Integral University, Lucknow

Effective from Session: 2021-2022							
Course Code	BS401	**Title of the Course**	Biomolecules: Structure & Functions	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The course aims to provide students with an understanding of biomolecules, the basic building blocks of living organisms, their structural underpinnings, unique properties, biological roles and functions and interrelations. Emphasis is on the association between structure and function of various biomolecules at a chemical level with a biological perspective.						

Course Outcomes	
CO1	The students will learn about the chemical structures of carbohydrate, and their structural and metabolic role in cellular system.
CO2	The students will learn about structure and function of membrane and storage lipids, circulating lipids and inflammatory lipid mediators etc.
CO3	The course will aid the students in understanding accessory molecules like vitamins, plant and animal hormones, plant secondary metabolite like terpenes etc.
CO4	The students will be acquainted about amino acids found regularly in proteins and uncommon amino acids. They will learn in detail about primary, secondary, tertiary and quaternary structure of proteins.
CO5	The students will understand the structure and function of nucleosides and nucleotides. They will also learn about the different types of DNA and RNA found in the various cellular systems and their functional relevance.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Carbohydrates**	Classification, characteristics and functions of simple carbohydrates; Structure and properties of mono, oligo and polysaccharides; Complex carbohydrates: Types, structure and general function; Chemistry of amino sugars, blood sugar compounds, sugar nucleotides	8	CO-1
2	**Fatty acids**	General formula, nomenclature and chemical properties; Lipid classification: simple, complex; General structure and functions of major lipid subclasses - acyl glycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins & free fatty acids; Circulating lipids - chylomicrons. LDL, HDL and VLDL.	8	CO-2
3	**Vitamins**	Structure, properties, deficiency, symptoms and functions including biochemical reactions. Hormones: Structure, properties & functions of animal & plant hormones.	8	CO-3
4	**Proteins**	Chemical structure and general properties of amino acids; Protein classification, size, shape, sequence of proteins; Primary, secondary, tertiary and quaternary structure of proteins.	8	CO-4
5	**Nucleic acids**	Structure of purines, pyrimidines, nucleosides and nucleotides; Physical & biochemical properties of DNA; Types of DNA: A, B and Z DNA, their structure and significance; Physical & biochemical properties of RNA: tRNA, rRNA, mRNA and hnRNA; Primary, secondary, and tertiary structures of RNA	8	CO-5

Reference Books:

1. Lehninger, AL "Principles of Biochemistry"
2. Lubert Stryer "Biochemistry"
3. Voet & Voet "Biochemistry"
4. Baltimore "Molecular Cell Biology"

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1						1	3			
CO2	3	1						1	3			
CO3	3	1						1	3			
CO4	3	1						1	3			
CO5	3	1						1	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: 2021-2022							
Course Code	BS421	**Title of the Course**	Bioinformatics and Applied statistics	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**	Biochemistry				
Course Objectives	The objective of this course is to develop an understanding of basics of Bioinformatics and Applied Statistics.						

Course Outcomes	
CO1	Introduction to Bioinformatics, Biological databases: types and categories; Nucleic acid and Protein Sequence Data Banks, Introduction to NCBI and its components; Sequence Alignment Pair wise sequence alignment & multiple sequence alignment
CO2	Database Similarity Searching: Heuristic algorithms for BLAST & FASTA, PSI BLAST algorithm. Multiple sequence alignments -concept and applications; overview of Phylogenetic studies; Protein structure prediction: Homology Modeling studies and applications; Application of Bioinformatics in Drug Designing.
CO3	Handling of data: tabulation and diagrammatic representation of data - bar diagram and pie diagram. Measures of central tendency: mean, median and mode. Measures of dispersion: range, quartile deviation, mean deviation and standard deviation. Coefficient of variation.
CO4	Tests of significance: Null hypothesis and alternative hypothesis, Z-test, Student"'s distribution, Paired t-test, F-test for equality of population variances. Contingency table, Chi-square test for goodness of fit and independence of attributes.
CO5	Correlation analysis: Positive and negative correlation, Karl person"s coefficient of correlation, Spearsman"'s rank cocfficient of correlation. Regression analysis: regression lines X on Y and Y on X

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Bioinformatics**	Introduction to Bioinformatics, Biological databases: types and categories; Nucleic acid and Protein Sequence Data Banks, Introduction to NCBI and its components; Sequence Alignment Pair wise sequence alignment & multiple sequence alignment	8	CO-1
2	**Database Similarity Searching**	Database Similarity Searching: Heuristic algorithms for BLAST & FASTA, PSI BLAST algorithm. Multiple sequence alignments -concept and applications; overview of Phylogenetic studies; Protein structure prediction: Homology Modeling studies and applications; Application of Bioinformatics in Drug Designing.	8	CO-2
3	**Handling of data**	Handling of data: tabulation and diagrammatic representation of data - bar diagram and pie diagram. Measures of central tendency: mean, median and mode. Measures of dispersion: range, quartile deviation, mean deviation and standard deviation. Coefficient of variation.	8	CO-3
4	**Tests of significance**	Tests of significance: Null hypothesis and alternative hypothesis, Z-test, Student"'s distribution, Paired t-test, F-test for equality of population variances. Contingency table, Chi-square test for goodness of fit and independence of attributes.	8	CO-4
5	**Correlation analysis**	Correlation analysis: Positive and negative correlation, Karl person"s coefficient of correlation, Spearsman"'s rank cocfficient of correlation. Regression analysis: regression lines X on Y and Y on X	8	CO-5

