UNIVERSITY OF THE PUNJAB

NOTIFICATION

It is hereby notified that the Syndicate at its meeting held on 09-03-2024 has approved the recommendations of the Academic Council made at its meeting dated 04-12-2023 regarding approval of the Revised Syllabi and Courses of Reading for BS Computational Physics 04 years degree Program under Semester System at the Centre for High Energy Physics w.e.f. the Academic Session, 2023-2027 and onward.

The Revised Syllabi and Courses of Reading for BS Computational Physics 04 years degree Program under Semester System is attached herewith as Annexure 'A'.

Sd/-
REGISTRAR

Admin. Block,
Quaid-i-Azam Campus,
Lahore.
No. D/2669/Acad.

Dated: 22–04 /2024.

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

1. Dean, Faculty of Sciences.
2. Director, Centre for High Energy Physics.
3. Controller of Examinations
4. Director, IT for placement at the website
5. Admin Officer (Statutes)
6. Secretary to the Vice-Chancellor.
7. PS to the Registrar.
8. Assistant Syllabus.

Assistant Registrar (Academic)
for Registrar

Program Curriculum
BS (HONS)
Computational Physics

Centre for High Energy Physics
University of the Punjab
Lahore

Program	BS(HONS) Computational Physics				
Duration	4 Years	**Semesters**	**8**	**Credit hours**	132
Department	**Centre for High Energy Physics**				
Faculty	**Sciences**				

Department Introduction

Research in Theoretical High Energy Physics at the Punjab University Physics Department was initiated in 1968. Starting with hardly any facility, a nucleus was generated in the next decade. In view of the outstanding contributions of the High Energy Group, the Centre for High Energy Physics (CHEP) was established in November 1982. CHEP was thus entrusted with the objectives of carrying out teaching and research in this field leading to M. Phil. and Ph.D. degrees.

Department Vision

At the Centre for High Energy Physics, our vision is to be a global leader in the pursuit of knowledge at the forefront of high energy physics and computational physics. We are committed to fostering a vibrant academic community that pushes the boundaries of human understanding in these fields. Our primary goal is to offer advanced degrees, including a PhD in High Energy Physics, an MPhil in High Energy Physics, and a BS (Hons) in Computational Physics, that equip our students with the skills, knowledge, and passion to make groundbreaking contributions to the world of physics and beyond.

Our vision encompasses the following key elements:

1. **Excellence in Research**

We strive for excellence in theoretical and experimental high energy physics research, continually pushing the boundaries of human knowledge. We conduct innovative computational physics research to solve complex problems in diverse scientific domains.

2. **Cutting-Edge Education**

We provide a world-class education to our students, empowering them with the latest theoretical and experimental techniques in high energy physics and computational physics. Our programs are designed to foster critical thinking, creativity, and problem-solving skills, preparing our students for success in academia, industry, and beyond.

3. **Interdisciplinary Collaboration**

We promote interdisciplinary collaboration, forging partnerships with other departments, research institutions, and industry leaders to address the most pressing scientific and technological challenges. Our students and faculty actively engage in collaborative research projects that bridge the gap between high energy physics and computational physics.

4. **Inclusivity and Diversity**

We are committed to building an inclusive and diverse academic community, where individuals from all backgrounds are welcomed and encouraged to pursue their passion for physics. We provide equal opportunities for all, ensuring that underrepresented groups have a voice and presence in our department.

5. **Outreach and Impact**

We share our enthusiasm for high energy physics and computational physics with the broader community through outreach programs, public lectures, and educational initiatives. We aim to make a positive impact on society by leveraging our expertise to address real-world challenges.

6. **Global Leadership**

We aspire to be recognized globally as a leading center for high energy physics and computational physics, contributing significantly to the advancement of human knowledge. Our alumni, faculty, and students are active contributors to the international scientific community, shaping the future of physics research.
In pursuit of this vision, the Centre for High Energy Physics is dedicated to fostering a culture of curiosity, innovation, and academic excellence, and we are committed to preparing our graduates to be leaders and pioneers in the fields of high energy and computational physics. Together, we will continue to explore the frontiers of the universe, unlocking its deepest secrets and inspiring future generations of physicists.

Department Mission

Fundamental Physics gives us an insight into the nature of matter. This serves as the foundation on which stands the entire structure of technology. Research in fundamental physics always introduces new dimensions, which pave the way for further technological advances. High Energy Physics is one of the most fascinating branches of fundamental physics. It is concerned with unravelling the ultimate constituents of matter and with the elucidation of forces between them. The research in the theoretical side of the field requires the use of most advanced mathematical and computational skills, whereas its experimental side involves the use of cutting-edge technologies.

High Energy physicists trained at the Centre have been making their contribution to the various research organizations and educational institutes in Pakistan as well as abroad. Imparting education and contribution in research in a much more effective ways as high Energy Physics is the most fundamental area of physics. If teachers conduct research in High Energy Physics, their capacity of grasping and understanding all other areas of physics will certainly enhance. Consequently, the teachers who are trained in CHEP and will be scattered in various universities and colleges of Pakistan will be able to communicate more effectively the basic concepts of physics to their students. This will boost up the level of Physics, and therefore the technological potential of our country.

Centre for high Energy Physics, as a research institution of high energy physics, has widely recognized contributions in the areas of Physics education and research. We see teaching and research environment as a place of discovery, critical thinking, and collaboration.

CHEP is committed to produce competitive physicists abreast of state-of-the-art in computer technology who can serve as the technically qualified workforce needed by the industry, academia, and other government non-government organizations.

Department Goals

Centre for High Energy Physics has the following goals:

1. **Research Excellence**: To conduct cutting-edge research in high energy physics and computational physics, contributing to the advancement of scientific knowledge and understanding of the fundamental forces and particles that govern the universe.
2. **Education and Training**: To provide a rigorous and comprehensive educational experience for students pursuing degrees in high energy physics and computational physics, equipping them with the skills, knowledge, and critical thinking abilities necessary for successful careers in academia, industry, and research.

3. **Interdisciplinary Collaboration**: To foster interdisciplinary collaboration among faculty and students, promoting the exchange of ideas and expertise with other departments and research institutions, thereby enriching the quality and scope of research in our fields.
4. **Inclusivity and Diversity**: To create an inclusive and diverse academic environment that welcomes individuals from all backgrounds and perspectives, ensuring equitable opportunities for all students and faculty members.
5. **Innovative Research Initiatives**: To initiate and support innovative research projects that explore emerging areas within high energy physics and computational physics, addressing both theoretical and experimental challenges.
6. **Technology Advancement**: To stay at the forefront of technological advancements in our fields, integrating state-of-the-art computational tools and experimental equipment into our research and teaching programs.
7. **Global Engagement**: To actively participate in international research collaborations and conferences, contributing to global scientific progress and expanding the reach and influence of the department.
8. **Outreach and Education**: To engage in outreach activities, including public lectures, educational programs, and community involvement, to inspire a passion for physics in the broader community and to communicate the importance and excitement of our research.
9. **Ethical Conduct**: To uphold the highest standards of ethical conduct in research, education, and collaboration, ensuring the integrity and credibility of our department's work.
10. **Alumni Success**: To support the success of our alumni by maintaining a strong network and providing ongoing opportunities for their professional development, as well as recognizing and celebrating their contributions to the field.
11. **Continuous Improvement**: To continually assess and enhance the quality of our programs, courses, and research endeavors, adapting to the evolving needs of the scientific community and society.
12. **Sustainability**: To promote sustainable practices within the department, minimizing our environmental footprint and contributing to a more sustainable future.

These goals collectively reflect the commitment of the Centre for High Energy Physics to excellence in research, education, collaboration, and community engagement, with the aim of advancing the frontiers of high energy physics and computational physics while preparing the next generation of physicists and researchers to excel in a rapidly evolving scientific landscape.

Program Introduction

The rapid increase in the power and use of computers has been the driving force in recent developments in science and technology. Yet there are a few graduates which have strong enough backgrounds in Computational Physics to play an effective role in doing science particularly physics using computers. Graduates in computer science understand the working of computers but do not have enough background of physics and mathematics that is required for technical fields. On the other hand, the graduates in physics or applied mathematics do not have any exposure to technical use of computers for doing physics. However, the graduates in Computational Physics possess competent education in physics, mathematics, computer science and valuable skills of solving complex problems by computers. With a graduate degree in Computation Physics, you could opt the career in:

- Scientific computing, in the energy, aerospace sectors, and analysis in high energy physics.
- Research in academic institutions.

- Research in national laboratories.
- Teaching.

With a degree in Computational Physics, you can also opt the careers in many related fields where computation plays key roles; oceanography, material science, computer science, applied mathematics, geophysics, medicine, telecommunication, or finance.

Program Objectives

Our objective is to have the students understanding how to perform scientific computations with high- performance computers. When successful, the mathematical and physical ideas become alive before the students' eyes, and the students understand physical systems at a level usually attained only in a research environment.

With the program student will:

1. Acquire a strong physics background through computer simulations.
2. Learn the necessary applied mathematics.
3. Learn computer hardware and programming languages.
4. Learn to use scientific problem-solving environments.
5. Learn to use various visualization techniques.
6. Learn the use to networked computer systems, shared resources and variety of operating systems.
7. Gain experience of developing computer simulations of physical systems.
8. Gain experience of computation with parallel supercomputer.
9. Gain experience of Data Science, Artificial Intelligence, Quantum Computing

Market Need / Rationale of the Program

Computational Physics deals with the tools used to solve the complex problems of physics on computer systems. The problems which Computational Physics addresses are either impossible to solve by alternative means or very laborious. A computational physicist not only understands the problem-solving tools but also the relevant physics mathematics and the working of computers. Computational Physics is not just another discipline in physics; rather it has recently emerged as an approach to physics significantly as much important as traditional approaches of theoretical and experimental physics.

Admission Eligibility Criteria

- **Years of Study completed.**
  12 years of study
- **Study Program/Subject**
  F.Sc., ICS, A-Level (physics & mathematics) or equivalent
- **Percentage/CGPA**
  Percentage (45% or more)
- **Entry Test (if applicable) with minimum requirement**
  Not Applicable

Categorization of Courses as per HEC Recommendations and Difference

Semester	Courses	Category (Credit Hours)					
		Core Courses	Basic Courses	Major Electives	Minor Electives	Any other	Semester Load
1	6	4	2				15
2	6	3	3				16
3	6	2	4				16
4	7	4	3				17
5	7		2	5			18
6	6			5	1		17
7	5			4	2		18
8	5			2	3		15
PU	48	13	14	16	6	0	132
As per HEC	49	9	13	16	4	7	132
Difference b/w HEC & CHEP	-1	+4	+1	0	+2	-7	0

Scheme of Studies

S. #.	Course Code	Title of the Course	Credit Hours
1	PHYS 1101	Mechanics	3
2	MATH 1101	Calculus I	3
3	COMP 1101	Introduction to Computing	3
4	HUM 1101	English I	3
5	HUM 1102	Islamic Studies/Ethics	2
6	PHYS 1102	Physics Lab I	1
7	PHYS 1201	Waves and Oscillations	3
8	PHYS 1202	Thermal Physics	3
9	MATH 1201	Calculus II	3
10	MATH 1202	Linear Algebra	3
11	HUM 1201	English II	3
12	PHYS 1203	Physics Lab II	1
13	PHYS 2301	Electricity and Magnetism	3
14	PHYS 2302	Modern Physics I	3
15	MATH 2301	Calculus III	3
16	MATH 2302	Differential Equations	3
17	STAT 2301	Probability and Statistics	3
18	PHYS 2303	Physics Lab III	1
19	PHYS 2401	Modern Physics II	3
20	PHYS 2402	Basic Electronics	3
21	MATH 2401	Discrete Mathematics	3
22	HUM 2401	Entrepreneurship Essentials	3
23	HUM 2402	Pakistan Studies	2
24	HUM 2403	Philosophy of Science	2
25	PHYS 2403	Physics Lab IV	1
26	PHYS 3501	Classical Mechanics	3

27	PHYS 3502	Digital Electronics	3
28	COMP 3501	Computer Programming (2+1Lab)	3
29	COMP 3502	Scientific Computation	3
30	MA TH 3501	Mathematical Methods I	3
31	PHYS 3503	Physics Lab V	2
32	PHYS 3504	Electronics Lab	1
33	PHYS 3601	Electromagnetic Theory I	3
34	PHYS 3602	Quantum Mechanics I	3
35	COMP 3601	Numerical Analysis	3
36	COMP 3602	Data Science (2+1Lab)	3
37	MA TH 3601	Mathematical Methods II	3
38	PHYS 3603	Physics Lab VI	2
39	PHYS 4701	Electromagnetic Theory II	3
40	PHYS 4702	Quantum Mechanics II	3
41	PHYS 4703	Statistical Physics	3
42	PHYS 4704	Solid State Physics I	3
43	COMP 4701	Computational Physics Simulation I (2+1 Lab)	3
44	COMP 4702	Artificial Intelligence (2+1Lab)	3
45	PHYS 4801	Solid State Physics II	3
46	PHYS 4802	Nuclear Physics	3
47	COMP 4801	Computational Physics Simulation II (2+1 Lab)	3
48	COMP 4802	Quantum Computing (2+1Lab)	3
49	PHYS 480X	Project/Elective Course	3
Total Credit Hours			132
Areas of Specialization (Elective Courses)			
50	PHYS 4803	Particle Physics	3
51	PHYS 4704	Detector Physics	3
52	PHYS 4805	Accelerator Physics	3
53	PHYS 4806	Non-linear Physics	3
54	PHYS 4807	Relativity and Cosmology	3

Scheme of Studies / Semester-wise workload

#	Code	Course title	Course Type	Prerequisite	Credit Hours	
Semester-I						
1.	PHYS 1101	Mechanics	Basic-1	F.Sc./A-Level Math	3	
2.	MATH 1101	Calculus I	Core-1	F.Sc/A-Level Physics	3	
3.	COMP 1101	Introduction to Computing	Core-2	F.Sc/A-Level	3	
4.	HUM 1101	English I	Core-3		3	
5.	HUM 1102	Islamic Studies/Ethics	Core-4		2	
6.	PHYS 1102	Physics Lab I	Basic-2	Accompanying PHYS 1101	1	

Total Credit Hours						**15**
Semester-II						
1.	PHYS 1201	Waves and Oscillations	Basic-3	PHYS 1101	3	
2.	PHYS 1202	Thermal Physics	Basic-4	PHYS 1101	3	
3.	MATH 1201	Calculus II	Core-5	MATH 1101	3	
4.	MATH 1202	Linear Algebra	Core-6	F.Sc./A-Level Math	3	
5.	HUM 1201	English II	Core-7		3	
6.	PHYS 1203	Physics Lab II	Basic-5	PHYS 1201, PHYS 1202	1	
Total Credit Hours						**16**
Semester-III						
1.	PHYS 2301	Electricity and Magnetism	Basic-6	PHYS 1201	3	
2.	PHYS 2302	Modern Physics I	Basic-7	PHYS 1101, PHYS 1201, PHY 1202	3	
3.	MATH 2301	Calculus III	Core-8	MATH 1201	3	
4.	MATH 2302	Differential Equations	Core-9	MATH 1101, MATH 1201	3	
5.	STAT 2301	Probability and Statistics	Basic-8	F.Sc./A-Level Math	3	
6.	PHYS 2303	Physics Lab III	Basic-9	Accompanyin g PHYS 2301	1	
Total Credit Hours						**16**
Semester-IV						
1.	PHYS 2401	Modern Physics II	Basic-10	PHY 2302	3	
2.	PHYS 2402	Basic Electronics	Basic-11	PHYS 2301, PHYS 2302	3	
3.	MATH 2401	Discrete Mathematics	Core-10	F.Sc./A-Level Math	3	
4.	HUM 2401	Entrepreneurship Essentials	Core-11		3	
5.	HUM 2402	Pakistan Studies	Core-12		2	
6.	HUM 2403	Philosophy of Science	Core-13		2	
7.	PHYS 2403	Physics Lab IV	Basic-12	2301 and Accompanyin g PHYS 2401	1	
Total Credit Hours						**17**
Semester-V						
1.	PHYS 3501	Classical Mechanics	Maj-1	PHYS 1101, PHYS 1201	3	
2.	PHYS 3502	Digital Electronics	Maj-2	PHYS 2402	3	
3.	COMP 3501	Computer Programming (2+1Lab)	Basic - 13	COMP 1101	3	
4.	COMP 3502	Scientific Computation	Basic - 14	COMP 1101	3	

