvind Kr.
3. Basic Environmental Technology - J.A. Nathanson
4. O.P. Gupta, “Elements of Solid & Hazardous Waste Management”, Khanna Publishing House, New Delhi, 2019.
5. George Tchobanoglous et.al., “Integrated Solid Waste Management”, McGraw-Hill Publishers, 1993.
6. B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, “Waste

Management", Springer, 1994.

Course Outcome(s):

1. The students shall get an adequate knowledge on waste.
2. Students should get enough knowledge on waste management
3. Students in groups shall develop concepts in managing waste of their institutions.
4. Students should get enough knowledge on waste upcycling

Course Code	PEC-BT-413-G
Course Title	Gene Expression & Transgenics
Number of Credits	4 (L: 3, T: 1, P: 0)
Course Category	Professional Elective Course
Continuous Assessment (C.A.)	25
End Semester Assessment (E.S.A.)	75

Course Objective(s):

- The course will provide the technical details and use of different gene expression systems for overexpression of recombinant proteins and protein complexes for different applications.
- The course will also provide details about purification of proteins expressed in different expression systems.
- The course will teach about generation of transgenic animals for research.

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*, yeasts like *S. cerevisiae* Mammalian cell line like Chinese Hamster ovary (CHO) and Human embryonic kidney (HEK), Plant single cell. Chloroplast transformation and protein expression in chloroplasts

UNIT-III

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. 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.
5. Ethical Use of Transgenic Animals (English, Paperback, Shah Krunal V). Lambert.
6. Transgenic Animals as Model Systems for Human Diseases. Edited E. F. Wagner F. Theuring. Springer.

Course Outcomes:

- At the end of this course the students will know protein expression in different heterologous host systems and application.
- The students will learn the methods for creation of transgenic animals and their use in biotechnology research.

Course Code	PEC-BT-415-G
Course Title	Genomics and Proteomics
Number of Credits	4 (L: 3; T: 1; P: 0)
Course Category	Professional Elective Course
Continuous Assessment (C.A.)	25
End Semester Assessment (E. S. A.)	75

Course Objective(s):

At the end of the course students should be able to:

- Explain principles of basic methods of genomic and proteomic analysis;
- To propose appropriate methods for analysis of given sample type with respect to purpose of analysis

Unit-I

Introduction: Structural organization of genome in Prokaryotes and Eukaryotes; mitochondrial DNA, chloroplast; DNA sequencing principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping: Physical mapping of genome: Conventional cytogenetics, Physical mapping by restriction hybridization analysis, FISH and related techniques, Chromosome painting and micro-dissection, Long range physical mapping, Contig assembly, Chromosome walking and map-based cloning.

Unit-II

Genome Sequencing Projects: Microbes, plants and animals; Accessing and retrieving genome project information from web; Identification and classification using molecular markers, EST's and SNP's, genealogy based on mtDNA and Y-chromosome haplogroups. Comparative and Evolutionary Genomics: Introduction, comparative genomics of plants, animals and microbes, introduction to genome evolution, Acquisition of new genes, Evolution of coding and non-coding regions, Molecular phylogenetics and applications, Evolution of multigene families in the genome

Unit-III

Proteomics: Structural proteomics, Protein analysis (includes measurement of concentration, aminoacid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution, isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hyrid system.

Unit-IV

Pharmacogenetics: High throughput screening in genome for drug discovery, identification of gene targets, pharmacogenetics and drug development Functional Genomics and Proteomics: Introduction, Strategies to find functional genes in the genome, Gene tagging strategies and application. ESTs and its utility in genomics, Differential gene profiling methods, DNA chips/Microarrays, SAGE and SNPs analysis, Protein and peptide microarray-based technology; PCR-directed protein in situ arrays

Texts/References:

1. Fundamentals of Biochemistry by D Voet, JG Voet and CW Pratt
2. Genomes by TA Brown
3. Molecular Biotechnology by BR Glick and JJ Pasternak

4. Discovering Genomics, Proteomics and Bioinformatics by AM Campbell and LJ Heyer 5. Principles of Gene Manipulation and Genomics by S Primrose and R Twyman

Course Outcomes:

The Students will be able to:

- Define genomics and proteomics
- Define whole genome sequencing
- Explain different applications of genomics and proteomics

Course Code	PEC-BT-417-G
Course Title	Biosimilars Technology
Number of Credits	4 (L: 3, T: 1, P: 0)
Course Category	Professional Elective Course
Continuous Assessment (C.A.)	25
End Semester Assessment (E.S.A.)	75

Course Objective:

- To introduce students about the design and development of different kinds of biologics, biomimetics and biosimilars.
- Students will learn about their different biotechnological applications.
- Further the course will introduce the regulatory framework about the Biosimilars.

