UNIVERSITY OF THE PUNJAB

NOTIFICATION

It is hereby notified that the Syndicate at its meeting held on 03-07-2025 has approved the recommendations of the Academic Council made at its meeting dated 03-06-2025 regarding start of new Program of BS Biophysics & Nano-Biotechnology (Morning &Self Supporting) alongwith approval of the Curriculum/Scheme of Studies/Syllabi and Courses of Reading prepared in the light of HEC undergraduate Education Studies Policy, 2023 to be offered jointly at the Centre of Excellence in Solid State Physics and the Institute of Microbiology & Molecular Genetics, University of the Punjab, Lahore w.e.f the Academic Session, 2024-2028 and onward.

The Curriculum/Scheme of Studies/Syllabi and Courses of Reading for BS Biophysics & Nano-Biotechnology (Morning &Self Supporting) Program is attached herewith as Annexure-A.

Sd/-
Dr. Ahmad Islam
Registrar

Admin. Block,
Quaid-i-Azam Campus,
Lahore.

No. D/ 6542 Acad. **Dated: 08--10 /2025.**

Copy of the above is forwarded to the following for information and further necessary action: -

1. Dean, Faculty of Sciences
2. Director, Centre of Excellence in Solid State Physics
3. Director, Institute of Microbiology & Molecular Biology
4. Controller of Examinations.
5. Director, IT Centre *(for uploading on website)*.
6. Secretary to the Vice-Chancellor
7. Secretary to Registrar
8. Assistant Registrar (Statutes)
9. A.O. Syllabus (W.F)

Assistant Registrar (Academic)
for Registrar

Program Curriculum

BS BIOPHYSICS & NANO-BIOTECHNOLOGY

Centre of Excellence in Solid State Physics
and
Institute of Microbiology and Molecular Genetics

University of the Punjab
Lahore

Programme	Bachelor of Science in Biophysics and Nanobiotechnology (BS BPNBT) (Morning & Self Support)				
Duration	4Years	**Semesters**	**8**	**Credit hours**	136
Department	**Centre of Excellence in Solid State Physics In Collaboration with Institute of Microbiology and Molecular Genetics**				
Faculty	**Faculty of Sciences**				

Department Introduction

The Centre of Excellence in Solid State Physics was established in 1973. The major aim of establishing the Centre in this field was to provide the country with technically trained manpower and to establish research facilities in solid state physics and allied fields. The analytical facilities established in the Centre were successfully utilized to help various projects of National Importance. Students of various universities of Pakistan are offered these analytical facilities, and hundreds of samples have been analyzed, through ASIP (HEC), to date. Centre of Excellence in Solid State now boasts to have established teaching and research facilities for both theoretical and experimental fields of materials preparation and characterization to device fabrication and characterization.

The Biological Sciences have progressed leaps and bounds and it is now strongly felt that if proper remedial measures are not taken to develop the Biological Sciences, the University may never be able to catch up with the rapid speed with which new developments are taking place in this field. There is a dire need to build up basic arsenal for venturing into collaborative teaching and research programme. There is no denying the fact that microbes are center of biological sciences these days and most of the new technologies in fact are based on microbes or microbe-based knowledge. Another very important component of modern biotechnology is the field of Genetics. In the wake of development in the areas of Genetic Engineering, Gene Therapy, Human Genome, it was long felt that a separate discipline of be established for a degree programme so as to provide basic training in the area with an objective (i) to produce specifically trained manpower and (ii) initiate teaching and research in Biophysics and Bionanotechnology leading to award of M.Sc., M.Phil, and Ph.D. Degrees.

Department Vision

The Centre of Excellence in Solid State Physics, and Institute of Microbiology and Molecular genetics being a prime teaching and research institutes of the country, visualizes its future in strengthening higher education and R&D through collaborations with world-renowned institutions in solid state physic, biological sciences and allied areas.

Department Mission

To play leading role as Centre of Excellence in Solid State Physics in teaching, research, innovation and commercialization by providing excellent facilities needed for research in designing and simulation of electronic and optoelectronic devices, organic materials and nanomaterials etc. The Centre makes endeavors to produce broad-based, creative and entrepreneur leaders, contributing to socio-economic development of the country.

Department Goals

1. To establish facilities for producing technically trained manpower in Solid State Physics and allied fields.
2. To establish excellent R&D facilities.
3. To enhance collaborative research with multi-disciplinary approach with other institutions.
4. To organize national and international conferences / workshops.

5. To educate students at par with international standards.

Program Introduction

The program aims to educate / train students with the latest developments in the field of Nanoscience & Nanotechnology. Moreover, it will help students to design and develop a strong background in fundamentals of nanosciences such as nanomaterials, bio-nanotechnology, nano-chemistry etc. Due to the diversity of options available to students, they will learn advanced-level techniques for synthesis of advanced nano-devices. This programme will train students to conduct independent scientific and analytical investigations in the emerging discipline, and to develop critical and scientific skills needed for a suitable career in academia and industry.

The PU major in biophysics will be a rigorous and challenging major that attracts students interested in biology as well as mathematics, physics, and computation. The goal of the major is to achieve true integration among biology, chemistry, physics, mathematics, and computation, and our majors will become competent in all five areas.

However, interdisciplinary education is not just a matter of taking courses in different departments. The strength of our major will be that we will integrate all these scientific areas. This integration is accomplished through courses in biophysics, the advanced laboratory course, and the independent research requirement. Our courses emphasize concepts and problem solving over memorization. We train our students to become thinkers who will have the quantitative skills and technical abilities to address any biological problem at hand.

Program Objectives

1. To educate students to know and follow the high professional and ethical standards of scientific work.
2. To equip students with an understanding of fundamental concepts in nanosciences with special emphasis on synthesis and characterization at nano-scale.
3. To train students for fabrication and characterization of electronic, opto-electronic, spintronic, energy storage and thermoelectric devices at nanoscale.
4. To furnish an in-depth understanding of some specialized areas of physics through choice ofelective courses.
5. To develop research based scientific thinking and to enhance professional skills for teaching, research, managerial positions in wide range of professions in national and international organizations.

Market Need / Rationale of the Program

The proposal for new program should include a market survey to address the need for introducing the program.

Program need assessment may include feedback from multiple sources such as:

a) ***Potential Students for the program***. The students who are interested to pursue a career in nanotechnology that provides the foundation for all future devices and materials in the current scenario of advancing world.

b) ***Potential Employers*** Public, private academic & research institutes e.g. Universities, NESCOM, PAEC, SUPARCO, KRL, NDC, NGOs, Hospitals etc., that require skill set, industry projections, employment opportunities. Apart from these local avenues international

universities offer opportunities through their own funding. These students will also be suitable for chemical based and pharmaceutical based industries.

c) ***Academic Projections*** This is the advanced version of BS offered in the country that will be at par with international universities from Europe and North America where such programs are offered.

d) ***Faculty*** The Centre of Excellence in Solid State Physics and Microbiology and Molecular genetics has highly skilled faculty with strong teaching and research background.

e) Physical Facilities The state-of-the-art laboratory and library facilities are available

Admission Eligibility Criteria

- Years of Study completed 12
- Study Program/Subject F.Sc. / I.C.S. / A-level
- Admission Rules and Regulation book of the University of the Punjab will be followed
- Any other (if applicable)

Categorization of Courses as per HEC Recommendation and Difference

Semester	Courses	Category(Credit Hours)					
		Core Courses	Basic Courses	Major Electives	Minor Electives	Any Other	Semester Load
1	8	5		3			**20**
2	8	4		4			**20**
3	8	5		3			**18**
4	7	3		3		1	**16**
5	6			4		1	**15**
6	6			4		2	**17**
7	6			4		1	**15**
8	5			5			**15**
PU							**136 (plus 4 Quran credit)**
HEC Guidelines							**131-144**

**Core: Compulsory, Basic: Foundation, Major Electives: Professional Minor Electives: Specialization*

Note: The course/column heads are customizable according to nature and level of the program.

Scheme of Studies / Semester-wise workload

#	Code	Course Title	Course Type	Prerequisite	Credit hours		
Semester I							
1.	SSP-101	Introductory Mechanics	Major		3 (2-1)		
2.	BP-101	Calculus	Major		3 (3-0)		
3.	GQR-101	Quantitative Reasoning – I	Gen. Education		3 (3-0)		
4.	GNS-201	Fundamentals of Physical Chemistry	Gen. Education		3 (2-1)		
5.	GENG-101	Functional English	Gen. Education		3 (3-0)		
6.	BP-102	Cell Biology	Major		3 (2-1)		
7.	GPKS-101	Pakistan Studies	Gen. Education		2 (2-0)		
8.	IDQT-101	Quran Translation	Compulsory		0		
Total Credit Hours 20							
Semester II							
1.	SSP-203	Heat & Thermodynamics	Major		3 (2-1)		
2.	BP-103	Introduction to Biophysics	Major		3(3-0)		
3.	BP-104	Nanobiotechnology	Major		3 (3-0)		
4.	GQR-102	Quantitative Reasoning – II	Gen. Education	GQR-I01	3 (3-0)		
5.	IDIC-101	*Social Sciences	Gen. Education		2 (2-0)		
6.	GENG-201	Expository Writing	Gen. Education		3 (3-0)		
7.	BP-105	Biochemistry	Major		3 (2-1)		
8.	IDQT-102	Quran Translation	Compulsory		1		
Total Credit Hours 20							
Semester III							
1.	SSP-201	Electricity & Magnetism	Major		3 (2-1)		
2.	SSP-202	Linear Algebra	Major		3 (3-0)		
3.	GAH-101	Arts & Humanities	Gen. Education		2 (2-0)		
4.	GICT-201	Applications of Information and Communication Technologies (ICT)	Gen. Education		3 (3-0)		
5.	GISL-101	*Islamic Studies (OR) Religious studies / Ethics (in lieu of Islamic Studies only for non-Muslim students)	Gen. Education		2 (2-0)		
6.	GICP-101	*Ideology and Constitution of Pakistan	Gen. Education		2 (2-0)		
7.	BP-201	Microbiology	Major		3 (2-1)		
8.	IDQT-201	Quran Translation	Compulsory		0		
Total Credit Hours 18							
Semester IV							

#	Code	Course Title	Course Type	Prerequisite	Credit hours		
1.	SSP-205	Modern Physics	Major		3 (2-1)		
2.	BP-202	Introduction to Nanomaterials	Major		3 (3-0)		
3.	IDEP-201	Environmental Physics	Interdisciplinary		3 (3-0)		
4.	GCCE-201	*Civics & Community Engagement	Gen. Education		2 (2-0)		
5.	GENT-201	Entrepreneurship	Gen. Education		2 (2-0)		
6.	BP-203	Biosafety & Biohazard Management	Major		3 (2-1)		
7.	IDQT-202	Quran Translation	Compulsory		1		
Total Credit Hours 16							
Semester V							
1.	SSP-301	Classical Mechanics	Major		3 (3-0)		
2.	BP-301	Electronics	Major	SSP-205	3 (2-1)		
3.	SSP-304	Basic Solid State Physics	Major		3 (3-0)		
4.	IDPS-301	Probability and Statistics	Interdisciplinary		3 (3-0)		
5.	BP-302	General Genetics	Major		3 (2-1)		
6.	IDQT-301	Quran Translation	Compulsory		0		
Total Credit Hours 15							
Semester VI							
1.	BP-303	Ecology and Ecosystem	Major	SSP-302			
2.	SSP-307	Quantum Mechanics	Major	SSP-205	3 (3-0)		
3.	BP-304	Molecular Biology	Major		3 (2-1)		
4.	BP-305	Bionanomaterials	Major		3 (2-1)		
5.	IDIT-301	Information Technology and Computer Simulations in Nanoscience	Interdisciplinary		2 (2-0)		
6.	IDSN-301	Environmental Microbiology	Interdisciplinary		3 (3-0)		
7.	IDQT-302	Quran Translation	Compulsory		1		
Total Credit Hours 17							
Semester VII							
1.	SSP-402	Atomic & Molecular Physics	Major		3 (3-0)		
2.	BP-401	Biophysical Techniques in Research	Major		3 (2-1)		
3.	BP-402	Internship	Major		3 (3-0)		
4.		Elective-I	Major		3 (3-0)		
5.	IDAI-301	Artificial Intelligence in Physics	Interdisciplinary		3 (3-0)		
6.	IDQT-401	Quran Translation	Compulsory		0		

#	Code	Course Title	Course Type	Prerequisite	Credit hours		
Total Credit Hours 15							
Semester VIII							
1.	BP-411	Structural Biophysics	Major		3 (3-0)		
2.		Elective-II	Major		3 (3-0)		
3.		Elective-III	Major		3 (3-0)		
4.		Elective-IV	Major		3 (3-0)		
5.	BP-412	Capstone Project	Major		3 (0-3)		
6.	IDQT-402	Quran Translation	Compulsory		1		
Total Credit Hours 15							

1. Type of course may be core (compulsory), basic (foundation), major elective (professional), minor elective (specialization) etc.

List of Elective Courses

1.	BP-403	Nanomaterials in Medicine	3 (2-1)
2.	BP-404	Biosensors and Bioelectronics	3 (2-1)
3.	BP-405	Lasers and Applications	3
4.	BP-406	Biomechanics	3
5.	BP-407	Bioenergetics	3
6.	BP-408	Radiation Biophysics	3
7.	BP-413	Epigenetics	3
8.	BP-414	Proteomics and Genomics	3 (2-1)
9.	BP-415	Bioinformatics, Protein Structures and Functions	3
10.	BP-416	Cell Membranes and Transport Systems	3
11.	BP-417	Computational Biology	3
12.	BP-418	Virology	3 (2-1)
13.	BP-419	Antimicrobial Agents and Resistance	3 (2-1)
14.	BP-420	Vaccinology	3
15.	BP-421	Biodegradation and Bioremediation	3 (2-1)

NOTE:

*Gen Education, Social Sciences, Natural Sciences etc. : Courses will be offered from the pool of Punjab University approved courses as per availability of teachers.

Elective Courses will be offered as per availability of teachers.

Research Thesis / Project /Internship

Internship (3 credit hours)

Award of Degree

Degree awarding criteria stating:

CGPA percentage required to Qualify 2.0

Thesis /Project/Internship Project & Internship

Any other requirement, e.g., Comprehensive examination (if applicable)

NOC from Professional Councils (if applicable)

Provide the status of NOC from the concerned Professional Council(s), if applicable, depending on nature of the program being propose N.A.

Faculty Strength

Degree	Area/Specialization	Total
PhD	1. Solid State physics 2 2. Nanotechnology 5	**7**
MPhil	1. Solid State Physics 5 2. Nanotechnology 7	**12**
MMG (PhD)	21	**21**
Total		**40**

Present Student Teacher CSSP

Total Faculty	**CSSP 19**	**Total Students**	**200**	**Ratio**	**1/11**

Course Outlines separately for each course

Centre of Excellence in Solid State Physics
Faculty of Science
University of the Punjab, Lahore

Checklist for a New Academic Program

Parameters	YES/NO
1. Department Mission and Introduction	YES ☐ NO ☐
2. Program Introduction	YES ☐ NO ☐
3. Program Alignment with University Mission	YES ☐ NO ☐
4. Program Objectives	YES ☐ NO ☐
5. Market Need/ Rationale	YES ☐ NO ☐
6. Admission Eligibility Criteria	YES ☐ NO ☐
7. Duration of the Program	YES ☐ NO ☐
8. Assessment Criteria	YES ☐ NO ☐
9. Courses Categorization as per HEC Recommendation	YES ☐ NO ☐
10. Curriculum Difference	YES ☐ NO ☐
11. Study Scheme / Semester-wise Workload	YES ☐ NO ☐
12. Award of Degree	YES ☐ NO ☐
13. Faculty Strength	YES ☐ NO ☐
14. NOC from Professional Councils (if applicable)	YES ☐ NO ☐

_____ _____

Program Coordinator **Chairperson**

Program	BS BioPhysics & Nano-Biotechnology	Course Code	SSP-101	Credit Hours	3
Course Title	**Introductory Mechanics**				

Course Introduction
The Mechanics course is an exploration of the fundamental principles governing the motion ofobjects in the universe. It covers concepts like position, velocity, and acceleration vectors, Newton's laws of motion, and forces driving motion. The course also delves into projectile motion and uniform circular motion. It explores momentum, linear momentum, impulse, and conservation of momentum, and systems of particles. It also covers rotational kinematics and dynamics, including torque, rotational inertia, equilibrium, and angular momentum. The coursealso delves into work and energy, including potential energy, conservative forces, and conservation of mechanical energy. The course concludes with a profound understanding of the mechanics that govern our physical world, from the smallest particles to celestial bodies.

Learning Outcomes
1. Understanding basic principles of mechanics and its applications. 2. Be able to solve relevant numerical problems. 3. Be able to use calculus in studying the mechanics systems.

Course Content	
Week 1	Position, velocity, and acceleration vectors
	Motion with constant acceleration in 1D and 3D
Week 2	Force, Newton’s laws of motion, weight
	Projectile motion
Week 3	Uniform circular motion
	Tension and normal forces, frictional forces
Week 4	The dynamics of uniform circular motion
	Non-inertial frame & pseudo forces;
Week 5	Linear momentum, Impulse and momentum
	Conservation of momentum, two body collision
Week 6	Elastic and inelastic collisions
	System of many particles,
Week 7	Centre of mass of solid objects
	Linear momentum of system of particles and its conservation, System of variable mass, Rocket motion
Week 8	Mid Term Exam

Week 9	Rotational kinematics, Rotational dynamics
	Torque, rotational inertia, rotational inertia of solid objects, torque due to gravity
Week 10	Equilibrium and nonequilibrium applications of Newton's law for rotational motion
	(Problem Solving)
Week 11	Angular Momentum and angular velocity, the spinning top,
	Work: work done by variable force, work kinetic energy theorem
Week 12	Work and kinetic energy in rotational motion
	Kinetic energy in collisions
Week 13	Potential energy, Conservative forces,
	Conservative forces, Conservation of mechanical energy
Week 14	Gravitation: Newton's law of universal gravitation,
	The shell theorems
Week 15	Problem Solving, Gravitational potential energy
	The motion of planets and satellites.
Week 16	Final Term Exam

Textbooks and Reading Material

1. Physics Vol.1 (4^{th}edition), Halliday and Resnic, *John Wiley and Sons* (1992).
2. Fundamentals of Physics (5^{th}edition), Halliday and Resnic, *John Wiley and Sons* (1999).
3. Classical Mechanics Simulations, Bruce Hawkins and Randall Jones, *John Wiley & Sons*
4. (1995).
5. Physics Vol.1 (5^{th}edition), Halliday and Resnic, *John Wiley and Sons* (2002).
6. Physics for Scientists and Engineers (Extended version), P. M. Fishbane, *Prentice-Hall International Editions* (2016).
7. *Fundamentals of Physics, Volume 1, Halliday D., Resnick R., & Walker J., John Wiley & Sons, Hoboken, United States (2017).*

Teaching Learning Strategies

The instructor is required to make use of Mathematica/Maple/Python to teach the concepts through visualization/antimutation and symbolic/numerical calculations. The students are required to solve a large portion of related exercises/questions/problems of the main textbooks.