5.	MA TH 3501	Mathematical Methods I	Maj-3	MATH 1101, MATH 1201, MATH 2301, MATH 2302	3	
6.	PHYS 3503	Physics Lab V	Maj-4	PHYS 2301, PHYS 2401	2	
7.	PHYS 3504	Electronics Lab	Maj-5	PHYS 3502	1	
Total Credit Hours						**18**
Semester-VI						
1.	PHYS 3601	Electromagnetic Theory I	Maj-6	PHYS 2301	3	
2.	PHYS 3602	Quantum Mechanics I	Maj-7	PHYS 2302, PHYS 2401	3	
3.	COMP 3601	Numerical Analysis	Maj-8	COMP 3502	3	
4.	COMP 3602	Data Science (2+1Lab)	Min-1	COMP 3501	3	
5.	MATH 3601	Mathematical Methods II	Maj-9	MATH 3501	3	
6.	PHYS 3603	Physics Lab VI	Maj-10	PHYS 2401	2	
Total Credit Hours						**17**
Semester-VII						
1.	PHYS 4701	Electromagnetic Theory II	Maj-11	PHYS 3601	3	
2.	PHYS 4702	Quantum Mechanics II	Maj-12	PHYS 3602	3	
3.	PHYS 4703	Statistical Physics	Maj-13	PHYS 1202, PHYS 3602	3	
4.	PHYS 4704	Solid State Physics I	Maj-14	PHYS 3602	3	
5.	COMP 4701	Computational Physics Simulation I (2+1 Lab)	Min-2	COMP 3502, COMP 3602	3	
6.	COMP 4702	Artificial Intelligence (2+1Lab)	Min-3	COMP 3602	3	
Total Credit Hours						**18**
Semester-VIII						
1.	PHYS 4801	Solid State Physics II	Maj-15	PHYS 4703	3	
2.	PHYS 4802	Nuclear Physics	Maj-16	PHYS 4702	3	
3.	COMP 4801	Computational Physics Simulation II (2+1 Lab)	Min-4	COMP 4701	3	
4.	COMP 4802	Quantum Computing (2+1Lab)	Min-5	PHYS 3602, PHYS 4702	3	
5.	PHYS 480X	Project/Elective Course	Min-6		3	
Total Credit Hours						15

Research Thesis / Project /Internship/Elective Subject
Project/Elective Course of 3 credit hours in the 8th semester

LIST OF ELECTIVE COURSES

A student can choose one out of the following courses.

PHYS 4803: Particle Physics	Cr. Hrs. 3
PHYS 4704: Detector Physics	Cr. Hrs. 3
PHYS 4805: Accelerator Physics	Cr. Hrs. 3
PHYS 4806: Non-linear Physics	Cr. Hrs. 3
PHYS 4807: Relativity and Cosmology	Cr. Hrs. 3

Award of Degree

As per university semester rules

NOC from Professional Councils (if applicable)

Not Applicable

Faculty Strength

Degree	Name	Designation	Area/Specialization	Total
PhD	Dr. Rashid Ahmed	Director & Professor	High Energy Physics, Computational Analysis of Properties of Condense Matter	
	Dr. Qadeer Afzal Malik	Associate Professor	Experimental High Energy Physics, Hadronic Physics, Computational Physics	
	Dr. Faisal Akram	Associate Professor	High Energy Physics: Particle Physics Phenomenology, Quantum chromodynamics, Schwinger-Dyson equations, Heavy ion collision Physics, Neutrino Physics	
	Dr. Talab Hussain	Assistant Professor	Experimental High Energy Physics; Data Analysis, Computational Physics; Artificial Intelligence, Quantum Computing.	
	Dr. Irfan Mahmood	Assistant Professor	Theoretical Physics	
	Dr. Teeba Rashid	Assistant Professor	Experimental High Energy Physics, Structure of Hadrons	
	Dr. Sohail Afzal Tahir	Assistant Professor	High Energy Physics, Hadronic Physics, Internetworking, and data communication	

	Dr. Abdul Aziz Bhatti	Assistant Professor	High Energy Physics	
	Dr. Bushra Kanwal	Assistant Professor (On Adhoc)	Experimental High Energy Physics	
	Dr. Muhammad Atif Sultan	Assistant Professor (On Adhoc)	High Energy Physics	
	Dr. Bushra Shafaq	Assistant Professor (On Adhoc)	High Energy Physics: Neutrino Physics.	
	Dr. Tariq Mahmood	Assistant Professor (On Adhoc)	High Energy Physics, Computational Physics, Quantum Computing, Data Science, Artificial Intelligence	
MS/ MPhil	Muhammad Anjum Javed	Lecturer	High Energy Physics	2
	Mr. Amjad Afzaal	Lecturer	Computer Science	
Total				14

Present Student Teacher Ratio in the Department					
Total Faculty	14	Total Students	411	**Ratio**	29.35 Approx. 1:30

Course Outlines Separately for Each Course

Program	BS (HONS) Computational Physics	**Course Code**	MATH 1101	**Credit Hours**	3
Course Title	Calculus I				
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 objectives are 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	Preliminaries: Real numbers
	Functions, families of functions
Week 2	Families of functions, Inverse functions
	Limit and Continuity: Definition of limit,
Week 3	Computing limits, Limit at infinity
	Rigorous definition of limit,
Week 4	Continuity, Continuity of trigonometric functions
	Derivative: Tangent lines and rates of change,
Week 5	Derivative: Tangent lines and rates of change,
	The derivative function, Techniques of differentiation
Week 6	(Problem Solving)
	The product and quotient rules
Week 7	Derivative of trigonometric functions
	The chain rule
Week 8	Implicit differentiation
	Local linear approximation;
Week 9	Differentials
	The derivative in Graphing and applications
Week 10	Increasing and decreasing functions
	Concavity, Relative extrema
Week 11	Graphing polynomials
	Rational functions
Week 12	Cusps, and Vertical tangents
	Absolute maxima and minima
Week 13	Applied maximum and minimum problems
	Newton's method
Week 14	Roll's Theory
	Mean- value theorem
Week 15	Partial derivatives
	Functions of two or more variables

Week 16	Functions of two or more variables, partial derivatives	
	Examples (Functions of two or more variables, partial derivatives), The chain rule.	

Textbooks and Reading Material

1. Calculus, H. Anton, I. Bevens, S. Davis (10th Edition), *Laurie Rosatone* (2012).
2. Calculus with Analytic Geometry, E. W. Swokowski, *PWS Publishers, Boston* (1988).
3. Calculus and Analytic Geometry (9th Edition), G.B. Thomas and R.L. Finney, *Addison-Wesley Publishing Company* (1995).
4. Calculus and Analytics Geometry, C. H. Edward and E. D Penney, *Prentice Hall* (1988).

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 (HONS) Computational Physics	Course Code	MATH 1201	Credit Hours	3
Course Title	Calculus II				

Course Introduction

The Calculus course is a comprehensive exploration of integral calculus, focusing on the indefinite integral and its connection to calculus. It covers techniques like integration by substitution, evaluating indefinite and definite integrals, and their practical applications in geometry and physics. The course also explores derivatives and integrals involving exponential, logarithmic, inverse trigonometric, and hyperbolic functions. Advanced principles of integral evaluation, such as integration by parts, trigonometric substitutions, and partial fractions, are introduced. The course also teaches how to use computer algebra systems and tables of integrals for more complex calculations. By the end of the course, students will have a deep understanding of integral calculus and its applications.

Learning Outcomes

The course introduces the subject of integral calculus at undergraduate level. Its objectives are as following.

1. Introduce plane analytical geometry and analytical geometry in 3D.
2. To study the concept of integration, relevant theorems, and techniques of evaluating integrals.
3. Study definite integrals and its applications.
4. Study multiple integrals and its applications.

Course Content

Week 1	Integration
	An overview of area problem
Week 2	The indefinite integral
	Integration by substitution
Week 3	The definition of area as limit
	The definite integral
Week 4	The fundamental theory of calculus
	Rectilinear motion and integration
Week 5	Average value of a function
	Evaluating definite integrals by substitution
Week 6	Application of definite integral in geometry and physics
	Area between two curves,
Week 7	Volume by slicing
	Disks and Washers
Week 8	Volumes by Cylindrical shells
	Length of a plane curve

Week 9	Area of a surface of revolution	
	Work, Moments, Centre of gravity, and Centroids	
Week 10	Derivates and integrals involving exponential and logarithmic functions	
	Examples (Derivates and integrals involving exponential and logarithmic functions)	
Week 11	Derivates and integrals involving exponential and logarithmic functions, Graphs and applications involving logarithmic and exponential functions	
	Examples (Derivates and integrals involving exponential and logarithmic functions, Graphs and applications involving logarithmic and exponential functions)	
Week 12	L'Hopital's rule	
	Indeterminate forms, Derivatives and integrals involving inverse trigonometric functions	
Week 13	Hyperbolic functions	
	Principles of integral evaluation	
Week 14	Integration by parts, Integrating trigonometric functions	
	Trigonometric substitutions	
Week 15	Integrating rational functions by partial fractions	
	Integrating rational functions by partial fractions	
Week 16	Using Computer algebra systems and tables of integrals	
	(Problem Solving)	

Textbooks and Reading Material

1. Calculus, H. Anton, I. Bevens, S. Davis (10th Edition), *Laurie Rosatone* (2012)
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 and Analytics Geometry, C. H. Edward and E. D Penney, *Prentice Hall* (1988).

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 (HONS) Computational Physics	**Course Code**	MATH 2301	**Credit Hours**	3
Course Title	Calculus III				

Course Introduction

The Multivariable Calculus course offers a comprehensive exploration of advanced calculus concepts and their applications in multiple dimensions. It covers Infinite Series, Parametric and Polar Curves, Three-Dimensional Space, Quadratic Surfaces, Vector-Valued Functions, Multiple Integrals, Vector Fields, Line Integrals, Conservative Vector Fields, and theorems of Green, Gauss, and Stokes. The course covers sequences, monotone sequences, convergence tests, Maclaurin and Taylor series, parametric equations, tangent lines, arc length, and polar coordinates. It also explores vector fields, line integrals, conservative vector fields, and theorems of Green, Gauss, and Stokes. By the end of the course, students will have a profound understanding of multivariable calculus and its diverse applications, making them skilled problem solvers in mathematics, engineering, and natural sciences.

Learning Outcomes

The course introduces the subject of analytical geometry, Infinite series and sequences, and vector analysis at undergraduate level. Its objectives are as following.

1. Introduce plane analytical geometry and analytical geometry in 3D.
2. To study the concept of integration, relevant theorems, and techniques of evaluating integrals.
3. Study definite integrals and its applications.
4. Study multiple integrals and its applications.

Course Content

Week 1	Infinite Series
	Sequences
Week 2	Monotone Sequences
	Convergence tests
Week 3	The comparison, ratio, root, and integral tests

	Maclaurin series
Week 4	Taylor series
	Convergence of Taylor series
Week 5	Parametric and Polar Curves
	Parametric equations
Week 6	tangent lines and arc length for parametric curves
	Polar coordinates
Week 7	Area of polar curves
	Conic sections
Week 8	Conic sections in polar coordinates.
	Three- dimensional space: rectangular coordinate in 3D space
Week 9	spheres; cylindrical surfaces,
	Vectors, Dot product, Cross product, Parametric equation of lines
Week 10	Planes in 3D space, Quadratic surfaces, cylindrical surfaces, Spherical surfaces
	Vector-valued functions: Calculus of vector valued functions
Week 11	Unit tangent, normal, and binomial vectors
	Multiple integrals: Double integrals in cartesian coordinates, Surface area
Week 12	Examples (Multiple integrals: Double integrals in polar coordinates, Surface area)
	Triple integrals in cartesian, cylindrical and spherical coordinates, Change of variables and Jacobians
Week 13	Vector fields, Line integrals
	Conservative vector fields, Green's theorem
Week 14	Surface integrals,
	Applications of surface integral
Week 15	Flux, The Divergence theorem
	Applications of the Divergence theorem
Week 16	Stokes's theorem
	Applications of the Stokes's theorem

Textbooks and Reading Material

1. Calculus, H. Anton, I. Bevens, S. Davis (10th Edition), *Laurie Rosatone* (2012)
2. Calculus with Analytic Geometry, E. W. Swokowski, *PWS Publishers*, *Boston* (1988).
3. Calculus and Analytic Geometry (9th Edition), G.B. Thomas and R.L. Finney, *Addison-Wesley Publishing Company* (1995).
4. Calculus and Analytics Geometry, C. H. Edward and E. D Penney, *Prentice Hall* (1988).

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 (HONS) Computational Physics	**Course Code**	MATH 1202	**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 applications such 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	System of Linear equations and matrices: Matrices and Matrix operations
	System of Linear equations and matrices: Inverse of Matrix, Algebraic properties of matrices
Week 3	System of Linear equations and matrices: Elementary matrices, and methods of finding inverse
	System of Linear equations and matrices: Diagonal, triangular, and symmetric matrices
Week 4	System of Linear equations and matrices: Applications of linear systems
	System of Linear equations and matrices: Determinants by Cofactor expansion
Week 5	System of Linear equations and matrices: Evaluating determinant by row reduction
	System of Linear equations and matrices: Properties of determinants
Week 6	System of Linear equations and matrices: 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
	Euclidean vector spaces: Cross product
Week 8	General Vector Spaces: Real vector spaces
	General Vector Spaces: Subspaces
Week 9	General Vector Spaces: Linear independence
	General Vector Spaces: Coordinates and basis, Dimension
Week 10	General Vector Spaces: Change of basis
	General Vector Spaces: Linear operators
Week 11	General Vector Spaces: matrix representation of linear operators
	General Vector Spaces: Matrix Transformations from R^n to R^m
Week 12	Eigen values and eigen vectors: Definitions
	Eigen values and eigen vectors: Diagonalization
Week 13	Eigen values and eigen vectors: 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
Week 16	Matrices for general linear transformation
	Similarity transformation

Textbooks and Reading Material
Recommended Books: **1.** Elementary Linear Algebra (11^{th} edition), Howard Anton, *John Wiley & Sons* (2013). **2.** Foundations of Mathematical Physics, Sadri Hassani, *Prentice-Hall International* (1991). **3.** Linear Algebra, G. Hadley, *Addison-Wesley* (1987). **4.** Elements of Modern Algebra (8^{th} edition), L. Gilbert and G. Gilbert, *Cengage Learning* (2014).
Teaching Learning Strategies
1. Instructor will provide mathematical details of linear algebra concepts so that students can 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 will solve the exercise problems assigned by the instructor. 4. Students can use software technology to better understand the linear algebra concepts.
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. 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 (HONS) Computational Physics	**Course Code**	MATH 2302	**Credit Hours**	3
Course Title	Differential Equations				

Course Introduction

Any scientific theory or a physical problem can be viewed as differential equation (or a system of differential equations). This course is an introduction to the various types of ordinary differential equation. Various techniques for solving 1^{st}, 2^{nd} and higher order differential equations are a focus of this course. Besides this, various applications of differential equations in science and engineering are discussed.