UNIT-I

Introduction to Biopharma

Generics in Biopharma, definition of biologics, biosimilars, super biologics, differences between chemical genetics and biosimilars, The developmental and regulatory challenges in biosimilar development, Prerequisites for Biosimilar development, Biosimilar market potential.

UNIT-II

Types of biosimilar drugs

Peptides, proteins, antibodies, Enzymes, Vaccines, Nucleic acid based therapies (DNA, RNA, etc), Cell based therapies (including stem cells)

UNIT-III

Characterization methods

Aggregation- precipitation, floccule strength, precipitate ageing & kinetics, adsorption of proteins & peptides on surfaces, effect of temperature on protein structure, hydration & thermal stability of proteins - solid powders, suspension on non-aqueous solvents, reversed micelles, aqueous solution of polyols, analytical and spectrophotometric characterization of proteins, protein sequencing and structure determination

UNIT-IV

Bioequivalence studies

Immunogenicity & allergenicity of biosimilars; factors affecting immunogenicity - structural, post-translational modifications, formulations, impurities, manufacturing and formulation methods for biosimilars; types of bioequivalence (average, population, individual), experimental designs & statistical considerations for bioequivalence studies (Non-replicated designs – General Linear Model, Replicated crossover designs), introduction to "ORANGE BOOK" & "PURPLE BOOK".

Text Books/References:

1. Laszlo Endrenyi, Paul Declerck and Shein-Chung Chow, Biosimilar Drug Development, Drugs and Pharmaceutical Sciences, Vol 216, CRC Press.
2. Cheng Liu and K. John Morrow Jr., Biosimilars of Monoclonal Antibodies: A

Practical Guide to Manufacturing, Preclinical and Clinical Development, Wiley, Dec 2016.
3. https://www.drugs.com/medical-answers/many-biosimilars-approved-united-states-3463281/

Course Outcomes:

- The course gives the student a perspective of the complexity to establish bio-similarity of therapeutic proteins and biologics.

Course Code	PEC-BT-419-G
Course Title	Stem-Cell Technology
Number of Credits	4 (L: 3, T: 1, P: 0)
Course Category	Professional Elective Course
Continuous Assessment (C.A.)	25
End Semester Assessment (E.S.A.)	75

Course Objective(s):
To impart knowledge of:

- wide-ranging topics related to stem cells and regenerative biology
- a brief history of the field, research on animal models of regeneration, tissue engineering
- social and ethical issues related to stem cell research.

Unit I

Introduction to Stem Cells: Principles and properties of stem cells, types of stem cells, comparison of embryonic and adult stem cells.
Stem Cell Niche: Introduction to stem cell niches in gut epithelium, bone marrow, epidermis, testis and neural tissues.

Unit-II

Cell Cycle and Development: Cell cycle regulators and checkpoints, cell fusion, differentiation of stem cells and their role in self-renewal.
Epigenetic Control: DNA-methylation and histone modifications, genomic imprinting, telomerase regulation, X-chromosome inactivation, reprogramming of cells, induced pluripotent stem cells and their therapeutic applications.

Unit-III

Types and Regeneration: Stem cells derived from amniotic fluid, extra embryonic membrane, germ cells, hematopoietic organs, neurons and kidney, cord blood transplantation, donor selection, HLA matching, patient selection, peripheral blood and bone marrow transplantation, bone marrow and cord blood collection procedures and cryopreservation and their applications.

Unit IV

Experimental Methods: Isolation and differentiation of human adult stem cells, embryonic stem cells and mouse stem cells, stem cell techniques: fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging.

Applications: Stem cells applications in cancer, diabetes, heart disease, muscular dystrophy, regeneration of epidermis; stem cell regulations, debate, social and ethical concerns, Organ farming.

Text Books/References:

1. Hematopoietic Stem Cell Transplantation by Treleaven, J., first edition 2009.
2. Essentials of Stem Cell Biology by Lanza, R., second Edition, 2009 Academic Press.
3. Molecular Cell Biology by Lodish et al., sixth Ed., W.H. Freeman & Co. 2008.
4. Stem Cells: From Bench to Bedside by Bongso and Ariff.

