Integral University, Lucknow

Effective from Session: 2025-2026							
Course Code	BE201	**Title of the Course**	Biochemistry	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**0**	**4**	**5**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The course deals with providing fundamental understanding about biomolecules, their structural and chemical properties and relationship to their biological functions along with ability to demonstrate the estimations and separation of various biomolecules using standard protocols						

Course Outcomes	
CO1	Classify and illustrate various biomolecules and analyze their properties.
CO2	Describe and analyze the concepts of carbohydrate and lipid metabolism and their regulation.
CO3	Describe and analyze the synthesis and degradation of acids amino acids.
CO4	Describe and analyze the synthesis and degradation of purine and pyrimidines.
CO5	Estimate the concentration of biomolecules like carbohydrates, nucleic acids, and proteins in given samples.
CO6	Demonstrate techniques like isoelectric precipitation in context of amino acids, lipid extraction, chromatography, and electrophoresis.
CO7	Determine enzyme activity and kinetic parameters.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Structures and functions of biomolecules	General structure, function and classification of carbohydrates (mono, di and poly saccharide.), lipids (Fatty acids, Phospholipids, Glycolipids, Waxes), proteins (primary, secondary and tertiary) and nucleic acid (Purines, pyrimidines, nucleosides, nucleotides)	8	CO1
2	Carbohydrate and Lipid metabolism	Glycolysis and its regulation, TCA cycle, Oxidative phosphorylation, Pentose phosphate pathway. Biosynthesis of polysaccharides: Photosynthesis, gluconeogenesis. Beta-oxidation of fatty acids-saturated and unsaturated and their regulations. Biosynthesis of fatty acids and cholesterol	8	CO2
3	Amino acid metabolism	Biosynthesis and oxidation of glutamate, serine and aspartate family amino acids and their regulation. Urea cycle	8	CO3
4	Nucleic acid metabolism	Biosynthesis of purines & pyrimidines by de novo & salvage pathway and their regulations. Biodegradation of purines and pyrimidines and regulation.	8	CO4

PRACTICAL

S. No.	**List of Experiments**	**Contact Hrs.**	**Mapped CO**
1	Estimation of carbohydrates	4	CO5
2	Estimation of proteins	4	CO5
3	Estimation of nucleic acids	4	CO5
4	Isoelectric precipitation	4	CO6
5	Separation of amino acids by paper chromatography	4	CO6
6	Thin layer chromatography	4	CO6
7	Extraction of lipids	4	CO6
8	Gel electrophoresis	4	CO6
9	Assay of enzyme activity and enzyme kinetics	4	CO7

Reference Books:

1. Murray Moo-Young-Comprhensive Biotechnology, II & IVth Vol.
2. Biochemistry- D. J. Voet & J. G. Voet, 6th ed.
3. Methods in Enzymology- A series.
4. Enzyme Kinetics-Hans Bisswanger, Wiley Publication.
5. Biocatelysis: Fundamentals and Application- A.S. Bommarius et al., Wiley Publication.
6. S.K. Sawhney; Introductory Practical biochemistry; Narrosa Pub.
7. J. Jayaraman; Lab. Manual in Biochemistry; New Age Int. Pub.
8. Wilson and Walker; Practical Biochemistry; Cambridge publication. David T Plummer; An introduction to practical biochemistry; Tata McGraw Hill.

e-Learning Source:

https://youtu.be/gJNMryCX3YY

https://jru.edu.in/studentcorner/lab-manual/bpharm/Lab%20Manual%20-%20Biochemistry.pdf

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1			1					3	3	2	
CO2	3	1	1			1					3	3	2	
CO3	3	1	1			1					3	3	2	
CO4	3	1	1			1					3	3	2	
CO5	3	3	1	3	3	1	1	3	2		3	3	3	3
CO6	3	3	1	3	3	1	1	3	2		3	3	3	3
CO7	3	3	1	3	2	1	1	3	2		3	3	3	3

1-**Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2025-2026							
Course Code	BE202	**Title of the Course**	Microbiology	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	This course utilizes the theoretical and practical approach to the study of microorganisms and offers the student a comprehensive knowledge of the fundamentals of microbiology.						

Course Outcomes	
CO1	Students will understand microbiology concepts, microbial diversity, and cell characteristics, applying scientific principles to analyze microbial structures and their role in various biological and industrial applications.
CO2	Students will analyze common pathogenic microorganisms, their transmission, and impact, applying scientific principles to assess and propose solutions for disease prevention and public health improvement.
CO3	Students will apply microbiological techniques for media preparation, microbial isolation, staining, and genetic exchange, analyzing microbial growth and characteristics to support research and industrial applications.
CO4	Students will understand and apply physical, chemical, and radiation-based microbial control methods, evaluating their effectiveness for sterilization, disinfection, and antimicrobial applications in diverse environments.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to microbiology and microbial diversity**	Microbiology and its scope, Biogenesis and Abiogenesis theories, Koch's postulates. Microbial diversity: Morphology, structure and microbial diversity of bacteria, fungi, viruses and protozoa. Characteristic of prokaryotic and eukaryotic cells	8	CO 1
2	**Pathogenesis of microorganisms**	Some common pathogenic microorganisms: Bacterial (tuberculosis, gall), viral (SARS, TMV), fungal (red rot of sugar cane, dermatitis) and protozoan (malaria)	8	CO 2
3	**Microbial nutrition and Genetics**	Microbial media design and types, microbial isolation techniques: dilution, pour plate and streak plate, Microbial growth curve and growth measurements, pure culture, starter culture, cultural characteristics of bacteria, Types of staining (Gram Staining and Endospore staining) Genetic exchange methods: transformation, conjugation and transduction	8	CO 3
4	**Control of microorganisms**	Physical agents (Autoclave, Hot air oven, Laminar airflow and membrane filter.), chemical agents (Alcohol, Halogens and Gaseous agents, antibiotics), Radiation Methods (UV rays)	8	CO 4

PRACTICAL

S. No.	**List of Experiments**	**Contact Hrs.**	**Mapped CO**
1	Preparation of nutrient agar slant, agar plates and nutrient broth and their sterilization	3	CO 3
2	Inoculation of agar slants, agar plates and nutrient broth (using incubator, water bath, laminar hood, dry heat sterilizer)	3	CO 3
3	Culture of micro-organism using various techniques	3	CO 1,3
4	Simple staining of bacteria	3	CO 1,3
5	Negative staining of bacteria	3	CO 1,3
6	Capsule staining technique	3	CO 1,3
7	Differentiate bacteria by gram-staining technique	3	CO 1,3
8	Endospore staining technique	3	CO 1,3
9	Bacterial colony counting (using moist chamber, spirit lamp, slide loop microscope and haemocytometer)	3	CO 1,3
10	Isolation of microbes from soil samples and determination of the number of colony forming units (using UV spectrophotometer, Colony counters etc.)	3	CO 1,3
11	Study of growth curve of E.coli	3	CO 1,3

Reference Books:

1. Prescott, Harley and Klevin: Microbiology; 2nd edition.
2. Brock, Micheal and Clark: Microbiology of Microorganisms; 12th edition.
3. Introduction to Microbiology: Pelczar.

e-Learning Source:

1. Introduction to microbiology, https://www.youtube.com/watch?v=H0xmxeh6qoo
2. Microbial diversity, https://www.youtube.com/watch?v=-IEOxfIPWsk
3. Pathogenesis of microorganisms, https://www.youtube.com/watch?v=xNgMtazlaPk
4. Microbial nutrition, https://www.youtube.com/watch?v=x3cni3pMTWw
5. Microbial genetics, https://www.youtube.com/watch?v=mg6tXQaiBaI&t=8s
6. Control of microorganisms, https://www.youtube.com/watch?v=c31PGSri4_k
7. Isolation of microorganisms, https://www.youtube.com/watch?v=eKDfO3AREmg
8. Types of microbial staining techniques, https://www.youtube.com/watch?v=Lvmn9EYZzKQ

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	1	1	1	2	1	3	2	1
CO2	3	3	2	3	2	3	2	2	1	2	1	3	3	2
CO3	3	3	3	3	3	2	2	2	1	2	2	3	3	3
CO4	3	3	3	3	3	3	2	2	1	2	2	3	3	3

1-**Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2025-26							
Course Code	BE203	**Title of the Course**	**Cell and Molecular Biology**	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**0**	**4**	**5**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To impart comprehensive understanding of cellular structures, communication, division, signaling and gene expression processes in prokaryotic and eukaryotic systems with regulatory mechanisms.						