Learning Outcomes

On the completion of the course, the students will: 1. Learn the classification of differential equations. 2. Learn how to mathematical model real life problems in the form of differential equations. 3. Learn techniques of solving various differential equations. 4. Get familiarize with different differential equations used in physics.

Course Content	
Week 1	Classification of differential equations
	Initial value and Boundary value problems
Week 2	General first order ordinary differential equation (FODE)
	Normal form of FODE
Week 3	Integrating factor & exact FODE
	General first order ordinary linear differential equation (FOLDE);
Week 4	Applications of FOLDE
	Non- linear FODE.
Week 5	Ordinary differential equations (ODE's) of first order (FO) and higher degree (HD)
	Separable first order (FO) equations.
Week 6	Methods of solution
	General properties of second order ordinary linear differential equation (SOLDE);
Week 7	Linearity; Superposition
	uniqueness & related theorems;
Week 8	SOLDE with constant coefficients.
	The Wronskian, inhomogeneous SOLDE
Week 9	Exact homogeneous SOLDE,
	The Riccati Equation
Week 10	Higher order ordinary linear DE with constant coefficients
	Homogeneous nth-order ordinary linear differential equation (NOLDE)
Week 11	Method of characteristic roots
	Inhomogeneous NOLDE and transfer function
Week 12	Method of undetermined coefficients
	Applications in physics.
Week 13	Cauchy-Euler Differential Equation
	Transformation of the Euler-Cauchy differential equation into a linear differential equation with constant coefficient
Week 14	Linear system of equations

	Homogeneous first order systems with constant coefficients
Week 15	Euler's method for homogeneous linear system
	Eigen value method for homogeneous linear system
Week 16	SODE's with variable Coefficients.
	Solution using Liouville formula

Textbooks and Reading Material

Textbooks

1. Differential Equations, A system Approach by Jack Goldberg, *Prentice-Hall International* (1998).

Suggested Readings

1. Differential Equations with Applications and Programs, S. B. Rao, *Universities Press, India* (1996).
2. Elementary Differential Equation and Boundary Value Problems, C.H. Edward, *Prentice- Hall International* (1996).
3. Foundations of Mathematical Physics by Sadri Hassani, *Prentice-Hall International* (1991).

Teaching Learning Strategies

The instructor is required to make use of Mathematica/Maple/Python to teach the concepts through visualization/animation 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. 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(HONS) Computational Physics	**Course Code**	STAT2301	**Credit Hours**	3

Course Title	Probability and Statistics

Course Introduction

Prediction (and decision making) and Data handling (and Data Analysis) are important concerns in almost in every matter of our daily life. This course provides the mathematical foundation of these ideas and gives precise and accurate treatment of fundamental concepts of Statistics probability, distribution theory and statistical inference at the introductory level. The course mainly focuses on the methods in mathematical statistics, which are important in regard to master the use of these for practical data analysis.

Learning Outcomes

On the completion of the course, the students will:

1. Learn the concept of descriptive statistics.
2. Know the theory of probability and its fundamental concepts and probability distributions.
3. Learn the concepts of statistical inference.
4. Learn the theory of error.

Course Content

Week 1	Descriptive Statistics: Tabular representation of samples,
	Frequency, Graphical representation of samples
Week 2	Mean and variance of a sample
	Probability Theory: Fundament Concepts
Week 3	Random experiments,
	Sample space, Events, Union and intersection of Events
Week 4	Mutually exclusive events
	Classical concept of Probability,
Week 5	Concept of Probability in statistics
	Conditional probability
Week 6	Independent events,
	Permutations and Combinations,
Week 7	Probability Distributions; Random variables
	Discrete distribution,
Week 8	Continuous distributions
	Mean and Variance of a distribution,
Week 9	Binomial and Poisson distribution
	Gaussian distribution,
Week 10	Probability distributions of several random variables.
	Statistical Inference,

Week 11	Introduction to Confidence Intervals
	Testing of Hypothesis and Goodness of Fit,
Week 12	Correlation analysis, Correlation coefficient
	Types of correlation
Week 13	Methods of studying correlation, Scatter diagram method
	Karl's Pearson coefficient of correlation
Week 14	Interpretation of coefficient of correlation, Covariance
	Coefficient of determination (r^2), Properties of r
Week 15	Theory of Error, Types of errors;
	Causes of errors, Correlated and un-correlated errors
Week 16	Propagation of errors
	Various functions and their error propagation formulas

Textbooks and Reading Material

Textbook

1. Introductory Mathematical statistics, Erwin Kreyszig, *John Wiley & Sons* (1970).

Suggested Readings

1. A Practical Guide to Data Analysis for Physical Science Students, Louis Lyons, *Cambridge University Press* (1993).
2. Statistics (A Guide to Use Statistical Methods in the Physical Sciences), R. J. Barlow, *John Wiley & Sons* (1989).
3. Modern Mathematical Statistics, Edward J. Dudewicz, *John Wiley & Sons* (1988).

Teaching Learning Strategies

The instructor is required to make use of Mathematica/Maple/Python to teach the concepts through visualizations/animations 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. 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 (HONS) Computational Physics	**Course Code**	**MATH 2401**	**Credit Hours**	3
Course Title	Discrete Mathematics				

Course Introduction

Discrete mathematics is mathematics that deals with discrete objects, rational numbers and with discrete objects. On the other hand real numbers which include irrational as well as rational numbers are not discrete. The course concepts are associated with them, their properties, and relationships among them among others. It discusses languages used in mathematical reasoning, basic concepts, and their properties and relationships among them.

Learning Outcomes

The course introduces the subject of Discrete Mathematics at undergraduate level. Its objectives are as following.

1. Introduce the concepts of Calculus of proposition, set theory and functions.
2. Study the methods of mathematical reasoning.
3. Learn the concepts of relations and their properties.
4. Learn the concepts of Graphs and Trees.

Course Content

Week 1	Introduction to discrete mathematics.
Week 2	Logic and Proofs: Propositional logic and Predicative logic
Week 3	Rules of inference, Introduction to proofs
Week 4	Proof methods and strategy
Week 5	Sequences and Summations: Sequences from set of non-negative integers to set of integers
Week 6	Summations, Summation indices. Algorithms
Week 7	Searching, Sorting, and Greedy algorithms

Week 8	The growth functions, Complexity of Algorithms
Week 9	Cryptography. Counting: The basics of counting
Week 10	The pigeonhole principle, Permutations and Combinations
Week 11	Relations: Relations and their properties
Week 12	Representing Relations, Equivalence relations, Partial ordering
Week 13	Introduction to Graphs
Week 14	Connectivity of graphs; Euler's and Hamilton's path
Week 15	Shortest Path Problems. Trees: Introduction to Trees, Applications of trees, Tree reversal; Spanning trees and Minimum spanning trees;
Week 16	Internet Routing Protocols RIP and OSPF

Textbooks and Reading Material

1. Discrete Mathematics and its Applications (4^{th} Edition), Kenneth H. Rosern, *William C Brown Pub.* (1998).
2. Discrete Mathematics, K.A. Ross & C.R.B. Wright, *Prentice-Hall* (2003).
3. Discrete Mathematical Structures with Application to Computer Science, J.P. Trembley & *R*. Manoher, *McGraw-Hill* (1988).
4. Discrete Mathematics, Gary Chartrand and Ping Zhang, *Waveland Pr Inc* (2011).

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.

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 (HONS) Computational Physics	**Course Code**	MATH 3501	**Credit Hours**	3
Course Title	Mathematical Method I				

Course Introduction

The Mathematical Methods course offers a thorough investigation of the mathematical methods necessary for resolving challenging issues in several disciplines, including physics. The course covers complex variables, analyticity, Cauchy's integral theorems, Taylor and Laurent series, residues, algebraic operations, coordinate transformations, covariant and contravariant tensors, metric tensors, Christoffel symbols, geodesics, Riemann tensor, infinite dimensional vector spaces, Fourier series and transforms, and Riemann tensor. The course seeks to increase students' awareness of the mathematical underpinnings of the physical world and provide them with a varied arsenal of mathematics to solve complicated issues.

Learning Outcomes

The course introduces the subject of Mathematical Methods at graduate level. Its objectives are as following.

1. Learning vector analysis in curvilinear coordinate systems and tensor analysis.
2. Studying finite and infinite dimensional vector spaces.
3. Studying Fourier series and transforms.
4. Studying the theory of complex variable and analysis.

Course Content

Week 1	Tensor Analysis, Tensor
	Coordinate transformation, Cartesian tensors
Week 2	Tensor algebra
	Covariant and Contravariant tensors
Week 3	Metric tensor, Christoffel symbols
	Equation of geodesic
Week 4	Riemann tensor
	Infinite Dimensional Vector Spaces, Convergence issue
Week 5	Hilbert space, space of square-integrable functions
	Generalized functions, Dirac delta function (1D and 3D)
Week 6	Dirac delta function (1D and 3D) and its properties
	Fourier Series and Transforms

Week 7	Fourier series and its complex form
	Applications of Fourier series
Week 8	Fourier transforms, Fourier integral theorem
	Applications of Fourier transforms
Week 9	Laplace transforms
	Applications of Laplace transforms
Week 10	Complex Variables, Complex functions
	Analytic functions; Properties of analytic functions; Derivative of analytic functions
Week 11	Cauchy-Riemann equations
	Applications of Cauchy-Riemann equations
Week 12	Laplace equation
	Line integral in the complex plane
Week 13	Surface Integral
	Volume Integral
Week 14	Cauchy's integral theorem, Cauchy's integral formula
	Taylor and Laurent series
Week 15	Residues, The residues theorem
	The residues theorem and its applications
Week 16	Poles on the real axis
	Branch points and integrals of multivalued functions

Textbooks and Reading Material

1. Foundations of Mathematical Physics, S. Hassani, *Allyn and Bacon* (1999).
2. Mathematical Methods for Physics (4th edition), G. Arfken, *Academic Press*, *NY* (1995).
3. Vector Analysis (3rd edition), K. L. Mir, *Ilmi Kitab Khana*, *Lahore* (2001).
4. Advanced Engineering Mathematics (8th Edition), E. Keyszig, *J. Wiley* (2001).
5. Mathematical Physics, E. Butkov, *Addison-Wesley* (1973).

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 (HONS) Computational Physics	**Course Code**	MATH 3601	**Credit Hours**	3
Course Title	Mathematical Method II				

Course Introduction

The sophisticated mathematical methods utilized in physics and other scientific fields are thoroughly explored in the Mathematical Methods course. It covers Sturm-Liouville Systems, Green Functions, special functions, power series techniques, and partial differential equations. The convergence of solutions, variable separation in coordinate systems, and equations regulating physical processes are all topics covered in this course. Additionally, it explores the subtleties of the Bessel, Modified Bessel, Spherical Bessel, Legendre, and Associate Legendre functions, Hermit and Laguerre functions, Chebyshev Polynomials, Hypergeometric functions, Gamma, and beta functions, as well as Hermit and Laguerre. To provide students a thorough knowledge of both mathematical techniques and real-world physics applications, the course also goes deeply into the characteristics of Hermitian Operators and Green Functions.

Learning Outcomes

The course introduces the subject of Mathematical Methods at graduate level. Its objectives are as following.

1. Studying the partial differential equations of physics.
2. Studying complex differential equations.
3. Studying special functions.
4. Studying the Sturm-Liouville systems and the theory of green functions.

Course Content

Week 1	Common partial differential equations in Physics
	Cartesian, cylindrical, and spherical coordinate systems
Week 2	Conversions of Cartesian, cylindrical and spherical coordinate systems
	Variable separation in Cartesian coordinates system
Week 3	Variable separation in cylindrical coordinates system

	Variable separation in spherical coordinates system
Week 4	Power Series Method
	Power series solution of standard SOLDE (Bessel and Legendre DE's);
Week 5	Power series solution of standard SOLDE (Hermit and Laguerre DE's);
	Power series solution of standard SOLDE (Chebyshev and Hypergeometric DE's);
Week 6	Convergence of solutions; Special cases of polynomial solutions
	Special functions: Bessel function; Modified Bessel function; Spherical Bessel functions;
Week 7	Legendre function; Associate Legendre function
	Study of the various Properties of these special functions including Generating functions, Recurrence relations, Orthonormalization, Asymptotic forms, and related properties.
Week 8	(Problem Solving)
	(Problem Solving)
Week 9	(Problem Solving)
	(Problem Solving)
Week 10	Hermit functions, Laguerre functions
	Chebyshev Polynomials, Hypergeometric functions,
Week 11	Gamma and beta functions
	The Sturm-Liouville Systems: Self-adjoint ODEs;
Week 12	Sturm Liouville DE's and systems; Applications of properties of Sturm Liouville Systems
	Hermitian Operators; Properties of Hermitian operators
Week 13	Green Functions: Green's functions in one dimension
	(Problem Solving)
Week 14	Green's functions for second-order linear differential operators
	(Problem Solving)
Week 15	Eigen function expansion of Green's functions
	(Problem Solving)
Week 16	Green functions in 3 dimensions.
	(Problem Solving)

Textbooks and Reading Material

1. Foundations of Mathematical Physics, Sadri Hassani, *Allyn and Bacon* (1999).
2. Mathematical Methods for Physics (4^{th} edition), G. Arfken, *Academic Press, NY* (1995).
3. Advanced Engineering Mathematics (8^{th} Edition), E. Keyszig, *J. Wiley* (2001)
4. An Introductory Course in Differential Equations, K.L. Mir, *Ilmi Kitab Khana* (1999).

5. Mathematical Physics, E. Butkov, *Addison-Wesley* (1973).

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 (HONS) Computational Physics	**Course Code**	PHYS 1101	**Credit Hours**	3
Course Title	Mechanics				

Course Introduction

The Mechanics course is an exploration of the fundamental principles governing the motion of objects 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 course also 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
Week 8	System of variable mass
	Rocket motion
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
Week 16	The motion of planets.
	The motion of planets and satellites.

Textbooks and Reading Material
1. Physics Vol.1 (4th edition), Halliday and Resnic, *John Wiley and Sons* (1992). 2. Physics Vol.1 (5th edition), Halliday and Resnic, *John Wiley and Sons* (2002). 3. Fundamentals of Physics (5th edition), Halliday and Resnic, *John Wiley and Sons* (1999). 4. Physics for Scientists and Engineers (Extended version), P. M. Fishbane, *Prentice-Hall International Editions* (2016). 5. Classical Mechanics Simulations, Bruce Hawkins and Randall Jones, *John Wiley & Sons* (1995)
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 (HONS) Computational Physics	Course Code	PHYS 1102	Credit Hours	1
Course Title	**Physics Lab I**				

Course Introduction
The course introduces Mechanics with hands on lab experiment in Lab
Learning Outcomes
The Lab will cover the experiment in Mechanics. After the completion of the Lab the students will be able to:

1. Verify the various laws of mechanics.
2. Learns different techniques of analyzing and presenting scientific data.

Course Content	
Week 1	To determine the value of "g" by compound pendulum/Kater's Pendulum -1
Week 2	To determine the value of "g" by compound pendulum/Kater's Pendulum -2
Week 3	To study the dependence of Centripetal force on mass, radius, and angular velocity of a body in circular motion -1
Week 4	To study the dependence of Centripetal force on mass, radius, and angular velocity of a body in circular motion -2
Week 5	To study the dependence of Centripetal force on mass, radius, and angular velocity of a body in circular motion -3
Week 6	To study the law of conservation of momentum -1
Week 7	To study the law of conservation of momentum -2
Week 8	To study the law of conservation of momentum -3
Week 9	To study the laws of sliding friction-1
Week 10	To study the laws of sliding friction -2
Week 11	To study the laws of drag force -1
Week 12	To study the laws of drag force -2
Week 13	Determination of moment of inertial of a solid/hollow cylinder and a sphere etc - 1
Week 14	Determination of moment of inertial of a solid/hollow cylinder and a sphere etc-2
Week 15	To study the laws of gyroscope-1
Week 16	To study the laws of gyroscope -2

Teaching Learning Strategies

The instructor is required to give a background of the theory relevant to the experiments, working of the equipment used. They are also required to submit a report including their data, results of fits, plots or results of any analysis method applied.