Course Outcomes:

- The students will learn isolation, characterization and applications of stem cells in Biotechnology.

Course Code	PEC-BT-421-G
Course Title	Precision Medicine & Wellness
Number of Credits	4 (L: 3, T: 1, P: 0)
Course Category	Professional Elective Course
Continuous Assessment (C.A.)	25
End Semester Assessment (E.S.A.)	75

Course Objective(s):

- The course will teach the students about use of modern omics techniques and systems biology in providing personalized medicine and preventive health care.

UNIT-I

Use of genomics, transcriptomics, proteomics and metabolomics in understanding disease condition. Biomarker identification and validation of a disease state

UNIT-II

Human Genome project. Cancer genome project. Different types of genetic and non-genetic variations, Genetic screening and diagnosis: prenatal carrier testing and newborn screening for Mendelian diseases

UNIT-III

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

UNIT-IV

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.

Course Outcomes:

- At the end of this course the students will be introduced to precision medicare and preventive care system using modern omics tools.
- They will be exposed to recent advances in disease risk prediction, molecular diagnosis and progression of diseases, and targeted therapies for individuals.

Course Code	PEC-BT-423-G
Course Title	Biochips & Microarray Technology
Number of Credits	4 (L: 3, T: 1, P: 0)
Course Category	Professional Elective Course
Continuous Assessment (C.A.)	25
End Semester Assessment (E.S.A.)	75

Course Objective(s):

UNIT – I

Introduction: Basics of biochips and microarray technology, historical development of biochip technology. Biochip and Microarray construction: DNA microarrays, oligonuleotide, cDNA and genomics microarrays, microchip production technologies, megaclone technology for fluid microarray labels, microarray scanners./headers, microarray robotics. Microfluidics systems, chips and mass spectrometry.

UNIT-II

Biochip and Microarray construction (Continued): Biochips, microarrays, Chromosome on a chip, tissue chip, RNA chip, Protein chip technology, glycochips, biochips assays, combination of microarray and biosensor technology, biochip versus gel-based methods, process flow for production and analysis of a chip, standardization of microarray analysis, bioinformatics and microarrays, integrated biochip system, evaluation of conventional microarray technology. Electrical detection methods for microarrays, SERS (SurfaceEnhanced Raman spectroscopy)-based microarrays.

UNIT-III

Applications of Biochip Technology: Molecular diagnostics and pharmacogenomics, Application of microarray technology in drug discovery and development, Gene expression studies, use of DNA chip technology for drug safety, use of microchips for drug delivery, biochips as neural prostheses, use of biochips in health care, use of microarrays in population genetics and epidemiology, use of microarray in forensics. DNA chip technology for water quality management, Bioagent chip, Application of microarray in the agro-industry, use of microarray in genetic disease monitoring, point of care (POC) applications, Limitations of biochip technology.

UNIT-IV

Commercial aspects of Biochip technology: Markets for biochip technologies, commercial support for the development of biochips, government support for biochip development, business strategies and patent issues

DNA Computing: Introduction, junctions, other shapes, biochips and large-scale structures. Discussion of Robinson and Kallenbach's methods for designing DNA shapes, DNA cube. Computing with DNA, Electrical analogies for biological circuits. Challenges and future trends.

REFERENCES:

1. Biochips and Microarrays-technology & Commercial Potential, Published byUrck Publishing, 2000.

2. DNA Arrays: Technology and Experimetal strategies, Grigorenko(ed), CRC Press, 2002.
3. Microarray Analysis Mark Schena; J. Wiley & Sons (ed., New York), 2002.

Course Outcomes:

The students will learn the concept of biochips and its applications in research and industry. They will be able to assemble DNA and genes into biological circuits to make a biosensor or even engineer organisms. The students will also appreciate that biological systems are highly dynamic and not static and can be manipulated by various design strategies.

Course Code	PEC-BT-425-G
Course Title	Environmental policy and Legislation
Number of Credits	4 (L: 3, T: 1, P: 0)
Course Category	Professional Elective Course
Continuous Assessment (C.A.)	25
End Semester Assessment (E.S.A.)	75

Course Objective(s):

Students will have knowledge of

- International Environmental Policies
- International agreements & Treaties
- Pollution Acts
- Legislation on Forest, Wildlife

Unit - I

International Environmental Policies

Nature of Environmental Policies; Stockholm Conference (1972); Rio Conference (UNCED)(1992); Merits of the Conference (Agenda 21); Failures of the Conference.