Course Outcomes	
CO1	Compare and analyze cellular structures and communication mechanisms in prokaryotic and eukaryotic cells and interpret their biological significance.
CO2	Analyze phases of cell division and signaling pathways to understand their roles in cellular regulation and communication.
CO3	Explain molecular mechanisms of DNA replication and transcription in prokaryotes and eukaryotes, and analyze associated enzymatic processes.
CO4	Illustrate the mechanisms of translation, gene regulation, and post-translational modifications in prokaryotes and eukaryotes.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Cell Structure and Communication**	Cell Theory, Prokaryotic vs. Eukaryotic cells, Structures and functions of cellular organelles, Structures and functions of sub-cellular structures in prokaryotes Cell-Cell Interactions & Communication: Cell junctions (tight junctions, gap junctions, desmosomes), extracellular matrix (ECM)	8	CO 1
2	**Cell Cycle and Signaling**	Cell Cycle and Cell Division: Phases of the cell cycle, Regulation of the cell cycle, Mechanisms and significance of mitosis and meiosis Cell Signaling Mechanisms: Types of signaling, G-protein coupled receptors, receptor tyrosine kinases, cyclic nucleotides, role of calcium in signaling, protein kinases as primary elements in signalling	8	CO 2
3	**Replication and Transcription**	DNA Replication: Semi-conservative replication, prokaryotic vs. eukaryotic replication, enzymes involved in replication Transcription and RNA Processing: Mechanism of transcription in prokaryotes and eukaryotes, RNA polymerases, transcription factors, post-transcriptional modifications	8	CO 3
4	**Translation**	Outline of the process of Translation in Prokaryotes and Eukaryotes, Genetic code, Ribosome and tRNA: structure and function,Concept of operon: lac and trp operons, Post-translational modifications	8	CO 4

PRACTICAL

S. No.	List of Experiments	Contact Hrs.	Mapped CO
1	Estimation of DNA by DPA Method	4	CO 1,3
2	Estimation of RNA by Orcinol Method	4	CO 1,3
3	Determination of Tm of DNA and RNA	4	CO 1,3
4	Isolation of Plasmid DNA	6	CO 1,3
5	Isolation of Bacterial Genomic DNA	6	CO 1,3
6	Isolation of Plant DNA	4	CO 1,3
7	Visualization of DNA by Agarose Gel Electrophoresis	4	CO 1,3

Reference Books:

1. Bruce Alberts, Dennis Bray et al. (1983) - Molecular Biology of the Cell, 3rd ed.
2. Watson, Hopkin, Roberts et al. (1987) - Molecular Biology of the Gene, 4th ed.
3. Monroe W. Strickberger (1976) - Genetics, 2nd ed.
4. David Friefelder (1994) - Microbial Genetics, 2nd ed.
5. David Baltimore (1994) - Molecular Cell Biology, 3rd ed.
6. Benjamin Levin (2003) - Genes VIII, 8th ed.

e-Learning Source:

1. DNA Replication, https://www.youtube.com/watch?v=T1aR77FLdi0
2. Operon Concept, https://www.youtube.com/watch?v=h_1QLdtF8d0

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2			1	1	1	1	1	2	1	3	2	2
CO2	3	2	1	1	1	1	1	1	1	1	1	3	2	2
CO3	3	3	1	1	2	2	2	1	1	2	1	3	2	2
CO4	3	3	1	1	2	1	2	1	1	2	1	3	3	2

1-**Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2025-26							
Course Code	**ME221**	**Title of the Course**	Fluid flow and solid handling	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**0**	**2**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	1. Understand the fundamental concepts of fluid mechanics including fluid properties, types, the continuum concept, surface tension, capillarity, and pressure measurement techniques. 2. Analyze fluid flow characteristics using Eulerian and Lagrangian descriptions, explore fluid velocity and acceleration, and apply the continuity and Bernoulli's equations in practical scenarios. 3. Apply knowledge of fluid flow measurement by studying the working principles and calculations associated with devices like orifice meters, venturi meters, rotameters, and Pitot tubes. 4. Explore the design and operation of hydraulic machines including centrifugal and reciprocating pumps, positive displacement pumps, and blowers, with focus on performance parameters and energy efficiency. 5. Gain insight into mechanical operations such as screening, particle size reduction, and the functioning of industrial equipment like crushers, grinders, and conveyors.						

Course Outcomes	
CO1	Learners will explain fluid properties, types, and surface phenomena, and apply fluid statics to measure pressure using manometers.
CO2	Analyze fluid flow using Eulerian and Lagrangian approaches, apply continuity and Bernoulli's equations, and evaluate energy losses in pipe flow.
CO3	Learners will understand the design, working principles, and applications of flow measurement devices and perform related flow calculations.
CO4	Students will understand the operation, principles, and performance of centrifugal and reciprocating pumps, along with positive displacement pumps, blowers, and fluidization concepts.
CO5	Learners will understand the characteristics of solid materials, screening processes, particle size reduction techniques, and the operation of equipment like crushers, grinders, and conveyors.
CO 6	Students will Apply experimental methods to analyze fluid flow behavior and calibrate flow measurement devices using principles such as Bernoulli's equation and discharge coefficients.
CO 7	Learners will Analyze flow behavior in pipes by studying laminar-turbulent transition, velocity distribution, friction factor variation, and verifying the Impulse-Momentum Equation experimentally.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction** **Fluid Statics**	Definition of fluid and the concept of continuum; essential physical properties of fluids. Classification of different types of fluids. Phenomena such as capillarity and surface tension, including their effects on liquid droplets and soap bubbles. The relationship between pressure, density, and height. Techniques for pressure measurement, including the use of manometers.	7	CO1
2	**Fluid Kinematics:** **Fluiddynamics:**	Various types of fluid flow, with descriptions based on Eulerian and Lagrangian approaches. Concepts of fluid velocity and acceleration, and the definitions of streamline, pathline, and streakline. The continuity equation Euler's equation of motion applied along a streamline, and derivation of Bernoulli's equation from it. Practical uses of Bernoulli's principle. Energy losses in fluid flow through pipes	7	CO2
3	**Flow Measurements**	Design, operation, and uses of flow measurement instruments: Orifice meter, Nozzle flow meter, Venturi meter, Rotameter, and Pitot tube, along with basic calculations related to them.	6	CO3
4	**Pumping and compressing**	Centrifugal Pumps: Types and working principles, basic introduction to velocity vector diagrams, and calculation of work done by the impeller. Reciprocating Pumps: Operational theory, slip and discharge coefficient, interpretation of indicator diagrams, effects of acceleration, and energy savings through the use of air vessels. Overview of positive displacement pumps, blowers, and the concept of fluidization.	6	CO4
5	**Solid and their handling**	Characteristics of solid materials, screening processes, industrial screening machinery, particle size measurement, screen analysis techniques, methods for reducing solid particle size, reduction stages, key operational parameters, intermediate and fine size reduction methods, power consumption and mechanisms involved. Overview of power-operated equipment such as crushers, grinders, and conveyors.	6	CO5
PRACTICAL				

Experiment No.	Title of the Experiment	Content of Unit	Contact Hrs.	Mapped CO
1	Hele-Shaw apparatus	To develop a flow net representation utilizing the Hele-Shaw apparatus to simulate fluid flow.	2	**CO 6**
2	Bernoulli's Equation	To verify Bernoulli's Equation experimentally.	2	**CO 6**
3	Venturi meter	To calibrate a venturi-meter and study the variation of the coefficient of discharge with the Reynolds number.	2	**CO 6**
4	Orifice meter	To calibrate a orifice-meter and study the variation of the coefficient of discharge with the Reynolds number.	2	**CO 6**
5	Notch apparatus	To determine the discharge coefficient by calibrating the given V-notch or rectangular notch.	2	**CO 6**
6	Reynold's Apparatus	To Study the transition from laminar to turbulent flow and determine the lower critical Reynolds number.	2	**CO 7**
7	Velocity Distribution	To study the velocity distribution in a pipe.	2	**CO 7**
8	Friction factor	To study the variation of friction factor 'f', for turbulent flow in commercial pipes.	2	**CO 7**
9	Impact of Jet apparatus	To verify Impulse-Momentum Equation experimentally		**CO 7**

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2						3	3	3
CO2	3	3	3	3	2	2						3	3	3
CO3	3	3	3	3	3	2						3	3	3
CO4	3	3	2	2	3	2						3	3	3
C05	3	3	2	2	2	2						3	3	3
C06	3	3	3	3	3	2	2	3	2	2	2	3	3	3
C07	3	3	3	3	3	2	2	3	2	2	2	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Corre2lation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2025-2026							
Course Code	BM226	**Title of the Course**	Human Values & Professional Ethics	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	IV	**2**	**0**	**0**	**0**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To help students understand the importance of human values and ethics in professional and personal life. • To develop a sense of social and environmental responsibility. • To enhance decision-making capabilities based on moral values and professional ethics. • To create awareness about the ethical responsibilities of engineers towards society. • To equip students with tools to handle ethical dilemmas in the workplace effectively.						