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 (HONS) Computational Physics	**Course Code**	PHYS 1201	**Credit Hours**	3
Course Title	Waves and Oscillations				

Course Introduction

This course encloses the basic understanding of wave mechanics from classical point of views with different physical aspects of mechanical and light waves.

Learning Outcomes

1. Understand basic principles of mechanics related to its applications on oscillating systems.
2. Understand the basic equation of wave in elastic medium and its properties.
3. Be able to solve relevant numerical problems.

Course Content

Week 1	Simple Harmonic Motion, Energy considerations in SHM
	Spring system and coupled pendulums
Week 2	Damped Vibrations, forced vibrations, Resonance, Phase of Resonance,
	Quality Factor. Mechanical waves
Week 3	Traveling waves, Phase velocity, Group velocity and dispersion
	Wave speed, Principle of superposition,
Week 4	Interference of wave, Standing wave
	Resonance. Sound Waves: Beats,
Week 5	The Doppler effect. Light Waves: Nature of light
	Speed of light in matter, Doppler effect for light

Week 6	Mirror and Lenses: Image formation by mirrors and Lenses,
	Plane mirror, spherical mirrors, spherical refracting surface
Week 7	Thin Lenses, Optical instrument.
	Interference: Coherence, double slit interference (analytical treatment)
Week 8	Interference from thin films, Newton's ring (analytical treatment),
	Michelson's interferometer.
Week 9	Fresnel's Biprism
	Single slit diffraction
Week 10	Intensity in single slit diffraction (analytical treatment)
	Double slit diffraction & interference combined
Week 11	Diffraction at circular aperture
	Diffraction from multiple slits
Week 12	Diffraction grating
	Dispersion and resolution power
Week 13	Definition of Polarization; polarizing sheet with mathematical discerption
	Polarization by reflection with some examples
Week 14	Polarization by double refraction
	Electromagnetic polarization
Week 15	Single slit polarization and double slits polarization
	Double scattering
Week 16	Polarization states
	Mechanical wave polarizations

Textbooks and Reading Material

Recommended Books:

1. Physics Vol.1 (4th edition), Halliday and Resnic, *John Wiley and Sons* (1992).
2. Physics Vol.1 (5th edition), Halliday and Resnic, *John Wiley and Sons* (2002).
3. Fundamentals of Physics (5th edition), Halliday & Resnic, *John Wiley and Sons* (1999).
4. Physics for Scientists and Engineers (extended version), P. M. Fishbane, *Prentice-Hall International Editions* (2016).
5. Classical Mechanics Simulations, Bruce Hawkins and Randall Jones, *John Wiley & Sons* (1995).

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. 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 Computational Physics	**Course Code**	**PHYS 1202**	**Credit Hours**	3
Course Title	**Thermal Physics**				

Course Introduction

This course encloses the basic physical understandings about thermodynamical laws and principles with applications.

Learning Outcomes

1. Study bulk properties of matters.
2. Study the laws of thermodynamics and its applications to simple system.
3. Be able to solve relevant numerical problems.

Course Content

Week 1	Bulk Properties of Matter: Elastic properties of matter;
	Elasticity; Tension; Compression & Shearing
Week 2	Elastic modulus; Elastic limit
	Poisson's ratio
Week 3	Relation b/w three types of elasticity.
	Fluid Statics and Dynamics
Week 4	Fluids; Pressure and density
	Variation of pressure in a fluid at rest
Week 5	Pascal and Archimedes principles
	surface tension; Viscosity
Week 6	Fluid flow, streamlines and equation of continuity

	Bernoulli's equation and its applications. problems.
Week 7	Entropy and Temperature:
	Thermal Equilibrium, temperature, entropy,
Week 8	Law of thermodynamics.
	Boltzmann distribution: Boltzmann factor,
Week 9	Pressure, Helmholtz free energy,
	Ideal gas. Chemical potential and Gibbs distribution:
Week 10	Definition of chemical potential,
	Gibbs factor and Gibbs sum; related examples and problems.
Week 11	Heat and work: Energy and entropy transfer,
	heat and work at constant temperature and pressure;
Week 12	Related examples
	Gibbs free energy and chemical reactions
Week 13	Gibb free energy, Equilibrium in reactions,
	Equilibrium for ideal gas
Week 14	Related examples and problems.
	Phase transformation
Week 15	Vapor pressure equation
	Van der wall equation of states
Week 16	Related examples and problems
	Landau theory of phase transition definitions of heat and work,

Textbooks and Reading Material

Recommended Books:

1. Physics Vol.1 (4th edition), Halliday and Resnic, *John Wiley and Sons* (1992).
2. Physics Vol.1 (5th edition), Halliday and Resnic, *John Wiley and Sons* (2002).
3. Fundamentals of Physics (5th edition), Halliday & Resnic, *John Wiley and Sons* (1999).
4. Thermal Physics (2nd edition) Charles Kittle and Herbert Kroemer, *W. H. Freeman company* (2000)
5. Thermal and Statistical Physics Simulations, Bruce Hawkins and Randall Jones, *John Wiley & Sons* (1995).

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. 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 (HONS) Computational Physics	**Course Code**	**PHYS 1203**	**Credit Hours**	1
Course Title	Physics Lab II				

Course Introduction

The course provides an introduction to with hands on for Mechanics, Oscillations, Waves and Optics. lab experiment in Lab

Learning Outcomes

The Lab will cover the experiment in Mechanics, Oscillations, Waves and Optics. After the completion of the Lab the students will be able to:

1. Verify the various laws of mechanics, wave and oscillation and optics.
2. Learns different techniques of analyzing and presenting scientific data.

Course Content

Week 1	Modulus of Rigidity by Static & Dynamics Methods (Maxwell's needle, Barton's Apparatus)
Week 2	Repeat
Week 3	To study the damping features of an oscillating system using simple pendulum of variable mass.
Week 4	Repeat
Week 5	Measurement of viscosity of liquid by Stoke's/Poiseuille's method.
Week 6	Surface tension of water by capillary tube method.

Week 7	Repeat
Week 8	To determine thermal emf and plot temperature diagram.
Week 9	Determination of temperature coefficient of resistance of a given wire.
Week 10	To determine Horizontal/Vertical distance by Sextant.
Week 11	The determination of wavelength of Sodium lines by Newton's Rings.
Week 12	Repeat
Week 13	The determination of wavelength of light/Laser by Diffraction grating.
Week 14	Repeat
Week 15	Determination of wavelength of sodium light by Fresnel's bi-prism.
Week 16	The determination of Resolving power of a diffraction grating.

Teaching Learning Strategies

The instructor is required to give a background of the theory relevant to the experiments, working of the equipment used. They are also required to submit a report including their data, results of fits, plots or results of any analysis method applied.

Assignments: Types and Number with Calendar

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

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 (HONS) Computational Physics	Course Code	PHYS 2301	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 and Gauss's Law. Electric current & density
Week 6	Ohm's law, microscopic view of Ohm's law. DC Circuits
Week 7	Calculating current in a single loop & multiple loops, Use of Kirchhoff's 1st and 2nd law, Thevenin and Norton theorems
Week 8	Transient behavior of RC circuit. Magnetic force on a charge particle and a current carrying wire, Torque on a current Loop
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

Week 16	Maxwell's Equations

Textbooks and Reading Material

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

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.

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 (HONS) Computational Physics	Course Code	PHYS 2302	Credit Hours	1
Course Title	**Physics Lab III**				

Course Introduction

Provides the basic knowledge and experiments in electricity, magnetism, and modern physics

Learning Outcomes

The Lab will cover the experiments related to electricity, magnetism, and modern physics. After the completion of the Lab students will be able to:

1. Verify the laws which are basis of modern physics.
2. Learns different techniques of analyzing and presenting scientific data.

Course Content

Week 1	Measurement of resistance using a Neon flash bulb and condenser.
Week 2	Conversion of galvanometer into Voltmeter & an Ammeter.
Week 3	Calibration of an Ammeter and a Voltmeter by potentiometer
Week 4	Charge sensitivity of a ballistic galvanometer.
Week 5	Comparison of capacitance by ballistic galvanometer
Week 6	To study the BH curve & measuring the magnetic parameters-1
Week 7	To study the BH curve & measuring the magnetic parameters-2
Week 8	Measurement of low resistance coil by a Carey Foster Bridge -1
Week 9	Measurement of low resistance coil by a Carey Foster Bridge -2
Week 10	Resonance frequency of an acceptor circuit.
Week 11	Study of the parameter of wave i.e. Amplitude, phase and time period of a complex signal by CRO -1
Week 12	Study of the parameter of wave i.e. Amplitude, phase and time period of a complex signal by CRO -2
Week 13	Measurement of self/mutual inductance
Week 14	Study of electric circuits by black box -1
Week 15	Study of electric circuits by black box -2
Week 16	Determining resistances using a Wheatstone bridge

Teaching Learning Strategies

The instructor is required to give a background of the theory relevant to the experiments, working of the equipment used. The students are also required to submit a report including their data, results of fits, plots or results of any analysis method applied. .

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 (HONS) Computational Physics	**Course Code**	PHYS 2302	**Credit Hours**	3
Course Title	Modern Physics I				

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, manifestation with examples
	Lorentz transformations and its applications
Week 2	Derivations of time dilation and length contraction.
	Twin paradox with examples
Week 3	Doppler effect and applications
	Transformation of velocity

Week 4	Relativistic Variation of mass
	Relativistic momentum and energy
Week 5	Energy Momentum Lorentz transformations
	Derivation of Energy mass relation.
Week 6	Black body radiation.
	Photo electric effect
Week 7	X-ray, X- ray diffraction.
	Compton effect
Week 8	Pair production.
	De Broglie's hypothesis,
Week 9	Davisson-Germer experiment
	Types of waves; Plan wave, Spherical waves
Week 10	Superposition principle, Wave packet, Phase, and group velocities.
	Phase and group velocities. Heisenberg's Uncertainty principle.
Week 11	Bohr's atomic model
	Energy levels and spectra, Laser
Week 12	Quantum mechanics: Introduction to Wave equation, Schrodinger equation (time dependent).
	Derivation of Schrodinger equation (time dependent)
Week 13	Linearity and Superposition, Operators, and expectation values.
	Schrodinger equation (time independent), Solutions of Schrödinger's equation in one dimension.
Week 14	Solutions of Schrödinger's equation in one dimension.
	A particle in a box, Finite potential well.
Week 15	Transmission and reflection by step and barrier potentials.
	Transmission and reflection by step and barrier potentials with examples
Week 16	Quantum tunneling and its applications in technology.
	Quantum harmonic oscillator

Textbooks and Reading Material

Recommended Books:

1. Concepts of Modern Physics (6th edition), Arthur Bieser, *McGraw-Hill Higher Education* (1994)
2. Physics Vol.1 (4th edition), Halliday and Resnic, *John Wiley and Sons* (1992)
3. Physics Vol.1 (5th edition), Halliday and Resnic, *John Wiley and Sons* (2002)
4. Modern Physics Simulation, R. Bigelow, J.R. Hiller and Moloney, *John Wiley and Sons* (1996)

5. Fundamentals of Physics (5th 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)

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. 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 (HONS) Computational Physics	**Course Code**	PHYS 2401	**Credit Hours**	3
Course Title	Modern Physics II				

Course Introduction

This course encloses the applications of quantum mechanical tools to study the various physical phenomenon on atomic scale and incorporates the basic understanding concerning radioactivity, nuclear physics, matter and energy relation at most fundamental and cosmological levels.

Learning Outcomes

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	Schrodinger equation for hydrogen atom.
	Quantum numbers: principal quantum number, orbital quantum number, magnetic quantum number.
Week 2	Radiative transitions, Selection rules

	Zeeman effect. Electron spin.
Week 3	Pauli's exclusion principle, Periodic table.
	Spin-orbit coupling, total angular momentum.
Week 4	X-ray spectra. Molecular bond
	Electron sharing, Hydrogen molecule, Complex molecules.
Week 5	Statistical distributions, Maxwell-Boltzmann statistics, quantum statistics.
	Raleigh-Jeans formula, Plank's radiation law.
Week 6	Specific heat of solids and examples
	Free electrons in metals with quantum mechanical descriptions
Week 7	Nuclear Physics: Binding energy, Binding energy per nucleon curve
	Radioactivity, Activity, and recovery
Week 8	Laws of radioactive decay in terms of activity and number atomics
	Half-life, Mean life
Week 9	Radioactive equilibrium and application
	Types of radioactive decays, Alpha, beta and gamma decays
Week 10	Displacement formula and isotopes
	Chain disintegration and examples
Week 11	Nuclear Reactions and their types
	Q-Value and calculation of Q-values nuclear reactions.
Week 12	Nuclear fission and basic process
	Nuclear fusion in stars and life cycle of a star
Week 13	Elementary particles: Leptons, Hadrons, Quarks
	Fundamental interactions and Quantum fields
Week 14	Introduction to the standard model of particle physics
	Cosmology and cosmological principles
Week 15	Hubble law and its application
	Big bang theory
Week 16	History of the universe, formations of stars and galaxies
	Cosmic ray microwave background

Textbooks and Reading Material

Recommended Books:

1. Concepts of Modern Physics (6^{th} edition), Arthur Bieser, *McGraw-Hill Higher Education* (1994)
2. Physics Vol.1 (4^{th} edition), Halliday and Resnic, *John Wiley and Sons* (1992)

3. Physics Vol.1 (5th edition), Halliday and Resnic, *John Wiley and Sons* (2002)
4. Modern Physics Simulation, R. Bigelow, J.R. Hiller and Moloney, *John Wiley and Sons* (1996)
5. Fundamentals of Physics (5th 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)

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. 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 (HONS) Computational Physics	Course Code	PHYS 2402	Credit Hours	1
Course Title	**Physics Lab IV**				

Course Introduction

Provides the basics of modern physics and optics through Lab work.

Learning Outcomes

The Lab covers the advance experiments in modern physics and optics. After the completion of the Lab students will be able to:

1. Verify the various result in modern physics, optics, and nuclear physics.
2. Learns different techniques of analyzing and presenting scientific data.