International Agreements and Treaties:

Concept of agreement and treaty; Need of international agreements and treaties; Johanesburg treaty; GAAT and Environment; CITES; Montreal Protocol

Unit - II.

National Policy on Environment:

National Committee on Environment and Planning (NCEP); Tiwari committee; Establishment of MoEF; National Forest Policy; National Water Policy and National Energy Policy; CPCB and SPCBs.

Constitutional provisions for Environmental Protection:

Historical Background of constitutional provisions; Article 14, 15, 19, 21, 32, 39, 47, Article 48(A), 49, 51A(g) as fundamental duties of citizen and directive principles of state policy, Article 243, 243(G) and (W); Art. 246, 248 and other articles related to Environment; Writ provisions for the protection of environment.

Unit - III

National Environmental Legislation related to water, air, mining etc.

The Water(Prevention and Control of Pollution) Act, 1974; The Air (Prevention and Control of Pollution) Act, 1981; The Environment (Protection) Act, 1986; Aims, objectives and major contents and Sec. 12 of Mining Act, 1952.

Unit - IV

National Legislation on Forest, Wildlife etc.

The Forest (conservation) Act, 1980; The Wildlife (Protection) Act, 1972; The Biodiversity (Protection) Act, 2002; Aims, objectives and major contents.

Course Outcomes:

Students will be able to understand:

- International Policies and recommendation of committees
- National Policy and Constitutional provisions for Environmental Protection
- Water, air and environmental protection Acts
- Forest, wildlife & Biodiversity Protection Act

Course Code	:	PEC-BT-427-G
Course Title	:	Entrepreneurship & Startups in Biotechnology
Number ofCredits	:	4 (L:3, T: 1, P: 0)
Course Category	:	Professional Elective Course
Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	75

Course Objective(s):

1. Acquiring Entrepreneurial spirit and resourcefulness.
2. Familiarization with various uses of human resource for earning dignified means of living.
3. Understanding the concept and process of entrepreneurship- its contribution and role in the growth and development of individuals and the nation.
4. Acquiring entrepreneurial quality, competency, and motivation.
5. Learning the process and skills of creation and management of entrepreneurial venture.

Unit-I

Introduction to Entrepreneurship and Start – Ups
Definitions,Traits of anentrepreneur, Intrapreneurship, Motivation, Types of Business Structures, Similarities/differences between entrepreneurs and managers.

Business Ideas and their implementation: Discovering ideas and visualizing the business, Activity map, Business Plan

Unit-II

Idea to Start-up: Market Analysis– Identifying the target market, Competition evaluation and Strategy Development, Marketing and accounting, Risk analysis.

Unit-III

Management: Company's Organization Structure, Recruitment and management of talent. Financial organization and management

Unit-IV

Financing and Protection of Ideas: Financing methods available for start-ups in India Communication of Ideas to potential investors– Investor Pitch Patenting and Licenses.

Text Books/References:

1. The Startup Owner's Manual: The Step- by-Step Guide for Building a Great Company. Steve Blank and Bob Dorf. K & S Ranch ISBN–978-0984999392.
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Eric Ries. Penguin UK ISBN–978-0670921607.
3. Demand: Creating What People Love Before They Know They Want It. Adrian J. Slywotzky with Karl Weber. Headline Book Publishing. ISBN–978-0755388974.
4. The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business. Clayton M. Christensen. Harvard business. ISBN: 978-142219602
5. Websiteshttps://www.fundable.com/learn/resources/guides/startup
6. https://corporatefinanceinstitute.com/resources/knowledge/finance/corporate- structure/

7. https://www.finder.com/small-business-finance-tips
8. https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-business/

Course Outcomes:

- Upon completion of the course, the student will be able to demonstrate knowledge of the following topics:
- Understanding the dynamic role of entrepreneurship and small businesses
- Organizing and Managing a Small Business
- Financial Planning and Control
- Forms of Ownership for Small Business
- Strategic Marketing Planning
- New Productor Service Development Business Plan Creation

Course Code	:	LC-BT-405-G
Course Title	:	Genome Editing Lab
Number of Credits	:	1.5 (L: 0, T: 0, P: 3)
Course Category	:	Lab Course
Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	25

Lab Course based on PEC-IV (LC-BT-405-G): Practicals will be based theory syllabus.