Assignments: Types and Number with Calendar

At least two assignments and two quizzes. A course project may also be assigned.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.

2.	Formative Assessment	25%	Continuous assessment includes Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. At least fifty percent of the question paper would involve new problems related to the concepts learned in the course. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Program	BS BioPhysics & Nano-Biotechnology	Course Code	BP-101	Credit Hours	3
Course Title	**Calculus**				

Course Introduction
The Calculus course is a comprehensive mathematical journey that teaches students the fundamentals of functions, their behavior, and real-world problems. It covers the basics of real numbers, functions, and inverse functions, as well as limits, continuity, derivatives, differentiation techniques, graphing, optimization, and partial derivatives. The course also covers the role of derivatives in graphing and applications, such as concavity and relative extrema. By the end of the course, students will have a solid understanding of calculus, enabling them to navigate the complexities of functions, derivatives, and their applications in theory and practice.

Learning Outcomes
The course introduces the subject of differential calculus at undergraduate level. Its objectivesare as following. 1. Understanding the concepts of functions, limit and differentiation. 2. Study the application of differentiation. 3. Be able to solve relevant numerical problems. 4. Be able to use calculus in physics and advance courses in mathematics.

Course Content	
Week 1	Functions, Domain and Range
	Introduction to Limit, Limit at infinity
Week 2	Rigorous definition of limit, Technique for evaluation limits.
	Continuity: Definition and examples, Properties of continuous functions
Week 3	Derivative: Tangent lines and rates of change
	Derivative rules: Power, Product, Quotient, and chain rules
Week 4	Differentiability and continuity
	High order derivative and Leibniz theorem
Week 5	Increasing and decreasing functions
	Extrema, maxima and minima
Week 6	Convexity and point of inflection
	Curve sketching

Week 7	Mean value theorem
	Intermediate forms and L'Hopital's rule, Functions of two or more variables, partial derivatives, Local linear approximation;
Week 8	Mid Term Exam
Week 9	Integration as antiderivative
	Riemann sum and definite integral
Week 10	Integration by substitution
	Integration of elementary and trigonometric functions
Week 11	Integration of logarithmic and exponential functions
	Integration by parts
Week 12	Integration by partial fraction
	Improper integrals
Week 13	Average value
	Area between curves
Week 14	Volume by slicing
	Volumes by Cylindrical shells
Week 15	Length of a plane curve, Area of surface of revolution
	Work, Moments, Centre of gravity, and Centroids, Using Computer algebra systems and tables of integrals
Week 16	Final Term Exam

Textbooks and Reading Material

1. Calculus and Analytics Geometry, C. H. Edward and E. D Penney, *Prentice Hall* (1988).
2. Calculus with Analytic Geometry, E. W. Swokowski, *PWS Publishers*, *Boston* (1988).
3. Calculus and Analytic Geometry (9^{th}Edition), G.B. Thomas and R.L. Finney, *Addison-Wesley Publishing Company* (1995).
4. Calculus by Thomas (13th Edition), *Addison Wesley* (2005).
5. *Calculus: A New Horizon,* Anton H, Bevens I, Davis S, (8th edition), *John Wiley, New York* (2005).
6. Calculus, H. Anton, I. Bevens, S. Davis (10th Edition), *Laurie Rosatone* (2012).

Teaching Learning Strategies

The instructor is required to make use of Mathematica/Maple/Python to teach the concepts through visualization/antimutation and symbolic/numerical calculations. The students are required to solve a large portion of related exercises/questions/problems of the main textbooks.

Assignments: Types and Number with Calendar

At least two assignments and two quizzes. A course project may also be assigned.

Assessment			
Sr. No.	**Elements**	**Weightage**	**Details**
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. At least fifty percent of the question paper would involve new problems related to the concepts learned in the course. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-102	Credit Hours	3 (2-1)
Course Title	**Cell Biology**				

Course Introduction

This course explores the fundamental concepts of cell biology, including cell structure, function, and communication. Emphasis is placed on the molecular mechanisms underpinning cell processes and how these contribute to the larger function of tissues and organs.

Learning Outcomes

On the completion of the course, the students will:

1. Understand cell structure and organelles
2. Grasp cell metabolism and energy dynamics
3. Learn about cell communication and signaling pathways
4. Explore cell division, growth, and development

Course Content

Week 1	Introduction to Cells and Cell Theory: Overview of cell types, cell theory, and historical perspectives
Week 2	Cell Organelles: Structure and function of membranes
Week 3-4	Cell Organelles: Structure and function of mitochondria, ER, Golgi apparatus
Week 5	DNA, RNA Structure
Week 6-7	Transcription, translation, and gene regulation
Week 8	Mid Term Exams
Week 9	Cell Metabolism and Energy: Metabolic Pathways
Week 10	Cell Metabolism and Energy: ATP production
Week 11	Cell Metabolism and Energy: photosynthesis and respiration.
Week 12	Cell Communication and Signaling: Signal transduction, cellular responses, and intercellular communication
Week 13-14	Cell Cycle and Division: Mitosis, meiosis, cell cycle regulation

Week 15	Apoptosis, necrosis
Week 16	Final Term Exams

Practicals

Laboratory techniques to study cell structure using microscopy, subcellular fractionation to isolate and identify organelles, DNA extraction and visualization through gel electrophoresis, investigation of photosynthetic activity in plants under varying light conditions, observation of mitosis and meiosis through slide preparation and staining.

Textbooks and Reading Material

1. Essential Cell Biology, Alberts B., *Garland Science, New York, United States* (2013).
2. Molecular biology of the cell (6th ed.) Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. *Garland Science, New York, United States* (2015).
3. The Cell: A Molecular Approach, Cooper G.M., *Oxford University Press*, *Oxford, United Kingdom* (2019).
4. Evolutionary Cell Biology: The Origins of Cellular Architecture, Lynch M.R., *Oxford University Press*, *Oxford, United Kingdom* (2024).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	SSP-203	Credit Hours	3 (2-1)
Course Title	**Heat and Thermodynamics**				

Course Introduction

This course will give the concept of:

1. Heat and temperature
2. To give the concept of classical distribution function
3. To understand the laws of thermodynamics and their application

Learning Outcomes

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

1. To relate heat transfer to temperature change.
2. Memorize temperature equations for Celsius, Fahrenheit, and Kelvin conversions.
3. Understand how body temperature can vary.

Course Content

Week 1	Statistical Mechanics: Statistical distribution and mean values, Mean free path, and microscopic calculations of mean free path
Week 2	Distribution of molecular speeds, Distribution of energies, Maxwell distribution, Maxwell-Boltzmann energy distribution
Week 3	Internal energy of an ideal gas. Brownian motion, Qualitative description. Diffusion, Conduction, and viscosity
Week 4	Heat and Temperature: Temperature, Kinetic theory of the ideal gas, Work done on an ideal gas
Week 5	Review of previous concepts
Week 6	Internal energy of an ideal gas: Equipartition of energy. Intermolecular forces. Qualitative discussion. Van der Waals equation of state
Week 7	Thermodynamics Review of previous concepts
Week 8	Mid Term Exams
Week 9	First law of thermodynamics and its applications to adiabatic, isothermal, cyclic and free expansion
Week 10	Reversible and irreversible processes, Second Law of thermodynamics, Carnot theorem, Carnot engines. Heat engine
Week 11	Refrigerators. Calculation of efficiency of heat engines. Thermodynamic temperature scale: Absolute zero:
Week 12	Entropy, Entropy in reversible process, Entropy in irreversible process. Entropy & second law. Entropy & probability
Week 13	Thermodynamic functions: Thermodynamic functions (Internal energy, Enthalpy)
Week 14	Gibb's functions, Entropy, Helmholtz functions, Maxwell's relations, TdS equations, Energy equations and their applications

Week 15	Low Temperature Physics, Liquification of gases, Joule Thomson effect and its equations. Thermoelectricity, Thermocouple, Seebeck's effect, Peltier's effect, Thomson effect
Week 16	Final Term Exams

Textbooks and Reading Material

1. Heat and Thermodynamics, M.W. Zemansky, *McGraw Hill*, *United States* (1951).
2. Thermodynamics, J.F. Lee, F.W. Sears, *Addison-Wesley*, *United States* (1954).
3. Introduction to Statistical Physics, A.J. Pointon, *Longman*, *United Kingdom* (1967).
4. Statistical Physics, F. Reif, *McGraw*, *United States* (1967).
5. Heat and Thermodynamics, Sprackling M., *Macmillan*, *Hong Kong* (1993).
6. Heat and Thermodynamics, Manna A., *Dorling Kindersley*, *India* (2011).
7. Heat and Thermodynamics, Saxena A.K., Tiwari C.M., *Alpha Science International, Limited*, *United Kingdom* (2014).
8. Fundamentals of Thermodynamics, Borgnakke C., *Wiley*, *United Kingdom* (2025).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-103	Credit Hours	3 (3-0)
Course Title	**Introduction to Biophysics**				

Course Introduction

Biophysics is the application of the laws of physics to biological problems. It utilizes the languages of math and computation in its effort to describe biology in quantitative terms. Biophysicists utilize the principles, instrumentation, and computational models of physics to comprehend living organisms.

Learning Outcomes

The students should be able to

1. Apply the principles of physical sciences to understand and solve biological complexities.
2. Using the knowledge gained during the course, students should be able to address the academic and industrial research problems.

Course Content

Week 1	Statistical mechanics
Week 2	Review of classical thermodynamics, equilibrium statistical mechanics and ensemble theory
Week 3	Boltzmann factor and protein folding energetics
Week 4	Applications to ideal gas, Einstein solid, two-state paramagnet, hemoglobin, DNA compaction, Bose-Einstein condensation and Fermi-Dirac gases
Week 5	Transport processes in cells: diffusion and active transport
Week 6	Random walks and diffusion with application to biological macromolecules.
Week 7	Brownian motion and cell membrane potential
Week 8	Mid Term Exams
Week 9	Langevin equation and fluctuation-dissipation theorems
Week 10	Driven diffusion of oxygen to cells, and receptors on a cell surface
Week 11-12	Biosystems
Week 13	Bio-electronics used to detect cells and viruses for medicine
Week 14	Numerical /statistical based problem solving related to the above topics
Week 15	Numerical based problem solving related to above topics
Week 16	Final Term Exams

Textbooks and Reading Material

1. Essentials of Biophysics, Campbell A., *New Age International (P) Limited*, *India* (2000).
2. Biophysics: Principles and Techniques, M., *MJP Publisher*, *(n.p.)* (2019).
3. Biophysics, Pattabhi V., Gautham N., *Springer*, *India* (2019).
4. Biophysics: A Student's Guide to the Physics of the Life Sciences and Medicine, Parke W.C., *Springer International Publishing*, *Switzerland* (2021).
5. Introduction to Molecular Biophysics, Daune M., *Oxford University Press*, *United Kingdom* (2022).
6. Biophysical Chemistry, M.G., *CRC Press*, *(n.p.)* (2024).
7. Biophysical Techniques in Biosciences: From Fundamentals to Advanced Applications, R. G-YU, *CRC Press*, *(n.p.)* (2025).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-104	Credit Hours	3
Course Title	**Nanobiotechnology**				

Course Introduction

Nanotechnology is an interdisciplinary field and attracts students from various disciplines. This course provides basic overview of nanomaterials and their applications. This course begins with a review of various types of nanomaterials and an introduction to general terminologies. Subsequently the course covers synthesis methodologies, physical and chemical characterization of nanomaterials. Finally, case studies illustrating application of nanomaterials in diverse fields will be discussed.

Learning Outcomes

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

1. Understand the nature and properties of nanomaterials.
2. To provide scientific understanding of application of nanomaterials and nanotechnology in agriculture, health and environmental conservation

Course Content

Week 1	Introduction, top down and bottom up approaches of nanotechnology
Week 2	interface between nanotechnology and bio-nanotechnology
Week 3	manipulating molecules; carbon fullerenes and nanotubes
Week 4	non-carbon nanotubes and fullerene-like materials
Week 5	quantum dots; nanowires, nanorods and other nanomaterial's
Week 6	magnetic nanoparticles
Week 7	natural biological assembly at the nanoscale and nanometric biological assemblies (complexes)
Week 8	Mid Term Exams
Week 9	nanobionics and bio-inspired nanotechnology
Week 10	applications of biological assemblies in nanotechnology
Week 11	Theory of nanotechnology & nanoeconomics
Week 12	Role of nanotechnology in medical, cosmetics, agriculture

Week 13	water purification and bioremediation applications of nano biotechnology
Week 14	future prospects of nano-biotechnology
Week 15	use of nanotechnology for diagnosing and curing disease
Week 16	Final Term Exams

Textbooks and Reading Material

1. Nano-biotechnology, Niemeyer C.M., Mirkin C.A., *Wiley VCH*, *(n.p.)* (2004).
2. Nano Scale Technology in Biological Systems, Greco et al., *CRC Press*, *(n.p.)* (2004).
3. Bio-nanotechnology: Proteins to Nano Devices, Renugopalakrishnan V., Lewis R.V., *Springer*, *(n.p.)* (2006).
4. Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology, Gazit E., *Imperial College Press*, *(n.p.)* (2007).
5. Nano-biotechnology II: More Concepts and Applications, Mirkin C.A., Niemeyer C.M., *John Wiley & Sons*, *(n.p.)* (2007).
6. Nanobiotechnology: Concepts and Applications in Health, Agriculture, and Environment, Tomar R.S., Kaushik A.J., Shuchi K., *Apple Academic Press*, *(n.p.)* (2020).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-105	Credit Hours	3 (2-1)
Course Title	**Biochemistry**				

Course Introduction

"Biochemistry," is a fundamental course that delves into the chemical processes and substances that underpin life. Biochemistry bridges the gap between biology and chemistry, exploring how biochemical molecules interact to sustain life. This course is designed for students seeking to understand the molecular mechanisms that drive biological functions and processes, providing a solid foundation in both theoretical concepts and practical applications.

Learning Outcomes

On the completion of the course, the students will be able to:

1. Understand the biochemical basis of life
2. Acquire basic knowledge of biomolecules
3. Know the structures, properties, and involvement of different types of macromolecules in biological systems.
4. Acquire the knowledge about intermediary biochemical processes
5. Demonstrate the metabolic pathways of carbohydrates, lipids, and protein, the energy-yielding and energy-requiring reactions in life.

Understand the diversity of metabolic regulation of macromolecules, and how this is specifically achieved in different cells

Course Content

Week 1	Structure and properties of proteins
Week 2	Structure and properties of enzymes
Week 3	Structure and properties of nucleic acids
Week 4	Structure and properties of carbohydrates
Week 5	Structure and properties of lipids
Week 6	Structure and properties of alkaloids
Week 7	Structure and properties of terpenoids
Week 8	Mid Term Exams
Week 9	Structure and properties of vitamins
Week 10	Metabolism of proteins
Week 11	Metabolism of carbohydrates

Week 12	Metabolism of lipids
Week 13	Metabolism of nucleic acids
Week 14-15	Integration of various metabolic processes.
Week 16	Final Term Exams

Practicals

Normal solutions; Various qualitative tests for Monosaccharides, oligosaccharides, and polysaccharides; Study of hydrolysis of starch by using mineral acids; Detection of reducing sugars in the presence of non-reducing sugars; Qualitative tests for different lipids; Paper and thin-layer chromatography of sugars; Paper chromatography of various amino acids
Estimation of glucose from unknown samples through UV spectrophotometry. Quantitative analysis of proteins by UV spectrophotometry; Extraction and quantitative analysis of amino acids. Determination of acid value of fats.

Textbooks and Reading Material

1. Principles of Biochemistry (General Aspects), E.L. Smith, R.L. Hill, R.I. Lehman, R.J. Lefkowits, Handler, Abraham, *McGraw Hill International Book Company*, *(n.p.)* (1983).
2. Biochemistry, J.D. Rawn, *Neil Patterson*, *North Carolina* (1989).
3. Biochemistry, G. Zubay, *Macmillan Publishing Co.*, *New York* (1994).
4. Fundamentals of Biochemistry: Life at the Molecular Level, D. Voet, J.G. Voet, C.W. Pratt, *John Wiley & Sons*, *Hoboken, NJ* (1998).
5. Principles of Biochemistry, A.L. Lehninger, D.L. Nelson, M.M. Cox, *W.H. Freeman*, *New York* (2000).
6. Biochemistry, L. Stryer, *Scientific American Book*, *(n.p.)* (2001).
7. Outlines of Biochemistry, E.L. Conn, P.K. Stumpf, G. Brunning, R.H. Doll, *John Wiley & Sons Inc.*, *New York* (2002).
8. Fundamentals of Biochemistry: Life at the Molecular Level (5th ed.), D. Voet, J.G. Voet, C.W. Pratt, *John Wiley & Sons*, *Hoboken, NJ* (2016).
9. Lehninger Principles of Biochemistry (6th ed.), A.L. Lehninger, D.L. Nelson, M.M. Cox, *W.H. Freeman*, *New York* (2012).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment			
Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Program	BS BioPhysics & Nano-Biotechnology	Course Code	SSP-201	Credit Hours	3

Course Title	Electricity and Magnetism

Course Introduction
This course introduces the fundamental concepts of electric charge, electric force, and electric fields, using hand-drawn animations. This is excellent for students who are taking a physics class but need extra help understanding the material, whether it's because your teacher is hard to understand, you miss some lectures, or you'd simply like a fresh perspective.