Course Content	
Week 1	Determination of e/m of an electron -1
Week 2	Determination of e/m of an electron -2
Week 3	Determination of e/m of an electron -3
Week 4	Ionization potential of mercury -1
Week 5	Ionization potential of mercury-2
Week 6	Ionization potential of mercury-3
Week 7	To study the characteristic curves of a G.M. counter and use it to determine the absorption co-efficient of Beta particle in Aluminum-1
Week 8	To study the characteristic curves of a G.M. counter and use it to determine the absorption co-efficient of Beta particle in Aluminum-2
Week 9	To study the characteristic curves of a G.M. counter and use it to determine the absorption co-efficient of Beta particle in Aluminum-3
Week 10	Determination of range of Alpha particles -1
Week 11	Determination of range of Alpha particles -2
Week 12	Determination of range of Alpha particles -3
Week 13	Mass absorption coefficient of Pb for gamma using G.M. counter-1
Week 14	Mass absorption coefficient of Pb for gamma using G.M. counter-2
Week 15	Mass absorption coefficient of Pb for gamma using G.M. counter -3
Week 16	Mass absorption coefficient of Pb for gamma using G.M. counter-4

Teaching Learning Strategies

The instructor is required to give a background of the theory relevant to the experiments, working of the equipment used, and the analysis of the experimental data using Mathematica/Maple/Python/Excel. The students are required to apply various analysis techniques including errors, fitting, and visualization etc. They are also required to submit a report including their data, results of fits, plots or results of any analysis method applied.

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 (HONS) Computational Physics	**Course Code**	**PHYS 2403**	**Credit Hours**	3
Course Title	**Basic Electronics**				

Course Introduction

This course is designed to provide the concepts of Semiconductors and their applications. Analysis of 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 basic principle of electronic circuits and electronics. Its objectives are as following.

1. Understanding basic principle of electric circuits and electronics.
2. Be able to solve relevant numerical problems.

Course Content

Week 1	Semiconductors: Classification of conductor, semiconductors, and insulators by Energy Band Theory
Week 2	P-type & N-type semiconductors such 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
Week 8	Model of transistor, Transistor biasing. Transistor as amplifier: Transistor as voltage, current and power amplifier.
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,
Week 16	Voltage multiplier circuits.

Textbooks and Reading Material

1. Electronic Principles (8^{th} edition), Paul Malvino, McGraw-Hill International (2015)
2. Electronics Circuits and Systems, J.D. Ryder, *Englewood Cliffs* (1976)
3. Electronics Devices, T.L. Floyd, *Prentice-Hall* (1996)
4. Electronic Devices and Circuit Theory, Boylestad and Nashhelsky, *Prentice-Hall* (1997)

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.

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 (HONS) Computational Physics	**Course Code**	**PHYS 3501**	**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
Week 8	Lagrange equations for nonholonomic constraints and Lagrange
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
Week 16	Solution of Hamilton-Jacobi DE for some elementary systems

Textbooks and Reading Material

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

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.

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 (HONS) Computational Physics	Course Code	PHYS 3502	Credit Hours	2
Course Title	**Physics Lab V**				

Course Introduction

The course provides an introduction to modern physics with hands on lab experiment in Lab

Learning Outcomes

The Lab covers the advance experiments in modern physics and optics. After the completion of the Lab students will be able to:

1. Verify the various laws in modern physics and optics.
2. Learns different techniques of analyzing and presenting scientific data.

Course Content

Week 1	Measurement of wavelengths of sodium light, difference of wave lengths and thickness of thin film e.g., mica using Michelson interferometer – 1
Week 2	Measurement of wavelengths of sodium light, difference of wave lengths and thickness of thin film e.g., mica using Michelson interferometer – 2
Week 3	The study of spectra using Fabry-Perot interferometers -1
Week 4	The study of spectra using Fabry-Perot interferometers -2
Week 5	The determination of Cauchy’s constants using spectrometer
Week 6	To study some aspects of Ferromagnetism by drawing B-H curve -1
Week 7	To study some aspects of Ferromagnetism by drawing B-H curve -1
Week 8	Measurement of speed of light using laser source rotating mirror method -1
Week 9	Measurement of speed of light using laser source rotating mirror method -2
Week 10	To measure the wave length of light by Fresnel biprism -1

Week 11	To measure the wave length of light by Fresnel biprism -2
Week 12	Study of sound with help of Noise-Level meter.
Week 13	To determine e/m of an electron using a fine beam tube -1
Week 14	To determine e/m of an electron using a fine beam tube -2
Week 15	To study the Hall effect in an n-type/p-type semiconductor or a metal-1
Week 16	To study the Hall effect in an n-type/p-type semiconductor or a metal -2

Teaching Learning Strategies

The students are required work on Optics and Modern Physics.

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 (HONS) Computational Physics	**Course Code**	**PHYS 3503**	**Credit Hours**	3
Course Title	**Digital Electronics**				

Course Introduction

Digital electronics is the foundation of all modern electronic devices such as cellular phones, MP3 players, laptop computers, digital cameras, high definition televisions, etc. Digital signals are more accurate and reliable than analog signals, as they are less susceptible to noise and interference. Digital signals can be easily stored, processed, and transmitted, as they are easy to represent with 1s and 0s. This course provides the detailed understanding of the principles and procedure of digital electronics.

Learning Outcomes

The course will introduce basic principles of digital electronics. Its objectives are as following.

1. Understanding fundamental principles of digital electronics.
2. Basic components of combinational and sequential logic.
3. Understand the components and functioning of processor logic design.

Course Content

Week 1	Review of characteristics of semiconductor diodes
Week 2	Transistors, and their simple applications
Week 3	Digital electronics: Binary and other number systems
Week 4	Boolean algebra, Boolean functions
Week 5	Digital logic gates. Simplification of Boolean functions: The map method, Product of Sums simplification, NAND and NOR simplification
Week 6	The tabulation method. Combinational logic, Adder and Subtractor
Week 7	Code conversion, Multilevel NAND and NOR circuits.
Week 8	Sequential logic: Flip flops, Flip flops excitation table
Week 9	Design of counter. Registers, Shift register, Ripple counter, Synchronous counter
Week 10	Timing Sequences, Memory unit. Register transfer logic
Week 11	Processor logic design: Processor organization,
Week 12	Arithmetic logic unit, Status register, Shifter, Accumulator.
Week 13	Control logic design: Control organization, Hard-Wired Control
Week 14	Microprogram control, Control of processor unit, PLA control. LabView
Week 15	Introduction to LabView, Virtual Instruments, Block Diagrams,
Week 16	Controls and indicators, Data Acquisition, Debugging

Textbooks and Reading Material

1. Digital Logic and Computer Design, M. M. Mano, *Prentice-Hall Inc* (1995).
2. Digital Fundamental (11th Edition) , T. L. Floyd, *Prentice-Hall* (2015).
3. Digital Electronics: Principles and Applications, R. Tokheim, *McGraw-Hill* (2013).
4. Digital Electronics, R. Dueck and K. Reid, *Cengage Learning* (2011).

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.

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 (HONS) Computational Physics	**Course Code**	**PHYS 3504**	**Credit Hours**	1
Course Title	**Electronics Lab**				

Course Introduction

Provides a basic understanding and hands on experience in working with measurements of voltage, current, resistance, Ohm's Law etc. and build an intuition about these electronics fundamentals.

Learning Outcomes

The Lab covers experiments in electronics. After the completion of the course students will be able to:

1. Develop and study characteristics of different electronics circuits.
2. Be able to use different instrument in the study of electronic circuits.

Course Content	
Week 1	Characteristics of a semiconductor Diode.
Week 2	To construct a power supply and study the rectified wave form, ripple factor and regulation (without regulator).
Week 3	To construct a voltage-regulated power supply with Zener diode.
Week 4	Characteristics of Transistors.
Week 5	To construct a single stage CE transistor voltage amplifier and study gain, input impedance, output impedance,
Week 6	Half power points by sine/square wave testing and effect of bias on the output and measurement of distortion.
Week 7	To construct a source follower FET voltage amplifier
Week 8	Study its gain, input impedance, output impedance, half power points by sine/square wave testing.
Week 9	To construct an R-C oscillator and compare it with a standard frequency.
Week 10	To construct a Hartley or Colpitts oscillator and measure it frequency.
Week 11	To construct and study the wave forms at the base and collector of the transistors of a free running a multi-vibrator.
Week 12	To construct and study of the height, duration and time period of the output pulses in a mono-stable and bi-stable multi-vibrator with reference to the input trigger.
Week 13	To construct from discrete components OR, AND, NOT and NAND circuits and verify their truth tables
Week 14	NOR, exclusive OR circuits and verify their truth tables.
Week 15	Study of wave shaping circuits of diode, integrators and differentiators.
Week 16	To construct the operational amplifier (741) by using discrete components and study its frequency response.

Teaching Learning Strategies
The instructor is required to give a background of the theory relevant to the experiments, working of the equipment used. The students are also required to submit a report including their data, results of fits, plots or results of any analysis method applied.
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 (HONS) Computational Physics	Course Code	PHYS 3601	Credit Hours	3
Course Title	**Electromagnetic Theory I**				

Course Introduction

The course introduces electromagnetic theory at undergraduate level.

Learning Outcomes

On the completion of the course, the students will:

1. Solve advance problems of electromagnetism.
2. Apply Maxwell's equation to explain various wave phenomena.
3. Solve simple problems of electrodynamics.
4. Introduce covariant form of Maxwell's equations.

Course Content

Week 1	Introduction of classical electrodynamics and its scope
	Electrostatics: Coulomb's law, the electric fields
Week 2	Divergence and curl of electric field

	Differential form of Gauss's law
Week 3	The electric flux, The electric potential
	Electric potential of charge distributions
Week 4	(Problem Solving)
	The electric dipole
Week 5	Multipole expansion
	Electric potential energy of system of charges
Week 6	Electric potential energy of a continuous distribution
	Potential energy stored in the electric field
Week 7	Poisson's and Laplace's equations
	Properties of solution of Laplace's equation
Week 8	Solution of Laplace's equation in 2D Cartesian
	Solution of Laplace's equation in polar coordinates
Week 9	(Problem Solving)
	Electrostatic Field in Dielectric Media
Week 10	Polarization
	Field outside a dielectric medium
Week 11	Electric field inside a dielectric
	Gauss's law in a dielectric, Electric susceptibility and dielectric constant
Week 12	Boundary conditions on the field vector at the interface b/w different medium
	(Problem Solving)
Week 13	Magnetostatics: Forces on a current carrying system
	Torque on a loop of wire
Week 14	Steady current, Equation of continuity.
	Biot and Savart law and its applications
Week 15	Divergence and curl of magnetic field
	Differential form of Ampere's law and Magnetic flux
Week 16	Magnetic vector potential and Coulomb's gauge
	Magnetic field of a distant circuit.

Textbooks and Reading Material

1. Classical Electrodynamics, Jackson, *Wiley* (1975).
2. Foundations of Electromagnetic Theory (4rd edition), Addison-Wesley (2008).
3. Introduction to Electrodynamics (2nd edition), D. Griffiths, *Prentice Hall* (1989).
4. Electromagnetic Theory, S. J. Adams, *Adams Press* (2008).

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. 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 (HONS) Computational Physics	Course Code	PHYS 4701	Credit Hours	3
Course Title	**Electromagnetic Theory II**				

Course Introduction
The course introduces electromagnetic theory at undergraduate level.
Learning Outcomes
On the completion of the course, the students will: 1. Solve advance problems of electromagnetism. 2. Apply Maxwell's equation to explain various wave phenomena. 3. Solve simple problems of electrodynamics. 4. Learn covariant form of Maxwell's equations.
Course Content

Week 1	Magnetic properties of Matter
	Magnetization
Week 2	Magnetic field produced by a magnetized material
	Magnetic scalar potential
Week 3	(Problem solving)
	Ampere's law in a magnetic material

Week 4	Magnetic intensity
	Magnetic susceptibility and permeability
Week 5	Ferromagnetism, Hysteresis
	(Problem solving)
Week 6	Boundary conditions on the field vector at the interface b/w different medium
	Faraday law of electromagnetic induction and its differential form.
Week 7	Energy density in the magnetic field.
	(Problem solving)
Week 8	Maxwell's Equations
	Poynting's theorem
Week 9	(Problem solving)
	Maxwell's equation in a material, General boundary condition of electromagnetic field.
Week 10	The wave equation of electromagnetic field in free space and its plane wave solutions.
	(Problem solving)
Week 11	Spherical waves
	Propagation of electromagnetic wave in a conductive material
Week 12	Reflection and refraction at the boundary of two non-conducting media (normal incidence)
	Reflection and refraction at the boundary of two non-conducting media (oblique incidence)
Week 13	Brewster's angle
	Reflection from a conducting plane
Week 14	The radiation from an oscillating dipole
	Parallel plate wave guide.
Week 15	(Problem solving)
	Covariant formulation Maxwell's equation
Week 16	(Continuing previous topic)
	(Problem solving)

Textbooks and Reading Material

1. Classical Electrodynamics, Jackson, *Wiley* (1975).
2. Foundations of Electromagnetic Theory (4rd edition), Addison-Wesley (2008).
3. Introduction to Electrodynamics (2nd edition), D. Griffiths, *Prentice Hall* (1989).
4. Electromagnetic Theory, S. J. Adams, *Adams Press* (2008).

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. 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 (HONS) Computational Physics	Course Code	PHYS 3602	Credit Hours	3
Course Title	Quantum Mechanics I				

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.
Week 8	Commuting operators and common eigenvectors.
	The parity operator. An even operator.
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.
	The 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.
Week 16	Spherical harmonics. Spin angular momentum; the Stern-Gerlach experiment.
	The matrix representation of spin half. Pauli spin matrices.
Textbooks and Reading Material	

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

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. 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 (HONS) Computational Physics	Course Code	PHYS 3603	Credit Hours	2
Course Title	**Physics Lab VI**				

Course Introduction

The course provides an introduction to with hands on for in modern physics and optics in Lab

Learning Outcomes	
The Lab covers the advance experiments in modern physics and optics. After the completion of the Lab students will be able to: 1. Verify the various laws in modern physics and optics. 2. Learns different techniques of analyzing and presenting scientific data.	
Course Content	
Week 1	To measure the critical potential of mercury by Frank-Hertz Method.
Week 2	Repeat
Week 3	To measure the Planck's constant by studying photoelectric effect.
Week 4	Repeat
Week 5	To measure work function of metal and verification of Richardson's equation.
Week 6	Determination of dielectric constant of liquid and solid.
Week 7	To determine the characteristic of G. M. tube and measure the range and maximum energy of beta particles.
Week 8	Measurement of half-life of radioactive source.
Week 9	Characteristics of G.M. counter and study of fluctuations in random process.
Week 10	To determine the charge of an electron by Millikan's oil drop method.
Week 11	Repeat
Week 12	Repeat
Week 13	To determine half-life of radiative element.
Week 14	Repeat
Week 15	To study random fluctuations in decay rate of unstable nucleus.
Week 16	To study inverse square law of radiation propagation.
Teaching Learning Strategies	
The instructor is required to give a background of the theory relevant to the experiments, working of the equipment used. They are also required to submit a report including their data, results of fits, plots or results of any analysis method applied.	
Assignments: Types and Number with Calendar	

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

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 (HONS) Computational Physics	**Course Code**	PHYS 4702	**Credit Hours**	3
Course Title	Quantum Mechanics II				

Course Introduction

This course extends the usage of the formalism of quantum mechanics to 3D problems, many-body applications, approximation methods and scattering theory.

Learning Outcomes

On the completion of the course, the students will:

1. Solving the central potential problems.
2. Study of system of identical particles.
3. Work in approximation methods in quantum mechanics.

Course Content

Week 1	The central potential; solution of stationary states in central potential.
	Reducing two body problem into one body. The radial Schrodinger equation.
Week 2	Hydrogen atom. Stationary states of hydrogen atom.
	Quantum numbers. Energies and state functions of the hydrogen atom.
Week 3	Shells and subshells in a hydrogen atom.
	Addition of angular momenta.
Week 4	Spin triplet and spin singlet combinations of two spin halves.
	Identical particles. Indistinguishability of identical particles.