Course Outcomes	
CO1	Develop an understanding of human values, morals, and ethics for professional and personal growth.
CO2	Analyze and apply ethical reasoning in decision-making for professional and social well-being.
CO3	Demonstrate awareness of environmental, social, and sustainability responsibilities in engineering practices.
CO4	Identify ethical dilemmas and implement professional ethics in engineering projects.
CO5	Develop skills for effective communication, teamwork, and leadership while adhering to ethical values.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Human Values	Definition, Types of Values, Morals, Ethics, and Character, Need for Ethics in Engineering. Value Education, Self-Exploration. Natural Acceptance and Experiential Validation, Continuous Happiness and Prosperity, Right understanding, Understanding Happiness and Prosperity correctly.	6	CO1
2	Introduction to Ethical Concept	Definition of industrial ethics and values, Ethical rules of industrial worker. Values and Value Judgments. Moral Rights and Moral rules, Moral character and responsibilities. Privacy, Confidentiality, Intellectual Property and the Law. Ethics as Law.	6	CO2
3	Corporate Social Responsibility & Sustainability	The basis and scope of Professional Responsibility, Professions and Norms of Professional Conduct, Ethical Standards versus Profession, Culpable mistakes, the Autonomy of professions and codes of ethics. Employee status and Professionalism. Central Professional Role of Engineers in Society, Ethical Theories, Decision Making Frameworks, Conflicts of Interest Environmental and Social Responsibilities, Sustainability, Safety, and Risk Assessment	6	CO3
4	Ethical Dilemmas and Case Studies	Senses of 'Engineering Ethics', variety of moral issues, types of inquiry, moral dilemmas, moral autonomy, Kohlberg's theory, Gilligan's theory, Valuing Time, Case Studies on Professional Ethics, Corporate Misconduct, Whistleblowing	6	CO4
5	Communication and A Glimpse of Life Stories on Leadership with Ethics	Effective Communication, Teamwork, Leadership, and Ethical Conduct. Environmental ethics, computer ethics, weapons development, engineers as managers consulting engineers, engineers as expert witnesses and advisors, moral leadership. Life story of Prophet Mohammad, Mahatma Gandhi, Swami Vivekanand, Marie Curie and Steve Jobs.	6	CO5

Reference Books:

- R. R. Gaur, R. Sangal, G. P. Bagaria, "A Foundation Course in Human Values and Professional Ethics," Excel Books, 2010.
- Govindarajan M., Natarajan S., Senthil Kumar V. S., "Engineering Ethics (Includes Human Values)," PHI Learning, 2013.
- Charles D. Fleddermann, "Engineering Ethics," Pearson Education, 4th Edition, 2012.
- Mike W. Martin, Roland Schinzinger, "Ethics in Engineering," McGraw Hill, 4th Edition, 2013.
- R.S. Naagarazan, "Professional Ethics and Human Values," New Age International, 2006.

e-Learning Source:

https://www.youtube.com/watch?v=XiN8iqJGb48&list=PLFW6lRTa1g83uYgRiZEy_F4pzedPNWpew

https://www.youtube.com/watch?v=vS31O3XfH_0&list=PLyVhmjhvTvDYR2K4FgFYuK2gfUibZG8YA

https://www.youtube.com/watch?v=8gpzLafYPcA

https://www.youtube.com/watch?v=xXyatU-l07w

PO-PSO	PO-PSO Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	3	3	2	2	1	3	2	2	1
CO2	2	2	2	1	1	3	3	2	2	1	3	2	3	2
CO3	2	2	2	2	1	3	3	2	2	1	3	2	3	2
CO4	1	2	2	2	1	3	3	2	2	1	3	2	2	2
CO5	1	1	2	2	2	3	3	3	3	2	3	2	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Effective from Session: 2025-2026							
Course Code	BE204	**Title of the Course**	PLANT AND ANIMAL PHYSIOLOGY	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To build up the knowledge of students in pertinent plant physiological processes and physiological aspects of crop yield. To familiarize students with the principles and basic facts of Animal Physiology with focus on cardiovascular, respiratory, digestive and excretory systems.						

Course Outcomes	
CO1	Understand the transport of water, gases and nutrients in plants.
CO2	Understand essential minerals, macro and micronutrients, their role and deficiency symptoms and analyze the growth of plants in their absence.
CO3	Students will understand the functioning and physiology of cardiovascular system and respiratory system.
CO4	Students will understand the concept of digestion of various biomolecules.
CO5	Students will understand the concept and functioning of excretory system.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Transport in plants	Movement of water, gases and nutrients; Cell to cell transport-Diffusion, facilitated diffusion, active transport; Plant–water relations–Imbibition, water potential, osmosis, plasmolysis; Long distance transport of water–Absorption, apoplast, symplast, transpiration pull, root pressure and guttation; Transpiration – Opening and closing of stomata; Uptake and translocation of mineral nutrients, Transport of food, phloem transport.	8	CO1
2	Mineral nutrition	Essential minerals, macro and micronutrients and their role; Mineral deficiency and their symptoms; Mineral toxicity; Elementary idea of Hydroponics as a method to study mineral nutrition.	8	CO2
3	Cardiovascular and Respiratory System	Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation. Respiratory system-transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.	8	CO3
4	Digestive system	Digestion, absorption, energy balance, BMR. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids..	8	CO4
5	Excretory system	Excretory system-Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, electrolyte balance	8	CO5

Reference Books:

1. Plant Physiology by Lincoln Taiz and Eduardo Zeiger
2. Plant Physiology by Frank Salisbury and Cleon Ross.
3. Text Book of Plant Physiology, Biochemistry, and Biotechnology by V.K. Varma and Mohit
4. Smith et al. Principles of Biochemistry. Mammalian Biochemistry. McGraw Hill 7th ed.
5. Guyton and Hall.Textbook of Medical Physiology 12ed 2011.

e-Learning Source:

https://www.youtube.com/watch?v=gUwwvGB0gz8

https://www.youtube.com/watch?v=xEF8shaU_34

https://drive.google.com/file/d/13hs2l-WfHzfR3AKhzWq-lFYVO5ODYvpW/view?usp=sharing

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	2	1	1	1	1	3	2	2	2
CO2	2	2	2	2	1	2	1	1	1	1	2	2	1	2
CO3	2	2	2	3	1	2	1	1	1	1	3	3	2	1
CO4	2	2	3	3	1	2	1	1	1	1	2	3	2	1
CO5	3	2	2	3	1	2	1	1	1	1	3	2	2	1

Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD

Integral University, Lucknow

Effective from Session: 2025-26 (NEP)							
Course Code	CS228	**Title of the Course**	Concepts of Web Development	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	0	0	3
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The course is meant to give students a clear, conceptual understanding of foundational elements and working of websites, basic tools, and the real-world application of web technologies.						