Course Code	:	LC-BT-407-G
Course Title	:	Bioinformatics Lab
Number of Credits	:	1.5 (L: 0, T: 0, P: 3)
Course Category	:	Lab Course
Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	25

Lab Course based on PEC-IV (LC-BT-407-G): Practicals will be based theory syllabus.

Course Code	:	LC-BT-409-G
Course Title	:	Drug Discovery Lab
Number of Credits	:	1.5 (L: 0, T: 0, P: 3)
Course Category	:	Lab Course

Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	25

Lab Course based on PEC-IV (LC-BT-409-G): Practicals will be based theory syllabus.

Course Code	:	LC-BT-411-G
Course Title	:	Solid Waste Management Lab
Number of Credits	:	1.5 (L: 0, T: 0, P: 3)
Course Category	:	Lab Course
Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	25

Lab Course based on PEC-IV (LC-BT-411-G): Practicals will be based theory syllabus.

Course Code	:	LC-BT-413-G
Course Title	:	Gene Expression and Transgenics Lab
Number of Credits	:	1.5 (L: 0, T: 0, P: 3)
Course Category	:	Lab Course
Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	25

Lab Course based on PEC-V (LC-BT-413-G): Practicals will be based theory syllabus.

Course Code	:	LC-BT-415-G
Course Title	:	Genomics and Proteomics Lab
Number of Credits	:	1.5 (L: 0, T: 0, P: 3)
Course Category	:	Lab Course
Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	25

Lab Course based on PEC-V (LC-BT-415-G): Practicals will be based theory syllabus.

Course Code	:	LC-BT-417-G
Course Title	:	Biosimilars Lab
Number of Credits	:	1.5 (L: 0, T: 0, P: 3)
Course Category	:	Lab Course
Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	25

Lab Course based on PEC-V (LC-BT-417-G): Practicals will be based theory syllabus.

Course Code	:	LC-BT-419-G
Course Title	:	Stem Cell Technology Lab
Number of Credits	:	1.5 (L: 0, T: 0, P: 3)
Course Category	:	Lab Course
Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	25

Lab Course based on PEC-V (LC-BT-419-G): Practicals will be based theory syllabus.

Course Code	:	OEC-BT-401-G
Course Title	:	Food & Nutrition Technology
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	Open Elective Course
Continuous Assessment (C.A.)	:	25

End Semester Assessment (E.S.A.)	:	75

Course Objective(s):

The objectives of this course are to acquaint the students to recent advances in biotechnology in foods to produce new products with desirable characteristics. These include characteristics such as disease and drought-resistant plants, leaner meat and enhanced flavor and nutritional quality of foods.

Unit-I

Introduction to food biotechnology: Introduction, History and scope of food Biotechnology, development and prospects of biotechnology in animal products, ancient and traditional food processing techniques; Biochemical and metabolic pathways of biological systems used in food production.

Unit-II

Methods in food biotechnology: Role of biotechnology in productivity of livestock, Modern biotechnological methods and processes in animal product development, chemical and physical factors required for growing microbial cultures in nutritive substrate; Meat species identification, Quality control, Screening products for contaminants.

Unit-III

Biotechnology methods in food processing:

Use of biotechnology in the production of food additives, use of biotechnological tools for the processing and preservation and foods of animal origin, use of biotechnology improved enzymes in food processing industry, Basic principles of the industrial use of bio-reactions for production of biomass-upstream and downstream processing application of microorganisms as starter cultures in meat industry, microbial production of food ingredients; Biosensors and novel tools and their application in food science.

Unit-IV

Food safety & security:

Consumer concerns about risks and values, biotechnology & food safety, Ethical issues concerning GM foods; testing for GMOs; current guidelines for the production, release and movement of GMOs; Future and applications of food biotechnology in India.

Text Books/References:

1. Potter, Norman. M. Food Science, 5th Ed. Springer US
2. Manay, S.; Shadakshara Swamy, M., (2004). Foods: Facts and Principles, 4 th Ed. New Age Publishers.
3. B. Srilakshmi., (2002) Food Science, New Age Publishers.
4. Meyer, (2004). Food Chemistry. New Age
5. Deman JM. (1990) Principles of Food Chemistry. 2 nd Ed. Van Nostrand Reinhold, NY
6. Ramaswamy H and Marcott M. Food Processing Principles and Applications. CRC Press

Course Code	:	OEC-BT-403-G
Course Title	:	Biosensors
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	Open Elective Course
Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	75

Course Objectives:

- This course helps to understand the use of biomolecules as recognition elements.
- To familiarize students with biosensor technology, their application in various fields.
- To know about different materials used foe electrode fabrication.