Reference Books:

1. O'Reilly "Developing Bioinformatics computer skills"
2. J.F. Griffiths "An intro to generic Analysis"
3. Lawrence hunter "Artificial Intelligence & molecular biology"
4. Andreas D. Baxevanis "Bioinformatics: A practical Guide to the analysis of genes and proteins"

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1					1	1	3	1		
CO2	3	1					1	1	3	1		
CO3	3	1					1	1	3	1		
CO4	3	1					1	1	3	1		
CO5	3	1					1	1	3	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: 2020-21							
Course Code	BS403	**Title of the Course**	Essentials of Molecular Biology	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The acid as genetic material, replication, gene organization and its regulation etc. The application of the course lays the foundation to understand the disease objective of the course is learning and understanding the fundamentals of molecular biology like nucleic processes.						

Course Outcomes

CO1	The students will learn about nucleic acid as genetic information carriers, Possible modes of replication, and roles of helicase, primase, gyrase, topoisomerase, DNA Polymerase, DNA ligase, and Regulation of replication.
CO2	Understand the detailed mechanism and regulation of Eukaryotic DNA replication, along with Mitochondrial and Chloroplast DNA Replication.
CO3	The students will learn about mechanism and regulation of transcription in prokaryotes along with Reverse transcription.
CO4	Understanding the classes of DNA sequences, Genome-wide and Tandem repeats, Retroelements, Transposable elements, Centromeres, Telomeres, Satellite DNA, Minisatellites, Microsatellites; Applications of satellite DNA and Split genes
CO5	Understanding of the movable genes, transposons and mechanism of transposition

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Nucleic acid as genetic information carriers**	Details of Griffith experiment, Avery, McLeod and McCarty experiment, Hershey and Chase experiment; Possible modes of replication: Details of Meselson and Stahl experiment; Prokaryotic DNA replication: Initiation, elongation and termination; Origin of replication; Roles, properties and mechanism of action of DnaA, Helicase, HD protein, Primase, DNA gyrase, Topoisomerase, DNA Polymerase, DNA ligase, Leading and lagging strands; Okazaki fragments; RNA or Rolling circleσprimers; Regulation of replication; Fidelity of replication; X174.ϕreplication in	8	CO-1
2	**Eukaryotic DNA replication**	Initiation, elongation and termination; Multiple initiation sites; Autonomously replicating sequence; Significance of Origin recognition complex, Minichromosome , Nucleases, DNAε, δ, αmaintenance proteins, DNA dependent DNA polymerases ligase and Telomeres in eukaryotic nuclear DNA replication; Regulation of eukaryotic DNA replication; Mitochondrial and Chloroplastic DNA replication.	8	CO-2
3	**Transcription in prokaryotes**	Outline of the process - Initiation, elongation and termination; Prokaryotic promoter; DNA dependent RNA polymerase (RNA polymerase): Physical properties, X-Ray subunit; Recognition of promoter;σcrystallographic structure, Subunits, Types of Binding and initiation sites; Melting of DNA; Direction of chain growth; Abortive initiations; Promoter clearance; Rho dependent and Rho independent termination of transcription; Sigma cycle; RNA - dependent DNA polymerase and Reverse transcription.	8	CO-3
4	**Classes of DNA sequences**	Unique DNA sequences, Repetitive DNA sequences; Zero time binding DNA; Reasons for generation of reiterative DNA sequences; Highly repetitive and Moderately repetitive DNA sequences; Direct and Inverted repeats; Genome - wide and Tandem repeats; Overview of repetitive DNA sequences: Pseudogenes, LINEs, SINEs, Retroelements, Transposable elements, rRNA, tRNA and Histone genes, Centromeres, Telomeres, Satellite DNA, Minisatellites, Microsatellites; Applications of satellite DNA. Methods of distinguishing or separating double stranded and single stranded DNA; C-value and C-value paradox; Split genes: Exons and Introns	8	CO-4
5	**Movable genes Transposons**	Simple and Composite transposons, Mechanism of transposition, Example of transposons: Ds/ Ac family of transposon, Ty of yeast, Copia, P and FB element of Drosophila, LINES and SINES.	8	CO-5

Reference Books:

1. Lewin B. (2000). Genes VII. Oxford University press
2. Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. (1987). Molecular biology of the gene.
3. Lodish H, Baltimore D, Berk A, Zipursky SL, Darnell J. (1995). Molecular cell biology.
4. Brown, TA Genomes (2020)

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1					1		3			
CO2	3	1					1		3			
CO3	3	1					1		3			
CO4	3	1					1		3			
CO5	3	1					1		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:							
Course Code	BS-404	**Title of the Course**	Biophysical & Biochemical Methods	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objectives of this course are to provide the students with the understanding of various analytical techniques used in biotechnology-based research centers and industry. The course will acquaint the students with the various instruments, their configuration and principle of working, operating procedures, data generation and its analysis.						