Learning Outcomes
1. Understand basic principle of electricity and magnetism and its applications. 2. Be able to solve relevant numerical problems.

Course Content	
Week 1	Coulomb's law; Electric Field, Gauss's law and its applications
Week 2	Electric field due to surface and volume charge distribution, electric field due to dipole
Week 3	Electric potential, Potential due to point charge, due to collection of point charges surface and volume charge distribution. Poisson's and Laplace equation (without solution)
Week 4	Capacitance, Calculating capacitance
Week 5	Energy storage in an electric field, Capacitor with dielectric, Dielectrics andGauss's Law. Electric current & density
Week 6	Ohm's law, microscopic view of Ohm's law. DC Circuits, Calculating current in a single loop & multiple loops
Week 7	Use of Kirchhoff's 1st and2nd law, Thevenin and Norton theorems, Transient behavior of RC circuit. Magnetic force on a charge particle and a currentcarrying wire, Torque on a current Loop
Week 8	Mid Term Exam
Week 9	The Hall Effect, Ampere's Law
Week 10	The Bio-Savart Law and its applications, Solenoids and Toroids
Week 11	Faraday's law of induction, Lenz's Law, Motional emf
Week 12	Induced electric fields. Magnetic properties of materials, magnetization. Inductance
Week 13	LR Circuit (transient behavior). AC current
Week 14	AC current in resistive, inductive and capacitive elements
Week 15	RLC series and parallel circuits, Maxwell's Equations
Week 16	Final Term Exam

Textbooks and Reading Material

1. Physics Vol.1 (4th edition), Halliday and Resnick, *John Wiley and Sons*, *(n.p.)* (1992).
2. Foundations of Electromagnetic Theory (3rd edition), J.R. Reitz, *Narosa Publishing House*, *(n.p.)* (1997).
3. Fundamentals of Physics (5th edition), Halliday and Resnick, *John Wiley and Sons*, *(n.p.)* (1999).
4. Physics Vol.1 (5th edition), Halliday and Resnick, *John Wiley and Sons*, *(n.p.)* (2002).
5. Physics for Scientists and Engineers (extended version), P.M. Fishbane, *Prentice-Hall International Editions*, *(n.p.)* (2016).

Teaching Learning Strategies

The instructor is required to make use of examples of the text books and the students are requiredto solve a large portion of related exercises/questions/problems of the main textbooks.

Assignments: Types and Number with Calendar

At least two assignments and two quizzes. A course project may also be assigned.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. At least fifty percent of the question paper would involve new problems related to the concepts learned in the course. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Program	BS BioPhysics & Nano-Biotechnology	Course Code	SSP-202	Credit Hours	3
Course Title	**Linear Algebra**				

Course Introduction

This course is about linear combinations. It involves vectors, matrices, vector spaces, matrix spaces, sets of linear equations and linear transformations involved in the spaces. It involves solving system of linear equations by using vector and matrix properties. It has many applicationssuch as in artificial intelligence, error correcting algorithms, search engine algorithms, etc.

Learning Outcomes

Following objectives are expected at the end of this course:

1. Learning the concepts of system of linear equations and matrices.
2. Learning the working principles in Euclidean vector spaces
3. Learning the methodology of general vector spaces
4. Having the grip of understanding eigen value problems
5. Understanding linear transformations in general way
6. Learning the concepts of similarity transformations

Course Content

Week 1	Course Introduction involving its scope and applications, etc.
	System of Linear equations and matrices: Introduction, Gaussian elimination method
Week 2	Matrices and Matrix operations
	Inverse of Matrix, Algebraic properties of matrices
Week 3	Elementary matrices, and methods of finding inverse
	Diagonal, triangular, and symmetric matrices
Week 4	Applications of linear systems
	Determinants by Cofactor expansion
Week 5	Evaluating determinant by row reduction
	Properties of determinants
Week 6	Cramer's rule
	Euclidean vector spaces: vector in 2D, 3D, nD space
Week 7	Euclidean vector spaces: Norm, Dot product and distance in R^n, Cross product
	General Vector Spaces: Real vector spaces, Subspaces
Week 8	Mid Term Exam

Week 9	Linear independence
	Coordinates and basis, Dimension
Week 10	Change of basis
	Linear operators
Week 11	matrix representation of linear operators
	Matrix Transformations from R^n to R^m
Week 12	Eigen values and eigen vectors: Definitions
	Diagonalization
Week 13	Complex vector spaces
	Inner Product Spaces: Inner product
Week 14	Inner Product Spaces: Gram-Schmidt process; QR Decomposition
	Inner Product Spaces: Orthogonal Matrices
Week 15	Inner Product Spaces: Diagonalization of orthogonal matrices, General linear transformations
	Matrices for general linear transformation, Similarity transformation
Week 16	Final Term Exam

Textbooks and Reading Material

1. Linear Algebra, G. Hadley, *Addison-Wesley*, *(n.p.)* (1987).
2. Foundations of Mathematical Physics, Sadri Hassani, *Prentice-Hall International*, *(n.p.)* (1991).
3. Elementary Linear Algebra (11th edition), Howard Anton, *John Wiley & Sons*, *(n.p.)* (2013).
4. Elements of Modern Algebra (8th edition), L. Gilbert and G. Gilbert, *Cengage Learning*, *(n.p.)* (2014).
5. Learning Modern Algebra, Rotman J.J., *American Mathematical Society*, *(n.p.)* (2015)

Teaching Learning Strategies

1. Instructor will provide mathematical details of linear algebra concepts so that studentscan better grip the concepts involved.
2. Instructor can use the software and multimedia technology to better highlight the linear algebra concepts.
3. Students will learn the concepts by practicing the mathematical details and then willsolve the exercise problems assigned by the instructor.
4. Students can use software technology to better understand the linear algebra concepts.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.

2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-201	Credit Hours	3(2-1)
Course Title	**Microbiology**				

Course Introduction

The main focus of the course of Microbiology involves the study of microorganisms with particular emphasis on the domain Bacteria and Archaea. This course introduces the basic principles of Microbiology, examining the microorganisms that inhabit our planet and their effects on plants, animals, and humans. Through theoretical and laboratory work, students will probe the science of microbes, and issues relevant to the field of Microbiology, including emerging infectious diseases and antibiotic resistance. Overall, students will be able to understand how microorganisms can be used as a model system to study other advanced disciplines of Microbiology

Learning Outcomes

On the completion of the course, the students will be able to:

1. Develop fundamental skills to work with different microbiological laboratory techniques.
2. Apply their microbial structure, growth, and metabolism knowledge to identify unknown microorganisms.
3. Identify major microbial interactions and illustrate how these interactions affect the well-being of humans, plants, and animals.
4. Work with diagnostic laboratories, the food industry, and academic and research organizations

Course Content

Week 1	History of microbiology: The golden age of microbiology, Modern development of microbiology, History of classification of prokaryotes
Week 2	Microscopy: Types of light and electron microscopy,
Week 3	structure and organization of prokaryotic cells: Structures external to the bacterial cell wall (glycocalyx, flagella, fimbriae, and pili), Bacterial cell wall, Internal structures, Inclusions, and Endospores,
Week 4	structure and organization of prokaryotic cells: Structures external to the bacterial cell wall (glycocalyx, flagella, fimbriae, and pili),
Week 5	Bacterial cell wall, Internal structures, Inclusions, and Endospores
Week 6	The cultivation of bacteria: Chemical requirements, Nutritional types of bacteria, Types of culture media
Week 7	Assessments and class assignment presentation
Week 8	Mid Term Exams
Week 9	Physical requirements for microbial growth, Microbial growth: Bacterial growth curve, Direct measurement of microbial growth
Week 10	Isolation of pure cultures, Methods for the preservation of bacterial cultures,
Week 11	Microbial metabolism: Comparative study of Embden-Meyerhof, Pentose phosphate, and Entner-Doudoroff pathways in Prokaryotes
Week 12	Microbial metabolism: Comparative study of Embden-Meyerhof, Pentose phosphate, and Entner-Doudoroff pathways in Prokaryotes

Week 13	Microbial symbiotic relationships: Positive and negative interactions
Week 14	Control of microorganisms: Physical methods and chemical agents.
Week 15	Assessments and class assignment presentation
Week 16	Final Term Exams

Practicals

Laboratory techniques to study different methods of sterilization of bacterial culture media, Cultivation of bacteria on complex, selective, and differential media, Methods for the isolation of pure microbial cultures from soil and water, Staining techniques, simple staining, gram's staining, negative staining, endospore and capsule staining, biochemical characterization of bacteria.

Textbooks and Reading Material

1. Microbiology: A Laboratory Manual (10th edition), Cappuccino J.G., Sherman N., *Pearson Education*, *United States* (2014).
2. Prescott's Microbiology (10th edition), Willey M.W., Sherwood L.M., Woolverton C.J., *McGraw-Hill Education*, *New York, United States* (2017).
3. Foundations in Microbiology (10th edition), Talaro K.P., Chess B., *McGraw-Hill*, *New York, United States* (2017).
4. Microbiology: Principles and Explorations (10th edition), Black J.G., Black L.J., *John Wiley and Sons*, *N.Y.* (2017).
5. Microbiology: An Introduction (13th edition), Tortora G.J., Funke B.R., Case C.L., *Pearson Education*, *United States* (2020).
6. Brock Biology of Microorganism (16th edition), Madigan M., Sattley W., Aiyer J., Stahl D., Buckley D., *Pears Education*, *United States* (2021).
7. Fundamentals of Microbiology (12th edition), Pommerville J.C., *Jones & Bartlett Learning*, *Burlington MA, United States* (2022).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Program	BS BioPhysics & Nano-Biotechnology	Course Code	SSP-205	Credit Hours	3
Course Title	**Modern Physics**				

Course Introduction

This course encloses the recent developments in modern physics and helpful to understand the basic relativistic and quantum mechanical tools can be applied in study of atomic physics and quantum physics.

Learning Outcomes

On the completion of the course, the students will:
The course will introduce modern physics and its applications. Its objectives are as following.

1. Understanding basic principles of relativity.
2. Study the experiments and phenomena that lead to quantum physics.
3. Be able to solve relevant numerical problems.

Course Content

Week 1	Postulates of special relativity, Lorentz transformations
	Derivations of time dilation and length contraction.
Week 2	Twin paradox with examples
	Doppler effect and applications
Week 3	Transformation of velocity and Relativistic Variation of mass
	Relativistic momentum and energy
Week 4	Black body radiation.
	Photo electric effect
Week 5	X-ray, X- ray diffraction.
	Compton effect and Pair production.
Week 6	De Broglie's hypothesis, Davisson-Germer experiment
	Bohr's atomic model, Energy levels and spectra
Week 7	Laser, Heisenberg uncertainty principle
	Superposition principle, Wave packet, Phase, and group velocities. Quantum mechanics: Introduction Schrodinger equation (time dependent and independent).
Week 8	Mid Term Exam
Week 9	A particle in a box, Finite potential well.
	Transmission and reflection by step and barrier potentials.
Week 10	Quantum tunneling and its applications in technology.
	Nuclear Physics: Binding energy, Binding energy per nucleon curve
Week 11	Radioactive decay and its types, Law of radio activity
	Half-life and average life
	Nuclear reaction and its types, Q-value of nuclear reaction

Week 12	Fission and fusion reaction
Week 13	Life cycle of a star
	Elementary particles: Leptons, Hadrons, Quarks
Week 14	Fundamental interactions and Quantum fields
	Introduction to the standard model of particle physics
Week 15	Cosmology and cosmological principles, Hubble law and its application
	History of the universe, formations of stars and galaxies, Cosmic ray microwave background
Week 16	Final Term Exam

Textbooks and Reading Material

1. Physics Vol.1 (4th edition), Halliday and Resnick, *John Wiley and Sons*, *(n.p.)* (1992).
2. Concepts of Modern Physics (6th edition), Arthur Bieser, *McGraw-Hill Higher Education*, *(n.p.)* (1994).
3. Modern Physics Simulation, R. Bigelow, J.R. Hiller, Moloney, *John Wiley and Sons*, *(n.p.)* (1996).
4. Physics Vol.1 (5th edition), Halliday and Resnick, *John Wiley and Sons*, *(n.p.)* (2002).
5. Fundamentals of Physics (5th edition), Halliday and Resnick, *John Wiley and Sons*, *(n.p.)* (2002).
6. Physics for Scientists and Engineers (extended version), P.M. Fishbane, *Prentice-Hall International Editions*, *(n.p.)* (2016).

Teaching Learning Strategies

The instructor is required to make use of Mathematica/Maple/Python to teach the concepts through visualization/antimutation and symbolic/numerical calculations. The students are required to solve a large portion of related exercises/questions/problems of the main textbooks.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce,attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It ismostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development,field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-202	Credit Hours	3
Course Title	**Introduction to Nanomaterials**				

Course Introduction

This course is design to understand (i) the influence of dimensionality of the object at nanoscale on their properties; (ii) size and shape controlled synthesis of nanomaterials and their future applications in industry.

Learning Outcomes

On the completion of the course, the students will:

1. Explain the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nanoscale.
2. Choose appropriate synthesis technique to synthesize quantum nanostructures of desired size, shape and surface properties.
3. Correlate properties of nanostructures with their size, shape and surface characteristics.
4. Appreciate enhanced sensitivity of nanomaterial based sensors and their novel applications in industry.

Course Content

Week 1	Introduction to Nanomaterial. Nanotechnology, Frontier of future-an overview, Length Scales, Variation of physical properties from bulk to thin films to nanomaterials
Week 2	Confinement of electron in 0D, 1D, 2D and 3D systems, Surface to Volume Ratio, Synthesis of Nanomaterials
Week 3	Structure and Bonding in Nanomaterials:Chemical Bonds (types and strength, Intermolecular Forces, Molecular and Crystalline Structures, Hierarchical Structures, Bulk to Surface transition, surface reconstruction, Self-assembly and thermodynamics.
Week 4	Properties and Size dependence of properties Chemical, Optical, vibrational, thermal, Electrical, Magnetic, Mechanical, Theoretical Aspects-e.g.
Week 5	Nanomaterial Synthesis:Bottom-Up approach: Chemical Routes for Synthesis of nanomaterials-Sol-gel
Week 6	Precipitation, Solution Combustion synthesis, Hydrothermal, SILAR, Chemical Bath Deposition.
Week 7	Top-Down approach- Ball milling technique, Sputtering, Laser Ablation.
Week 8	Mid Term
Week 9	Electrochemical methods**,** Vapor growth**,** Thin films methods: chemical vapor deposition,

Week 10	Physical vapor deposition (sputtering, laser ablation), Langmuir-Blodgett growth**,** Mechanical methods: mechanical attrition**,** Sol-gel methods**,**
Week 11	Special nanomaterials: carbon nanotubes, fullerenes, nanowires, porous silicon**,** Bio-inspired synthesis**,** Nanocomposite fabrication
Week 12	Nanomaterial characterization techniques: Scanning and Transmission Electron Microscopy,
Week 13	Scanning Probe Microscopies: Atomic Force
Week 14	Diffraction and scattering techniques
Week 15	Vibrational spectroscopy**,** Surface techniques.
Week 16	Final Term

Textbooks and Reading Material

1. Nanomaterials – Synthesis, Properties and Applications, edited by A.S. Edelstein and R.C. Cammarata, *Institute of Physics Publishing*, *London* (1998).
2. Nanochemistry: A Chemical Approach to Nanomaterials, G. Ozin and A. Arsenault, *RSC Publishing*, *(n.p.)* (2005).
3. Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, Edward L. Wolf, *Wiley-VCH*, *(n.p.)* (2005).
4. Nanoparticles: Workhorses of Nanoscience, edited by Celso De Mello Donega, *Springer*, *(n.p.)* (2024).

Teaching Learning Strategies

1. Course teaching
2. Quiz
3. Presentation
4. Practice

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-203	Credit Hours	3
Course Title	**Biosafety and Biohazard Management**				

Course Introduction

This comprehensive program is designed to equip the students with essential knowledge and practical skills for managing biological risks in a variety of settings. As science and technology continue to advance, the importance of maintaining high standards of biosafety becomes increasingly critical to ensure the protection of human health, the environment, and research integrity.

Learning Outcomes

1. This course is designed to understand how biosafety adhere to personal health and safety practices.
2. How to maintain a clean and organized workspace.
3. Disinfect and dispose of infectious materials. Take appropriate actions following accidental exposure to potentially infectious specimen. Follow written safety procedures and keep proper safety records.

Course Content

Week 1	Risk associated with decontamination
Week 2	Chemical decontaminants Classification
Week 3	Waste Disposal. Risk Control, Methods used to control the risk include: administrative controls, engineering controls, personal, protective equipment, medical surveillance, and facility design
Week 4	Hazardous roles of microbes in the environment
Week 5	Microorganisms as a source of disease and other nuisances
Week 6	Solution to various hazards
Week 7	New trends in monitoring of toxic environmental hazards by microbes
Week 8	Mid Term Exams
Week 9	Biosafety and recombinant DNA technology Safety and the genetic manipulation of organisms
Week 10	Risk assessment in genetic manipulation

Week 11	Deliberate release of deliberate genetically modified microorganisms (GMMOs)
Week 12	Role of genetic modification safety committee
Week 13	Hazard groups of organisms, guidelines for microbial and animal cell cultivation
Week 14	Animal and human cloning
Week 15	Moral, ethical, legal, and patent issues, trade secrets
Week 16	Final Term Exams

Practicals

1. Biosafety Manual preparation with comparison from different developed countries.
2. Creative activity for construction of Biosafety level 2 design and budget.
3. Biohazards associated with each equipment in BSL-2.