UNIT-I

Biosensors- Advantages and limitations, various components of biosensors, Biocatalysis based biosensors, Bio affinity-based biosensors & Microorganisms based biosensors.

UNIT-II

Transducers in Biosensors: Various types of transducers; principles and applications - Calorimetric, Optical, Potentiometric / Amperometric, Conductometric / Resistometric, Piezoelectric, Semiconductor, Impedimetric

UNIT-III

Application and Uses of Biosensors: Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food Low cost - biosensor for industrial processes for online monitoring; biosensors for environmental monitoring.

Materials used & Characterization Techniques for Biosensor: Materials used for electrode fabrication. UV-Visible spectroscopy, Particle size analyzer, X-Ray diffraction, Scanning Electron Microscopy, Transmission Electron Microscopy.

Materials used & Characterization Techniques for Biosensor: Materials used for electrode fabrication. UV-Visible spectroscopy, Particle size analyzer, X-Ray diffraction, Scanning Electron Microscopy, Transmission Electron Microscopy.

UNIT-IV

Materials used & Characterization Techniques for Biosensor: Materials used for electrode fabrication. UV-Visible spectroscopy, Particle size analyzer, X-Ray diffraction, Scanning Electron Microscopy, Transmission Electron Microscopy.

COURSE OUTCOMES:

- Able to learn about principle of biosensor.
- Learn about different materials used for biosensor fabrication.
- Learn about different types of transducers used.
- Learn about application of biosensors in various fields.

TEXT / REFERENCE BOOKS:

1. Donald G. Buerk - Biosensors Theory and Applications, First Edition Technomic Publishing. Co, Inc, 1993.
2. Brian R Eggins - Biosensors an Introduction, First edition, John Wiley & Sons Publishers, 1996.
3. Loic J Blum, Pierre R Coulet - Biosensors Principles and Applications, First edition,

Marcel Dekker, Inc, 1991.
4. Tran Minh Canh - Sensor Physics & Technology - Biosensors, First Edition, Champan & Hall, 1993.

Course Outcomes:

On completion of this course, students should have gained knowledge about recent advances in biotechnology related to food technology.

Course Code	:	OEC-BT-405-G
Course Title	:	Bioterrorism & National Security
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	Open Elective Course
Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	75

Course Objective(s):
Familiarization of issues involved and threats facing society due to bioterrorism and approaches to tackle it effectively.

UNIT-I

Terrorism and Bioterrorism
Definition-Traditional Terrorists-New Terrorists-Nuclear, chemical, and radiological weapons-The psychology of Bioterrorism-Historical perspective.

UNIT-II

Microbes and Immune System
Primary classes of Microbes-bacteria, virus, and other Agents-Immune system-Interaction between microbes and the immune system.

Bioterrorism Weapons and Techniques
Characteristics of microbes and the reasons for their Use-Symptoms-Pathogenicity-Epidemiology-natural and targeted release-The biological, techniques of dispersal, and case studies of Anthrax, Plague-Botulism, Smallpox, and Tularemia and VHF.

UNIT-III

Prevention and Control of Bioterrorism
Surveillance and detection- Detection equipment and sensors –Diagnosis-Treatment-Vaccinations-Supplies- Effectiveness-Liability-Public Resistance-Response-First Responders-Infectious Control-Hospital-Prevention- Protection-Decontamination-Notification-Role of Law Enforcement-Economic impact.

UNIT-IV

Bioterrorism Management
Ethical issues: personal, national, the need to inform the public without creating fear, cost-benefit Rations-Information Management-Government control and industry Support-Microbial forensics.

Text Books:

1. Bioterrorism: Guidelines for Medical and Public Health Management, Henderson, Donald, American Medical Association, 1st Edition, 2002.
2. Biological Weapons: Limiting the Threat (BCSIA Studies in International Security), Lederberg, Joshua (Editor), MIT Press, 1999.
3. Bioterrorism and Infectious Agents: A New Dilemma for the 21st Century (Emerging Infectious Diseases of the 21st Century), I.W. Fong and Kenneth Alibek, Springer, 2005.