Course Outcomes

CO1	The course will help students to acquaint with basic principles and applications of various sophisticated instruments like phase contrast, fluorescence, electron microscopy, confocal microscopy, fluorescent activated cell sorting, and Freeze drying.
CO2	The students will get theoretical knowledge of Radioisotopes and its uses in the biological system as well as the principle and practical applications of Geiger-Muller counter, Liquid scintillation counter, autoradiography, XRD and Biosensors.
CO3	The students will learn about Instrumentation, types, working and principle of Centrifugation & Electrophoresis.
CO4	Learn various types of chromatography techniques for solving industrial and research problems.
CO5	Students will be able to acquire the knowledge of techniques like UV-VIS spectroscopy, NMR, CD, ORD in biological research

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Microscopy**	Microscopy: Simple, compound, phase contrast, fluorescence, electron microscopy (TEM, SEM & STM) and confocal microscopy, fluorescent activated cell sorting (FACS), Freeze drying.	8	CO-1
2	**Radiotracer technology**	Radiotracer technology: Use of radioactive isotopes in biological system, detection and measurement of isotopes, Geiger-Muller counter, Liquid scintillation counter, autoradiography, X-ray Diffraction studies. Biosensors: Basic techniques, enzyme electrode, microbial biosensors.	8	CO-2
3	**Centrifugation & Electrophoresis**	Centrifugation & Electrophoresis: Centrifugation: types of rotors, techniques and their applications: differential, zonal, density gradient and ultra-centrifugation. Electrophoresis: Principle, techniques and applications: capillary electrophoresis, paper and gel electrophoresis (SDS & NATIVE-PAGE, Agarose, Pulse Field gel electrophoresis, 2D-PAGE), Isoelectric focusing, isotachophoresis.	8	CO-3
4	**Chromatography**	Chromatography: Adsorption, paper, partition, ion-exchange, reverse phase, gel filtration, affinity, gas chromatography, HPLC and FPLC.	8	CO-4
5	**Spectroscopy Techniques**	Principle, Theory and applications of UV and VIS spectrophotometry, Fluorescence spectroscopy, atomic absorption, nuclear magnetic resonance, mass spectrometry.	8	CO-5

Reference Books:

1. Narayanan, P: Essentials of Biophysics, New Age Int. Pub. New Delhi.
2. Keith Wilson & John Walker: Principles and Techniques of Biochemistry and Molecular Biology.
3. Upadhyay, Upadhyay and Nath: Biophysical Chemistry: Principle and Techniques.
4. David Sheehan: Physical Biochemistry Principle and Applications.

e-Learning Source:

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

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				3		1			3	
CO2	3	1				3		1			3	
CO3	3	1				3		1			3	
CO4	3	1				3		1			3	
CO5	3	1				3		1			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: 2021-2022							
Course Code	BS422	**Title of the Course**	Essentials of Microbiology	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objective of the course is learning and understanding the fundamentals of Microbiology like important characteristics and biology of bacteria, fungi, mycoplasma, viruses etc. Moreover, this course is designed to learn basic knowledge of fermentation process and industrial application of microbes for the production various useful products such as enzymes and solvents.						

Course Outcomes	
CO1	Understand the basics of microbiology like Characterization and classification of microorganisms, cultivation, nutrition, physiology and growth of microbial cells, Genetic recombination in bacteria.
CO2	The student will learn and understand the basics of mycology and Production of mutants and their characterization.
CO3	The student will learn about Bacterial toxins, and mode of action of bacterial protein toxins. Host Microbe Interactions, Viruses of bacteria, plant and animal cells, Mycoplasma and viriods.
CO4	The student will learn about Media for Industrial Fermentation, Large scale production and commercial applications of enzymes, such as Amylase and Protease.
CO5	The student will learn about Media for Industrial Fermentation, Large scale production and commercial applications of solvents and antibiotics.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Classification and Characterization of microorganisms**	Morphology and structure of bacteria, gram positive and gram negative bacteria, cultivation of bacteria, nutrition, physiology and growth of microbial cells. Reproduction and growth, synchronous growth, continuous culture of microorganisms. Pure cultures and cultural characteristics. Genetic recombination in bacteria, conjugation, transformation and transduction.	8	CO-1
2	**Structure of fungus**	yeast and mold. Fundamentals of control of microbial growth, control by physical and chemical agents. Production of mutants by chemical and physical agents and their characterizations.	8	CO-2
3	**Bacterial toxins**	Classification, structure and mode of action of bacterial protein toxins. Host Microbe Interactions. Viruses of bacteria, plant and animal cells, structure classification life cycle, Mycoplasma and viriods, diseases Viruses – General structure, properties and classification.	8	CO-3
4	**Media for Industrial Fermentation**	Substrates for bioconversion processes, preparation, sterilization, design. Large scale production and commercial applications of enzymes: proteases and amylases.	8	CO-4
5	**Large scale production and commercial applications of solvents and antibiotics**	Acetic acid, ethanol, acetobutanol, penicillin and streptomycin.	8	CO-5

Reference Books:

1. Pelczar MJ Jr.; Chan ECS and Kreig NR.; Microbiology; 5th Edition; Tata McGraw Hill; 1993.
2. Maloy SR; Cronan JE Jr.; and Freifelder D; Microbial Genetics; Jones Bartlett Publishers; Sudbury; Massachusetts; 2006.
3. Crueger and A Crueger; (English Ed.; TDW Brock); Biotechnology: A textbook of Industrial Microbiology; Sinaeur Associates; 1990.
4. G Reed; Prescott and Dunn"s; Industrial Microbiology; 4th Edition; CBS Publishers;

e-Learning Source:

https://microbiologyonline.org/index.php

https://www.cdc.gov/labtraining/training-courses/basic-microbiology/index.html

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				3	3	1	2		2	
CO2	3	1				3	1	1	3	1	2	
CO3	3	1					3	1	3			
CO4	3	1			2	3	3	1		3	3	
CO5	3	1			1	2	1	1	2	2	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: 2020-21							
Course Code	BS423	**Title of the Course**	Genetic Engineering Lab	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	0	0	12	6
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The lab is designed to train the students in basic and some advanced techniques of Biochemistry like isolation, purification, and estimation of biomolecules. It also deals with microbial techniques of isolation, purification and maintenance of microbial cultures.						

Course Outcomes	
CO1	The student will get practical knowledge on preparation of buffers and measurement of ph.
CO2	The student will learn qualitative testing of carbohydrates, proteins & Amino Acids, and Comparative evaluation of protein analysis by various methods.
CO3	The students will learn to determine Calcium (Ca) and inorganic phosphorus (P), and estimate glycogen in a given sample.
CO4	The student will learn sterilization, preparation of various culture media and purification techniques.
CO5	Identification of isolated bacteria, and Growth curve of microorganisms.

Unit No.	**Exp. No.**	**Title of Experiment**	**Contact Hrs.**	**Mapped CO**
1.	**Exp-01**	Preparation of buffers and measurement of pH.	3	CO-1
2.	**Exp-02**	Qualitative tests of carbohydrates: Molish's Test, Fehling's Test; Benedict's Test; Barfoed's Test; Phenyl Hydrazine Test; Seliwanoff's Test; mucic acid Test, bial's test; Iodine Test, Nelson-Somogyi Method.	3	CO-2
3.	**Exp-03**	Qualitative tests of proteins & Amino Acids: Millon's test, Biuret test; Ninhydrin Test; Xanthoproteic Test; Hopkin's Cole Test.	3	CO-2
4.	**Exp-04**	Comparative evaluation of different methods of protein analysis: UV, Lowry, Biuret, Bradford.	3	CO-2
5.	**Exp-05**	Determination of Calcium (Ca) and inorganic phosphorus (P).	3	CO-3
6.	**Exp-06**	Isolation and estimation of Glycogen.	3	CO-4
7.	**Exp-07**	Methods of sterilization and preparation of various culture media.	3	CO-4
8.	**Exp-08**	Purification techniques: Serial dilution, pour plate and streak plate method.	6	CO-4
9.	**Exp-09**	Identification of isolated bacteria: Gram staining other staining methods, metabolic characterization.	6	CO-5
10.	**Exp-10**	Growth curve of microorganisms	3	CO-5

Reference Books:

1. Keith Wilson John Walker John M. Walker "Principles and Techniques of Practical Biochemistry Chirikjian "Biotechnology Theory & Techniques"
2. William M., O'Leary Robert Dony Wu "Practical Handbook of Microbiology"

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	1	3		3		2	2
CO2	3	3	3	1	1	3		3		3	2
CO3	3	3	3	1	1	3		3		3	2
CO4	3	3	3	1	1	3	2	3		3	2
CO5	3	3	3	1	1	3	2	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: 2020-21							
Course Code	BS411	**Title of the Course**	Gene Expression & Regulation	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objective of the course is to introduce to the students the basic knowledge about how genes are transcribed and how translation takes place in prokaryotes and eukaryotes and how these processes are regulated, so that students can apply this knowledge in enhancing their analytical and problem solving skills.						