Course Outcomes	
CO1	Students will be able to recall the history and functions of the internet and web.
CO2	Students will be able explain the principles of good design and describe how websites are made user-friendly.
CO3	Students will apply their understanding of how content is organized and managed on websites by working with a Content Management System (CMS).
CO4	Students will be able analyze the backend logistics involved in running a website to understand how different components interact and contribute to its functionality.
CO5	Students will be able assess the broader context, real-world applications, and potential careers in web development to make informed decisions about their future direction.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Internet and Websites**	Introduction to Internet and Web, Evolution of the Web, How Websites Work: Servers, Clients, and Browsers, Understanding URLs, Domain Names, and Hosting, Introduction to Web Browsers and Search Engines, Introduction to Static vs Dynamic Websites, Types of Websites (Personal, Business, E-commerce, Portfolio)	8	1
2	**Understanding Web Design & User Experience**	Basics of Visual Design in Websites, Fonts and Layout Principles, Importance of User Experience (UX) and Accessibility, Principles of responsive design, Adapting to Mobile and Tablets, Good vs Bad Website Examples: Design Analysis, Web Design Trends	8	2
3	**Basic Building Blocks of a Web Page**	Introduction to HTML: the structure of a web page (basic tags like headings, paragraphs, images, links), Introduction to CSS: basic styling concepts (color, font, layout), Separation of content (HTML) and design (CSS), Role of multimedia (images, video, audio)	8	3
4	**Content Management Systems (CMS) and No-Code Tools**	Introduction to CMS, Differences between CMS and custom development, Buying a domain and web hosting, How to build a basic website using a CMS, Plugins: Extending Website Functionality Without Coding, Website Maintenance: Updates, Backups, and Security, SEO Basics: Making Websites Search Engine Friendly, Legal & Ethical Aspects: Copyrights, Privacy, GDPR	8	4
5	**Careers, Tools, and Future Trends in Web Development**	Roles in Web Development: Designer, Developer, Content Creator, Content manager, SEO specialist, etc., Portfolio Creation, Analytics & User Tracking (Basic Intro to Google Analytics), Monetizing Websites: Blogs, Ads, Affiliate Marketing, Future Trends: AI in Web, Progressive Web Apps, Voice UI	8	5

Reference Books:

1- "HTML and CSS: Design and Build Websites" by Jon Duckett

2- "WordPress for Beginners 2023" by Dr. Andy Williams

3- "The Principles of Beautiful Web Design" by Jason Beaird & James George

e-Learning Source:

https://onlinecourses.swayam2.ac.in/nou24_cs09/preview

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	2	1		1				1	1	1	1	2	1

CO2	3	3	3		2				2	2	1	1	2	2
CO3	2	1	1		3				2	1	1	2	2	1
CO4	3	3	3		2				1	2	2		2	1
CO5	2	3	2		3				2	2	1		2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow
Attributes &SDGs Common for all branches/Disciplines

Course Code	Course Title	Attributes							SDGs No.
ES203	Disaster Management and Mitigation	Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
						√			SDGs 3,11 & 17

B.Tech. (All Branches)

Effective from Session:							
Course Code	**ES203**	**Title of the Course**	**Disaster Management and Mitigation**	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	**IV**	2	1	**0**	**3**
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	1. **Understand** the various types of disasters and analyze their profiles in the Indian context. 2. **Explain** the causes and **evaluate** the impacts of different disasters through case studies of national and global events. 3. **Apply** risk reduction approaches in disaster management and **analyze** safety measures for mitigating industrial disasters. 4. **Comprehend** the fundamental concepts of the Disaster Management Cycle and **implement** appropriate risk reduction strategies. 5. **Examine** national disaster mitigation acts and policies, and **assess** the roles of key stakeholders such as the Army, Police, Community, Corporate sector, and Media in post-disaster management from both national and global perspectives.						

Course Outcomes	
CO1	Students will be able to learn types of disasters and its profile in India
CO2	Students will be able to understand the causes and impacts of disasters on environment
CO3	Students will be able to learn about risk reduction approaches of disasters with safety issues in mitigating industrial disasters.
CO4	To understand the concept of Disaster Management Cycle and its Risk Reduction
CO5	Students will be able to learn the role of Acts, Policies, National and International Organizations in Disaster Management
CO6	Students will be able to learn about Global Perspectives of Disasters

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction to disaster	Introduction to Disasters, Concepts, Definition and types (Natural and Man-made), Disaster profile of India.	6	CO1
2	Impact of Disaster	Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem., Case studies from Disasters, Large Hydro projects and its risks for Disasters.	8	CO2
3	Disaster Risk Reduction	Approaches to Disaster risk Reduction, Risk Assessments and Vulnerability Analysis Techniques, Safety issues in mitigating, Case studies, EHS	7	CO 3
4	Disaster Management	Disaster Management Cycle. Reconstruction and Rehabilitation. Early warning Systems Pre-Disaster Management, Post Disaster Management	6	CO4
5	Disaster Act and Policies	National Acts and policies for mitigating Disasters (Disaster Management Act 2005, NDRF, National Policy for Disaster Management 2009, Role of Army and Police Force in Disaster, Role of International/National Humanitarian aid/ Relief Organizations for Disaster management, Role of Community, Corporate, Media etc. for post Disaster Management.	9	CO5
6	Global Perspective (Natural and Manmade Disasters)	Case Studies of disasters induced by Human Activities and climate change such as earthquake, forest fire, flood, drought, landslides, Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.	9	CO 6

Reference Books:

(1) Gupta Harsh K., Disaster Management, Hyderabad University Press, Publications-Meerut.
(2) Sethi, V.K., Disaster Management, New Delhi Maxford Books
(3) Bhattacharya, Tushar, Disaster Science and Management, New Delhi Tata Mc Graw Hill.
(4) Nidhi Gauba, Dhawan/ Ambrina Sardar Khan, Disaster Management and Preparedness, CBS

e-Learning Source:

https://www.youtube.com/watch?v=9WIwlljva_s

https://www.youtube.com/watch?v=uA_OLKfQpYA

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	1	1	1	2	3	-	2	2	1	2	1	2	-	-	-	-
CO2	2	2	2	1	2	2	3	-	2	2	2	2	1	2	-	-	-	-
CO3	3	2	2	1	2	2	3	-	2	2	1	2	1	2	-	-	-	-
CO4	2	2	3	1	2	2	3	-	2	1	1	2	1	2	-	-	-	-
CO5	1	1	2	2	1	1	2	-	2	2	1	2	1	2	-	-	-	-

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD

Integral University, Lucknow

Effective from Session: 2025-2026							
Course Code	BE209	**Title of the Course**	Immunology	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**3**	**0**	**2**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The course equips students with fundamental knowledge of innate and adaptive immunity, including humoral and cellular responses, antigen-antibody interactions, and serological techniques. Additionally, it covers immunological disorders, graft rejection, tumor immunity, and immunosuppressive strategies.						

Course Outcomes	
CO1	Understand and analyze the principles of innate and adaptive immunity, immune cells, lymphoid organs, antigenicity, and factors affecting immunogenicity.
CO2	Understand and evaluate humoral immunity, including B-cell activation, immunoglobulin structure and function, monoclonal and polyclonal antibodies, and MHC molecule roles.
CO3	Assess, comprehend, and interpret cellular immunity, including T-cell classification, antigen presentation pathways, cytokine functions, immune tolerance, and immunosuppression mechanisms.
CO4	Apply and analyze antigen-antibody interactions, serological techniques (ELISA, RIA, Immunoblotting), hypersensitivity reactions, complement system, and vaccine development.
CO5	Investigate, analyze, and determine graft rejection, autoimmunity, tumor immunity, and immunosuppressive strategies for autoimmune disorders and cancer therapy.
CO6	Identify antigen-antibody interactions using double diffusion and immuno-electrophoresis techniques.
CO7	Apply ELISA and immunoblotting (ELISA-dot) techniques and interpret results from Western blot for antigen or antibody detection.
CO8	Determine ABO blood groups and perform RBC and WBC cell counting using a haemocytometer.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Fundamentals of the Immune System	Overview of the immune system, structure and functions, innate and adaptive immunity characteristics, humoral and cellular immunity mechanisms, cells and molecules of the immune system, primary and secondary lymphoid organs (bone marrow, thymus, lymph nodes, spleen), antigens, antigenicity and immunogenicity, factors influencing immunogenicity (chemical nature, size, foreignness).	8	CO1
2	Humoral Immunity	B-lymphocytes development, activation and differentiation, immunoglobulins structure, function, classes and subclasses, clonal selection theory and antibody production, polyclonal and monoclonal antibodies production and diagnostic applications, idiotypic antibodies concept and significance, Major Histocompatibility Complex (MHC) structure, function and role in immune recognition.	8	CO2
3	Cellular Immunity	T-lymphocytes classification (helper, cytotoxic, regulatory T cells), antigen-presenting cells (APCs) types (dendritic cells, macrophages) and functions, antigen processing and presentation via exogenous and endogenous pathways, cytokines structure, function and role in immune regulation, macrophage activation and granuloma formation, immunosuppression and immune tolerance mechanisms, applications of cytokines in immunotherapy.	8	CO3
4	Clinical and Diagnostic Immunology	Antigen-antibody interactions; serological techniques – ELISA, RIA, Immunoblotting; hypersensitivity reactions; complement system; adjuvants and antigen dosage; vaccine types; immunity against infections (virus, bacteria, protozoa); graft rejection – mechanisms and prevention; immunosuppressive drugs; HLA and disease; tumor immunity; autoantibodies; autoimmune disease mechanisms and treatment.	8	CO4, CO5