Week 5	Systems of identical particles; symmetric and anti- symmetric states functions.
	The Pauli's exclusion principle.
Week 6	Approximation methods.
	Time independent perturbation theory, non-degenerate first order energy.
Week 7	First order perturbation to an eigenfunction and second order energy.
	The degenerate perturbation theory.
Week 8	Applications of time independent perturbation theory.
	The variational method.
Week 9	Approximate values for the energies of first few excited states.
	The WKB approximation-I.
Week 10	The WKB approximation-II.
	Time dependent perturbation theory-I.
Week 11	Time dependent perturbation theory-II.
	The transition probability, general formalism.
Week 12	Transition probability for constant perturbation.
	Scattering theory in quantum mechanics.
Week 13	Differential and total cross section.
	The lab and CM Cross sections.
Week 14	Scattering amplitude of spinless particles.
	The relation of scattering amplitude to differential cross section.
Week 15	The Born approximation.
	Validity of the first Born approximation.
Week 16	Partial wave analysis for elastic scattering.
	Partial wave analysis for inelastic scattering.

Textbooks and Reading Material

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

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. 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 (HONS) Computational Physics	**Course Code**	PHYS 4703	**Credit Hours**	3
Course Title	**Statistical Physics**				

Course Introduction

The course introduces Thermal and Statistical Physics at undergraduate level

Learning Outcomes

On the completion of the course, the students will:

1. Basic principles of equilibrium thermodynamics.
2. Basic principles of statistical mechanics.
3. Study of partition function and different statistical systems.

Course Content

Week 1	Equilibrium Thermodynamics
	Thermodynamical quantities
Week 2	The laws of thermodynamics
	Equations of state of an ideal gas
Week 3	Specific heats
	Maxwell relations and their applications
Week 4	(Continuing)

	Elements of Probability Theory: Probabilities and its laws
Week 5	Probability distributions; binomial distribution; Gaussian distribution.
	Formulation of Statistical Mechanics
Week 6	Micro and macro states of system
	counting the states of a system (harmonic oscillators, ideal gas)
Week 7	micro canonical system
	Thermal and mechanical interactions in statistical physics
Week 8	absolute temperature and equations of state
	Derivation of laws of thermodynamics
Week 9	System in contact with heat reservoir and canonical ensemble
	Partition Function
Week 10	Partition function and its relationship with thermodynamical variables
	Examples ideal gas
Week 11	Collection of simple harmonic oscillators
	Pauli and Van Vleck paramagnetization
Week 12	Theorem of equipartition of energy
	Classical Statistics: Maxwell-Boltzmann distribution
Week 13	Quantum Statistics:
	Bose-Einstein distribution
Week 14	Fermi- Dirac and Planck's distributions
	Back body radiations
Week 15	Bose-Einstein condensation
	Gas of electrons in solids
Week 16	Description of phase transitions in statistical physics and its types
	Ising model

Textbooks and Reading Material

1. Fundamental of Statistical and Thermal Physics, R. Reif, *McGraw-Hill* (1988).
2. Elementary Statistical Physics, C. Kittle, *Dover Publications* (1958).
3. Statistical and Thermal Physics, H. Gould and I. Tobochnik, *Princeton University Press* (2010).
4. Statistical Physics, Gregory H. Wannier, *Dover Publications*, *Inc.*, *New York* (1987).

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. 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 (HONS) Computational Physics	Course Code	PHYS 3602	Credit Hours	3

Course Title	Solid State Physics I

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. In addition, 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

Week 3	Fundamental types of lattices
Week 4	Index system for crystal planes
Week 5	Simple crystal structures
Week 6	Direct imaging of atomic structure; Non-ideal crystal structure; Random Stacking and Polytypism
Week 7	Reciprocal Lattice: Diffraction of waves by crystals
Week 8	Scattered wave amplitude; Brillouin zones
Week 9	Fourier analysis of the basis
Week 10	Crystal Binding and Elastic Constants: Crystal of Inert Gases
Week 11	Ionic Crystals; Covalent crystals; Metals; Hydrogen Bonds
Week 12	Atomic Radii; Analysis of elastic strains
Week 13	Elastic compliance and stiffness constants; Elastic waves in cubic crystal
Week 14	Crystal Vibrations: Vibrations of crystals with a monatomic basis
Week 15	Two atoms per primitive basis; Quantization of elastic waves
Week 16	Phonon momentum; Inelastic scattering by phonons

Textbooks and Reading Material

1. Introduction to Solid State Physics (7th Edition), C. Kittle, *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, *Thomson Press (India)*, 2003).
5. Solid State Physics (2nd Edition), G. Grosso, 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.

Assignments: Types and Number with Calendar

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

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 (HONS) Computational Physics	Course Code	PHYS 4801	Credit Hours	3
Course Title	**Solid State Physics II**				

Course Introduction

The physics of the electronic structure of solids is fundamental to understanding the properties of solids. This course provides valuable theoretical knowledge to determine the electronic structure of solids and their properties. The course also includes a theoretical description of different approaches to determining the electronic band structure of solids. The course also involves the theory of lattice dynamics and properties of different materials (metals, semiconductors, dielectrics, magnetic materials, and superconductors) which are based on the classical and quantum physics phenomenon.

Learning Outcomes

The course mainly deals with the Physics of the electronic structure of solids and the properties of solids. With the completion of this course, students will be able to:

1. Understanding the electronic structure of solids.
2. Obtaining knowledge of different approaches to determine the electronic structure of solids
3. Determining the thermal properties of solids.
4. Understanding the band theory and semiconductor physics.
5. Familiarizing the computation techniques in solid state physics.

Course Content

Week 1	Thermal Properties: Phonon heat capacity (Plank Distribution, Normal Mode Numeration, Density of States in one dimension)
Week 2	Density of States in three dimensions; Debye Model for Density of states; Einstein Model of the Density of states
Week 3	Inharmonic crystal interactions; Thermal conductivity; electronic heat capacity

Week 4	Free Electron Theory: Energy levels in 1D; Effect of Temperature on the Fermi-Dirac distribution
Week 5	Free electron Gas in 3D; Heat capacity of the electron gas
Week 6	Electrical conductivity and Ohm's law; Motion in a magnetic field
Week 7	Hall Effect; Thermal conductivity of metals
Week 8	Band Theory: Nearly free electron model
Week 9	Bloch function; Kronig-Penney model
Week 10	Wave equation of electron in a periodic potential
Week 11	Number of orbital in a band: Metals and Insulators
Week 12	Semiconductor: Theory of semiconductors; Extrinsic semiconductors
Week 13	Mobility of current carriers; Minority carriers; Lifetime; Surfaces; Contacts;
Week 14	Semiconductor devices.
Week 15	Computational Techniques: Hartee-Fock Methods
Week 16	Density Functional Theory and LAPW method

Textbooks and Reading Material

1. Introduction to Solid State Physics (7th Edition), C. Kittle, *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, *Thomson Press (India)*, 2003).
5. Solid State Physics (2nd Edition), G. Grosso, G. P. Parravicini, Academic Press (2013).

Teaching Learning Strategies

The instructor is required to make use of visualization/animations as well as 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.

Assignments: Types and Number with Calendar

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

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 (HONS) Computational Physics	**Course Code**	PHYS 4802	**Credit Hours**	3
Course Title	**Nuclear Physics**				
Course Introduction					
The course introduces Nuclear and Particle Physics at undergraduate level.					
Learning Outcomes					
On the completion of the course, the students will: 1. Learn different nuclear models and explain the nuclear properties. 2. Theory of nuclear forces and its application to different nuclear processes. 3. Theories of radioactive decay. 4. Study of different mechanics of particles acceleration and detections. 5. Introduction of reactor physics. 6. Introduction of elementary particles and their interaction.					
Course Content					
Week 1	Discovery of nucleus and its basic properties				
	Differential and total cross sections				
Week 2	Rutherford and Mott's formula				
	Nuclear form factor				
Week 3	Study of size of nucleus through electron experiments				
	Study of size of nucleus through neutron scattering experiment and Optical Model				
Week 4	The isotope shift method				
	X-ray spectroscopy of muonic atoms				
Week 5	The properties of stable nuclei				
	Characteristics of experimental curve of binding energy per nucleon				

Week 6	Liquid drop model
	Comparison of experimental and theoretical curves of binding energy per nucleons
Week 7	Decay modes of unstable nuclei
	Q value analysis of alpha and Energy level diagram
Week 8	Q value analysis of beta decay and Energy level diagrams
	Spontaneous fission.
Week 9	Total angular momentum of odd and even nuclei
	Magnetic moment, nuclear magneton
Week 10	Schmidt model
	Parity of a nucleus
Week 11	Shell model: Nuclear magic numbers
	Spin- orbit coupling and energy level diagram of states of a nucleus
Week 12	Obtaining nuclear magic number from energy level diagram
	Gamow theory of alpha decay.
Week 13	Derivation of formula of decay constant of a alpha decay
	Nuclear Reactions and types
Week 14	Bohr's theory of compound nucleus and its limitations
	Breit-Wigner formula
Week 15	Interaction of nuclear radiation with matter
	Photographic emulsions; Gas-filled detectors; Scintillation counters and solid-state detectors
Week 16	Classification of elementary particles, Fundament interactions.
	The quark model

Textbooks and Reading Material

Textbooks

1. Nuclear and Particle Physics (2nd edition), Burcham, E. E. and Jobes, M., Longman, *John Wiley & Sons* (1995).
2. Introduction to Nuclear and Particle Physics, Das, A. and Ferbel, T., *John Wiley and Sons* (1994).
3. Nuclear and Particle Physics, Williams, W.S.C., *Oxford University Press* (1995).
4. Elementary Particle Physics by D. Griffiths, *John Wiley and Sons* (1987).
5. Nuclear and Particle Physics Simulations, Michael J. Moloney & Roberta Bigelow, *John Wiley & Sons* (1996).

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. 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 (HONS) Computational Physics	**Course Code**	PHYS 4804	**Credit Hours**	3
Course Title	**Particle Physics**				

Course Introduction

The course introduces particle physics at undergraduate level.

Learning Outcomes

On the completion of the course, the students will:

1. Learn properties of fundamental particles from historical perspective.
2. Studying the probes in high energy physics.
3. Symmetries and their applications.

Course Content

Week 1	Historical Introduction to Particle Physics
	Elementary particles and fundamental forces
Week 2	Antiparticles
	Mesons
Week 3	Neutrinos
	Lepton and baryon numbers
Week 4	Strange particles and strange quantum number

	Eightfold way
Week 5	Quark model
	Natural system of units
Week 6	(Problem solving)
	Modern particle colliders and detector
Week 7	(Continuing)
	Nature of the experimental data in particle physics
Week 8	Decay rates
	Differential and total cross-sections
Week 9	Continuous and discrete symmetries
	Space-time symmetries in quantum mechanics and the laws of conservation
Week 10	Consequences of symmetries
	Translational and rotation symmetries
Week 11	Parity and its violation in weak interaction
	Internal symmetries
Week 12	Charge conjugation and C parity
	Isospin symmetry and its application
Week 13	CP violation
	(Problem solving)
Week 14	Quantum fields
	The standard model of particle physics
Week 15	Higgs mechanism.
	Incompleteness of the standard model
Week 16	Dark matter, matter-antimatter asymmetry
	Beyond the standard model (BSM) theories.

Textbooks and Reading Material

Textbooks.

1. Introduction to elementary particles, D. Griffiths, *John Wiley & Sons* (1987).
2. Quarks and leptons, F. Halzen and A. D. Martin, *John Wiley & Sons* (1984).
3. Special Relativity: Applications to Particle Physics and Classical Theory of Fields, M. Saleem and M. Rafique, *Ellis Horwood* (1992).
4. A Modern Introduction to Particle Physics, Riazuddin and Fayyuddin, *World Scientific* (1992).
5. Quantum Mechanics, Thankapan, *John Wiley India* (1993).
6. Introduction to High Energy Physics, D. H. Perkins, *Addison Wesley* (2000).

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. 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 (HONS) Computational Physics	Course Code	PHYS 4803	Credit Hours	3
Course Title	Detector Physics				

Course Introduction

This course deals with mainly the interaction of microscopic particles (radiation) with the material through which they pass. The detailed mechanisms/processes involved during such interaction are to be focused in this course. Devices called detectors which are used to measure the effects of interaction, will be detailed out along-with their applications. Learning of such course will develop necessary knowledge in the student minds so that they can excel in different fields such as High Energy Physics, Medical Physics, Material Physics, Space Physics etc.

Learning Outcomes

Following objectives are expected at the end of this course:

1. Learning of different of mechanism of energy loss of radiation in matter.
2. Learning of working principles and applications of particles detector.

Course Content

Week 1	Course Introduction involving its scope and applications, etc.
	Energy loss by radiation through ionization and excitations
Week 2	Bohr's Classical formula for energy loss
	Bethe-Bloch formula for energy loss

Week 3	Bremsstrahlung, Interactions of photons	
	Ionization counter	
Week 4	Proportional counters	
	Geiger counter	
Week 5	Scintillation counters, Photomultipliers and photodiodes	
	Cherenkov counters	
Week 6	Cloud chambers, Bubble chambers	
	Multiwire proportional chambers	
Week 7	Drift chambers	
	Time-projection chambers	
Week 8	Semiconductor track detectors	
	Electromagnetic calorimeters	
Week 9	Electron-photon cascades	
	Homogeneous calorimeters	
Week 10	Sampling calorimeters	
	Hadron calorimeters	
Week 11	Charged-particle identification	
	Time-of-flight counters	
Week 12	Identification by ionization losses	
	Neutron detection	
Week 13	Introduction to Detector Simulation Softwares; GEANT4(GEometry ANd Tracking 4)	
	Installation Details of GEANT4 and Its Allied softwares	
Week 14	Simulation categories of GEANT4	
	Geometrical construction of detectors in GEANT4	
Week 15	Material definitions in the detector geometry in GEANT4	
	Defining Physics Processes and Particles in GEANT4	
Week 16	GAENT4 Action Classes	
	Execution of particle passage through a simple detector; An example	

Textbooks and Reading Material

Recommended Books:

1. Particle Detectors (2nd Edition), C. Grupen and B. Shwartz, *Cambridge Monographs on Particles Physics, Nuclear Physics and Cosmology* (2008).
2. Radiation Detection and Measurements (2nd edition), G. F. Knoll, *John Willey* (1989).
3. Introduction to High Energy Physics (3nd edition), D. Perkins, *Addison-Welsey* (1987).

4. Techniques for Nuclear and Particle Physics Experiments (2nd edition), W. R. Leo, *Springer-Verlag* (1994).
5. Instrumentation in High Energy Physics, Sauli, *World Scientific* (1993)
6. Review of Particle Properties, Phys. Rev. D 98, 030001 (2018).

Softwares:

GEANT4 and its Allied Softwares, Website: https://geant4.web.cern.ch/

Teaching Learning Strategies

1. The instructor will detail out the concepts particle interaction with matter, starting with basic examples
2. The instructor will use detector simulation softwares such as GEANT4 for trying out effective explanations of the concepts of particle interactions
3. Students will need to solve particle interaction exercise problems in the suggested textbooks
4. For better understanding of the concepts of particles and detectors, students should install and learn the sophisticated software of GEANT4

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. 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 (HONS) Computational Physics	**Course Code**	PHYS 4804	**Credit Hours**	3
Course Title	Accelerator Physics				

Course Introduction

This course deals with the electromagnetic devices which are used for accelerating different types of particles. There are different types of particle accelerators which will be discussed in detail. This course is of paramount significance in the field of High Energy Physics, radiation physics, etc.