Textbooks and Reading Material

1. Laboratory Biosafety Manual, World Health Organization, *World Health Organization, Geneva* (2004).
2. Biological Safety: Principles and Practices, Diane O.F. and Debra L.H., *ASM Press, Washington DC* (2016).
3. High-containment Biosafety Laboratories: Preliminary Observations on the Oversight of the Proliferation of BSL-3 and BSL-4 Laboratories in the United States, United States Government Accountability Office, *CreateSpace Independent Publishing Platform* (2018).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Program	BS BioPhysics & Nano-Biotechnology	Course Code	SSP-301	Credit Hours	3

Course Title	Classical Mechanics

Course Introduction
This course introduces classical mechanics concepts. Historically, a set of core concepts — space, time, mass, force, momentum, torque, and angular momentum — were introduced in classical mechanics in order to solve the most famous physics problem, the motion of the planets.

Learning Outcomes
The course introduces Classical Mechanics at undergraduate level. Its objectives are as following. 1. Solve advance problems of mechanics. 2. Learn different formalism of classical mechanics. 3. Learn basic principles of non-linear dynamics.

Course Content	
Week 1	Review of Newtonian mechanics of a system of particles
Week 2	The Independent Coordinates of a Rigid Body
Week 3	The Euler angles, Rate of Change of a Vector, Rotational Kinetic Energy and Angular Momentum
Week 4	The Inertia Tensor, Euler's Equations of Motion, Motion of a Torque-free Symmetrical Top
Week 5	The Motion of a Heavy Symmetrical Top with One Point Fixed. Lagrange Formalism: Constraints
Week 6	Generalized coordinate
Week 7	D'Alembert Principle and Derivation of Lagrange equations, Lagrange equations for nonholonomic constraints and Lagrange
Week 8	Mid Term Exam
Week 9	Central Force Problem
Week 10	Two body problem and its reduction to one body problem, equation of motion solution of one body problem, Planetary motion and derivation of Kepler's laws
Week 11	Rutherford scattering formula. Hamilton's Formalism: Legendre transformation and Hamilton's equations of motion; Calculus of variation and Hamilton's principle

Week 12	Derivation of Lagrange's equation from Hamilton's principle; Phase space and Liouville's theorem
Week 13	Solution of some elementary problems by Hamilton's Formalism
Week 14	The canonical transformation
Week 15	Poisson bracket. Hamilton-Jacobi theory, Solution of Hamilton-Jacobi DE for some elementary systems
Week 16	Final Term Exam

Textbooks and Reading Material

1. Classical Mechanics (3rd edition), H. Goldstein, *Addison-Wesley* (1950).
2. Classical Mechanics, V.D. Barger and M.G. Olsson, *McGraw-Hill* (1995).
3. Classical Mechanics Simulations, Bruce Hawkins and Randall Jones, *John Wiley & Sons* (1995).
4. Classical Mechanics (2nd edition), T.L. Chow, *John Wiley* (1995).
5. Classical Mechanics (2nd edition), Atam and P. Arya, *Prentice Hall Int. Inc.* (1998).
6. Classical Mechanics (2nd edition), Greiner, *Springer* (2003).
7. Classical Mechanics (3rd edition), John R. Taylor, *University Science Books* (2022).

Teaching Learning Strategies

The instructor is required to make use of examples of the text books and The students are required to solve a large portion of related exercises/questions/problems of the main textbooks.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes Classroomparticipation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. At least fifty percent of the question paper would involve new problems related to the concepts learned in the course. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Program	BS BioPhysics & Nano-Biotechnology	Course Code	BP-301	Credit Hours	3 (2-1)

Course Title	Electronics

Course Introduction
This course is designed to provide the concepts of Semiconductors and their applications. Analysisof basic simple circuits using Ohm's law, Kirchhoff's laws and network theorems Diodes and Diode circuits: diode circuits and characteristics, model, and behavior in relation to the circuits and analysis. Bipolar Junction Transistors (BJT), the physical structure of the BJT, circuit representation, transistor biasing, and transistor ratings. Field Effect Transistors and Circuits: MOSFET characteristics and model, biasing techniques, circuit symbol, analog MOSFET amplifier and Operational Amplifiers.

Learning Outcomes
The course will introduce the basic principles of electronic circuits and electronics. Its objectives are as follows. 1. Understanding the basic principles of electric circuits and electronics. 2. Be able to solve relevant numerical problems.

Course Content	
Week 1	Semiconductors: Classification of conductor, semiconductors, and insulatorsby Energy Band Theory
Week 2	P-type & N-type semiconductorssuch as silicon (Si) or germanium (Ge)
Week 3	Doping, PN junction. Diode theory and Circuit
Week 4	Characteristics of diode, Ideal Diode, Models of diode,
Week 5	Surge current, The Zener diode
Week 6	Optoelectronic devices, The Schottky diode.
Week 7	Bipolar Transistors: PNP and NPN transistors, Characteristics of transistors, Model of transistor, Transistor biasing. Transistor as amplifier: Transistor asvoltage, current and power amplifier.

Week 8	Mid Term Exam
Week 9	Field-Effect transistors: The JFET, The biased JFET, Characteristics of JFET,FET circuits. Frequency effects: Frequency response of an amplifier, Miller's theorem, High Frequency FET analysis.
Week 10	OP-AMP: OP-AMP theory, OP-AMP negative feedback,
Week 11	Linear OP-AMP circuits, Non- linear OP-AMP circuits.
Week 12	Applications of common diodes
Week 13	Transformers and power supply, Half-wave rectifiers
Week 14	Full-wave rectifiers, full-wave Bridge rectifiers,
Week 15	Wave shaping circuits using diode, Voltage multiplier circuits
Week 16	Final Term Exam

Practicals

Characteristics of a semiconductor Diode. To construct a power supply and study the rectified wave form, ripplefactor and regulation (without regulator). To construct a voltage-regulated power supply with Zener diode. Characteristics of Transistors. To construct a single stage CE transistor voltage amplifier and study gain, input impedance, output impedance, Half power points by sine/square wave testing and effect of bias on theoutput and measurement of distortion. To construct a source follower FET voltage amplifier. Study its gain, input impedance, output impedance, half power points bysine/square wave testing. To construct an R-C oscillator and compare it with a standard frequency. To construct a Hartley or Colpitts oscillator and measure it frequency. To construct and study the wave forms at the base and collector of thetransistors of a free running a multi-vibrator. To construct and study of the height, duration and time period of the output pulses in amono-stable and bi-stable multi-vibrator with reference to theinput trigger. To construct from discrete components OR, AND, NOT and NANDcircuits and verify their truth tables. NOR, exclusive OR circuits and verify their truth tables. Study of wave shaping circuits of diode, integrators and differentiators. To construct the operational amplifier (741) by using discrete componentsand study its frequency response.

Textbooks and Reading Material

1. Electronics Circuits and Systems, J.D. Ryder, *Englewood Cliffs* (1976).
2. Electronics Devices, T.L. Floyd, *Prentice-Hall* (1996).
3. Electronic Devices and Circuit Theory, Boylestad and Nashelsky, *Prentice-Hall* (1997).
4. Electronic Principles (8th edition), Paul Malvino, *McGraw-Hill International* (2015).
5. Microelectronic Circuits (8th edition), Adel S. Sedra and Kenneth C. Smith, *Oxford University Press* (2020).
6. Foundations of Analog and Digital Electronic Circuits, Anant Agarwal and Jeffrey H. Lang, *Morgan Kaufmann* (2021).

Teaching Learning Strategies

The instructor is required to make use of examples of the text books and The students are required to solve a large portion of related exercises/questions/problems of the main textbooks.

Assessment			
Sr. No.	**Elements**	**Weightage**	**Details**
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes Classroomparticipation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester.At least fifty percent of the question paper would involve new problems related to the concepts learned in the course. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Program	BS BioPhysics & Nano-Biotechnology	Course Code	SSP-304	Credit Hours	3

Course Title	Basic Solid State Physics

Course Introduction

Solid State Physics is a major branch of Condensed Matter Physics and provides a theoretical basis to Material science. The course will provide a valuable introduction to Solid State Physics and an overview of crystal structure. The course not only will equip the students with the theoretical knowledge of crystal structure determination methods, but students will also learn X- ray diffraction, Neutron Diffraction, and Electron Diffraction experimental techniques as well. Inaddition, students will also get comprehensive knowledge about atomic bonding and the elastic behavior of the crystal lattice.

Learning Outcomes

With the completion of the course, students will be able to:

1. Understanding the basic theme of Solid State Physics
2. Theoretical knowledge of the Crystal Structure
3. Learning the Experimental techniques to determine the crystal structure
4. Knowledge of atomic bonding in Solids and elastic behavior of crystal lattices

Course Content

Week 1	Introduction to Condensed Matter Physics/Solid State Physics and its relation with materials Science. Why do we study Solid State Physics? Relationship of Solid State Physics to Other Areas
Week 2	Crystal Structure: Periodic arrays of atoms Fundamental types of lattices Index system for crystal planes Simple crystal structures
Week 3	Direct imaging of atomic structure; Non-ideal crystal structure; Random Stacking and Polytypism
Week 4	Reciprocal Lattice: Diffraction of waves by crystals Scattered wave amplitude; Brillouin zones
Week 5	Fourier analysis of the basis
Week 6	Crystal Binding and Elastic Constants: Crystal of Inert Gases
Week 7	Ionic Crystals; Covalent crystals; Metals; Hydrogen Bonds, Atomic Radii; Analysis of elastic strains

Week 8	Mid Term Exam
Week 9	Elastic compliance and stiffness constants; Elastic waves in cubic crystal
Week 10	Crystal Vibrations: Vibrations of crystals with a monatomic basis
Week 11	Two atoms per primitive basis; Quantization of elastic waves
Week 12	Thermal properties, Lattice heat capacity,
Week 13	Classical model, Einstein Model, Debye model,
Week 14	The thermal conductivity and resistivity, Umklapp processes
Week 15	Introduction to Crystal Defects, Point defects (Frenkel defects, Schottky defects, impurity defects), Line defects.
Week 16	Final Term Exam

Textbooks and Reading Material

1. Introduction to Solid State Physics (7th edition), C. Kittel, *John Wiley & Sons, Inc.* (1996).
2. Solid State Physics, J. S. Blakemore, *Cambridge University Press* (1991).
3. Solid State Physics Simulations, Steven Spicklemire, *John Wiley & Sons* (1996).
4. Solid State Physics, Neil W. Ashcroft and N. D. Mermin, *Thomson Press (India)* (2003).
5. Solid State Physics (2nd edition), G. Grosso and G. P. Parravicini, *Academic Press* (2013).

Teaching Learning Strategies

The instructor is required to make use of visualization/animations and symbolic/numerical calculations to teach the concepts. The students are required to solve a large portion of related exercises/questions/problems of the main textbooks.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.

3.	Final Assessment	40%	Written Examination at the end of the semester. At least fifty percent of the question paper would involve new problems related to the concepts learned in the course. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-302	Credit Hours	3 (2-1)
Course Title	**General Genetics**				

Course Introduction

"General Genetics," is designed to introduce students to the principles and applications of genetics. This course offers a comprehensive exploration of how genetic information is inherited, expressed, and manipulated. This course will provide the students with a solid grounding in genetic principles and their practical implications.

Learning Outcomes

On the completion of the course, the students will be able to understand

1. Basic and general principles of genetics
2. Chromosome transmission to predict patterns of inheritance
3. DNA structure, replication, mutation, repair, genetic code, sex linkage and inheritance

Course Content

Week 1	Introduction and History of Genetics
Week 2	Heredity and variation
Week 3	Chromosomal theory of inheritance
Week 4	Mendel's laws of inheritance
Week 5	Gene interaction; genotypic and phenotypic ratios
Week 6	Multiple alleles, Multiple factor hypothesis and use of binomial theorem
Week 7	Linkage and crossing over, gene mapping
Week 8	Mid Term Exams
Week 9	Sex determination and sex linked inheritance
Week 10-11	Chromosome mutations and repair
Week 12	Genetic code
Week 13	Extra–nuclearinheritance: maternal effects and maternal inheritance
Week 14	Qualitative inheritance
Week 15	Quantitative inheritance

Week 16	Final Term Exams

Textbooks and Reading Material

1. Genetics (3rd edition), W. M. Strickberger, *Macmillan Publishing Co.* (2001).
2. Essentials of Genetics (3rd edition), D. L. Hartl and E. W. Jones, *Jones and Bartlett Publishers* (2002).
3. Principles of Genetics (7th edition), R. H. Tamarin, *McGraw-Hill Science* (2004).
4. Gene-Environment Interactions: Fundamentals of Ecogenetics, L. G. Costa and D. L. Eaton, *John Wiley and Sons* (2006).
5. Genetics of Population (4th edition), P. W. Hedrick, *Jones and Bartlett Publishers* (2010).
6. Principles of Genetics (6th edition), D. P. Snustad and M. J. Simmons, *John Wiley and Sons* (2011).
7. Introduction to Genetic Analysis (12th edition), A. J. F. Griffiths, J. Doebley, C. Peichel and D. A. Wasserman, *W. H. Freeman and Company* (2015).
8. Genetics: A Conceptual Approach (7th edition), B. A. Pierce, *W. H. Freeman and Company* (2017).
9. Essentials of Genetics (10th edition), W. S. Klug, M. R. Cummings, C. A. Spencer and M. A. Palladino, *Prentice Hall* (2021).
10. Genetics: Analysis and Principles (6th edition), R. J. Brooker, *McGraw-Hill Book Co.* (2021).

Practicals

Laboratory techniques to study different methods of sterilization of bacterial culture media, Cultivation of bacteria on complex, selective, and differential media, Methods for the isolation of pure microbial cultures from soil and water, Staining techniques, simple staining, Gram's staining, negative staining, endospore and capsule staining, biochemical characterization of bacteria.

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.

3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-303	Credit Hours	3
Course Title	**Ecology and Ecosystem**				

Course Introduction

The "Ecology and Ecosystem" course is designed to introduce students to the fundamental principles of ecology and the complex interactions within ecosystems. This course explores the relationships between organisms and their environments, the dynamics of ecosystems, and the impact of human activities on ecological balance. Through a combination of theoretical knowledge and practical experience, students will gain insights into ecological processes, biodiversity, and conservation strategies.

Learning Outcomes

On the completion of the course, the students will be able to:

1. Become familiar with the interactions of organisms with the physical and the biological environment.
2. Understand the workings of ecological systems at different spatial and temporal scales.
3. Apprehend how human survival depends upon the resources and benefits provided by natural ecosystems.
4. Explore how human activities can negatively affect natural ecosystems.

Course Content

Week 1	Distribution and activities of microorganisms in natural systems
Week 2	role of bacteria in elemental cycles and plant microbe-interaction
Week 3	relationship between physical and ecological attributes of microorganisms
Week 4	Development and interaction of microbial communities with their living and abiotic environment with specific reference to air, soil, water
Week 5	Microbial role in global carbon cycle
Week 6	Biodegradation of environmentally significant materials
Week 7	Techniques to study microbial ecology
Week 8	Mid Term Exams
Week 9	Concept, structure and components of Ecosystem
Week 10	Energy flow in ecosystems and energy transformation in nature
Week 11	Food chain, Food webs, Food cycle, Trophic levels, Ecological pyramids
Week 12	Biogeochemical cycles (carbon, nitrogen, phosphorus)
Week 13	Productivity of ecosystems

Week 14	Impact of man on ecosystem
Week 15	Fundamental of population ecology
Week 16	Final Term Exams

Textbooks and Reading Material

1. Microbial Ecology, Larry L. B. and Dian E. W., *Wiley Blackwell* (2011).
2. Ecology: Concepts and Application, Manuel M., *McGraw-Hill Science* (2012).
3. Biology: The Unity and Diversity of Life (15th edition), Starr C., Taggart R., Evers C. and Starr L., *Wadsworth Publishing Company* (2015).
4. Environmental Science: A Study of Interrelationships, Enger E. D. and Smith B. F., *McGraw Hill Education* (2016).
5. Ecosystem Ecology: A New Synthesis, David G. R. and Christopher L. J. F., *Cambridge University Press* (2017).
6. Marine Animal Forests: The Ecology of Benthic Biodiversity Hotspots, Rossi S., Bramanti L., Gori A. and Orejas S. V. C., *Springer* (2017).
7. Fundamentals of Ecosystem Science (2nd edition), Weathers K. C., Strayer D. L. and Likens G. E., *Academic Press* (2021).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Program	BS BioPhysics & Nano-Biotechnology	Course Code	SSP-307	Credit Hours	3
Course Title	**Quantum Mechanics**				

Course Introduction

Quantum Mechanics is the part of modern physics that is essential for understanding microscopic processes involving atoms, molecules, subatomic particles, etc. This course teaches why the classical physics is insufficient for this purpose, but how its wave and particle concepts combine in a way to result in quantum mechanics. After introducing some further mathematical tools, the postulates of quantum are introduced and used for solving some one-dimensional problems. The course ends with introducing raising and lower operators for the simple harmonic oscillator and angular momentum.

Learning Outcomes

On the completion of the course, the students will:

1. Understand the fundament principles of Quantum Mechanics,
2. Be able to solve basic problems of quantum mechanics in 1D
3. Learn raising and lowering operator, and
4. Learn theory of angular momentum in quantum mechanics

Course Content

Week 1	Visible effects of a moving ball, a bullet, light waves (and an electron).
	Wave equation, wave function, probability density and probability.
Week 2	Measurement of probability. Explaining brightness pattern by classical and quantum (i.e., probability) theory of light.
	Double slit electron beam experiment; a quantum particle in motion and in detection.
Week 3	Wavefunction collapse. Normalization and localization of a wavefunction
	A wave-packet. Fourier transform. Gaussian integral.
Week 4	The de Broglie relation and quantization in the Bohr model.
	The Heisenberg uncertainty principle.
Week 5	The group velocity and phase velocities of a wave packet.
	A wave-vector relating all wavefunctions. The Dirac notation.
Week 6	Orthonormal basis; the Dirac delta function.
	Operator and their representations.