Reference Books:

1. The Demon in the Freezer: A True Story, Preston, Richard, Fawcett Books, 2003.
2. The Anthrax Letters: A Medical Detective Story, Cole, Leonard A., Joseph Henry Press, 2003.
3. Biotechnology research in an age of terrorism: confronting the dual use dilemma, National Academies of Science, 2003.
4. http://www.centerforhealthsecurity.org/our-work/pubs_archive/pubs-pdfs/2012/sloan_book/Preparing%20for%20Bioterrorism_Gigi%20Kwik%20Gronvall_December%202012.pdf

Course Outcomes:

Exposure to threats for national security, methods to tackle them and support law enforcing & health agencies to handle them.

Course Code	:	OEC-BT-407-G
Course Title	:	Block Chain
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	Open Elective Course
Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	75

Course Objective(s):

- The objective of this course is to provide conceptual understanding of how block chain technology can be used to innovate and improve business processes.
- The course covers the technological underpinning of block Chain operations in both theoretical and practical implementation of solutions using block Chain technology.

Unit-1

Introduction: Overview of Block chain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Block chain, Transactions, Distributed Consensus, Public vs Private Block chain, Understanding Crypto currency to Block chain, Permissioned Model of Block chain, Overview of Security aspects of Block Chain.

Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic cryptocurrency.

Unit-2

Understanding Block chain with Crypto currency: Bitcoin and Block chain: Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay.

Working with Consensus in Bitcoin: Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, Hashcash PoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.

Unit-3

Understanding Block chain for Enterprises: Permissioned Block chain: Permissioned model and use cases, Design issues for Permissioned block chains, Execute contracts, State machine replication, Overview of Consensus models for permissioned block chain- Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport-Shostak-Pease BFT Algorithm, BFT over Asynchronous systems.

Enterprise application of Block chain: Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Block chain, Block chain enabled Trade, We Trade – Trade Finance Network, Supply Chain Financing, Identity on Block chain.

Unit-4

Block chain application development

Hyperledger Fabric- Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contract using Hyperledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda.

Text Books/References:

1. Melanie Swan, "Block Chain: Blueprint for a New Economy", O'Reilly, 2015
2. Josh Thompsons, "Block Chain: The BlockChain for Beginners- Guide to Block Chain Technology and Leveraging BlockChain Programming"
3. Daniel Drescher, "BlockChain Basics", Apress; 1stedition, 2017
4. Anshul Kaushik, "BlockChain and Crypto Currencies", Khanna Publishing House, Delhi.

5. Imran Bashir, “Mastering BlockChain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained”, Packt Publishing
6. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and Block Chain”, Packt Publishing
7. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O’Dowd, Venkatraman Ramakrishna, “Hands-On Block Chain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer”, Import, 2018.

Course Outcome (s): Course Outcomes: At the end of this course, the students will be able to: ● Understand block chain technology. ● Develop block chain based solutions and write smart contract using Hyperledger Fabric and Ethereum frameworks. ● Build and deploy block chain application for on premise and cloud based architecture. ● Integrate ideas from various domains and implement them using block chain technology in different perspectives.

Course Code	:	OEC-BT-409-G
Course Title	:	Environmental Pollution and Control
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	Open Elective Course
Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	75

1. **Course Objective(s):**
2. To know about sources, types and controlling measures of air pollution
3. To learn about sources, types and controlling measures of noise pollution
4. To learn about sources, types and controlling measures of water pollution
5. To learn about sources, types and controlling measures of soil pollution

UNIT - I

Air Pollution:

Sources and types of Pollutants - Natural and anthropogenic sources, primary and secondary pollutants. Criteria air pollutants. Sampling and monitoring of air pollutants (gaseous and particulates); period, frequency and duration of sampling. Principles and instruments for measurements of (i) ambient air pollutants concentration and (ii) stack emissions. Indian National Ambient Air Quality Standards. Impact of air pollutants on human health, plants and materials. Acid rain. Dispersion of air pollutants. Control devices for particulate matter: Principle and working of: settling chamber, centrifugal collectors, wet collectors, fabric filters and electrostatic precipitator. Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion. Indoor air pollution, Vehicular emissions and Urban air quality.

UNIT - II

Noise Pollution:

Sources, weighting networks, measurement of noise indices (Leq, L10, L90, L50, LDN, TNI). Noise dose and Noise Pollution standards. Noise control and abatement measures: Active and Passive methods. Vibrations and their measurements. Impact of noise and vibrations on human health.