Course Outcomes	
CO1	To understand the gene expression and regulation in Eukaryotes
CO2	To gain better knowledge about Post - transcriptional / Cotranscriptional processing (Maturation of precursors of rRNA, mRNA, tRNA.
CO3	Learn about the Translation in prokaryotes and eukaryotes and Properties of Genetic code.
CO4	To study the Post - translational processing: Basics of Protein folding.
CO5	To study about the Regulation of gene expression and concept of operon.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Transcription in eukaryotes**	Transcription in eukaryotes: Synthesis of pre-mRNA: Outline of process - Initiation, elongation and termination, RNA Pol II promoter, Enhancer elements, Subunit structure of RNA Pol II, Roles of RNA polymerase II, Transcription factors, Nucleosome modifiers, Mediator complexes, Chromatin remodellers, Elongation factors in transcription; Cleavage and polyadenylation; Synthesis of pre-rRNA and pre-tRNA: Outline of process, RNA Pol I and III promoters sequences, RNA Pol I and III; DNA-binding motifs: Helix-turn-Helix, Zinc Finger, LeucineZipper, Homeodomain.	8	CO-1
2	**Post - transcriptional / Cotranscriptional processing**	Post - transcriptional / Cotranscriptional processing (Maturation of precursors of rRNA, mRNA, tRNA): End modifications (Addition of 5` cap and 3‟ Poly A tail in mRNA), RNA splicing - Self splicing and Spliceosome mediated splicing, Cutting events or action of ribonucleases, Covalent modifications, RNA editing, Alternative splicing.	8	CO-2
3	**Translation in prokaryotes and eukaryotes**	Outline of the process - Initiation, elongation and termination; Adapter role of tRNA, Evidences for a triplet code; Properties of Genetic code; Ubiquitous code and deviations; Synonymous codons; Codon family and Codon pairs; Nonsense and Sense codons; Degeneracy: Significance of Isoacceptor tRNAs and Wobble hypothesis; Codon bias; Amino acyl tRNA synthetase: Classification, Specificity, Reaction catalyzed; A, P and E sites of ribosome; Start and stop codons, Ribosome binding site; Formation of initiation complex; Transpeptidation and Translocation; Ribosome cycle; Roles of Initiation factors, Elongation factors, Release factors, Aminoacyl tRNA synthetase, tRNA, rRNA, GTP, Peptidyl transferase site and Factor binding site of ribosomes in translation.	8	CO-3
4	**Post - translational processing**	Post - translational processing, Basics of Protein folding, Intein splicing, Chemical modification, Proteolytic cleavage, Zymogen activation; Polycistronic and monocistronic.	8	CO-4
5	**Regulation of gene expression**	Regulation of gene expression; Concept of operon: Lac, Trp and Ara operons, Significance of repressor, Attenuation; Inhibitors of transcription and translation.	8	CO-5

Reference Books:

1. Lehninger, AL “Principles of Biochemistry”
2. Lubert Stryer “Biochemistry”
3. Voet & Voet “Biochemistry”
4. Baltimore “Molecular Cell Biology”
5. Brown, TA “Genomes”
6. Watson, JD “Molecular Biology of the cell”

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1						1	3			
CO2	3	1						1	3			
CO3	3	1						1	3			
CO4	3	1						1	3			
CO5	3	1						1	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: 2021-2022							
Course Code	BS412	**Title of the Course**	Enzymology & Enzyme kinetics	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	This course has been designed to teach the student majoring in science all the major aspects of the study of enzymes. The course focuses on the theories of enzyme kinetics, the mechanisms of enzyme catalysis, and immobilization of enzyme.						

Course Outcomes	
CO1	To understand the general properties of enzymes and their classification & nomenclature.
CO2	To understand the theories of enzyme kinetics.
CO3	To understand the mechanisms of enzyme catalysis and enzyme inhibition & activation.
CO4	To understand the Multisubstrate enzyme kinetics.
CO5	To understand the enzyme Immobilization and its clinical & industrial use.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Classification and nomenclature of enzymes**	General properties of enzymes. Mechanism of enzyme action: Chymotrypsin, ribonuclease, activation of transition metal cation, activation by alkaline earth metal cation, nicotinamide nucleotide, flavin nucleotide and adenosine phosphate.	8	CO1
2	**Enzyme kinetics**	Michaelis-Menten initial rate equation based on equilibrium assumption, Briggs-Haldane steady state approach, integrated form of the Michaelis equation, methods for the determination of K_m and V_{max} normalized initial rate equation and normalized curves, Haldane relationship.	8	CO2
3	**Effect of factors and inhibitors on enzyme kinetics**	Effect of enzymes concentration, pH and temperature on kinetics of enzyme reactions. Enzyme inhibition and activation: Types of reversible inhibitors, qualitative analysis of data, derivation of equations for different types of inhibitions, determination of inhibitor constant, determination of activator constant.	8	CO3
4	**Multi-substrate enzyme kinetics**	Multisubstrate enzyme kinetics: random bi-bi, and ping pong reactions. Intracellular localization of enzymes, purification of enzymes and tests for homogeneity.	8	CO4
5	**Applied Enzymology**	Immobilization; kinetics of immobilized systems. Isozymes. Allosteric enzymes. Industrial and clinical scope of enzymes.	8	CO5

Reference Books:

1. Lehninger, AL "Principles of Biochemistry"
2. Lubert Stryer "Biochemistry"
3. Voet & Voet "Biochemistry"
4. Shuler "Bioprocess Engineering"

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				2		1	3			
CO2	3	1				2		1	3			
CO3	3	1				2		1	3			
CO4	3	1				2		1	3			
CO5	3	1				3		1	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: 2021-2022							
Course Code	BS413	**Title of the Course**	Metabolism & Bioenergetics	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objective of this course is to enable the students to provide basic knowledge about catabolism, anabolism, regulation of metabolism and pathway analysis. It also gives understanding of how enzymes and metabolites in living system work to produce energy and synthesizing different biomolecules. The course also extends comprehensive knowledge about biochemical pathways involved in intermediary metabolism of carbohydrate, protein, lipid and nucleic acid.						