Week 7	The momentum operator in position representation. The Hermitian operator, eigenvalues, and related theorems.
	Commuting operators and common eigenvectors. The parity operator. An even operator.
Week 8	Mid Term Exam
Week 9	Postulates of quantum mechanics.
	Schrodinger equations; stationary states.
Week 10	Expectation value; probability current.
	One dimensional systems: A free particle. A travelling wave.
Week 11	The potential step.
	The potential barrier. Tunneling.
Week 12	Alpha decay and tunneling.
	An infinite square well.
Week 13	Bound states and nodes.
	Ther harmonic oscillator.
Week 14	Raising and Lowering operators. SHO energies and wavefunctions.
	General angular momentum.
Week 15	The commuting set ($\hat{J}^2$and $\hat{J}_z$) and comm eigenvectors. The raising and lowering. Orbital angular momentum.
	Spherical harmonics. Spin angular momentum; the Stern-Gerlach experiment. The matrix representation of spin half. Pauli spin matrices.
Week 16	Final Term Exam

Textbooks and Reading Material

1. Understanding Quantum Physics Vol. I & II, M. A. Morison, *Prentice Hall Inc.* (1990).
2. A Text Book of Quantum Mechanics, Mathew P. M. and Venketeson K., *Tata McGraw Hill, New Delhi* (1991).
3. Quantum Mechanics, Gasiorowicz and Stephen, *John Wiley & Sons, New York* (1996).
4. Introductory Quantum Mechanics (4th edition), Liboff Richard L., *Pearson Education, New Delhi* (2003).
5. Quantum Mechanics: Concepts and Applications (2nd edition), Zettili, *John Wiley & Sons* (2009).
6. Introduction to Quantum Mechanics, Griffiths David J., *Pearson Education, New Delhi* (2014).

Teaching Learning Strategies
The instructor is required to make use of Mathematica/Maple/Python to teach the concepts through visualization/antimutation and symbolic/numerical calculations. The students are required to solve a large portion of related exercises/questions/problems of the main textbooks.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-304	Credit Hours	3 (2-1)
Course Title	**Molecular Biology**				

Course Introduction

This BS course in Molecular Biology offers a comprehensive exploration of the fundamental concepts and techniques that define the field. Beginning with an introduction and a brief history of molecular biology, the course provides an in-depth study of the molecular tools used to analyze genes and gene activity. Students will explore the transcriptional machinery of both prokaryotes and eukaryotes, delving into the intricacies of operon regulation, RNA polymerases, and the roles of general transcription factors and activators. The course also covers key post-transcriptional modifications, including splicing, capping, and polyadenylation, which are crucial for RNA processing. Additionally, the molecular mechanisms underlying translation and DNA replication are examined, along with the processes of homologous and site-specific recombination. This curriculum is designed to equip students with both theoretical knowledge and practical skills,
preparing them for advanced studies and careers in molecular biology and related fields.

Learning Outcomes

On the completion of the course, the students will be able to:

1. Understand the Historical and Conceptual Foundations of Molecular Biology
2. Master Molecular Tools and Techniques
3. Comprehend the Mechanisms of Transcription and Translation in Prokaryotes and Eukaryotes
4. Explore Post-Transcriptional Modifications and RNA Processing

Course Content

Week 1	Introduction and a brief history of Molecular Biology
Week 2-3	Methods in Molecular Biology, including molecular tools for studying gene and gene activity
Week 4-5	The transcription apparatus of prokaryotes, operons: fine control of prokaryotic transcription
Week 6	Eukaryotic RNA polymerases and their promoters
Week 7	General transcription factors in eukaryotes
Week 8	Mid Term Exams
Week 9	transcription activators
Week 10	Posttranscriptional events I, II, III
Week 11-12	Splicing, Capping, Polyadenylation, RNA processin
Week 13-14	The Mechanism of translation I, II
Week 15	DNA replication I, II, Homologous and Site-specific recombination.

Week 16	Final Term Exam

Practicals

Calculations and practice of making solutions/buffers, Isolation of DNA from bacteria (Heat lysis, CTAB, SDS methods), Miniprep/alkaline lysis Plasmid Isolation, extraction of DNA from blood, Saliva, Hair, fruit (banana or strawberry), plant (leaves, roots), yeast, Horizontal and vertical Gel electrophoresis, Preparation of loading dye, Polymerase chain reaction, Restriction digestion

Textbooks and Reading Materials

1. Molecular Cloning: A Laboratory Manual – Sambrook, J., Fritsch, E. F., & Maniatis, T., *Cold Spring Harbor Laboratory Press* (2012).
2. Essential Cell Biology – Alberts, B., *Garland Science* (2013).
3. Molecular Biology of the Cell – Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P., *Garland Science* (2015).
4. Molecular Biology – Weaver, R. F., *McGraw-Hill Education* (2018).
5. Genomes 4 – Brown, T. A., *Garland Science* (2018).
6. The Cell: A Molecular Approach – Cooper, G. M., *Oxford University Press* (2019).
7. Molecular Biology: Principles and Practice – Cox, M. M., Doudna, J. A., & O'Donnell, M., *Macmillan Learning* (2020).
8. Molecular Genetics of Bacteria – Snyder, L., Peters, J. E., Henkin, T. M., & Champness, W., *ASM Press* (2020).
9. Molecular Biology Techniques: A Classroom Laboratory Manual – Miller, H., Witherow, D. S., & Haro von Mogel, K. J., *Academic Press* (2020).
10. Short Protocols in Molecular Biology – Ausubel, F. M., Brent, R., Kingston, R. E., Moore, D. D., Seidman, J. G., Smith, J. A., & Struhl, K., *John Wiley & Sons* (2020).
11. Molecular Biology of the Cell – Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P., *Garland Science (Taylor and Francis)* (2022).

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on activities, short tests, projects, practicals, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, fieldwork , report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology y	Course Code	BP-305	Credit Hours	3
Course Title	**Bionanomaterials**				

Course Introduction

This course introduces students to the interdisciplinary field of bionanomaterials, focusing on the synthesis, properties, and applications of nanomaterials in biological systems. It covers the design and fabrication of nanomaterials, their interaction with biological molecules, and their applications in medicine, diagnostics, and biotechnology.

Learning Outcomes

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

1. Understand the fundamental principles of nanomaterials and their relevance to biological systems.
2. Explore various methods for the synthesis and characterization of bionanomaterials.
3. Examine the interaction of nanomaterials with biological molecules and cells.
4. Investigate the applications of bionanomaterials in drug delivery, tissue engineering, diagnostics, and biosensing.
5. Discuss the ethical, environmental, and safety considerations in the development and use of bionanomaterials.

Course Content

Week 1	Introduction to Bionanomaterials Definition and scope of bionanomaterials, Historical development and key milestones, Historical development and key milestones
Week 2	Basic Concepts in Nanotechnology Nanomaterials: types, properties, and classification
Week 3	Synthesis methods: top-down vs. bottom-up approaches Characterization techniques: electron microscopy, atomic force microscopy, spectroscopy
Week 4	Biological Molecules and Systems Structure and function of proteins, nucleic acids, lipids, and carbohydrates, Cellular structures and their interactions with nanomaterials, Biocompatibility and bioinspired materials
Week 5	Synthesis of Bionanomaterials, Chemical synthesis methods (e.g., sol-gel, hydrothermal), Biological synthesis methods (e.g., biomineralization, microbial synthesis)
Week 6	Self-assembly of nanostructures Surface modification and functionalization
Week 7	Properties and Characterization of Bionanomaterials Physical, chemical, and mechanical properties, Optical and electronic properties

Week 8	Mid Term Exams
Week 9	Surface properties and interactions with biological environments Analytical techniques for characterization
Week 10	Interaction of Nanomaterials with Biological Systems Nanoparticle-protein interactions (protein corona)
Week 11	Cellular uptake and trafficking of nanoparticles Cytotoxicity, immunogenicity, and biocompatibility In vivo behavior and biodistribution
Week 12	Applications in Drug Delivery, Nanocarriers for targeted drug delivery, Controlled release systems, Nanomaterials in gene therapy, Case studies: liposomes, dendrimers, and polymeric nanoparticles
Week 13	Tissue Engineering and Regenerative Medicine Nanomaterials in scaffold design, Nanocomposites for tissue regeneration, Nanofibers and hydrogels in tissue engineering, Applications in bone, cartilage, and neural tissue engineering
Week 14	Nanodiagnostics and Biosensing, Nanoparticles in molecular imaging, Quantum dots and magnetic nanoparticles for diagnostics, Biosensors and lab-on-a-chip technologies, Point-of-care diagnostics using nanomaterials
Week 15	Environmental and Ethical Considerations, Environmental impact of nanomaterials, Ethical and societal implications of nanotechnology, Safety regulations and guidelines for nanomaterials, Case studies on environmental and health risks Future Trends in Bionanomaterials, Emerging technologies and innovations Personalized medicine and nanotechnology, Nanorobotics and artificial cells, Industrial and commercial applications
Week 16	Final Term Exams

Textbooks and Reading Material

1. Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer and Chad A. Mirkin, *Wiley-VCH* (2004).
2. Bionanotechnology: Lessons from Nature, David S. Goodsell, *Wiley-Liss* (2004).
3. Introduction to Nanomedicine and Nanobioengineering, Paras N. Prasad, *Wiley* (2012).
4. Nanoparticle Technology Handbook, Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama (Eds.), *Elsevier* (2012).
5. Nanotechnology in Drug Delivery, Melgardt M. de Villiers, Pornanong Aramwit, and Glen S. Kwon, *Springer* (2014).
6. Bionanotechnology: Biological Self-assembly and Its Applications, Yi Ge, Qun Wang, and Yubing Xie, *Springer* (2015).
7. Biomedical Nanomaterials: From Design to Implementation, Naik Rangaprasad Arun and Gopalan Ravindra (Eds.), *Elsevier* (2016).
8. Nanotechnology: Principles and Practices, Sulabha K. Kulkarni, *Springer* (2016).

9. Nanomaterials and Biomedicine – Therapeutic and Diagnostic Approach, E. R. Banerjee (Ed.), *Springer* (2020).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	SSP-402	Credit Hours	3
Course Title	**Atomic and Molecular Physics**				

Course Introduction

This course is designed to:

1. Review the existing theories of atomic structure
2. Introduce the experimental proof of quantization
3. Introduce the use of Schrodinger Equation in real system like Hydrogen atom
4. Understand the Molecular spectrum

Learning Outcomes

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

1. Describe the atomic spectra of one and two valance electron atoms.
2. Explain the change in behavior of atoms in external applied electric and magnetic field.
3. Explain rotational, vibrational, electronic and Raman spectra of molecules.
4. Describe electron spin and nuclear magnetic resonance spectroscopy and their applications.

Course Content

Week 1	Structure of Atoms, Review of Bohr's theory.
Week 2	Sommerfeld model
Week 3	Frank Hertz experiment and approximation methods
Week 4	One Electron System Review of Schrodinger equation for hydrogen atom
Week 5	Fermi Golden rule, Quantum numbers, Atoms in radiation field
Week 6	Radiative transitions, Einstein coefficients, Selection rules, normal Zeeman effect, Hyperfine structure.
Week 7	Many body Systems Pauli exclusion principle, Periodic system of the elements
Week 8	Mid Term Exams
Week 9	Stern Gerlach experiment, Spin orbit coupling, Central field approximation
Week 10	Hartree Fock methods and self-consistent field

Week 11	Thomas Fermi potential, LS coupling, jj coupling and other type of coupling, X-ray spectra.
Week 12	Interaction with field, Many electron atoms in an electromagnetic field, Anomalous Zeeman effect, Paschen back effect, Stark effect
Week 13	Molecules, Ionic and covalent bonding, Diatomic molecules-rotational, vibrational, and electronic spectra
Week 14	Born Oppenhimer approximation, Transition probabilities of diatomic molecules, electron spin and Hund's cases, Polyatomic molecules (brief introduction)
Week 15	Raman effect, Hydrogen Molecular ion (LCAO approximation), Hydrogen molecule (Heitler London and molecular orbital theories)
Week 16	Final Term Exams

Textbooks and Reading Material

1. Physics of Atomic and Molecules, B. H. Bransden and C. J. Joachain, *Longmans, London* (1983).
2. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles (2nd edition), R. Eisberg and R. Resnick, *John Wiley and Sons* (1985).
3. Spectrophysics (2nd edition), Anne P. Thorn, *Chapman and Hall* (1988).
4. Modern Atomic and Molecular Physics, H. Kopfermann, *Taylor & Francis* (2009).
5. Quantum Mechanics: Concepts and Applications (4th edition), N. Zettili, *John Wiley & Sons* (2014).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
4.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
5.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
6.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-401	Credit Hours	3 (2-1)
Course Title	**Biophysical Techniques in Research**				

Course Introduction

This course introduces students to essential experimental techniques in biophysics, including spectroscopy, microscopy, and imaging methods. Emphasis is placed on the principles, applications, and data analysis associated with each technique. The course aims to equip students with a practical understanding of how these techniques are used to investigate biological systems.

Learning Outcomes

By the end of this course, students should be able to:

1. Describe the principles and applications of key biophysical techniques.
2. Perform basic experiments or simulations with selected techniques.
3. Analyze and interpret data from biophysical experiments.
4. Understand the use of various tools in addressing biological research questions.

Course Content

Week 1	Overview of biophysical techniques and their role in biological research. Basic concepts: resolution, sensitivity, and specificity.
Week 2	Basic concepts: resolution, sensitivity, and specificity.
Week 3	Principles of UV-Vis and fluorescence spectroscopy.
Week 4	Applications in protein and nucleic acid analysis, including concentration and conformational studies.
Week 5	Principles of circular dichroism (CD) for studying protein secondary structure.
Week 6	Basics of Nuclear Magnetic Resonance (NMR) spectroscopy for structure elucidation.
Week 7	Light microscopy (brightfield, phase contrast, fluorescence).
Week 8	Mid Term Exams
Week 9	Advanced imaging: confocal microscopy, atomic force microscopy (AFM).
Week 10	Light microscopy (brightfield, phase contrast, fluorescence).

	Advanced imaging: confocal microscopy, atomic force microscopy (AFM).
Week 11	Principles of X-ray crystallography and Cryo-EM for high-resolution structure determination. Sample preparation, data collection, and structural analysis.
Week 12	Basics of mass spectrometry and its application in proteomics and biomolecule identification.
Week 13	Techniques like optical tweezers, single-molecule fluorescence, and patch-clamp electrophysiology. Applications in studying molecular interactions and mechanics at the single-molecule level. Electromyography: Basic Principles, Clinical Applications
Week 14	Electroencephalography: Basic Principles, Clinical Applications, Basic data processing and analysis for biophysical techniques. Introduction to relevant software tools (e.g., ImageJ, PyMOL, or spectroscopy data analysis software).
Week 15	Project: Choose a biophysical technique covered in the course, conduct a small project (conceptual or data-driven), and present findings.
Week 16	Final Term Exams

Practicals

Nuclear Magnetic Resonance (NMR) spectroscopy for structure elucidation. Advanced imaging: confocal microscopy, atomic force microscopy (AFM). Simulate crystal structure analysis or visualize Cryo-EM datasets (software-based exercise). Analyze simulated mass spectrometry data to identify proteins or peptides. Simulation or data analysis of single-molecule experiments (e.g., single-molecule FRET). Practice data analysis using a software tool on provided datasets. Sample preparation, data collection, and structural analysis. Use of various tools (e.g., ImageJ, PyMOL, or spectroscopy data analysis software).

Textbooks and Reading Material

1. Principles and Techniques of Biochemistry and Molecular Biology, Keith Wilson and John Walker, *Cambridge University Press* (2010).
2. Physical Biology of the Cell, Rob Phillips, Jane Kondev, Julie Theriot, and Hernan Garcia, *Garland Science* (2012).
3. Niedermeyer's Electroencephalography: Basic Principles, Clinical Applications, and Related Fields, 7th Edition, D. L. Schomer (Editor), F L da Silva (Editor), Oxford University Press (2017).
4. Electromyography in Clinical Practice, B Katirji, 3rd Edition, Oxford University Press (2018)
5. Biophysical Techniques, Iain Campbell, *Oxford University Press* (2017).

Teaching Learning Strategies			
4. Course Teaching 5. Presentations 6. Quiz			
Assessment			
Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-411	Credit Hours	3
Course Title	**Structural Biophysics**				

Course Introduction

The object of this course is that the student could appreciate the function of various bio-medical instruments built on the basics of bio-physical principles.

Learning Outcomes

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

1. Apply the principles of physical sciences to understand and
2. Solve biological complexities.
3. Using the knowledge gained during the course, students should be able to address the academic and industrial research problems.

Course Content

Week 1	Sound: Hearing and Echolocation, Ultrasound
Week 2	Optics of Vision: Quantum Nature of Vision
Week 3	Nervous system: Biophysics of Neural Spike
Week 4	Information theory and Memory; Nervous system.
Week 5	Structural Biophysics: Conformational analysis and forces that determine protein and nucleic acid structure.
Week 6	Radiation and Radiobiology: Interaction of radiation with matter
Week 7	Biological effects of radiation, radiobiological effects of radiation,
Week 8	Mid Term Exams
Week 9	Biopotentials: Electrocardiograms and electric shocks
Week 10	Fundamental laws for current in biological tissues, Biopotentials in hearts, electrocardiogram,
Week 11	Bioenergetics: Thermodynamic principles

Week 12	First law (energy, enthalpy), Second law of Thermodynamics. Free energy, standard physical free energy and standard biological free energy
Week 13	Determination of the free energy from equilibrium constant and EMF measurements.
Week 14	Thermodynamics of phosphate compounds (phosphate transfer reactions) and role of ATP for biological energy transfer, thermodynamics of life.
Week 15	Energy Pathways: Coupled Reactions, Group Transfer Potential, Role of Pyridine Nucleotides, Energy Conversion Pathways, Biological Membrane, Active Transport, Chemiosmotic theory-passive transport
Week 16	Final Term Exams

Textbooks and Reading Material

1. Biophysics, Christaan Sybesma, *Kluwer Academic Publishers* (1999).
2. Computational Biochemistry and Biophysics, Becker, Oren M., *Marcel Dekker* (2001).
3. Physics in Biology & Medicine (3rd Edition), Paul Davidovits, *Academic Press* (2007).
4. Biophysics, V. Pattabhi and N. Gautham, *Narosa Publishing House* (2010).
5. Physics of Bio-Molecules and Cells, Henrik Flyvbjerg (Ed.), *Springer* (2012).
6. Forces, Growth and Form in Soft Condensed Matter: At the Interface between Physics and Biology, A. T. Skjeltorp and A. V. Belushkin (Eds.), *NATO Science Series II* (2015).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-403	Credit Hours	3(2-1)
Course Title	**Nanomaterials in Medicine**				

Course Introduction

This course provides an introduction to nanomaterials and their applications in medicine, including drug delivery, diagnostics, imaging, and tissue engineering. Students will learn about the types of nanomaterials used in healthcare, how they interact with biological systems, and the regulatory and ethical considerations involved.