PRACTICAL

S. No.	**List of Experiments**	**Contact Hrs.**	**Mapped CO**
1	Double diffusion techniques for identification of Antigen-Antibody samples.	2	CO6
2	Immuno-electrophoresis techniques.	2	CO6
3	ELISA (Enzyme Linked Immunosorbent Assay)	2	CO7
4	Immunoblotting Using ELISA-dot	2	CO7
5	Western blot technique (Demonstration)	2	CO7
6	Blood groups (ABO blood group typing)	2	CO8
7	Cell Counting (RBC and WBC count by Heamocytometer)	2	CO8

Reference Books:

1. Kuby's Immunology- Murry, 5thed.
2. Ivan M. Roitt, J. Brostoff and David K. Male. Immunology, Glower Medical Publishers, London.
3.Immunology by David Male (Editor); Victoria Male (Editor); Ray Stokes Peebles (Editor)
4.Review of Medical Microbiology and Immunology, Sixteenth Edition by Warren E.
5.Oxford Handbook of Clinical Immunology and Allergy by Gavin Spickett.
6.Cellular and Molecular Immunology by Abul K.

e-Learning Source:
https://www.avit.ac.in/lab/immunology_bioprocess_engineering_lab/download/17BTCC89/lab_manual.pdf

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1		2		3	3	1	1	1		2	3	1	1
CO2	1		2		2	3	1	1	1		2	3	1	1
CO3	2		1		3	3	1	1	1		3	3	1	1
CO4	1		3		3	3	2	3	2		3	3	1	1
CO5	1		3		3	3	2	3	2		3	3	1	1
CO6	3	3	1	3	3	1	1	3	2		3	3	3	3
CO7	3	3	1	3	3	1	1	3	2		3	3	3	3
CO8	3	3	1	3	2	1	1	3	2		3	3	3	3

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2025-26							
Course Code	BE210	**Title of the Course**	Enzymology	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**3**	**0**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The objective of the course is to provide a deeper insight into the fundamentals of enzyme structure, function and kinetics of enzymes along with their current applications and future potential.						

Course Outcomes	
CO1	Describe and classify enzymes and illustrate their physic-chemical properties.
CO2	Explain enzyme kinetics, analyze the enzyme kinetic parameters, and differentiate between types of enzyme inhibitions based on their kinetic characteristics.
CO3	Describe and analyze mechanism of action and applications of industrial enzymes, evaluate factors affecting enzyme stability, and compare and design enzyme immobilization strategies to develop innovative applications in biotechnology.
CO4	Design protocol for isolation and purification of microbial enzymes and assess the applicability of enzymes.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Enzymes	Introduction, classification and nomenclature of enzymes. Active site, isoenzymes, coenzymes, cofactors, turn over number, enzyme specificity, enzyme activity, specific activity, multi-enzyme complexes, Physico-chemical characteristic of enzymes. Effect of pH, temperature and substrate concentration on enzyme activity.	8	CO1
2	Enzyme kinetics	Enzyme kinetics, derivation of Michaelis Menten equation, measurement of Km and Vmax, Enzyme inhibition, kinetics of competitive, non-competitive and un-competitive inhibition of enzymes. Allosteric enzymes and their kinetics.	8	CO2
3	Industrial enzymes and enzyme immobilization	Chymotrypsin, lysozyme, carboxypeptidase, and ribozyme and their mechanism of action. Enzyme stability, Methods of enzyme immobilizations and their applications.	8	CO3
4	Isolation, purification, and characterization of the enzymes	Methods for cell disruption, Isolation, purification, and characterization of the intra and extracellular enzymes from microorganisms. Use of detergents in isolation of membrane proteins. Industrial, diagnosis and therapeutic application of enzymes.	8	CO5

Reference Books:

1. Murray Moo-Young-Comprhensive Biotechnology, II & IVth Vol.
2. Biochemistry- D. J. Voet & J. G. Voet, 6th ed.
3. Methods in Enzymology- A series.
4. Enzyme Kinetics-Hans Bisswanger, Wiley Publication.
5. Biocatelysis: Fundamentals and Application- A.S. Bommarius et al., Wiley Publication.

e-Learning Source:

https://youtu.be/gJNMryCX3YY

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	1					3	3	1	
CO2	3	3	2	3	2	1					3	3	3	
CO3	3	2	3	3	3	3	2				3	3	3	2
CO4	3	3	3	3	3	3	2	3		1	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective Session: 2025-2026							
Course Code	BE211	**Title of the Course**	Bioinformatics	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	3	0	0	0
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	This course aims to provide a foundational understanding of bioinformatics, focusing on the nature and structure of biological data and the tools required to organize, retrieve, and analyze them. It introduces major biological databases, sequence alignment methods, and similarity search tools. Students will learn to access and interpret genomic and proteomic data using standard tools such as BLAST and FASTA. The course also builds analytical thinking and data handling skills relevant to biotechnology, healthcare, and environmental sciences through the use of real-world biological data and case studies.						

Course Outcomes	
CO1	Explain the foundational concepts of bioinformatics, types of biological data, and bioinformatics workflows; describe the role of data generation technologies in molecular biology.
CO2	Identify and classify biological databases and file formats, retrieve nucleotide, protein, and bibliographic data using appropriate bioinformatics tools.
CO3	Perform sequence similarity searches using BLAST and FASTA, analyze and interpret alignment results using scoring systems and alignment metrics.
CO4	Evaluate the applications of bioinformatics in genomics, proteomics, drug discovery, agriculture, and environmental sciences using relevant tools and case studies.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Fundamentals of Bioinformatics	Introduction to bioinformatics: genesis, definition, brief history, and interdisciplinary nature; Importance in modern biology and biotechnology; Basic biological concepts: DNA, RNA, protein, gene expression; Introduction to bioinformatics workflows; Types of biological data: genomic, proteomic, transcriptomic, metabolomic; Levels of biological information: sequence, structure, and function; Overview of data generation technologies: sequencing, microarrays, mass spectrometry; Role of bioinformatics in data organization, storage, and interpretation.	8	CO1
2	Biological Databases and File Formats	Introduction to biological databases: Types and importance; Nucleotide databases: GenBank, EMBL, DDBJ, INSDC; Protein databases: UniProt, Prosite, neXtProt, RCSB PDB, AlphaFold; Open access bibliographic databases: PubMed, PubMed Central, Bookshelf; Chemical database: PubChem database; Sequence file formats: GenBank, EMBL, UniProt, FASTA; Structure file format: PDB.	8	CO2
3	Database Similarity Searching	Concepts of homology, identity, and similarity: Definitions and biological significance, Orthologs, paralogs, xenologs; Overview of pairwise sequence alignment: Global vs local alignment, Applications and examples; FASTA algorithm: Overview and working principles, Output interpretation and result evaluation; BLAST Algorithm: Types of BLAST, Output interpretation: E-value, P-value, bit score, Understanding graphical and tabular outputs; Comparison of BLAST and FASTA. Overview of scoring matrices: PAM and BLOSUM, Selection criteria and usage.	8	CO3
4	Applications of Bioinformatics	Genomics: annotation, gene prediction, comparative analysis; Proteomics: structure and interaction analysis; Transcriptomics: expression profiling; Drug discovery: target identification, screening; Agriculture: crop improvement, marker-assisted selection; Environmental and clinical bioinformatics: metagenomics, DNA barcoding, disease diagnosis, vaccine design; Case studies and real-world examples: Success stories from human genome projects, cancer genomics, COVID-19 research.	8	CO4

Reference Books:

1. D. W. Mount: Bioinformatics-sequence and genome analysis, 2nd Edition, Cold Spring Harbor Lab Press, 2004.
2. Jin Xiong: Essential Bioinformatics, Cambridge University Press, 2006.
3. D.E. Krane and M.L. Raymer, Fundamental concepts of bioinformatics, Pearson Education Inc. 2006.

e-Learning Source:

1. https://www.vlab.co.in/broad-area-biotechnology-and-biomedical-engineering

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	2	1	2	1	1	3	3	2	1
CO2	3	3	3	2	1	2	1	1	1	1	3	3	3	2
CO3	3	3	3	3	3	1	1	2	2	2	3	3	3	3
CO4	3	3	3	3	2	2	1	3	2	2	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2025-26							
Course Code	BE212	**Title of the Course**	Genetics	**L**	**T**	**P**	**C**
Year	3rd	**Semester**	6th	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To understand the basics of genetic inheritance and Mendelian laws of inheritance. To learn the modern cytogenetics and molecular mapping techniques for eukaryotic chromosomes. To know the mechanism involved in chromosome segregation, different genetic disorders and use of statistics in advanced genetics.						