Course Outcomes	
CO1	The student will be able to learn Carbohydrate catabolism and its association with cellular energy production. They will learn different metabolic pathways and cycles for the degradation of carbohydrates.
CO2	The student will be acquainted with carbohydrate anabolism in plants and animal cells. They will be able to understand different metabolic pathways for the biosynthesis of carbohydrates like glucose and glycogen.
CO3	The student will get familiar to the biosynthesis of membrane glyco- and phospholipids like glycerolipids and sphingolipids; and storage lipids like triglycerides etc. They will also learn the biosynthesis of plasmalogens and cholesterol.
CO4	The student will also learn about the breakdown or degradation of fatty acids via various mechanisms like alpha, beta and omega oxidation and its connection with cellular energy generation. He will also be familiar with ketone bodies and acidosis/ketosis. They will also learn about the degradation of cholesterol and importance of bile salts and pigments.
CO5	The student will learn and understand about the biosynthesis and degradation of amino acids; and inborn errors (genetic diseases) of metabolism. He will also learn about the de novo biosynthesis of purines and pyrimidine nucleotides and salvage pathways; and degradation of nucleotides.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Carbohydrate catabolism**	Glycolytic pathway and Non- glycolytic pathways, Hexose monophosphate pathway, Tricarboxylic acid cycle. Anaplerotic sequences in metabolism, glycogenolysis, Krebs-Kornberg pathway, Glyoxylate pathway. Glucose catabolism in cancerous tissue, Energy production by aerobic and anaerobic respiration: Electron transport chain, oxidative phosphorylation	8	CO-1
2	**Biosynthesis of carbohydrates**	Gluconeogenesis, glycogen synthesis, reductive pentose phosphate pathway, carbon dioxide assimilation in C3 and C4 plants.	8	CO-2
3	**Lipid biosynthesis**	Synthesis of saturated and unsaturated fatty acids, biosynthesis of triacylglycerols glycerophospholipids and membrane phospholipids, plasmologens, sphingolipids, cholesterol..	8	CO-3
4	**Lipid metabolism**	Degradation of fatty acids: α, β, ω oxidation; Ketone bodies, acidosis, ketosis, Cholesterol degradation.	8	CO-4
5	**Nucleic acid metabolism**	Biosynthesis of purines and pyrimidines, degradation of nucleosides, nucleotides and nucleic acids, Salvage pathways. Biosynthesis and biodegradation of amino acids. Inborn errors of metabolism.	8	CO-5

Reference Books:

1. Lehninger AL "Principles of Biochemistry"
2. Lubert Stryer "Biochemistry"
3. Voet & Voet "Biochemistry"
4. Shuler "Bioprocess Engineering"

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1						1	3			
CO2	3	1						1	3			
CO3	3	1						1	3			
CO4	3	1						1	3			
CO5	3	1						1	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: 2020-21							
Course Code	BS431	**Title of the Course**	Cytology & Cell signalling	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**3**
Pre-Requisite	UG in Biological Sciences	**Co-requisite**					
Course Objectives	The objectives of the course are to learn and understand the fundamentals of cell biology like cell organelles, cytoskeleton, cellular transport, cell-extracellular matrix interaction, cell division, and protein trafficking and signal transduction etc						

Course Outcomes	
CO1	The student will learn about structural organization of prokaryotic and eukaryotic cells, ultrastructure and functions of cell organelles and cell wall.
CO2	The student will learn about the structural and functional aspects of cytoskeleton, cell membrane, various means of transport of molecules across cell membrane, exocytosis, receptor mediated endocytosis.
CO3	The student will learn about cell division: mitosis and meiosis; Cell cycle: check points, role of cyclin and cyclin dependent kinases in cell cycle regulation.
CO4	Students would be able to understand various kinds of cell-cell and cell-extracellular matrix interactions, as well as basics of intracellular signal transduction.
CO5	The course will aid in gaining insight on protein trafficking in cells, protein sorting, vesicular transport and protein targeting to various cellular organelles.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Cell classification	Cell classification, cell variability (size, shape, complexity, functions). Structural organization of prokaryotic and eukaryotic cells. The ultra-structure and functions of cell wall, nucleus, mitochondria, chloroplast, endoplasmic reticulum, microsomes, Golgi apparatus, lysosomes & peroxisomes.	8	CO-1
2	The cytoskeleton	The cytoskeleton – microtubules and microfilaments. Structure and functions of cell membrane, Transport across cell membrane: Diffusion, Facilitated diffusion, Active transport; transport proteins, exocytosis, receptor mediated endocytosis, osmoregulation.	8	CO-2
3	Cell division	Cell division: mitosis and meiosis; Cell cycle: check points, role of cyclin and cyclin dependent kinases in its regulation.	8	CO-3
4	Cell Extracellular matrix interactions	Cell- Extracellular matrix interactions: Plasmodesmata, Gap junction, Tight junction, Adherens, Cohesin, Elastin, Collagen, Fibronectins, Laminins, Integrins; Basics of signal transduction: Role of calcium, cAMP, G-protein, inositol phosphates, phospholipases and protein kinases in signal transduction.	8	CO-4
5	Protein traffic in cells	Protein sorting and signal sequences; protein translocation in ER and vesicular transport to Golgi, lysosomes and plasma membrane; protein import into nuclei, mitochondria, chloroplasts and peroxisomes.	8	CO-5

Reference Books:

1. Animal Cytology & Evolution – MJD, White Cambridge University Publications
2. Molecular Cell Biology – Daniel , Scientific American Books.
3. Cell Biology – Jack D. Burke, The William Twilkins Company.
4. Principles of Gene Manipulations – Old & Primrose, Black Well Scientific Publications.
5. Cell Biology & Molecular Biology – EDP Roberties & EMF Roberties, Sauder College.
6. Principles of Genetics – E.J. Gardener, M.J. Simmons and D.P. Snustad, John Wiley & Sons Publications