Learning Outcomes

By the end of this course, students should be able to:

1. Describe different types of nanomaterials and their unique properties.
2. Explain how nanomaterials are used in drug delivery, imaging, and regenerative medicine.
3. Identify and analyze key safety, regulatory, and ethical issues surrounding nanomedicine.
4. Conduct basic experiments or case studies related to nanomaterials in medical applications.

Course Content

Week 1	Basics of nanotechnology and its evolution in medicine. Types of nanomaterials: nanoparticles, liposomes, dendrimers, quantum dots, and nanofibers.
Week 2	Basics of nanotechnology and its evolution in medicine. Types of nanomaterials: nanoparticles, liposomes, dendrimers, quantum dots, and nanofibers.
Week 3	Types of nanocarriers (liposomes, polymeric nanoparticles, lipid nanoparticles) and their properties. Mechanisms of drug loading, release, and targeting. Case studies: Nanoparticle-based cancer therapies.
Week 4	Types of nanocarriers (liposomes, polymeric nanoparticles, lipid nanoparticles) and their properties. Mechanisms of drug loading, release, and targeting. Case studies: Nanoparticle-based cancer therapies.
Week 5	Imaging agents (quantum dots, gold nanoparticles, superparamagnetic nanoparticles). Applications in MRI, PET, and fluorescence imaging.
Week 6	Imaging agents (quantum dots, gold nanoparticles, superparamagnetic nanoparticles). Applications in MRI, PET, and fluorescence imaging.
Week 7	Scaffold materials (nanofibers, hydrogels) and their role in tissue engineering. Cell-nanomaterial interactions and biocompatibility.
Week 8	Mid Term Exams

Week 9	Scaffold materials (nanofibers, hydrogels) and their role in tissue engineering. Cell-nanomaterial interactions and biocompatibility.
Week 10	Surface chemistry for targeting and biocompatibility. Techniques for functionalizing nanoparticles (PEGylation, antibody conjugation).
Week 11	Surface chemistry for targeting and biocompatibility. Techniques for functionalizing nanoparticles (PEGylation, antibody conjugation).
Week 12	Assessing the safety of nanomaterials in biological systems. In vitro and in vivo toxicology testing, immune response, and long-term safety.
Week 13	Regulatory pathways for nanomedicines (FDA, EMA requirements). Ethical implications, patient consent, and environmental impacts.
Week 14	Recent advances in nanomedicine (e.g., mRNA vaccines, nanorobots). Potential future applications and innovations in nanomedicine.
Week 15	**Project:** Students select a specific application of nanomaterials in medicine (e.g., targeted cancer therapy, regenerative medicine) and develop a concept or review of the current technology.
Week 16	Final Term Exams

PRACTICALS

Evaluate case studies of nanotoxicity in drug delivery or imaging applications. Case study discussions on clinical trials and regulatory approvals for specific nanomedicine products.

Textbooks and Reading Material

1. Nanomedicine, Volume IIA: Biocompatibility, Robert A. Freitas Jr., *Landes Bioscience* (2006).
2. Nanotechnology in Drug Delivery, Melgardt M. de Villiers, Pornanong Aramwit, and Glen S. Kwon, *Springer* (2014).
3. Nanomaterials for Medical Applications, Arshi Malik, Pooja Goyal, and Susheel Kalia (Eds.), *Elsevier* (2019).
4. Nanomedicine and Nanobiotechnology: Drug Delivery and Targeting, Tuan Vo-Dinh, *Wiley* (2021).

Teaching Learning Strategies

1.Course Teaching
2.Presentations
3.Quiz

Assessment

Sr. No.	Elements	Weightage	Details

4.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
5.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
6.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-404	Credit Hours	3 (2-1))
Course Title	**Biosensors and Bioelectronics**				

Course Introduction

This course introduces the fundamental principles of biosensors, the types of biorecognition elements, electronic transduction mechanisms, and practical applications in various fields, including healthcare and environmental monitoring. Students will gain theoretical knowledge and practical skills in designing and testing biosensors.

Learning Outcomes

By the end of this course, students should be able to:

1. Identify and describe the main components and functions of biosensors.
2. Explain different types of bioreceptors and transducers used in biosensing applications.
3. Design a basic biosensor setup and understand signal processing for biosensing.
4. Recognize applications, ethical concerns, and regulatory standards relevant to biosensors.

Course Content

Week 1	Overview of biosensors: history, importance, and applications. Basic components: biorecognition elements, transducers, and signal processors.
Week 2	Overview of biosensors: history, importance, and applications. Basic components: biorecognition elements, transducers, and signal processors.
Week 3	Types of bioreceptors: enzymes, antibodies, nucleic acids, and whole cells. Mechanisms of interaction with analytes.
Week 4	Types of bioreceptors: enzymes, antibodies, nucleic acids, and whole cells. Mechanisms of interaction with analytes.
Week 5	Transduction types: electrochemical (potentiometric, amperometric), optical, and piezoelectric. Basic electronic principles relevant to signal transduction.
Week 6	Transduction types: electrochemical (potentiometric, amperometric), optical, and piezoelectric. Basic electronic principles relevant to signal transduction.
Week 7	Transduction types: electrochemical (potentiometric, amperometric), optical, and piezoelectric. Basic electronic principles relevant to signal transduction.
Week 8	Mid Term Exams
Week 9	Introduction to signal processing, amplification, and noise reduction Importance of sensitivity, selectivity, and stability in biosensors.
Week 10	Introduction to signal processing, amplification, and noise reduction.

	Importance of sensitivity, selectivity, and stability in biosensors.
Week 11	Key applications: glucose monitoring, environmental detection, point-of-care diagnostics. Case studies of commonly used biosensors (e.g., glucose biosensors, COVID-19 rapid tests).
Week 12	Key applications: glucose monitoring, environmental detection, point-of-care diagnostics. Case studies of commonly used biosensors (e.g., glucose biosensors, COVID-19 rapid tests).
Week 13	Advances in wearable and implantable biosensors. Miniaturization and integration with IoT for real-time monitoring.
Week 14	Regulatory standards and ethical implications of biosensors. Environmental impact and safety of biosensor materials.
Week 15	simple biosensor prototype (conceptual or physical) addressing a specific problem (e.g., water quality monitoring, glucose detection).
Week 16	Final Term Exams

Practicals

Design a simple biosensor prototype (conceptual or physical) addressing a specific problem (e.g., water quality monitoring, glucose detection). Enzyme-based biosensing using colorimetric assays. Build a simple potentiometric or amperometric sensor using an electronic kit. Analyze and amplify signals from sensors and observe the effect of noise. Analyze and amplify signals from sensors and observe the effect of noise. Develop and test a simple biosensor prototype relevant to healthcare or environmental monitoring

Textbooks and Reading Material

1. Biosensors: An Introduction, Brian R. Eggins, *Wiley* (2003).
2. Electrochemical Methods: Fundamentals and Applications, Allen J. Bard and Larry R. Faulkner, *Wiley* (2000).
3. Handbook of Biosensors and Bioelectronics, Joseph Wang, *Wiley* (2010).
4. Biosensors and Bioelectronics: Principles, Design and Applications, John Turner, *Oxford University Press* (2018).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.

2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-405	Credit Hours	3
Course Title	**Lasers and Applications**				

Course Introduction

The course starts with a short introduction to the laser and its physical properties. We then discuss light-matter interaction using a quantum mechanical description, starting from the basics of atoms and molecules. We study a number of modern spectroscopic techniques and their use in biological and chemical physics, medicine, and environmental science. Focus is on practical examples from society and advanced techniques used in the research laboratory. The course includes laborations where we apply the measurement techniques and the data analysis studied.

Learning Outcomes

By the end of this course, students will be able:

1. Solve technical problems related to the quantum physical structure of atoms and molecules and their spectral properties.
2. Use laser spectroscopic measurement methods, instruments and calculation programs, and report results and evaluate limitations.

Course Content

Week 1	Spontaneous Emission, Absorption, Stimulated Emission, Pumping Schemes, Absorption and Stimulated Emission Rates
Week 2	Absorption and Gain Coefficients, Resonance Energy Transfers. Properties of Laser Beam: Monochromaticity, Coherence, Directionality, Brightness
Week 3	Spectroscopy of Molecule and Semiconductors Electronic Energy Levels, Molecular Energy Levels, Level Occupation at Thermal Equilibrium, Stimulated Transition, Selection Rules, Radiative and Nonradiative Decay, Semiconductor.
Week 4	Plane Parallel (Fabry-Perot) Resonator, Concentric (Spherical) Resonator, Confocal, Resonator, Generalized Spherical Resonator, Ring Resonator, Stable Resonators, Unstable Resonators
Week 5	Matrix Formulation of Geometrical Optics, Wave Reflection and Transmission at a Dielectric Interface, Stability Condition Standing and Traveling Waves in a two Mirror Resonator
Week 6	Longitudinal and Transverse Modes in a Cavity, Multilayer Dielectric Coatings, Fabry-Perot Interferometer. Small Signal Gain and Loop Gain

Week 7	Pumping Processes, Optical pumping: Flash lamp and Laser, Threshold Pump Power, pumping efficiency
Week 8	Mid Term Exams
Week 9	Electrical Pumping: Longitudinal Configuration and Transverse Configuration, Gas Dynamics Pumping, Chemical Pumping.
Week 10	Continuous Wave (CW) and pulsed lasers Rate Equations, Threshold Condition and Output Power, Optimum Output Coupling, Laser Tuning, Oscillation and Pulsations in Lasers
Week 11	Q- Switching and Mode-Locking Methods, Phase Velocity, Group Velocity, and Group-Delay Dispersion, Line broadening
Week 12	Lasers Systems Solid State Lasers: Ruby Laser, Nd: YAG & Nd: Glass Lasers and Semiconductor Lasers: Homojunction Lasers Double-Heterostructure lasers
Week 13	Gas lasers**:** Helium Neon laser, CO_2 laser, Nitrogen Laser and Excimer Lasers, Free-Electron and X-Ray Lasers
Week 14	Laser applications, Material Processing: Surface Hardening, Cutting, Drilling, Welding etc.
Week 15	Holography, Laser Communication, Medicine, Defense Industry, Atmospheric Physics
Week 16	Final Term Exams

Textbooks and Reading Material

1. Laser Theory, H. Haken, *Springer, Berlin* (1985).
2. Laser, A. E. Siegman, *University Science Books, Mill Valley, CA* (1986).
3. Principles of Lasers, O. Svelto, *Plenum Press, New York & London* (1992).
4. Quantum Optics, M. O. Scully and M. S. Zubairy, *Cambridge University Press* (1997).
5. Laser Fundamentals, W. T. Silfvast, *Cambridge University Press* (2004).
6. Lasers, J. Eberly and P. Milonni, *Wiley, New York* (2010).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment			
Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-406	Credit Hours	3
Course Title	**Biomechanics**				

Course Introduction

This course provides a comprehensive introduction to the mechanical principles underlying biological systems, bridging concepts from physics, engineering, and biology. Students will examine the structural and functional behavior of biological materials such as bones, muscles, connective tissues, blood vessels, and cells under various mechanical conditions. The course emphasizes how forces are generated, transmitted, and resisted in living organisms, from the molecular scale to whole-body movement. Through theoretical foundations, case studies, and hands-on exposure to modern techniques, students will develop the skills to analyze and model mechanical phenomena in biology and medicine.

Learning Outcomes

1. Understand and apply the laws of mechanics to analyze biological tissues and systems.
2. Quantify stress, strain, and viscoelastic behavior in biological materials.
3. Analyze the mechanics of fluid transport in biological systems such as blood flow and respiration.
4. Evaluate muscle contraction mechanisms and the biomechanics of movement.
5. Gain introductory experience with biophysical techniques used to measure forces at the cellular and molecular level.

Course Content

Week 1	Principles of Mechanics Applied to Biological Tissues: Newtonian mechanics, static and dynamic analysis
Week 2	Principles of Mechanics Applied to Biological Tissues: Constitutive models, and scaling laws in biology.
Week 3	Stress, Strain, and Viscoelasticity of Tissues: Elastic and plastic deformation, viscoelastic behavior of skin
Week 4	Stress, Strain, and Viscoelasticity of Tissues: Viscoelastic behavior of skin, tendons, cartilage, and other soft tissues
Week 5	Stress, Strain, and Viscoelasticity of Tissues: Viscoelastic behavior of skin, tendons, cartilage, and other soft tissues; time-dependent mechanical response.
Week 6	Stress, Strain, and Viscoelasticity of Tissues: Viscoelastic behavior of skin, tendons, cartilage, and other soft tissues; time-dependent mechanical response.
Week 7	Fluid Dynamics in Biological Systems: Hemodynamics, flow in microvasculature

Week 8	Mid Term Exams
Week 9	Fluid Dynamics in Biological Systems: Non-Newtonian fluid behavior of blood, pulmonary airflow mechanics
Week 10	Fluid Dynamics in Biological Systems: Applications of Poiseuille's law and Reynolds number in physiology.
Week 11	Muscle Contraction and Skeletal Mechanics: Sarcomere dynamics, force-length and force-velocity relationships in muscle, joint mechanics
Week 12	Muscle Contraction and Skeletal Mechanics: Sarcomere dynamics, force-length and force-velocity relationships in joint mechanics, load distribution in bones, and locomotion analysis.
Week 13	Biophysical Techniques and Instrumentation: *Atomic Force Microscopy (AFM):* Nanoscale measurement of mechanical properties in single cells and molecules.
Week 14	Biophysical Techniques and Instrumentation: *Optical Tweezers:* Force spectroscopy for manipulating single biomolecules and probing mechanical responses of cells.
Week 15	Biophysical Techniques and Instrumentation: *Digital Image Correlation and Motion Capture Systems:* For tissue deformation analysis and gait studies. Revision
Week 16	Final Term Exams

Textbooks and Reading Material

1. Biomechanics: Mechanical Properties of Living Tissues, Yuan-Cheng Fung, *Springer* (1993).
2. Biomechanics: Principles and Applications, Donald R. Peterson and Joseph D. Bronzino (Eds.), *CRC Press* (2006).
3. Introductory Biomechanics: From Cells to Organisms, C. Ross Ethier and Craig A. Simmons, *Cambridge University Press* (2007).
4. Cellular Biophysics and Modeling: A Primer on the Computational Biology of Excitable Cells, Greg Conradi Smith, *Cambridge University Press* (2011).
5. Biomechanics: A Case-Based Approach, Sean P. Flanagan, *CRC Press* (2013).
6. An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, Jay D. Humphrey and Sherry L. O'Rourke, *Springer* (2014).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
4.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.

5.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
6.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-407	Credit Hours	3
Course Title	**Bioenergetics**				

Course Introduction

This course explores the fundamental principles of energy flow and transformation in living organisms. It provides a detailed understanding of how cells capture, convert, store, and utilize energy to sustain life processes. Through an integration of thermodynamics, biochemistry, and cellular biology, students will examine key metabolic pathways and energy-producing mechanisms such as ATP synthesis, the electron transport chain, and photosynthesis. The course also introduces analytical techniques used to measure biological energy transfer, preparing students for further study in physiology, molecular biology, and bioengineering.

Learning Outcomes

1. Apply the laws of thermodynamics to biological systems.
2. Understand the molecular mechanisms of ATP production and energy coupling.
3. Analyze metabolic pathways involved in energy conversion.
4. Explain the role of electron transport and proton gradients in oxidative phosphorylation and photophosphorylation.
5. Use techniques such as calorimetry, respirometry, and spectrophotometry to study energy metabolism.

Course Content

Week 1	Background: Thermodynamics and Biology
Week 2	Thermodynamics of Biological Energy Conversion: First and second laws of thermodynamics in biological systems
Week 3	Thermodynamics of Biological Energy Conversion: Gibbs free energy and reaction spontaneity; energy coupling in cells.
Week 4	ATP Synthesis and Energy Metabolism: Structure and hydrolysis of ATP; glycolysis, the citric acid cycle
Week 5	ATP Synthesis and Energy Metabolism: Substrate-level phosphorylation; metabolic regulation and efficiency.
Week 6	ATP Synthesis and Energy Metabolism: Substrate-level phosphorylation; metabolic regulation and efficiency.
Week 7	Electron Transport Chain and Oxidative Phosphorylation: Mitochondrial structure, redox potential
Week 8	Mid Term Exams

Week 9	Electron Transport Chain and Oxidative Phosphorylation: Proton gradient generation, chemiosmotic theory, and ATP synthase mechanism.
Week 10	Photosynthesis and Bioenergetics in Plants: Light reactions, chlorophyll function, electron transport in thylakoid membranes, and the Calvin cycle.
Week 11	Photosynthesis and Bioenergetics in Plants Light reactions, chlorophyll function, electron transport in thylakoid membranes, and the Calvin cycle.
Week 12	Experimental Techniques in Bioenergetics: *Calorimetry:* Measurement of heat changes during metabolic reactions.
Week 13	Experimental Techniques in Bioenergetics: *Calorimetry:* Measurement of heat changes during metabolic reactions. *Respirometry:* Quantifying oxygen consumption and metabolic rates in cells or tissues.
Week 14	Experimental Techniques in Bioenergetics: *Respirometry:* Quantifying oxygen consumption and metabolic rates in cells or tissues.
Week 15	Experimental Techniques in Bioenergetics: *Spectrophotometry:* Monitoring enzyme activity, redox states, and reaction kinetics using light absorption.
Week 16	Final Term Exams

Textbooks and Reading Material

1. Principles of Bioenergetics, Vladimir P. Skulachev and Alexander V. Tserkovnyak, *Springer* (1996).
2. Biological Thermodynamics, Donald T. Haynie, *Cambridge University Press* (2001).
3. Bioenergetics (5th Edition), David G. Nicholls and Stuart J. Ferguson, *Academic Press* (2013).
4. Molecular Biology of the Cell, Bruce Alberts et al., *Garland Science* (2015).
5. Biochemistry, Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer, *W.H. Freeman* (2015).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
7.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
8.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.