UNIT - III

Water Pollution:

Types and sources of water pollution. Impact on humans, plants and animals. Measurement of water quality parameters: sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants. Indian standards for drinking water (IS:10500, 2012). Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening. Wastewater Treatment: Primary, Secondary and Advanced treatment methods

UNIT - IV

Soil Pollution:

Physico-chemical and biological properties of soil (texture, structure, inorganic and organic components). Analysis of soil quality. Soil Pollution control. Industrial effluents and their interactions with soil components. Soil micro-organisms and their functions - degradation of pesticides and synthetic fertilizers.

References

1. Air pollution and control - K.V.S.G. Murlikrishan
2. Industrial noise control - Bell & Bell
3. Environmental engineering -Peary
4. Introduction to environmental engineering and science
- Gilbert Masters.

Course Outcome (s):

1, The students will be able to learn about air pollution and its controlling measures

2. Students will be able to learn about noise pollution and its controlling measures.

3. Students will be able to learn about water pollution and its controlling measures.

4. Students will be able to learn about soil pollution and its controlling measures.

Course Code	:	OEC-CSE-430-G
Course Title	:	Computer Communication
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	Open Elective Course
Continuous Assessment (C.A.)	:	25
End Semester Assessment (E.S.A.)	:	75

Learning Objectives:

- To Build an understanding of the fundamental concepts of computer networking and familiarizing the student with the basic taxonomy and terminology of the computer networking and data communication.
- To outline various models, topologies and devices of Computer Networks.
- To explain the functions of various layers in Network Reference Model.
- To apply different network concepts in various network communication protocols.

Unit-1

Introduction to Data Communication: Need, components, Data representations communication model, Characteristics of an effective Communication system, Transmission modes: Simplex, Half Duplex and Full Duplex. Serial and parallel transmission. Unicasting, Multicasting, Broadcasting, Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation (PM), Amplitude Shift Keying, Frequency Shift Keying, Phase Shift Keying, MULTIPLEXING: FDM, WDM, TDM, packet switching and circuit switching.Transmission Media: Copper cable, Twisted-Pair Cable, Coaxial Cable, Fiber-Optic Cable. Introduction to Computer Network: applications, benefits and problems, Types of Networks: PAN, LAN, MAN and WAN.

Unit-2

Network Topologies: Introduction to Computer Network Topologies: Mesh Topology, Bus Topology, Star Topology, Ring Topology, Tree Topology, Hybrid Topology, Irregular – Topology.

OSI and TCP/IP Model: Layering architecture of networks, OSI model, Functions of each layer, Services and Protocols of each layer

Unit-3

Media Access Control, Random Access: ALOHA, CSMA and CSMA/CD. Controlled Access: Reservation, Polling and Token Passing. Channelization: FDMA, TDMA and CDMA

Ethernet: Features and types of LANs, Types of Ethernets- Thicknet, Thinnet, Fast Ethernet and Gigabit and 10G Ethernet etc. Concept of Carrier Sense Multiple Access (CSMA)/CD in Ethernet,

Network addressing: Physical addressing, logical addressing and port addressing, MAC addressing in Ethernet, IP V4 addressing: concept of subnet, network and host address, IP address Classes- A, B, C, D and E classes. Introduction to classless addressing.

Unit-4

LAN interconnecting devices: Repeater, Hubs, Switches, Bridges, Routers, Gateways.

Internet and E-mail: Concept of Internet, Advantages of Internet, Security issues in using internet. Application of Internet in various fields: Scientific, Business, Research, Sports, Medicine & Health Care, Engineering, Teaching. HTTP and FTP

Email: Concept, Protocols: SMTP, POP, IMAP.

Text Book:

1.Andrew S Tanenbaum, Computer Networks, 5th Edition, Pearson publications, 2010.

2. Forouzan, Data Communication and networking ,5th Edition, Tata McGrawHill, 2012.

3. William Stalling, Data & Computer Communication 6th edition, LPE Pearson Education, 2013.

Reference Books:

1. Data Communications, Computer Networks and Open Systems (4th edition), Halsall Fred, 2000, Addison Wesley, Low Price Edition.
2. Computer Networks – A System Approach, Larry L. Peterson & Bruce S. Davie, 2 Edition
3. Computer Networking – ED Tittel , 2002, T.M.H.

Corse Outcomes:

By the end of the course the students will be able to:

1. Independently understand basic computer network technology.
2. Understand and explain Data Communications System and its components.
3. Identify the different types of network topologies and protocols.
4. Enumerate the layers of the OSI model and TCP/IP. Explain the function(s) of each layer.
5. Identify the different types of network devices and their functions within a network