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	**3**	1					**1**		2	2		
CO2	**3**	1				3	**1**		3			
CO3	**3**	1				3	1		3			
CO4	**3**	1				3	1		3			
CO5	**3**	1				3	1		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: 2021-2022							
Course Code	BS415	**Title of the Course**	Molecular Genetics	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Sciences	**Co-requisite**					
Course Objectives	The aim of the course is to provide students with an understanding of both classical and modern concepts in genetics with special emphasis on the areas of chromosome structure and function, molecular and developmental genetics, DNA damage and repair and chromosomal aberrations. The course will also provide in-depth knowledge of cancer etiology, Human Genome project and genetic diversity including Legal and Ethical Issues in Genetics**.**						

Course Outcomes	
CO1	Students would understand the Genome organization and DNA packaging including Chromosome structure and function in both prokaryotes and eukaryotes.
CO2	Students would be able to understand the Genetic Control of Development in *C. elegans, Drosophila, Neurospora crassa, Arabidopsis thaliana.*
CO3	Students would understanding the principles of Mendelian genetics, extensions and applications.
CO4	To understand the Physical and Chemical Mutagens, Drug metabolism and detoxification; DNA damage: Types of mutations, DNA repair mechanism, and the role of various oncogenes in cancer etiology
CO5	Able to understand The Human Genome project and genetic diversity including Legal and Ethical Issues in Genetics

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Genome organization and DNA packaging**	Genome organization and DNA packaging; Nuclear decondensation (in both prokaryotes and eukaryotes); Chromosome structure and function; Numerical and structural changes in chromosomes; Cytogenetics: chromosome aberration..	8	CO-1
2	**Genetic Control of Development**	Genetic Control of Development in *C. elegans*, Drosophila, *Neurospora crassa, Arabidopsis thaliana*.	8	CO-2
3	**Principles of Mendelian inheritance**	Principles of Mendelian inheritance, Linkage and genetic mapping; Extrachromosomal inheritance, Sex-linked inheritance and genetic disorders, Somatic cell genetics, Population genetics.	8	CO-3
4	**Mutation and cancer**	Physical and Chemical Mutagens, Drug metabolism and detoxification; DNA damage: Types of mutations, DNA repair mechanisms: Y-family DNA Polymerases; Micronuclei; FISH; COMET Assay. Etiology of cancer: Oncogenes; proto- oncogenes; Viral and cellular oncogenes; tumour suppressor genes from humans; Structure; function and mechanism of action of pRb and p53 tumour suppressor proteins.	8	CO-4
5	**Applied Genetics**	The Human Genome Project; gene therapy, integration of DNA into mammalian genome, Expression of foreign genes in transgenic animals, Genetic Testing-DNA Fingerprinting; Genetic Diversity - Conservation Genetics; Legal and Ethical Issues in Genetics; Genetic Counseling	8	CO-5

Reference Books:

1. Gardener "Principles of Genetics"
2. Tom Strachan, T. Strachan, Andrew Read, Andrew P. Read "Human Molecular Genetics"
3. William S. Klug Michael R. Cummings "Concepts of Genetics (7th Edition)"
4. Ricki Lewis "Human Genetics: Concepts and Applications"

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1						1	3			
CO2	3	1				2		1	3			
CO3	3	1				2		1	3			1
CO4	3	1				1		1	3		2	
CO5	3	1			2	1	1	1		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: 2021-2022							
Course Code	BS416	**Title of the Course**	Environmental biology	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Sciences	**Co-requisite**	Biochemistry				
Course Objectives	The course content aims to make the Students identify and explain the environmental factors responsible for the pollution. It also helps in understanding how biotechnology can provide solutions for environmental problems and understand legal aspects related with environmental issues and environmental protection. This course enables the students to select the appropriate method for the treatment of wastewater and solid waste management as well as can apply Suitable bioremediation methods for the treatment.						

Course Outcomes	
CO1	Comprehend environmental issues and role of biotechnology in the cleanup of contaminated Environments
CO2	Comprehend fundamentals of biodegradation, biotransformation and bioremediation of organic contaminants and toxic metals
CO3	Apply biotechnological processes in waste water and solid waste management.
CO4	Demonstrate innovative biotechnological interventions to combat environmental challenges
CO5	Biodeterioration concept of different organic and in-organics materials and their control.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Microbiology of air and aquatic environments**	Microbiology of air and aquatic environments - Bacteriological indicators of pollution, Bacteriological examination of water, nuisance bacteria in water systems. Chemical and microbiological characteristics, Biological Oxygen Demand (BOD), Microorganisms and pollution problems and interaction with human bodies.	8	CO-1
2	**Environmental pollution**	Definition, source and types of pollution (air, water and soil). Xenobiotic toxicity/ genotoxicity, Mode of action of pesticides, fungicides and insecticides; Mutation detection by Ames, microsomal assay. Bioaccumulation and bioremediation, Biosensors, DNA probes and their environmental applications, Toxicogenomics.	8	CO-2
3	**Recycling of organic waste**	Recycling of organic waste: Major sources of recyclable materials including agricultural waste. Key technology in recycling of crop residues, human and animal wastes. Composting and vermicomposting; Production and application. Role of microbes in composting and biogas production. Municipal solid waste treatment and management.	8	CO-3
4	**Microbes of toxic environments**	Microbes of toxic environments: Microbial biotransformation/ degradation of organic pollutants in soil. Microbial degradation and persistence of xenobiotics, pesticides, herbicides, heavy metals and radio isotopic materials. Pesticides toxicity to microbes and plants. Acid mine drainage, coal desulphurization.	8	CO-4
5	**Biodeterioration-concept**	Biodeterioration-concept, biodeterioration of wood, stonework, pharmaceutical products, rubber, plastic, paints, lubricants, cosmetics, control of biodeterioration.	8	CO-5