Learning Outcomes

Following objectives are expected at the end of this course:

1. Learning of the physics of particle accelerator and related phenomena.

2. Learning the related electronics coupled with design of particle accelerators.

Course Content	
Week 1	Course Introduction involving its scope and applications, etc.
	Historical Developments of accelerators
Week 2	Layouts and Components of Accelerators
	Accelerator Applications
Week 3	Hamiltonian for particle motion in accelerators
	Linear accelerators
Week 4	Circular accelerators.
	Betatron accelerator
Week 5	Effect of linear magnet imperfections
	Off-momentum Orbits
Week 6	Chromatic aberration
	Linear coupling
Week 7	Nonlinear resonances
	Collective instabilities
Week 8	Landau Damping
	Synchrotron Motion
Week 9	Longitudinal equation of motion
	Adiabatic synchrotron motion
Week 10	RF Phase and voltage Modulations
	Non-adiabatic and nonlinear synchrotron motion
Week 11	Beam manipulation in synchrotron phase space
	Fundamentals of RF systems
Week 12	Longitudinal collective instabilities
	Famous Accelerators of the world
Week 13	A discussion on cosmological accelerator
	Large Electron Positron Collider (LEPC)
Week 14	Large Hadron Collider (LHC)
	Beijing Electron Positron Colliders
Week 15	Future Colliders
	International Linear Collider (ILC)
Week 16	Circular Electron Positron Collider (CEPC)

	Super Proton Proton Collider (SPPC)

Textbooks and Reading Material

Recommended Books:

1. Accelerator Physics (3rd edition), S. Y. Lee, *World Scientific Publishing* (2012).
2. An Introduction to the Physics of High Energy Accelerators, D. A. Edwards and M. J. Syphers, *John-Wiley & Sons* (2008).
3. Introduction to the Physics of Particle Accelerators, Mario Conte and William W Mackay, *World Scientific* (1991).
4. Particle Accelerator Physics, Helmut Wiedemann, *Springer* (1993).

Teaching Learning Strategies

1. The instructor will detail out the concepts particle acceleration
2. The students will practice the accelerator concepts by solving exercise problems in the recommended books

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. 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 (HONS) Computational Physics	**Course Code**	**PHYS 4805**	**Credit Hours**	3
Course Title	**Non-linear Physics**				

Course Introduction

This course encloses basic understandings about the nonlinear interacting physical systems, their integrability without approximations and their physical applications.

Learning Outcomes

1. Physical understanding of non-linear interacting systems.

2. Physical features of solitons from application point of view (nonlinear optical fibre)
3. Learn the related application to chaotic systems.

Course Content	
Week 1	Introduction to nonlinear physical systems
	Nonlinear oscillators, Pendulum, Duffing oscillator
Week 2	Van der Pol oscillator, Forced nolinear oscillators
	Determination of dynamical systems and state space
Week 3	Classifications of dynamical systems
	Chaos and randomness
Week 4	Fractals and Solitons
	Dissipative versus conservative dynamical systems
Week 5	Stability analysis
	De-dimesionalization and examples
Week 6	Lyapunov exponents
	Chaos in the logistic map,
Week 7	The Lorenz model
	Invariants, Attractors
Week 8	Bifurcation
	chaotic attractors Models and applications
Week 9	Simulations and scaling
	Origin of soliton, Types of solitons
Week 10	Derivation of solitoinc equation
	The KdV solitons
Week 11	Coupling oscillators,
	Periodic solutions : soliton trains
Week 12	Solitary wave solutions
	Nonlinear Riccati equation
Week 13	Nonlinear Schrodinger (NLS) equations
	Hamiltonian formalism
Week 14	Mechanical linearization
	Solitonic solutions of NLS equation
Week 15	Bright and dark solitons

	Simulations, Hamiltonian form of Painlevé II (P-II) equation
Week 16	P-II equation as integrable model in nonlinear electrostatic system
	P-II equation and rational solutions.

Textbooks and Reading Material

Recommended Books:

1. An Introduction to Nonlinear Physics, Liu Lam, Springer, New York (2003)
2. Nonlinear Partial Differential equations for Scientists and Engineers, L. Debnath, *Springer* (1997).
3. Darboux Transformations in Integrable Systems, Gu Chaohao, Hu Hesheng, Zhou Zixiang *Springer* (2005).
4. Solitons: An Introduction, P. G. Drazin and R. S. Johnson, *Cambridge University Press* (1989).
5. The Direct Methods in Soliton Theory, R. Hirota, *Cambridge University Press* (2004).
6. Mechanics, From Newton's Laws to Deterministic Chaos, (6th edition) *Springer, Florian Scheck* (2018).

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. 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 (HONS) Computational Physics	**Course Code**	PHYS 4806	**Credit Hours**	3
Course Title	**Relativity and Cosmology**				

Course Introduction

The course introduces special and general relativity and basic cosmology at undergraduate level.
Learning Outcomes
On the completion of the course, the students will: 1. Study basic principles of special and general relativity. 2. Cover the related mathematical concepts. 3. Study some basic application of relativity to Black-hole physics and cosmology.

Course Content

Week 1	Space-Time Formalism of Special Relativity
	Lorentz Transformation
Week 2	Minkowski spacetime and the light-cone line element
	Four-Vectors, Four Velocity and Momentum
Week 3	(Problem Solving)
	Relativistic Kinematics
Week 4	Force Equation in Relativity
	Law of Conservation of 4-Momentum
Week 5	(Problem Solving)
	Covariant Form of Maxwell's Equations: Four-vector potential
Week 6	Field Stress Tensor
	Maxwell's Equation in Covariant Form.
Week 7	(Problem Solving)
	Curved Manifold
Week 8	Contravariant and Covariant Vectors,
	the Metric
Week 9	Geodesics and the Geodesic Equation
	the Christoffel Symbols
Week 10	Curvature
	Covariant Derivative
Week 11	Parallel Transport
	The Riemann Curvature Tensor
Week 12	Ricci Tensor
	General Relativity: Principle of Equivalence
Week 13	Tidal Gravitational (Newtonian) Forces
	Einstein's Field Equations

Week 14	Introducing the Schwarzschild Metric (without fully deriving it as a Solution to the Einstein Field Equation).	
	Experimental proves general relativity.	
Week 15	Expansion of the universe and Hubble's law	
	Freidman equations	
Week 16	Black hole	
	Hawking radiation	

Textbooks and Reading Material

Textbooks.

1. Gravity, An Introduction to Einstein's General Relativity, James B. Hartle, *Addison-Wesley* (2003).
2. Introducing Einstein's Relativity, R. D'Inverno, *Oxford University Press* (1992)
3. Dynamics and Relativity, W. D. McComb, *Oxford University Press* (1999)
4. A First Course on General Relativity, Bernard Schutz, *Cambridge University Press* (2009).
5. Relativity Demystified, David McMahon, *McGraw-Hill*, (2006).

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. 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 (HONS) Computational Physics	Course Code	COMP 1101	Credit Hours	3
Course Title	**Introduction to Computing**				

Course Introduction
This course provides an overview to number representation, hardware architecture, operating systems, databases, some computing models, languages and grammars, software development and engineering and networking techniques and necessary concept of development of software, called computer programming.

Learning Outcomes
The course introduces the subject of Computer Science. Its objectives are as following. 1. Studying the history of computer and its applications. 2. Studying the architects of computer and various operating systems. 3. Learn to use the word processor and graphics packages. 4. Learning the basics of programing in Python.

Course Content	
Week 1	Introduction: Architects of computer: CPU
Week 2	Motherboard, RAM, ROM, Storage devices, IO devices,
Week 3	Networking.
Week 4	Operating systems: Windows and Linux. Linux terminal and shell commands,
Week 5	Computer Software's: MS Office including Word, Excel, and Power point.
Week 6	Introduction to computer programing. History of programing,
Week 7	Type of programing languages, Installing Python,
Week 8	Variable and datatypes:
Week 9	Variables and constants,
Week 10	Data types: Integer, float, string, logical, list, tuple, sets.
Week 11	User input and output, String formatting,
Week 12	Operations on lists, Arithmetic operation. Control structures: Conditional, loops,
Week 13	Defining and calling a function. Passing a function to another function.
Week 14	Scope of variables, File handling, Reading, and writing data on files.
Week 15	Modules including NumPy, math, and matplotlib,

Week 16	Problem analysis, Algorithm, Flow chart.

Textbooks and Reading Material

1. Introduction to Computers (6th edition), Peter Norton, *McGraw-Hill* (2006).
2. Mastering Office 2010, Microsoft Press.
3. Introduction to Computers, D. W. Hajek, *CreateSpace Independent Publishing Platform* (2017)
4. Introduction to Computing Systems: From Bits and Gates to C and Beyond (2nd Edition), Y. N. Pat and S. J. Patel, *McGraw-Hill* (2003)
5. Python Crash Course: A Hands-On, Project-Based Introduction to Programming, by Eric Matthes (2019)

Teaching Learning Strategies

The instructor is required to make use of computer to demonstrate the concepts and Python to teach the basic concepts and working. 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.

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 (HONS) Computational Physics	**Course Code**	COMP 3501	**Credit Hours**	3 (2+1Lab)
Course Title	Computer Programming				

Course Introduction

The Computer Programming course is a gateway to the dynamic world of programming languages and software development. It covers data types, variable types, control structures, arrays, functions, pointers, user-defined data types, inheritance and object-oriented programming, and parallel programming with MPI. By the end of the course, students will have

a solid grasp of programming fundamentals and be well-prepared for diverse coding endeavors, from software development to scientific computing.
Learning Outcomes
The course introduces the subject of Computer Programming. Its objectives are as following. 1. Studying the basic concepts of computer programming. 2. Learning to develop algorithms and its translation into programs. 3. Get familiar with programming Languages like C, C++, FORTRAN 90/Python etc. 4. Learning Debugging and testing programs and its documentation.
Course Content

Week 1	Introduction to Flow charts
	Flow charts of different Problems
Week 2	Introduction to Algorithm
	Algorithm of different problems
Week 3	Programming Languages: Introduction to C, C++, C#, and Python:
	Pre-processors, Code Editors, Compiler, Executor and Error handling
Week 4	Data types, Variable types,
	Control structure: Selection Statements
Week 5	Iteration/loop (For)
	Iteration/loop (while)
Week 6	Iteration/loop (Do-while)
	Programs through For, while, and Do-while loops
Week 7	(Problem Solving)
	(Problem Solving)
Week 8	One Dimensional Arrays
	Two Dimensional Arrays
Week 9	Functions
	Programs of different problems through functions
Week 10	Pointers, Pointer of a functions
	User-defined data types, Structures; Defining a structure, Defining a structure variable
Week 11	structures within structures, structures as arguments of functions
	Defining a class, creating objects of classes, Calling member functions of classes
Week 12	Constructors and Destructors, Constructor overloading,
	Objects as arguments, Returning objects from functions, static classes, Static class data types,
Week 13	Inheritance; Derived and base classes, Types of inheritance, Accessing base class members

	Abstract and concrete classes, Single and multiple inheritance, Ambiguity in multiple inheritance
Week 14	Virtual functions, Abstract classes, and virtual functions,
	Friend functions, Friend classes
Week 15	Static functions
	Accessing class members with pointer
Week 16	Introduction to parallel programming with MPI
	Programming with MPI

Textbooks and Reading Material

1. C Programming Language (2nd Edition), B. W. Kernighan, *Prentice Hall* (1988).
2. C++ How to program (9th edition), Paul Dietel and Harvey Dietel, *Pearson Education, Inc.* (2013).
3. Object Oriented Programming Using C++ (4th edition), Robert Lafore, *Sams Publishing* (2004).
4. Programming with C (2nd edition) Schaum Outlines Series, B. S. Gottfried, *McGraw Hill Press* (1996).
5. Fluent Python: Clear, Concise, and Effective Programming" by Luciano Ramalho (2015)

Teaching Learning Strategies

The instructor is required to make use of FORTRAN/C/C++/Mathematica/Python/C# 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 (HONS) Computational Physics	Course Code	COMP 3502	Credit Hours	3
Course Title	Scientific Computation				

Course Introduction

The Computer Programming course offers a thorough investigation of Mathematica and Python-based mathematical computing. The course prepares students for more difficult programming problems by covering math, variables, lists, expressions, patterns, and replacement rules. The construction of functions, data visualization, symbolic and numerical computations, and the solution of linear and nonlinear equations are all covered in the course. The ability to execute accurate numerical computations and simplify algebraic statements will be taught to students. They will also gain knowledge of methods for solving differential equations symbolically as well as how to handle complicated mathematical problems utilizing vectors, matrices, and tensors. Data file reading and writing procedures, output formats, and input and output activities are all covered in the course. By the end, pupils will be adept math and science problem solvers.

Learning Outcomes

The course introduces the subject of scientific computing. Its objectives are as following.

1. Studying the concepts of computer arithmetic and approximations in computing.
2. Getting experience of working with different problem-solving environments.
3. Getting experience of working with different Scientific Libraries.

Course Content

Week 1	Building Blocks of Mathematica
	Arithmetic, Variables
Week 2	Lists, Expressions, Patterns
	Replacement Rules, Programming;
Week 3	Functions
	Visualization in Mathematica/Python: Graphics, Plotting Functions, Plotting Data, Animating Graphics
Week 4	(Problem Solving)
	Symbolic vs numerical calculations,
Week 5	Differentiations
	Integration
Week 6	Power Series
	Solving linear and nonlinear equations
Week 7	Simplifying Algebraic Expressions
	Numerical Calculations
Week 8	Types of Numbers, Precision and Accuracy, Numerical Functions
	Root finding, Finding the Minimum of a Function
Week 9	Numerical Integration, Sums and Products

	Interpolations functions, Curve Fitting
Week 10	Computation with Vectors Matrices
	Tensors
Week 11	Gradient, Divergence, Curl
	Solving Differential Equations, Symbolic Solutions,
Week 12	Series approximations
	Laplace transformation, Inverse Laplace transformation
Week 13	Variation of parameters
	Variation of parameters examples
Week 14	Numerical Solutions, Inhomogeneous Boundary Values Problem
	(Problem Solving)
Week 15	Shooting Method
	Shooting Method example
Week 16	Input and Output Operations
	Output formats, Reading and Writing data files

Textbooks and Reading Material

1. Scientific Computing: An Introductory Survey, M. Heath, *McGraw-Hill International Edition* (1997).
2. Mathematica for Scientists and Engineers, Thomas B. Bahder, *Addison-Wesley* (1995).
3. Introduction to Scientific Computing (1st edition), Brigitte Lucquin, *John Wiley & Sons* (1998).
4. Numerical Recipes in C: The Art of Scientific Computing (2nd Edition), W. H. Press, B. P. Teukolsky, W. T. Vetterling, *Cambridge University Press* (1992).

Teaching Learning Strategies

The instructor is required to make use of FORTRAN/C/C++/Mathematica/Python/C# 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 (HONS) Computational Physics	**Course Code**	COMP 3601	**Credit Hours**	3
Course Title	Numerical Analysis				

Course Introduction

This course introduces the numerical analysis technique, An area of mathematics and computer science that is used to creates, analyzes, and implements algorithms for obtaining numerical solutions to problems involving continuous variables.

Learning Outcomes

The course introduces the subject of numerical analysis. Its objectives are as following.

1. Studying different methods of numerical differentiation and integrations.
2. Learning different numerical methods of solving ordinary differential equations and partial differential equations.
3. Numerical study of boundary and characteristic value problems.
4. Get experience of developing computer programs to implement various numerical methods.