Course Outcomes	
CO1	Understand, analyze and able to describe the basics of genetic inheritance and Mendelian laws of inheritance, Extra chromosomal inheritance like inheritance of mitochondrial and chloroplast genes, maternal inheritance.
CO2	Analyze, examine and able to illustrate the modern cytogenetics and molecular mapping techniques for eukaryotic chromosomes like Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids.
CO3	Assess, examine and determine the mechanism involved in chromosome segregation, different genetic disorders and understanding of Euphenics, Eugenics and Genetic counseling.
CO4	Assess, summarize and design the use of statistics in advanced genetics in Population genetics analysis and issues.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Mendelian principles, Extra-Chromosomal Inheritance**	Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy. Chromosome morphology, chemical composition structure and function. Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes, maternal inheritance.	8	CO1
2	**Gene Mapping Methods**	Linkage and crossing over, sex linkage, sex limited and sex influenced characters; Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids.	8	CO2
3	**Cytogenetics**	Chromosome banding, Chromosome aberration, genetic studies: genetic diseases, blood group, disputed parentage, animal and crop improvement, Euphenics, Eugenics and Genetic counseling.	8	CO3
4	**Use of Statistics in Genetics**	Pedigree analysis, Karyotypes, Population genetics: Gene frequency, genotype frequency, gene pool, Hardy-Wienberg law and equllibrium, t-test; analysis off variance; $\chi 2$ test	8	CO4

Reference Books:

1. Gardner, M. J. Simmons, D. P. Snustad, Principles of Genetics, John Wiley & Sons, (8th Edition).
2. Tom Strachan, T. Strachan, Andrew Read, Andrew P. Read “Human Molecular Genetics” William S. Klug Michael R. Cummings “Concepts of Genetics (7th Edition)”.
3. B.D.Singh, Genetics, Kalyani Publications (4th Edition).
4. P.S.Verma and V.K.Agarwal, Cell Biology, Molecular Biology, Genetics, Evolution and Ecology, S.Chand Publications (4th Edition).

e-Learning Source:

https://drive.google.com/file/d/1MqwWCB_OZjWiaq_u3_nUaeRZo-1ckN0b/view?usp=sharing

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1		1					3	3	2	
CO2	3	2	1	1		1					3	3	2	
CO3	3	2	1	1		1					3	3	2	
CO4	3	2	1	1		1					3	3	2	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:2025-2026							
Course Code	BE213	**Title of the Course**	Heat and Mass Transfer Operations	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**3**	**1**	**4**	**6**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	Develop comprehensive understanding of heat and mass transfer principles through hands-on experiments and analytical techniques to model, design, and optimize efficient separation and process systems in complex engineering applications.						

Course Outcomes	
CO1	Analyze heat transfer modes and design efficient heat exchangers using engineering principles, tools, and problem-solving skills.
CO2	Apply mass transfer principles to model diffusion and inter-phase transport in engineering systems and processes.
CO3	Apply phase equilibrium and distillation principles to design separation processes for ideal and non-ideal mixtures.
CO4	To understand ternary liquid equilibria and design multistage separation processes using graphical and analytical techniques effectively.
CO5	Apply equilibrium principles to analyze and design absorption, adsorption, and drying systems.
CO6	Apply engineering principles to design experiments, analyze data, and innovate effective heat transfer solutions for complex problems.
CO7	Apply analytical, design, and evaluation techniques to assess heat exchanger performance and mass transfer phenomena.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Heat Transfer**	Modes of heat transfer: conduction, convection and radiation; Heat transfer between fluids; Design equations for heat transfer; Heat transfer equipment: heat exchangers, types of heat exchangers, design of heat exchangers	8	CO1
2	**Mass transfer: Fundamentals**	Molecular and turbulent diffusion, diffusion coefficient, Fick's law of diffusion. Dependence of diffusion coefficient on temperature, pressure and composition. Diffusion in multi-component gasmixtures. Diffusion in solids: Molecular, Knudsen & Surface diffusion. Inter-phase mass transfer: Masstransfer coefficients, Diffusion between phases. Mass transfer theories, Simultaneous heat and mass transfer.	8	CO2
3	**Distillation**	Pressure-composition, Temperature-concentration, Enthalpy-concentration diagrams for ideal and non ideal solutions, Raoult's law and its application, Maximum and minimum boiling mixtures, concept of relative volatility. Single stage Distillation, Differential distillation, Flash vaporization Vacuum, molecular and steam distillation.	8	CO3
4	**Liquid-Liquid Extraction**	Ternary liquid equilibria. Triangular graphical representation concept of theoretical or ideal stage. Equipment used for single stage and multistage continuous operation. Analytical and graphical solution of single and multistage operation Super critical fluid extraction.	8	CO4
5	**Absorption, Adsorption & Drying**	Absorption: Gas-Liquid equilibria, Henry's Law, Selection of solvent, Absorption in tray column.Graphical and analytical methods, Absorption in packed columns. HTU, NTU & HETP concepts. Adsorption: Types of adsorption, nature of adsorbents, adsorption equilibria and adsorption hysterises, Stage wise and continuous contact adsorption operations, Drying: Different modes of drying operations, Definition of moisture contents, Types of batch and continuous dryers, Rate of batch drying, Time of drying, Mechanism of batch drying, continuous drying.	8	CO5

PRACTICL

S. No.	List of Experiments	Contact Hrs.	Mapped CO
1	To determine the surface heat transfer coefficient for a vertical tube losing heat by natural Convection.	2	CO6
2	To find the heat transfer coefficient of forced convection in internal pipe flow	2	CO6
3	To study the heat transfer through conduction in composite wall, and calculate thermal resistance, thermal conductivity and plot the temperature profile along the composite wall.	2	CO6
4	To determine the Steffen's Boltzmann constant.	2	CO6
5	To determine the LMTD, overall heat transfer coefficient and effectiveness of a heat Exchanger working in parallel flow mode.	2	CO7
6	To determine the LMTD, over all heat transfer coefficient and effectiveness of a heat Exchanger working in counter flow mode.	2	CO7
7	To observe the process of boiling and condensation	2	CO7
8	To study the heat transfer in the process of condensation	2	CO7

Reference Books:

1. Treybal, R "Mass Transfer Operations", 3rded. New York: McGraw-Hill, (1980).
2. Geankoplis, C.J., "Transport Processes and Unit Operations", 3rd ed. Prentice Hall (1983).
3. Heat Transfer: J.P. Holman, McGraw Hill.

e-Learning Source:
1. https://www.youtube.com/watch?v=qa-PQOjS3zA&list=PL5F4F46C1983C6785
2. https://nptel.ac.in/courses/112101097

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	2	1	1	1	1	2	3	3	2
CO2	3	3	2	2	3	2	1	1	1	1	2	3	3	2
CO3	3	3	3	2	3	2	1	1	1	1	2	3	3	2
CO4	3	3	3	3	3	2	1	1	1	1	2	3	3	2
CO5	3	3	3	2	3	2	1	1	1	1	2	3	3	2
CO6	3	3	3	3	3	2	1	1	1	2	3	3	3	3
CO7	3	3	3	2	3	2	1	2	2	2	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD

Integral University, Lucknow

Effective from Session: 2025-26 (NEP)							
Course Code	CS203	**Title of the Course**	Cyber Law and Information Security	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	2	0	0	3
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	• Knowledge about cyber law, intellectual property and cybercrimes (internet security threats), trademarks and domain theft. • Knowledge on the disciplines of technology, E-business and law to allow them to minimize the occurrence and severity of information security incidents. • Knowledge about Information System and principles of Information Security (as confidentiality, integrity, and availability). • Knowledge of cryptography and techniques used to detect and prevent network intrusions.						