Reference Books:

1. Environmental biotechnology (Industrial pollution Management).Jogdand S.N., Himalaya pub. house.
2. Waste water treatment – Rao M.N. and A.K.Datta
3. Industrial pollution Control, Vol. 1, E. Joe, Middle Brooks.
4. The treatment of industrial wastes, 2nd Ed. Edmund D. Besselievere and Max Schwartz.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				2	3	1	3			
CO2	3	1				2	3	1	3	1	2	
CO3	3	1				2	3	1	1		2	
CO4	3	1				2	3	1	2		1	
CO5	3	1				2	3	1	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: 2020-21							
Course Code	BS417	**Title of the Course**	Pharmaceutical biology	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Sciences	**Co-requisite**					
Course Objectives	This course enables the students to learn the various aspects of pharmaceutical sciences. In this course, students get exposed to the insights into various therapeutic strategies against infectious and non-infectious diseases i.e. via monoclonal antibodies (mABs), peptide based therapeutics, liposome/emulsion-based drug delivery systems, PEG-conjugates-based drug delivery and various factors affecting the drug delivery, its release, and absorption.						

Course Outcomes

CO1	Understand the principle of monoclonal antibodies generation, their mode of action, and their application in targeting various diseases.
CO2	Formulate therapeutic proteins and peptides, their encapsulation with other macromolecules and implications in drug delivery.
CO3	Prepare lipid-based drug delivery systems as well as PEG-conjugates for fast drug delivery and release inside the body.
CO4	Develop the strategies of pulmonary drug delivery.
CO5	Apply the knowledge of polymers for production of biopharmaceuticals with controlled drug delivery.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Monoclonal antibodies**	Monoclonal antibodies: applications, generation, recombinant antibodies, production methods, Pharmaceutical, regulatory and commercial aspects.	8	CO-1
2	**Formulation of proteins and peptides**	Formulation of proteins and peptides: making small protein particles, precipitation of proteins, quality control issues, multi-phase drug delivery system; Preparation of collagen, gelatin particles, albumin microparticles.	8	CO-2
3	**Proteins and phospholipids**	Proteins and phospholipids: structural properties of phospholipids, injectable lipid emulsions, liposomes, cochleal phospholipids structures; Polymeric systems for oral protein and peptide delivery.	8	CO-3
4	**Pulmonary drug delivery systems for biomacromolecules**	Pulmonary drug delivery systems for biomacromolecules; Lipid based pulmonary delivery; Solid colloidal particles; Polycyanoacrylates; Poly (ether-anhydrides); Diketopiperazine derivatives; Poly ethylene glycol conjugates; Factors affecting pulmonary dosing	8	CO-4
5	**Polymers used for controlled drug delivery**	Polymers used for controlled drug delivery: Hydrophobic polymers poly(esters), poly(cyanoacrylate), poly (ortho esters), poly (phosphazenes), Hydrophobic polymers poly (alkyl methacrylates), poly (methacrylates), poly (acrylates)], alginates, chitosan, polyethylene glycol. Gene therapy: the current viral and nonviral vectors.	8	CO-5

Reference Books:

1. Groves MJ, Pharmaceutical Biotechnology", Taylor and Francis Group.
2. Crommelin DJA, Robert D, Sindelar, Pharmaceutical Biotechnology.
3. Kayser O, Muller R, Pharmaceutical Biotechnology
4. Banga AK, Therapeutic peptides and proteins

e-Learning Source:

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

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1		1		3		2	3		3	
CO2	3	1		1		3		2			3	
CO3	3	1		1		3		2	3		3	
CO4	3	1		1		3		2			3	
CO5	3	1		1		3		2	1		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: 2020-21							
Course Code	BS 419	**Title of the Course**	Educational Tour	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	0	0	0	0
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The main objective of this course is to provide the students an exposure to various research activities in the country and acquaint the student with state of the art technique/instruments used in various research institutions and industries of national repute. The student needs to submit a report after completion of the tour.						

Course Outcomes	
CO1	Develop understanding of state of the art techniques/instruments used in various reputed research institutions. and industries
CO2	Take part in Group discussion and learn Team work.
CO3	Enhance communication and social skills by communication with peers.
CO4	Student shall be able to plan and improve the Technical Report writing skills
CO5	Have created Interest to pursue lifelong learning.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1			2		3	2	1	3	3
CO2	3	2	2	1				1				3
CO3	3	2	2	1				1			1	3
CO4	3	2				2		2	2			3
CO5	3							3				3

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

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