9.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-408	Credit Hours	3
Course Title	**Radiation Biophysics**				

Course Introduction

This course provides an in-depth exploration of how ionizing radiation interacts with biological matter, with an emphasis on the physical principles, biological effects, and applications in medicine, biotechnology, and radiation protection. Students will study the mechanisms of energy deposition at the molecular and cellular levels, the resulting biochemical and physiological responses, and the techniques used to detect and quantify radiation damage. Applications such as cancer radiotherapy, radiation safety, and radiobiological research are also addressed, making this course essential for students interested in medical physics, nuclear biology, and environmental biophysics.

Learning Outcomes

1. Understand the fundamental physics of ionizing radiation and radioactive decay.
2. Analyze the physical and chemical interactions between radiation and biological tissues.
3. Evaluate the biological consequences of radiation at the molecular, cellular, and systemic levels.
4. Understand the principles behind radiation therapy and diagnostic imaging.
5. Apply radiation dosimetry techniques and assess radiation risk and protection measures.

Course Content

Week 1	Fundamentals of Ionizing Radiation: Types of radiation (alpha, beta, gamma, X-rays, neutrons), Radioactive decay, half-life, activity, and interactions with matter
Week 2	Fundamentals of Ionizing Radiation: Radioactive decay, half-life, activity, and interactions with matter, Linear energy transfer (LET), relative biological effectiveness (RBE), and stopping power
Week 3	Radiation–Matter Interactions: Photoelectric effect, Compton scattering, pair production, Interaction mechanisms in water and biological macromolecules
Week 4	Radiation–Matter Interactions: Interaction mechanisms in water and biological macromolecules, Production of free radicals and oxidative stress
Week 5	Molecular and Cellular Radiation Effects: DNA damage: strand breaks, base modifications, crosslinking, DNA repair mechanisms and cell cycle response
Week 6	Molecular and Cellular Radiation Effects: DNA repair mechanisms and cell cycle response, Apoptosis, necrosis, and mitotic catastrophe
Week 7	Tissue and Organ-Level Effects: Deterministic and stochastic effects, Acute radiation syndrome, long-term carcinogenic risks, Dose-response relationships and radiation sensitivity
Week 8	Mid Term Exams
Week 9	Medical Applications of Radiation: Principles of radiation therapy (external beam, brachytherapy, proton therapy)

Week 10	Medical Applications of Radiation: Radiosensitizers and radioprotectors
Week 11	Medical Applications of Radiation: Use of radiotracers in nuclear medicine (PET/SPECT imaging)
Week 12	Radiation Detection and Dosimetry: Geiger-Müller counters, scintillation detectors, ionization chambers
Week 13	Radiation Detection and Dosimetry: Dose units (Gray, Sievert), equivalent and effective dose, Biological dosimetry (micronucleus assay, chromosomal aberrations)
Week 14	Radiation Protection and Safety: ALARA principle, shielding, monitoring, and regulatory guidelines, Natural vs. anthropogenic radiation sources
Week 15	Radiation Protection and Safety: Natural vs. anthropogenic radiation sources, Risk assessment and emergency response
Week 16	Final Term Exams

Textbooks and Reading Material

1. Introduction to Radiological Physics and Radiation Dosimetry, Frank Herbert Attix, *Wiley-VCH* (1986).
2. Radiobiology Handbook: For Biophysics and Medical Physics Students, Kenneth Chadwick, *Taylor & Francis* (1999).
3. Basic Clinical Radiobiology, Michael C. Joiner and Albert van der Kogel (Eds.), *CRC Press* (2009).
4. Fundamentals of Radiation Biology, Gaurav Thakur and L. J. Peters, *CRC Press* (2013).
5. Radiation Biology for the Radiologist, Eric J. Hall and Amato J. Giaccia, *Lippincott Williams & Wilkins* (2018).

Teaching Learning Strategies

1.Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
4.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
5.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.

6.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-413	Credit Hours	3
Course Title	**Epigenetics**				

Course Introduction

The course on epigenetics aims to introduce how heritable changes in gene function occur without a change in the underlying DNA sequence. Further it will also explain how changes can affect and how genes are expressed and interpreted by cells, leading to variations in traits and diseases.

Learning Outcomes

On the completion of the course, the students will be able to:

1. Understand epigenetic mechanisms and their role in gene regulation.
2. Explain how epigenetics influences development, disease, and inheritance.
3. Analyze epigenetic data and research findings.
4. Apply epigenetic principles to real-world problems, Stay up-to-date with cutting-edge epigenetics research and applications

Course Content

Week 1	Foundations of Epigenetics, What is Epigenetics? Definition and history,Key concepts and terminology
Week 2	DNA Methylation, Mechanisms of DNA methylation, Enzymes involved (DNMTs), Effects on gene expression
Week 3	Histone Modifications, Types of histone modifications (acetylation, methylation, phosphorylation), Histone-modifying enzymes, Impact on chromatin structure and gene expression
Week 4	Non-Coding RNAs and Epigenetics, MicroRNAs, siRNAs, and long non-coding RNAs, Role in gene regulation, Interaction with other epigenetic mechanisms
Week 5	Epigenetic Mechanisms in Development and Disease, Epigenetics in Development, Role in embryogenesis and cell differentiation, Genomic imprinting, X-chromosome inactivation
Week 6	Epigenetics in Cancer, DNA methylation and histone modification patterns in cancer, Epigenetic therapies in oncology
Week 7	Epigenetics and Neurodevelopmental Disorders, Epigenetic factors in autism, schizophrenia, and other disorders
Week 8	Mid Term Exams

Week 9	Environmental Epigenetics, Influence of diet, toxins, and stress on the epigenome, Transgenerational epigenetic inheritance
Week 10	Techniques and Applications in Epigenetics, Techniques for Studying Epigenetics, Bisulfite sequencing, ChIP-seq, and RNA-seq, CRISPR/Cas9 and epigenome editing
Week 11	Bioinformatics in Epigenetics, Data analysis and interpretation, Databases and tools for epigenetic research
Week 12	Clinical Applications of Epigenetics, Epigenetic biomarkers for disease diagnosis and prognosis, Personalized medicine and epigenetic therapies
Week 13	Current Trends and Future Directions, Epigenetics and Aging, Epigenetic clocks and biomarkers of aging, Role in age-related diseases
Week 14	Emerging Topics in Epigenetics, New discoveries and technological advancements, Ethical considerations in epigenetic research
Week 15	Student Presentations and Discussions
Week 16	Final Term Exams

Textbooks and Reading Material

1. The Molecular Hallmarks of Epigenetic Control, C. D. Allis and T. Jenuwein, *Nature Reviews Genetics* (2016).
2. Epigenetic regulation of gene expression: Mechanisms and functions, R. Jaenisch and A. Bird, *Springer* (2017).
3. Introduction to Epigenetics, R. Paro, U. Grossniklaus, R. Santoro, and A. Wutz, *Springer* (2021).
4. Handbook of Epigenetics: The New Molecular and Medical Genetics, T. O. Tollefsbol, *Academic Press* (2022).
5. Cancer Epigenetics, R. Kalkan, *Springer Cham* (2023).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.

2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-414	Credit Hours	3 (2-1)
Course Title	**Proteomics and Genomics**				

Course Introduction

This course is designed to provide an in-depth understanding of the principles, technologies, and applications of genomics and proteomics. Genomics involves the study of genomes, the complete set of DNA within an organism, and focuses on understanding gene structure, function, and regulation. Proteomics, on the other hand, is the large-scale study of proteins, which are vital components of living organisms and perform a vast array of functions within biological systems.

Throughout this course, students will explore the latest advancements in DNA sequencing technologies, genome assembly and annotation, gene expression analysis, and protein identification and quantification techniques. Additionally, the course will cover the computational tools and bioinformatics methods essential for analyzing genomic and proteomic data. By the end of the course, students will have a comprehensive understanding of how genomics and proteomics are revolutionizing fields such as personalized medicine, cancer research, and biotechnology.

Learning Outcomes

By the end of this course, students will be able:

1. Understand Fundamental Concepts
2. Apply Genomic Technologies
3. Analyze Gene Expression and Epigenomics
4. Utilize Proteomic Techniques
5. Explore Protein Function and Interactions
6. Compare Genomic and Proteomic Data
7. Understand Clinical Applications
8. Employ Bioinformatics Tools

This course aims to equip students with both theoretical knowledge and practical skills, preparing them for careers in biomedical research, biotechnology, and healthcare. Through lectures, hands-on lab sessions, and research projects, students will gain a holistic understanding of how genomics and proteomics are transforming science and medicine.

Course Content

Week 1	Overview of Genomics and Proteomics, Definitions and scope, Historical background, Importance in modern biology

Week 2	Genomics Technologies, DNA Sequencing, Sanger sequencing, Next-generation sequencing (NGS), Genome Assembly and Annotation, Assembly algorithms, Functional annotation
Week 3	Bioinformatics Tools, Sequence alignment, Genomic databases
Week 4	Gene Expression Analysis, RNA sequencing, Microarrays, Epigenomics, DNA methylation, Histone modification
Week 5	CRISPR and Gene Editing, CRISPR/Cas9 technology, Applications in research and therapy
Week 6	Proteomics Technologies, Protein Extraction and Quantification, Protein purification techniques, Mass spectrometry (MS)
Week 7	Protein Identification, Tandem MS/MS, Database searching, Protein Structure Analysis, X-ray crystallography, Nuclear magnetic resonance (NMR)
Week 8	Mid Term Exams
Week 9	Functional Proteomics, Protein-Protein Interactions, Co-immunoprecipitation, Yeast two-hybrid system, Post-Translational Modifications, Phosphorylation, Ubiquitination, Proteomics Data Analysis, Bioinformatics tools, Proteomic databases
Week 10	Comparative Genomics and Proteomics, Comparative Genomics, Orthologs and paralogs, Evolutionary genomics, Comparative Proteomics, Differential expression analysis, Proteome evolution
Week 11	Clinical and Translational Genomics, Genomic Medicine, Personalized medicine, Pharmacogenomics
Week 12	Cancer Genomics, Genomic alterations in cancer, Targeted therapies
Week 13	Clinical Proteomics, Biomarker Discovery, Clinical Applications
Week 14	Emerging Technologies and Future Directions, Single-cell Genomics and Proteomics, Metagenomics and Metaproteomics
Week 15	Project Presentations and Review
Week 16	Final Term Exams

Practicals

Differential proteome analysis by 2D gel electrophoresis, In silico analysis and comparison of different proteomes, In silico analysis and comparison of different genomes. Tools and databases used in genomics research (e.g., BLAST, genome browsers)

Textbooks and Reading Material

1. Principles of proteomics, R. M. Twyman, *Taylor and Francis* (2004).
2. Microbial Biotechnology. The world of Omics: Genomics, Transcriptomics, Proteomics and Metabolomics, N. G. Alexander and H. N., *Springer* (2007).
3. Integrative proteomics, E. W. L. Hon-Chiu, *Intech Publishing, Germany* (2012).
4. The dictionary of genomics, transcriptomics and proteomics (5th ed), G. K., *Wiley Blackwell* (2015).
5. Clinical genomics, S. Kulkarni and J. D. Pfeifer, *Elsevier/Academic Press* (2015).
6. Bioinformatics and functional genomics (3rd Ed.), J. Pevsner, *John Wiley and Sons* (2015).
7. Statistical analysis in proteomics, K. Jung, *Humana Press, New York* (2016).
8. Proteomics in systems biology: Methods and protocols, J. Reinders, *Humana Press, New York* (2016).
9. Quantitative proteomics by mass spectrometry, S. Sechi, *Humana Press, New York* (2016).
10. Genomics, A. Zayed, *Elsevier Science* (2016).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-415	Credit Hours	3
Course Title	**Bioinformatics, Protein Structures and Functions**				

Course Introduction

Bioinformatics is a multidisciplinary field that combines biology, computer science, and information technology to analyze and interpret biological data. In this course, the main focus is on the bioinformatics methods used to study protein structures and functions, which are crucial for understanding the molecular mechanisms underlying various biological processes and diseases. Proteins are the workhorses of the cell, performing a wide range of functions, from catalyzing biochemical reactions to providing structural support. Understanding their structure and function is essential for various applications, including drug discovery, disease diagnosis, and the development of novel therapeutics.

This course will cover the fundamental concepts and techniques in bioinformatics, including sequence alignment, protein structure prediction, structural bioinformatics, and protein-protein interactions. Students will gain hands-on experience with bioinformatics tools and databases, enabling them to analyze protein sequences and structures and predict their functions. By the end of the course, students will be well-equipped to apply bioinformatics methods to real-world biological problems.

Learning Outcomes

By the end of this course, students will be able:

1. Understand the Fundamentals of Bioinformatics
2. Perform Sequence Alignment
3. Analyze Protein Sequences
4. Predict Protein Structures
5. Visualize and Validate Protein Structures
6. Study Protein-Protein Interactions
7. Explore Functional Genomics and Proteomics
8. Apply Bioinformatics in Drug Discovery
9. Stay Current with Advanced Topics and Trends

Course Content

Week 1	Introduction to Bioinformatics, Definition and scope of bioinformatics, History and development of bioinformatics, Importance in modern biology and medicine
Week 2	Biological Databases, Types of biological databases (primary, secondary, composite), Nucleotide sequence databases (GenBank, EMBL, DDBJ), Protein sequence databases (UniProt, PDB), Specialized databases (Pfam, InterPro)

Week 3	Sequence Alignment, Basic concepts of sequence alignment, Pairwise sequence alignment (global and local), Multiple sequence alignment, Tools and algorithms (BLAST, FASTA, ClustalW)
Week 4	Protein Sequence Analysis, Protein sequence motifs and domains, Functional annotation of proteins, Tools for protein sequence analysis (InterProScan, Pfam, PROSITE)
Week 5	Protein Structure Prediction, Levels of protein structure (primary, secondary, tertiary, quaternary), Methods for secondary structure prediction
Week 6	Homology modeling, threading, and ab initio methods, Software tools (SWISS-MODEL, Phyre2, Rosetta)
Week 7	Structural Bioinformatics, Protein structure visualization (PyMOL, Chimera), Structure validation and quality assessment, Structural alignment and comparison, Molecular dynamics simulations
Week 8	Mid Term Exams
Week 9	Protein-Protein Interactions, Methods to study protein-protein interactions (yeast two-hybrid, co-immunoprecipitation), Databases for protein-protein interactions (STRING, BioGRID), Computational prediction of protein-protein interactions
Week 10	Functional Genomics and Proteomics, Transcriptomics and proteomics, Mass spectrometry and protein identification
Week 11	Post-translational modifications, Functional annotation of proteomes
Week 12	Bioinformatics Applications in Drug Discovery, Target identification and validation, Virtual screening and molecular docking
Week 13	Pharmacogenomics and personalized medicine, Case studies in drug discovery
Week 14	Advanced Topics and Current Trends, Next-generation sequencing and bioinformatics, Systems biology and network analysis
Week 15	Machine learning in bioinformatics, Recent advancements and future directions
Week 16	Final Term Exams

Textbooks and Reading Material

1. Bioinformatics: Sequence and Genome Analysis, David W. Mount, *Cold Spring Harbor Laboratory Press* (2004).
2. Introduction to Bioinformatics, Arthur M. Lesk, *Oxford University Press* (2008).
3. Bioinformatics and Functional Genomics, Jonathan Pevsner, *Wiley* (2015).

4. Protein Structure Prediction: Methods and Protocols, Michael J. E. Sternberg (Ed.), *Humana Press* (2015).
5. Molecular Modelling: Principles and Applications, Andrew R. Leach, *Pearson* (2016).
6. Bioinformatics and Computational Biology in Drug Discovery and Development, W. T. Loging (Ed.), *Cambridge University Press* (2016).
7. The Protein Protocols Handbook, John M. Walker (Ed.), *Humana Press* (2016).
8. Computational Biology: A Practical Introduction to BioData Processing and Analysis with Linux, MySQL, and R, Röbbe Wünschiers, *Wiley* (2017).
9. Introduction to Bioinformatics in Microbiology, H. Christensen (Ed.), *Springer International Publishing* (2018).
10. Proteins: Structure and Function, David Whitford, *Wiley* (2019).
11. Bioinformatics for Dummies, Jean-Michel Claverie and Cedric Notredame, *Wiley* (2019).
12. Bioinformatics, A. D. Baxevanis, G. D. Bader, & D. S. Wishart, *John Wiley & Sons* (2020).
13. Structural Bioinformatics, Philip E. Bourne and Helge Weissig (Eds.), *Wiley* (2020).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-416	Credit Hours	3
Course Title	**Cell Membrane and Transport Systems**				

Course Introduction

This course is designed to provide an in-depth understanding of the fundamental principles and mechanisms underlying the structure and function of cell membranes and the various transport systems that facilitate the movement of substances across these membranes.

Cell membranes are essential components of all living cells, acting as selective barriers that regulate the internal environment of the cell. Understanding the structure and dynamics of cell membranes, as well as the transport systems they encompass, is crucial for comprehending numerous biological processes, including nutrient uptake, waste removal, cell signaling, and energy transduction.

Throughout this course, students will explore the molecular composition of cell membranes, the physical principles governing membrane dynamics, and the diverse mechanisms of membrane transport. Students will also examine how these processes are regulated and how they contribute to cellular function in both health and disease.

Learning Outcomes

By the end of this course, students will be able:

1. Describe the Structure and Composition of Cell Membranes
2. Understand Membrane Dynamics
3. Explain the Principles of Membrane Transport
4. Characterize Ion Channels and Transporters
5. Describe Vesicular Transport Mechanisms
6. Understand Signal Transduction Related to Membranes
7. Explore Specialized Membranes and Transport Systems
8. Apply Knowledge to Real-World Contexts

This course will combine lectures, discussions, laboratory exercises, and case studies to provide a comprehensive understanding of cell membrane and transport systems. Active participation and engagement with the course material will be crucial for mastering these concepts and achieving the learning outcomes.