Course Outcomes	
CO1	Understand key terms and concepts in cyber law, intellectual property and cybercrimes (internet security threats), trademarks and domain theft.
CO2	Apply and analyze knowledge of technology, E-business, and law to minimize the occurrence and impact of information security incidents.
CO3	Understand and evaluate the principles of Information Security, including confidentiality, integrity, and availability, in relation to information systems.
CO4	Understand and apply cryptographic techniques and methods to detect and prevent network intrusions, ensuring secure data transmission.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Fundamentals of Cyber Law**	Jurisprudence of Cyber Law, Object and Scope of the IT Act 2000, Introduction to Indian Cyber Law, Unicitral Model Law, ISP Guideline. Intellectual property issues and cyber space, Indian perspective, Overview of Intellectual property related legislation in India, Patent, CopyRight, Trademark law, Law related to semiconductor layout & design.	8	CO1
2	**E - Commerce**	Security Threats to E - Commerce, Virtual Organization, Business Transactions on Web, EGovernance and EDI, Concepts in Electronics payment systems, E-Cash, Credit/Debit Cards, E- Agreement, Legal recognition of electronic and digital records, E- Commerce Issues of privacy, Wireless Computing- Security challenges in Mobile devices. Digital Signatures - Technical issues, legal issues, Electronic Records, Digital Contracts, and Requirements of Digital Signature System.	7	CO2
3	**Investigation and Ethics**	Cyber Crime, Cyber jurisdiction, Cyber crime and evidence act, Treatment of different countries of cyber crime, Ethical issues in data and software privacy, Plagiarism, Pornography, Tampering computer documents, Data privacy and protection, Domain Name System, Software piracy, Issues in ethical hacking. Internet security threats: Hacking, Cracking, Sneaking, Viruses, Trojan horse, Malicious Code & logic bombs. Introduction to biometric security and its challenges, Finger prints, Cyber crime forensic: CASE STUDY in Cyber Crime.	9	CO3
4	**Information security**	Information Systems and its Importance, Role of Security in Internet and Web Services, Principles of Information Security, Classification of Threats and attacks, Security Challenges, Security Implication for organizations, Security services - Authentication, Confidentiality, Integrity, Availability and other terms in Information Security, Information Classification and their Roles. Introduction to Cryptography, Issues in Documents Security, Keys: Public Key, Private Key, Firewalls, Basic Concepts of Network Security, Perimeters of Network protection & Network attack, Need of Intrusion Monitoring and Detection.	9	CO4

Reference Books:

Harish Chander "Cyber Law and IT Protection" , PHI Publication, New Delhi

Merkov, Breithaupt," Information Security", Pearson Education

"Cyber Law in India" - Farooq Ahmad-Pioneer books.

K. K. Singh, Akansha Singh "Information Security and Cyber law", Umesh Publication, Delhi

e-Learning Source:

https://nptel.ac.in/courses/106106248

https://onlinecourses.swayam2.ac.in/cec24_cs14/preview

Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO / **CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	2	1	2	1	3	1	1		1	1	2		2
CO2	3	1	2		2			2	2		2		2	
CO3	2	2		1	1	1	3	2	1	1	1	2	1	3
CO4	1		2		2			1					3	1

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2025-26							
Course Code	BE214	**Title of the Course**	**Artificial Intelligence In Biotechnology**	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**2**	**1**	**0**	**0**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	Students will learn how AI can be applied in the field of biotechnology, enabling them to critically analyze and contribute to advancements in this rapidly evolving interdisciplinary field.						

Course Outcomes	
CO1	Explain the fundamentals, history, and ethical aspects of artificial intelligence in biotechnology.
CO2	Apply machine learning techniques such as feature selection, natural language processing (NLP), and sentiment analysis to biotechnology datasets
CO3	Use statistical tools and exploratory data analysis for data collection, cleaning of biological data, text mining and conservation strategies in biotech research.
CO4	Apply various AI applications in agricultural biotechnology, medical biotechnology, pharmacology industry, bioproduct development and computational biology.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to artificial intelligence	History and evolution of AI, comparison of human and computer skills, Component of AI, Scope and significance in different domains, Ethical considerations in AI development and deployment, Intelligent Agent, logical agent. Problem solving through AI: Defining the problem as a state space search, analyzing the problem, solving the problem by searching, informed search and Uninformed Search	8	CO1
2	Machine Learning Basics	Neural networks and deep learning, Supervised and unsupervised learning, Feature selection and engineering, learning from observation, and knowledge in learning. Natural Language Processing: Brief history of NLP, Text processing, Sentiment analysis, language translation, Early NLP system, ELIZA system, LUNAR system, General NLP system.	8	CO2
3	Data Science for Biologists	Data collection and cleaning of biological data set. Feature Selection and Data preprocessing, Exploratory data analysis, Statistical tools for data interpretation, conservation strategies with machine learning, text mining in literature review in research, ethical considerations in AI research.	8	CO3
4	AI in Biotechnology	Intersection of AI and Biotechnology: Historical perspective and key milestones, Application of AI in Agricultural Biotechnology, Medical Biotechnology, Bioproduct development, Pharmacology Industry and Computational Biology.	8	CO4

Reference Books:

1. Artificial Intelligence in Biotechnology (2020). United States: Arcler Education Incorporated.
2. Hilbush, B. S. In Silico Dreams: How Artificial Intelligence and Biotechnology Will Create the Medicines of the Future. United States: Wiley.
3. Alkhalifa, S. Machine Learning in Biotechnology and Life Sciences: Build Machine Learning Models Using Python and Deploy Them on the Cloud. United Kingdom: Packt Publishing.

e-Learning Source:

1. https://www.youtube.com/watch?v=1Y171DnU5nM
2. https://www.sciencedirect.com/science/article/pii/S2666154320300144

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	3	1	3		1	1	1	1	1
CO2	3	3	3	3	3	3	1	1		2	2	2	1	1
CO3	3	3	3	3	3	3	1	3		2	3	3	2	1
CO4	3	3	3	3	3	3	1	2		2	3	3	3	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Effective from Session: 2020-2021							
Course Code	BE215	**Title of the Course**	Plant Biochemistry	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	2	1	0	3
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The main objective of the course is to make students understand the biochemistry of phytochemicals and plant metabolites.						

Course Outcomes	
CO1	Analyze the phenomenon of photosynthesis and understand Hill reaction and photosynthetic electron transport chain.
CO2	Understand the structure of nitrate reductase and nitrite reductase and ammonia incorporation into organic Compounds.
CO3	Analyze the biosynthesis of auxins, cytokinins, gibberllic and abscisic acids.
CO4	Understand different types of environmental stresses and analyze their impact on plant growth, metabolism and tolerance. Understand the concepts of anaerobiosis and pathogenesis.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Concept of photosynthesis**	Photosynthetic apparatus, pigments of photosynthesis, role of carotenoids, photosystems I and II, their location; Hill reaction, photosynthetic electron transport and generation of NADPH & ATP, cyclic and non-cyclic photophosphorylations, complexes associated with thylakoid membranes; light harvesting complexes, path of carbon in photosynthesis – C3 and C4 pathway of carbon reduction and its regulation, Photorespiration.	8	CO1
2	**Metabolism of reactions**	Nitrate assimilation- structural features of nitrate reductase and nitrite reductase, incorporation of ammonia into organic compounds, regulation of nitrate assimilation.	8	CO2
3	**Plant Hormones**	Biosynthesis of growth regulating substances-auxins, cytokinins, gibberllic and abscisic acids.	8	CO3
4	**Environmental factors**	Environmental stresses, salinity, water stress, heat, chilling, anaerobiosis, pathogenesis, heavy metals, radiations and their impact on plant growth and metabolism, criteria of stress tolerance.	8	CO4

Reference Books:

1. Plant Biochemistry by P. M. Dey and J. B. Harborne, Harcourt Aria PTE Ltd. Singapore.
2. Plant Physiology by Salinbury.
3. Plant Physiology by Davin.
4. Lehninger Biochemistry.

e-Learning Source:

https://drive.google.com/file/d/1cVgp-OnY-s0QqJWbYhM91GFCOJv3VeXy/view?usp=sharing

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	1	3	2	3				1	3	1	1	1
CO2	1	1	1	2	1	2				1	3	1	1	1
CO3	2	1	2	2	1	1				1	3	2	1	2
CO4	1	2	2	3	3	3				2	3	2	1	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2025-26							
Course Code	BE216	**Title of the Course**	Clinical Biochemistry	**L**	**T**	**P**	**C**
Year	2nd	**Semester**	4th	2	1	0	3
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To equip the students with the knowledge of biochemistry and pathophysiology associated with tests performed in a clinical biochemistry laboratory. Detailed knowledge about the homeostasis of water and electrolytes, inborn errors of metabolisms, diseases and disorders related to kidney, liver, gastrointestinal tract and pancreas will be given. In-depth knowledge of diabetes, cancer and tumor markers regarding diagnosis and their management will also be focused.						