Course Content

Week 1	Introduction to Cell Membranes, Overview of cell membranes, Composition and structure of membranes, Phospholipid bilayer, Membrane proteins and their functions, Membrane carbohydrates
Week 2	Membrane Dynamics, Fluid mosaic model, Membrane fluidity and factors affecting it, Lipid rafts and membrane domains, Methods to study membrane dynamics (FRAP, FRET)

Week 3	Transport Across Cell Membranes, Principles of membrane transport
Week 4	Diffusion and osmosis, Passive transport (simple diffusion, facilitated diffusion), Active transport (primary and secondary active transport)
Week 5	Ion Channels and Transporters, Types of ion channels (voltage-gated, ligand-gated, mechanically-gated)
Week 6	Function and regulation of ion channels, Transporters and pumps (Na+/K+ pump, Ca2+ pump), Electrogenic and electroneutral transport
Week 7	Vesicular Transport, Endocytosis (phagocytosis, pinocytosis, receptor-mediated endocytosis)
Week 8	Mid Term Exams
Week 9	Exocytosis, Mechanisms and regulation of vesicular transport, Role of the cytoskeleton in vesicular transport
Week 10	Signal Transduction and Membranes, Receptor-mediated signaling
Week 11	G-protein coupled receptors, Tyrosine kinase receptors, Second messengers (cAMP, IP3, DAG)
Week 12	Specialized Membranes and Transport Systems, Membranes in organelles (mitochondria, ER, Golgi)
Week 13	Transport in specialized cells (neurons, muscle cells), Membrane transport in disease
Week 14	Review and Case Studies, Case studies on membrane transport disorders
Week 15	Review of key concepts, Final exam preparation
Week 16	Final Term Exams

Textbooks and Reading Material

1. Molecular Biology of the Gene, J. D. Watson, *Benjamin Cummings* (2004).
2. Molecular Cloning: A laboratory manual, J. Sambrook, E. F. Fritsch, & T. Maniatis, *Cold Spring Harbor Laboratory Press* (2012).
3. Essential Cell Biology, B. Alberts, *Garland Science, New York, United States* (2013).
4. Molecular biology of the cell (6th ed.), B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, & P. Walter, *Garland Science, New York, United States* (2015).
5. Molecular Cell Biology, H. Lodish et al., *W. H. Freeman* (2016).
6. The Cell: A Molecular Approach, G. M. Cooper, *Oxford University Press, Oxford, United Kingdom* (2019).
7. Principles of Molecular Biology, R. D. Watson et al., *Cambridge University Press* (2021).

Teaching Learning Strategies

1. Course Teaching
2. Presentations

3. Quiz

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-417	Credit Hours	3
Course Title	**Computational Biology**				

Course Introduction

Computational Biology is an interdisciplinary field that leverages computational techniques and tools to understand and model biological systems and relationships. This course aims to equip students with the knowledge and skills necessary to analyze biological data, develop algorithms, and create models to solve complex biological problems.

Learning Outcomes

By the end of this course, students will be able:

1. Understand Core Concepts
2. Analyze Biological Data
3. Develop Computational Models
4. Apply Machine Learning Techniques
5. Conduct Research and Problem Solving
6. Ethical and Practical Considerations
7. Collaborative and Interdisciplinary Skills
8. Technical Proficiency

Course Content

Week 1	Introduction to Computational Biology, Overview of Computational Biology, Historical perspective, Key applications in genomics, proteomics, and systems biology
Week 2	Molecular Biology Basics, DNA, RNA, and Protein structures, Central Dogma of Molecular Biology, Techniques in Molecular Biology
Week 3	Bioinformatics Databases, NCBI, EMBL, DDBJ, Protein Data Bank (PDB), Genome Browsers
Week 4	Sequence Analysis, Sequence alignment: local and global, BLAST and FASTA algorithms, Multiple sequence alignment, Phylogenetic analysis
Week 5	Genomics, Genome sequencing technologies, Genome annotation, Comparative genomics, Functional genomics
Week 6	Proteomics, Protein structure prediction
Week 7	Protein-protein interactions, Mass spectrometry data analysis

Week 8	Mid Term Exams
Week 9	Systems Biology, Pathway analysis, Gene regulatory networks, Metabolic network modeling
Week 10	Machine Learning in Computational Biology, Introduction to machine learning, Applications in genomics and proteomics, Neural networks and deep learning
Week 11	Structural Bioinformatics, Molecular docking, Molecular dynamics simulations, Drug design and discovery
Week 12	Computational Tools and Software, Bioinformatics toolkits (e.g., Bioconductor, BioPython), Software for sequence and structure analysis, High-throughput data analysis tools
Week 13	Ethics and Data Privacy in Computational Biology, Ethical issues in genomics and bioinformatics, Data sharing and privacy concerns
Week 14	Current Trends and Future Directions, CRISPR and gene editing
Week 15	Single-cell sequencing, Personalized medicine, Emerging technologies and future prospects
Week 16	Final Term Exams

Textbooks and Reading Material

1. Introduction to Computational Biology: Maps, Sequences, and Genomes, Michael S. Waterman, *CRC Press* (1995).
2. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, *Cambridge University Press* (1998).
3. Bioinformatics: Sequence and Genome Analysis, David W. Mount, *Cold Spring Harbor Laboratory Press* (2004).
4. Introduction to Bioinformatics, Arthur M. Lesk, *Oxford University Press* (2002).
5. Structural Bioinformatics, Philip E. Bourne and Helge Weissig (Eds.), *Wiley* (2003).
6. Essential Bioinformatics, Jin Xiong, *Cambridge University Press* (2006).
7. Machine Learning in Bioinformatics, Yanqing Zhang and Jagath C. Rajapakse, *Wiley* (2009).
8. Systems Biology: A Textbook, Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Hans Lehrach, Ralf Herwig, *Wiley-VCH* (2009).
9. Bioinformatics Algorithms: An Active Learning Approach, Phillip Compeau and Pavel Pevzner, *CreateSpace* (2015).
10. Computational Biology: A Practical Introduction to BioData Processing and Analysis with Linux, MySQL, and R, Röbbe Wünschiers, *Wiley* (2017).

Teaching Learning Strategies			
1. Course Teaching 2. Presentations 3. Quiz			
Assessment			
Sr. No.	**Elements**	**Weightage**	**Details**
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-418	Credit Hours	3 (2-1)
Course Title	**Virology**				

Course Introduction

This course is designed for students in applied microbiology and general biology which covers an introduction to the field of virology and examines the important aspect and fundamentals of Virology including, virus structure, viral replication cycles, virus classification, architecture and nomenclature, laboratory diagnosis of virus, how viruses enter and spread in the host cells, host resistance to viruses and viral epidemiology.

Learning Outcomes

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

1. Review the history and principles of virology.
2. List the general properties of viruses
3. Write the different types of viruses
4. Describe the basic structure of viruses.
5. Differentiate between viruses and other microorganisms.
6. State the characteristics used to classify viruses.

Course Content

Week 1	Basic principles of virology
Week 2	Structure/architecture of virus
Week 3	Characteristics of viruses
Week 4	Virus-host cell interaction
Week 5	Viral replication
Week 6	Genetics of viruses
Week 7	Transmission of viruses
Week 8	Mid Term Exams

Week 9	Classification of viruses
Week 10	Effects on the infected cell
Week 11	Mechanisms of pathogenicity
Week 12	HIV
Week 13	Retrovirus infection
Week 14	Prions, hepatitis viruses
Week 15	Virus cultivation and propagation, viral oncogenes.
Week 16	Final Term Exams

Practicals

Isolation and purification of bacteriophages, quantification of bacteriophages through spot assay and double layer diffusion method, One-step growth curve of bacteriophages, Detection and quantification of viruses and antibodies from clinical specimens, ELISA, PCR.

Textbooks and Reading Material

1. Medical Virology, David O. O., White F. J., Fenner W. F., & Fenner J., *Academic Press, U.S.A.* (1994).
2. Virus Culture: A Practical Approach, A. J. Cann, *Oxford University Press, N.Y.* (2000).
3. A Dictionary of Virology, W. Brian, B. Mahy, & W. Mahy, *Academic Press, U.S.A.* (2001).
4. Fields Virology, David M. Knipe & Peter M. Howley (Eds.), *Lippincott Williams & Wilkins* (2001).
5. Principles of Molecular Virology, A. J. Cann, *Elsevier Science & Technology Book* (2005).
6. Introduction to Modern Virology, Nigel J. Dimmock, Andrew J. Easton, & Keith N. Leppard, *Wiley-Blackwell* (2007).
7. Molecular Virology, Leland V. Pierce, *Academic Press* (2014).

Teaching Learning Strategies

1. Course Teaching
2. Presentations
3. Quiz

Assessment			
Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-419	Credit Hours	3 (2-1)
Course Title	**Antimicrobial Agents and Resistance**				

Course Introduction

This course provides a deep understanding of how antimicrobial agents work, the factors leading to antimicrobial resistance, and strategies to combat this critical global health issue. Students will explore the mechanisms of action of various antimicrobial agents and analyze the causes and public health impact of resistance. The course emphasizes the application of this knowledge to develop effective strategies for the responsible use of antimicrobial agents, aiming to mitigate the spread of resistance. Through lectures and lab work, students will gain both theoretical and practical skills essential for addressing antimicrobial resistance in clinical and public health settings.

Learning Outcomes

On the completion of the course, the students will be able to:

1. Understanding the mechanism of action of various antimicrobial agents and their role in treating microbial infections.
2. Analyze the factors contributing to antimicrobial resistance and its impact on public health.
3. Apply knowledge of antimicrobial resistance to develop strategies for the effective use of antimicrobial agents and so mitigate the spread of resistance.

Course Content

Week 1	Introduction to Antimicrobial Agents
Week 2	Mechanisms of Antimicrobial Resistance
Week 3	Antibacterial, Antiviral
Week 4	Antifungal, and Antiparasitic Agents
Week 5	Laboratory Techniques in Antimicrobial Testing
Week 6	Antimicrobial Resistance in Healthcare and the Community
Week 7	Epidemiology and Global Impact of Antimicrobial Resistance
Week 8	Mid Term Exams
Week 9	Antimicrobial resistance in Pakistan
Week 10	New Approaches to Overcome Resistance
Week 11	Strategies to Combat Antimicrobial Resistance
Week 12	Ethical, Social, and Economic Aspects of Antimicrobial Resistances

Week 13	Antimicrobial Stewardship
Week 14	Case Studies in Antimicrobial Resistance and Control
Week 15	Integration and Application
Week 16	Final Term Exams

Practicals

Hands-on training in disk diffusion (Kirby-Bauer) and broth dilution methods, Phenoty[ic detection methods for detecting bacterial resistance, Impact of Antimicrobial Resistance, PCR and gel electrophoresis for detecting resistance genes markers, MIC and MBC determination using microdilution assays, analysis of clinical isolates for resistance patterns, Antimicrobial Stewardship in Practice, Novel Approaches to Mitigating Resistance: Investigating the efficacy of bacteriophages and antimicrobial peptides

Textbooks and Reading Material

1. Antibiotic Resistance: Implications for Global Health and Novel Intervention Strategies, E. R. Choffnes, D. A. Relman, & L. Olsen, *National Academies Press* (2020).
2. Antimicrobial Resistance in Gram-Positive Bacteria, L. B. Rice, *Springer* (2020).
3. Global Antimicrobial Resistance and Use Surveillance System (GLASS) Report: 2021, World Health Organization (WHO), *WHO Press* (2021).
4. Antimicrobial Resistance: Challenges and Therapeutic Approaches, S. L. Hoffman & B. D. Walker, *Wiley* (2021).
5. The Antimicrobial Therapy Handbook (31st ed.), S. M. Opal & A. A. Medeiros, *Oxford University Press* (2022).
6. Infectious Diseases and Antimicrobial Stewardship in Critical Care, M. M. Neuhauser & C. MacDougall, *Cambridge University Press* (2023).

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on activities, short tests, projects, practicals, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, fieldwork , report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-420	Credit Hours	3
Course Title	**Vaccinology**				

Course Introduction

The Course aims to provide a comprehensive overview of Vaccines and its types. It covers a wide range of aspects, from basic immunology, the process of pre-clinical and clinical vaccine development, licensure and regulatory requirements, vaccine trials, translation of research into policy to the introduction of a new vaccine into an immunization program and communication with the society.

Learning Outcomes

On the completion of the course, the students will be able to:

1. Understand and describe the immune system and immunology as it applies to vaccines and vaccination.
2. Understand the various types of vaccines and risk communication in today's society.
3. Demonstrate an understanding of the processes of vaccine development and manufacture
4. Understand the Pakistan Immunization Program.

Course Content

Week 1	Introduction to Vaccinology: Definition and significance of vaccines
Week 2	Role of immunology in the field of vaccinology, Historical milestones in the field of vaccinology
Week 3	Types of vaccines: Inactivated vaccines, Live-attenuated vaccines
Week 4	Messenger RNA (mRNA) vaccines, Subunit, recombinant, polysaccharide, and conjugate vaccines
Week 5	Toxoid vaccines, Viral vector vaccines
Week 6	Vaccine design to clinical steps: Exploratory – Research, Preclinical – Safety & Efficacy
Week 7	Clinical – Safety & Efficacy in Humans, Regulatory Review & Approval – Licensure
Week 8	Mid Term Exam
Week 9	Production – Scaling up, Quality Control – Performance Review
Week 10-11	Post-Marketing, Vaccine development against major infectious diseases: Polio, Small pox, Rotavirus, Rubella, Shingles, Tetanus, Hepatitis B, COVID- 19
Week 12	Challenges and lessons learnt from COVID-19 pandemic

Week 13	Setting policy
Week 14	Delivering public health interventions
Week 15	Pakistan Immunization program and providing effective communication
Week 16	Final Term Exam

Textbooks and Reading Material

1. Vaccines: Preventing Disease and Protecting Health, De Quadora & Ciro A., *Pan Americas Health Organization* (2005).
2. Vaccines, P.A., *Elsevier Health Sciences* (2008).
3. Vaccine Adjuvants and Delivery Systems, M. Singh, *Amazon Publishers* (2009).
4. Practical Aspects of Vaccine Development, P. Parag Kolhe & S. Ohtake, *Elsevier* (2021).
5. Vaccinology and Methods in Vaccine Research, R. Ashfield, A. N. Oli, C. Esimone, & L. O. Anagu, *Elsevier* (2022).

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on activities, short tests, projects, practicals, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, fieldwork , report writing etc.

Programme	BS BioPhysics & Nano-Biotechnology	Course Code	BP-421	Credit Hours	3 (2-1)
Course Title	**Biodegradation and Bioremediation**				

Course Introduction

Bioremediation and biodegradation are revolutionary approaches to environmental cleanup, utilizing living organisms and their enzymes to transform pollutants into harmless substances. This course delves into the principles, applications, and latest advancements in bioremediation and biodegradation, empowering you to tackle complex environmental challenges.

Learning Outcomes

On the completion of the course, the students will be able to:

1. Understand the fundamental principles of bioremediation and biodegradation.
2. Describe the types of bioremediations (in situ, ex-situ, biostimulation) and biodegradation (aerobic, anaerobic, co-metabolic).
3. Explain the role of microorganisms and enzymes in bioremediation and biodegradation.
4. Apply biodegradation and bioremediation principles to develop sustainable solutions for waste management.

Course Content

Week 1	Introduction to Bioremediation and Biodegradation
Week 2	Definition and overview of bioremediation and biodegradation
Week 3	Principles of Bioremediation: Biological processes involved in bioremediation
Week 4	Types of bioremediation: in situ, ex-situ, and biostimulation
Week 5	Factors affecting bioremediation: pH, temperature, oxygen levels, and nutrient availability Biodegradation Processes
Week 6	Types of biodegradation: aerobic, anaerobic, and cometabolic
Week 7	Factors affecting biodegradation: microbial communities, substrate availability, and environmental conditions
Week 8	Mid Term Exam
Week 9	Bioremediation of Organic and inorganic Pollutants: case studies, bioremediation of heavy metals, radionuclides, and other inorganic contaminants
Week 10	Biodegradation of Xenobiotics: Microbial interactions and synergies in bioremediation:
Week 11	Bioremediation Technologies and Applications
Week 12	Bioreactors, biofilters, and biostimulation technologies
Week 13	Applications in soil, groundwater, and surface water remediation
Week 14	Monitoring and Assessment of Bioremediation

Week 15	Monitoring parameters and analytical techniques, Assessment of bioremediation effectiveness and sustainability
Week 16	Final Term Exam

Practicals

Soil Sampling and Analysis: Collect soil samples from contaminated sites and analyze for pH, nutrient content, and microbial populations. Bioreactor Setup: Design and set up bioreactors for bioremediation of heavy metal pollutants. Phytoremediation Experiment: Investigate the ability of plants to remove pollutants from soil. Enzyme Assays: Measure any one enzyme activity involved in biodegradation (e.g., peroxidase). Microbial Degradation of Pollutants: Investigate the ability of microorganisms to degrade specific pollutants (e.g., plastics, pesticides). Biodegradation Kinetics: Study the kinetics of biodegradation reactions. Anaerobic Biodegradation: Investigate biodegradation processes under anaerobic conditions. Field Visits: Visit contaminated sites (e.g., industrial sites, landfills) to observe bioremediation and biodegradation processes in action. Visit bioremediation facilities (e.g., bioreactors, phytoremediation sites) to understand large-scale bioremediation processes. Computer Simulations: Model bioremediation and biodegradation processes using computer simulations (e.g., MATLAB).

Textbooks and Reading Material

1. Biodegradation and bioremediation, J. W. Bennet & P. A. Lemke, *Elsevier* (2017).
2. Bioremediation and biodegradation: Mechanisms and applications, S. Das & H. R. Dash, *Springer* (2017).
3. Bioremediation of contaminated soil and groundwater, K. S. Jorgensen & S. J. T. Pollard, *Springer* (2017).
4. Bioremediation and biodegradation of pollutants, R. Khalladi, O. Benhabiles & F. Bentahar, *IGI Global* (2017).
5. Advances in bioremediation of wastewater and polluted soil, L. M. Coelho, H. C. Rezende, L. M. Coelho, P. A. R. Sousa, D. F. O. Melo & N. M. M. Coelho, *Elsevier* (2020).
6. Microbial bioremediation and biodegradation, M. P. Shah, *Elsevier* (2020).

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
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3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, fieldwork , report writing etc.