Course Outcomes	
CO1	Understand and analyze about the concept of water and electrolyte homeostasis, blood pH and acidosis and alkalosis.
CO2	Understand and analyze the concept of inborn errors of metabolism related to all biolmolecules.
CO3	Understand and determine the concept of various pathological tests related to kidneys and Protein energy malnutrition-Marasmus and Kwashiorkor.
CO4	Develop, summarize and acquire the knowledge of various pathological tests related to Liver function tests, Jaundice, Diabetes and Cancer.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Hydrogen ion and Electrolyte Homeostasis**	Hydrogen ion homeostasis: Factors regulating blood pH-buffers, respiratory and renal regulation. Acid-base balance- causes, biochemical findings and management of metabolic and respiratory acidosis and alkalosis. Water, sodium and potassium homeostasis: Distribution of water and electrolytes in the ECF and ICF.	8	CO1
2	**Inborn Errors of Metabolism**	Disorders of amino acid metabolism- aminoaciduria, phenylketonuria, alkaptonuria, cystinuria, and maple syrup urine disease. Disorders of carbohydrate metabolism-glycogen storage diseases, galactosemia, fructose intolerance Disorders of purine, pyrimidine and porphyrin metabolism-Hyperuricemia and gout, Hypouricemia. Disorders of lipid metabolism- lipid storage diseases, fatty liver.	8	CO2
3	**Kidney and Nutritional Disorders**	Kidney function tests: Glomerular and tubular function tests. Abnormal constituents of urine. Pathogenesis, biochemical findings and management of glomerulonephritis, renal failure, nephrotic syndrome Protein energy malnutrition- Marasmus and Kwashiorkor.	8	CO3
4	**Liver and Gastrointestinal Disorders, Diabetes, and Cancer**	Liver function tests (excretory, synthetic, detoxification and metabolic). Plasma enzymes in liver disease. Jaundice- neonatal. Gastric function tests. Pathogenesis, biochemical findings and management of peptic ulcer and gastritis. Pancreatic and intestinal function tests. Classification of diabetes. Metabolic abnormalities–glycosuria. Acute and long-term complications, Diagnosis and management. Cancer: Differences between benign and malignant tumours. Morphological and biochemical changes in tumour cells. Tumour markers (AFP, CEA, hCG only).	8	CO4

Reference Books:

Principles of Internal Medicine. Harrison's Vol 1 & 2, 14th edition McGraw Hill, 1998.

Harper's Biochemistry McGraw Hill, 27th ed, 2006.

Biochemistry – A case-oriented approach. Montgomery *et al*. Mosby.1990 5th editon.

Clinical Chemistry – Principles, procedures, correlations – Bishop, Lippincott, 2005, 5th edition.

Guyton and Hall. Textbook of Medical Physiology 12 ed 2011.

e-Learning Source:

https://drive.google.com/file/d/1cVgp-OnY-s0QqJWbYhM91GFCOJv3VeXy/view?usp=sharing

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	1		3					3	2	1	
CO2	3	1	2	1		3					3	2	1	
CO3	3	1	2	1		3					3	2	1	
CO4	3	1	2	1		3					3	2	1	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	BE 217	**Title of the Course**	Process Engineering Economics	**L**	**T**	**P**	**C**
Year	2025-26	**Semester**	IVth	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**					
Course Objectives	In this course, students learn how to apply knowledge and understand the economic principles behind bioprocess and bioproduct development. Students evaluate the cost structures and profitability of biotechnological operations. Student's equipped with tools for techno-economic feasibility and cost-benefit analysis in industrial biotech processes.						

Course Outcomes	
CO1	**Understand** the fundamental principles of engineering economics and **evaluate** economic and technical feasibility in process engineering.
CO2	**Evaluate** different types of costs and **perform** operating cost estimation and to conduct break-even and profitability **analyses** for effective engineering decision-making.
CO3	**Classify** and **analyze** various components of operating costs and **evaluate** cost implications of batch vs. continuous processes and facility scale-up for **optimal** plant layout and economic **design**.
CO4	**Evaluate** the impact of regulatory compliance and **analyze** green process strategies and real-world case studies for sustainable industrial economic **decision**-making.

Unit No.	**Title**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Process Economics	Basic principles of engineering economics; Role of economics in process engineering; Economic feasibility vs. technical feasibility; Importance of economic analysis in engineering design and decision-making; Real-world relevance in chemical, biochemical, and pharmaceutical plants.	8	CO1
2	Economic Evaluation & Cost Estimation	Analysis of costs; Types of costs: Fixed, variable, direct, indirect etc; Operating cost estimation: Raw materials, utilities, labor, maintenance; Break-even analysis; Profitability analysis and decision-making.	8	CO2
3	Bioprocess Economic Considerations	Classification of operating costs: Raw materials, Utilities (steam, electricity, water), Labor (direct and indirect), Maintenance and depreciation, Waste treatment and disposal, Consumables and analytical costs; Batch vs. continuous processes: cost differences; Facility layout and scale-up economics.	8	CO3
4	Techno-Economic Feasibility	Regulatory compliance cost (FDA, EMA, CDSCO, etc.); Optimization of bioprocess for cost reduction; Green process economics; Case studies on plant economics (e.g., bioethanol, antibiotics, biosurfactants, enzymes).	8	CO4

Reference Books:

Peters, M.S., Timmerhaus, K.D., West, R.E. – *Plant Design and Economics for Chemical Engineers*

G.S. Davies, "Process Engineering Economics" CEED III Madras.

Schweyer, "Process Engineering Economics".

Happel, "Chemical Process Economics"

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	2	1		1	1	2		3	2	2	2	1
CO2	1	1		1	1	1	2	1		2	1	2	1	3
CO3	2	1	1		1	1	2	1	1	3	1	2	2	1
CO4	3	2	2	1	2	1	1	1	1	1	1	1	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2025-26							
Course Code	BE221	**Title of the Course**	Enzyme Technology	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**3**	**0**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The objective of the course is to provide a deeper insight into the fundamentals of enzyme structure, its function and kinetics along with current applications and future potential.						

Course Outcomes	
CO1	Classify enzymes and analyze the basic principles of the enzyme mechanism
CO2	Explain and illustrate the mechanisms of enzyme-substrate interaction
CO3	Evaluate enzyme kinetics with and without inhibitors
CO4	Demonstrate the immobilization techniques and their potential applications and design strategies for isolation and purification of industrially important enzymes

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Enzymes	Nomenclature and Classification of enzymes, Types of specificity, Active sites. Enzyme activity—chemical nature of enzymes. Protein nature of enzymes and nonprotein enzymes—ribozymes and DNAzymes. Coenzymes and Cofactors—prosthetic group, coenzymes involved in different metabolic pathways.	8	CO1
2	Enzyme-substrate interaction	Lock and Key mechanism, Induced Fit mechanism, transition state Hypotheses, Enzyme function, and general mechanism. Mechanism of enzyme catalysis: Acid-base catalysis, covalent catalysis, Metal ion catalysis, Proximity and orientation effects, etc. Mechanism of Serine proteases: Chymotryspin, Lysozyme, Carboxypeptidase A and Ribonuclease, and Proenzymes (Zymogens).	8	CO2
3	Kinetics of free enzymes	Basic concepts of bioenergetics, Factors affecting the rates of chemical reactions, Enzyme Kinetics: Michaelis-Menten Equation, Measurement of Km and Vmax, Enzyme inhibition: Reversible (competitive, uncompetitive and mixed) and irreversible. Multienzyme complex and multifunctional enzymes, Kinetics of allosteric enzymes and enzyme regulation.	8	CO3
4	Immobilized enzymes and Production and Application of Enzymes	Principles & techniques of immobilization, Immobilized enzyme reactions; Analysis of mass transfer effects on kinetics of immobilized enzyme reaction. Sources of industrial enzymes, Strategies of isolation and purification of enzymes from different sources, Industrial, diagnosis and therapeutic application of enzymes.	8	CO5

Reference Books:

1. Murray Moo-Young-Comprhensive Biotechnology, II & IVth Vol.
2. Biochemistry- D. J. Voet & J. G. Voet, 6th ed.
3. Methods in Enzymology- A series.
4. Enzyme Kinetics-Hans Bisswanger, Wiley Publication.
5. Biocatelysis: Fundamentals and Application- A.S. Bommarius et al., Wiley Publication.
6. Palmer, T., Bonner, P., Enzymes Biochemistry, Biotechnology, Clinical chemistry, WoodHead Publishing, 2008, 2nd Edition

e-Learning Source:

https://youtu.be/gJNMryCX3YY

https://nptel.ac.in/courses/102/102/102102033/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1							3	3	1	
CO2	3	3	2	3	1	1					3	3	3	
CO3	3	3	2	3			2				3	3	3	
CO4	3	3	3	3	3	3	2	3		1	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**