Course Content

Week 1	Numerical Differentiation and Integration: Getting Derivatives and Integrals Numerically, Derivatives from difference tables
Week 2	Higher-Order derivatives
Week 3	Extrapolation techniques, Newton- Cotes Integration Formulas
Week 4	The Trapezoidal, Simpson’s, Gaussian Quadrature, Adaptive Integration,
Week 5	Multiple Integrals, Applications of Cubic Splines
Week 6	Numerical Solution of Ordinary Differential Equations

Week 7	Taylor-Series Method, Euler and Modified Euler Methods, The Runge-Kutta Methods Multistep Method, Milne's Method
Week 8	The Adams-Moulton Method, Multivalued Methods, Convergence Criteria
Week 9	Errors and Error Propagations, Systems of Equations and Higher-Order Equations: Comparison of Methods.
Week 10	Boundary-Value Problems and Characteristic-Value Problems: Introduction, The 'Shooting Method', Solution Through a Set of Equations
Week 11	Derivative Boundary conditions
Week 12	Rayleigh-Ritz method, The Finite-Element method, Characteristic-value problems
Week 13	Numerical Solution of Partial-Differential Equations
Week 14	Finite difference method, Representation as a difference equation
Week 15	Finite-element method, Laplace's equation on a rectangular region,
Week 16	The Poisson Equation

Textbooks and Reading Material

1. Applied Numerical Analysis, Curtis F. Gerald, *Addison-Wesley* (1994).
2. Introduction to Numerical Methods and FORTRAN Programming, Thomas Richard McCalla, *John Wiley & Sons* (1964).
3. Elementary Numerical Analysis, An Algorithmic Approach (3rd edition), Samuel D. Conte, *McGraw-Hill International Edition* (1981).
4. Numerical Analysis: Mathematics of Scientific Computing (3rd Edition), David Kincaid, *American Mathematical Society* (2010).
5. Numerical Recipes in C: The Art of Scientific Computing (2nd Edition), W. H. Press, B. P. Teukolsky, W. T. Vetterling, *Cambridge University Press* (1992).

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.

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 (HONS) Computational Physics	**Course Code**	COMP 3602	**Credit Hours**	3 (2+1Lab)
Course Title	Data Science				

Course Introduction

In this course, we set out on a journey that makes use of the fundamental tenets of physics to unleash the enormous potential of computers and data analysis. The capacity to draw meaningful conclusions from complicated datasets is a talent of utmost significance in today's data-driven environment. As a future physicist, you will leave this course with the skills and knowledge needed to fully utilize data science. Together, we will investigate how physics may be used to describe intricate physical systems, analyze experimental data, and resolve practical issues. By the end of the course, you'll be proficient in data science approaches and have a stronger grasp of how data science may improve your comprehension and use of physics. So, let's start this thrilling trip where data and physics merge to reveal the secrets of the cosmos.

Learning Outcomes

On the completion of the course, the students will:
This course is designed to introduce students to the basics of data science. Students will learn the fundamental concepts of data analysis, data manipulation, and data visualization using Python/R/Sql.

1. Understand the basics of data science.
2. Learn how to manipulate data in Python/R/Sql.
3. Learn how to perform basic data analysis in Python/R/Sql.
4. Lear how to visualize data in Python/R/Sql.

Course Content

Week 1	Introduction to Data science, Definition of data science, Applications of data science
	Types of data, Data collection methods, Data cleaning, Data integration and transformation
Week 2	Creating spreadsheets in excel and Jupyter notebooks in python,

	Storing data in excel spreadsheets and Jupyter notebooks
Week 3	Exploratory data analysis,
	Descriptive statistics.
Week 4	Exploratory data analysis techniques.
	Exploratory data analysis techniques I
Week 5	Exploratory data analysis techniques II
	Exploratory data analysis techniques III
Week 6	Statistical inference: Probability theory,
	Hypothesis testing confidence intervals.
Week 7	Regression analysis.
	Regression analysis example I
Week 8	Regression analysis example II
	Regression analysis example III
Week 9	Regression analysis example IV
	Introduction to big data
Week 10	Distributed computing
	Distributed computing I
Week 11	Cloud computing platforms
	Cloud computing platforms I
Week 12	Introduction to Hadoop and Spark.
	Data Ethics, Privacy and Security, Fairness and Bias,
Week 13	Data wrangling and mining from spreadsheets by using Excel Accessing data from Jupyter notebooks by using Python
	Using Python libraries Pandas and Numpy
Week 14	APIs and web servers for data analysis
	Data visualization in software such as excel and Python/R/Sql
Week 15	Artificial Neural Networks
	Data Analysis and Artificial Neural Networks
Week 16	Data Analysis using ANN.
	Data Analysis Using ANN Example

Textbooks and Reading Material

1. Python Data Science Handbook by Jake VanderPlas, O'Reilly Media Inc. (2016).
2. Data Science from Scratch by Joel Grus, 2nd Edition, O'Reilly Media Inc. (2018).
3. An Introduction to Statistical Learning with Applicatios in R/Python by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, Springer (2013).

4. Doing Data Science: Straight talk from frontlines by Cathy O’Neil and Rachel Schutt, O'Reilly Media, Inc.(2013).
5. R for Data Science by Hadley Wichkham and Garrett Grolemund, O’Reilly Media Inc (2017)

Teaching Learning Strategies

The instructor is required to make use of FORTRAN/C/C++/Mathematica/Python/C# 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 (HONS) Computational Physics	**Course Code**	COMP 4702	**Credit Hours**	3 (2+1Lab)
Course Title	Artificial Intelligence				

Course Introduction

In this course we will explore the domain of artificial intelligence (AI), where the bounds of physics collide with the boundless potential of intelligent machines. In this course, we cross the boundaries between physics and AI to investigate how the principles that control our physical universe might motivate and guide the creation of intelligent systems. Since you are physicists, you already have a solid foundation in mathematical and computational concepts. In this course, we will expand on your knowledge of these concepts to explore the interesting topic of artificial intelligence. This course will enable you to not only comprehend the fundamental ideas of AI but also envision how it can completely transform the field of physics research and problem-solving. Topics covered in this course include the fundamentals of machine learning and neural networks, as well as applications in physics such as data analysis and simulations. Join us for this fascinating investigation of artificial intelligence as we reveal how the rules of physics and AI may work together to improve our knowledge of the cosmos.

Learning Outcomes

On the completion of the course, the students will:

1. Giving introduction to Artificial Intelligence.
2. Applications and Success stories on artificial intelligence.
3. Approaches to machine intelligence.
4. Intelligent Agents.
5. Machine Learning and Methods.
6. Data preparation and encoding techniques for machine learning.

Course Content

Week 1	Central dogma of artificial intelligence
	Alan Turing's concept of intelligent machines
Week 2	Levels/types of intelligence; weak and strong artificial intelligence
	Neat artificial intelligence, scurfy artificial intelligence
Week 3	Hypothesis for weak artificial intelligence
	Hypothesis for strong artificial intelligence
Week 4	Working of human brain, neuron as a structural unit of brain
	Modeling of neuron and brain using concepts of linear algebra
Week 5	Vector analysis
	Supervised learning through neural networks
Week 6	Unsupervised learning through neural networks
	Application examples of neural networks
Week 7	Algorithm of Artificial Neural Networks
	Simulation of Artificial Neural Networks
Week 8	Simulation of linear digital logic gates using neural networks
	Simulation of non-learning digital logic gates using neural networks
Week 9	Genetic evolution and Darwin theory
	Genetic Algorithm
Week 10	Genetic algorithm for function approximation
	Genetic algorithm for function approximation example
Week 11	Bayesian theorem and Bayesian networks
	Computer vision
Week 12	Face detection using OpenCV

	Machine consciousness and artificial life
Week 13	Models of machines consciousness
	Models of machines consciousness (IDA)
Week 14	Models of machines consciousness (LIDA)
	Models of machines consciousness (QuBIC)
Week 15	Artificial neural networks to solve differential and integral equations.
	Artificial neural networks to solve differential and integral equations example
Week 16	Genetic algorithm to solve differential and integral equations
	Genetic algorithm to solve differential and integral equations example

Textbooks and Reading Material

1. Artificial Intelligence: A Modern Approach, (4th edition) by Stuart Russell and Peter Norvig, *Pearson, 2020.*
2. Artificial Intelligence: Structures and Strategies for Complex Problem Solving (Six Edition) by G. F. Lugar, *Addison-Wesley (Pearson Education),* (2008).
3. Pattern Recognition and Machine Learning" by Christopher M. Bishop, *Springer*, (2006).
4. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, *MIT Press* (2016).
5. Python Machine Learning (3rd Edition) by Sebastian Raschka and Vahid Mirjalili, *Packet Publishing*, (2019).
6. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (2nd Edition) by Aurélien Géron, *O'Reilly Media*, (2019).

Teaching Learning Strategies

The instructor is required to make use of FORTRAN/C/C++/Mathematica/Python/C# 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(HONS) Computational Physics	**Course Code**	COMP 4701	**Credit Hours**	3 (2+1Lab)
Course Title	Computational Physics Simulations I				

Course Introduction

This course is about studying physical systems through simulations. Simulations are aimed at providing information about the physical systems very near to the reality. In this course the details of different deterministic as well as indeterministic problems will be explored with or without using random numbers. This course has vast level of applications such as in exploring the dynamics of complex situations such as; military applications, weaponry processes, missile designing and testing, manufacturing processes, etc. The simulations can be performed by using computer programming environments of C++/C#/Python, etc.

Learning Outcomes

Following objectives are expected at the end of this course:

1. Students will be able to convert differential forms of any physical problems into iterative forms.
2. The students will acquire applied expertise of programming languages such as Python while performing simulations.
3. The students will be able to better understand the underlying physics details in the topics involved in this course.

Course Content

Week 1	Course Introduction involving its scope and applications, etc.
	Introductory Lab work in the programming environment of C++/C#/Python, etc.
Week 2	Realistic Projective Motion: The Effects of Air Resistance, The effects of Air density and Altitude on Projectile motion
	Lab work for simulation of Realistic Projective Motion
Week 3	Non-linear damped driven oscillatory systems, Oscillatory motion and Chaos
	Lab work for simulation of Realistic Projective Motion
Week 4	Weather Prediction, Navier Stokes equations and the Lorenz Model
	Lab work for simulation of Non-linear damped driven oscillatory systems
Week 5	Solar system and the Kepler’s laws
	Lab work for simulation of Non-linear damped driven oscillatory systems
Week 6	Electromagnetic Potentials and Fields

	Lab work for simulation of Solar system and the Kepler's laws
Week 7	Electromagnetic mirror and its applications
	Lab work for simulation of Solar system and the Kepler's laws
Week 8	Waves and optics: Interference, diffraction and polarization
	Lab work for simulation of Electromagnetic mirror and its applications
Week 9	Frequency spectrum of waves on a string; Motion of a realistic string
	Lab work for simulation of Waves and optics: Interference, diffraction and polarization
Week 10	Random Systems: Generation of random numbers
	Lab work for simulation of motion of a realistic string
Week 11	Monte Carlo method
	Lab work for generation of random numbers of different types
Week 12	Random walks
	Lab work for simulation of random walks
Week 13	Self-avoiding walks
	Lab work for simulation of self-avoiding walks
Week 14	Diffusion process and random walks
	Lab work for simulation of diffusion process
Week 15	Entropy and the arrow of time
	Lab work for simulation of entropy of diffusion system
Week 16	Cluster growth models
	Lab work for simulation of cluster growth models/processes

Textbooks and Reading Material

Recommended Books:

1. Computational Physics: Problem Solving with Computers (2nd edition), Rubin H. Landau, *John Wiley & Sons* (2000).
2. Computational Physics (2st edition), Nicholas J. Giordano, *Prentice Hall* (2005).
3. Computational Physics, Mark Newman, *CreateSpace Independent Publishing Platform* (2012).
4. Computational Physics, Jos Thijssen, *Cambridge University Press* (2007).
5. Applied Computational Physics, J. F. Boudreau and E. S. Swanson, *Oxford University Press* (2017).

Teaching Learning Strategies

1. The instructor will detail out the process/concept of converting the mathematical forms (such as differential equations) of physical problems into iterative forms which can be used for computer simulations.
2. The instructor will provide the details about the programming environment of C++/C#/Python etc.

3. Students will learn the concept of converting the differential equations, etc. into iterative form and will practice by solving the exercise problems.
4. Students will practice the process of making algorithms and implementing them in the available arbitrary programming language.
5. Students will learn how to analyze the simulation results in order to have better physics understanding.

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. 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 (HONS) Computational Physics	**Course Code**	COMP 4801	**Credit Hours**	3 (2+1Lab)
Course Title	Computational Physics Simulations II				

Course Introduction

This course is about studying mainly quantum mechanical systems through simulations. Simulations are aimed at providing information about the physical systems very near to the reality. In this course the details of different deterministic as well as non-deterministic problems will be explored with or without using random numbers. This course will provide detailed mechanism of solving Schrodinger wave equation through different methods. It will also cover the details of using Monte Carlo method for solving different microscopic systems. The simulations will be performed by using computer programming environments of C++/C#/Python/Mathematica/MatLab, etc.

Learning Outcomes

Following objectives are expected at the end of this course:

1. Students will be able to convert differential forms of any physical problems into iterative forms.
2. The students will enhance their expertise of programming languages such as Python while performing simulations.
3. The students will be able to better understand the underlying physics details in the topics involved in this course.

Course Content	
Week 1	Course Introduction involving its scope and applications, etc.
	Introductory Lab work in the programming environment of C++/C#/Python, etc.
Week 2	Schrödinger Equation (SE) and Its solutions
	Lab work for simulation of plane wave solution of SE
Week 3	1D (Shooting and Matching methods) for solving SE
	Lab work for simulation of Shooting and Matching solution of SE
Week 4	Variational approach for Solving SE
	Lab work for simulation of Variational approach solution of SE
Week 5	Basis diagonalization method for SE
	Lab work for basis diagonalization method for SE
Week 6	Spectral methods for SE
	Lab work for spectral method solutions of SE
Week 7	Bound state solutions of SE
	Lab work for bound state solutions of SE
Week 8	Direct solutions of SE
	Lab work for direct solutions of SE
Week 9	Fourier Transform, Bound states in momentum space
	Lab work for Random walk solutions of SE
Week 10	Quantum mechanical scattering, Monte Carlo Integration, Diffusion Monte Carlo (DMC)
	Lab work for diffusion Monte Carlo
Week 11	Path Integral Monte Carlo (PIMC), Quantum Monte Carlo Methods: Variational Monte Carlo for atoms
	Lab work for PIMC
Week 12	The Born- Oppenheimer Approximation; The Hydrogen Atom; Metropolis sampling for the hydrogen atom and the harmonic oscillator
	Lab work for sampling of atomic statistics such as for Hydrogen atom
Week 13	The Ising Model and Statistical Mechanics; Mean-Field theory, Monte Carlo Method
	Lab work for simulation of Mean Field Theory
Week 14	The Ising model and second order phase transitions
	Lab work for simulation of second order phase transitions
Week 15	The Ising model and first order phase transitions
	Lab work for simulation of first order phase transitions
Week 16	Comparison of Mean Field Theory and Monte Carlo method for Ising Model

	Lab work for simulation of Mean Field Theory Versus Monte Carlo Method of Ising Model

Textbooks and Reading Material

Recommended Books:

1. Computational Quantum Mechanic, J. Izaac and Jingbo Wang, *Springer* (2019).
2. Quantum Mechanics Simulations, J. R. Hiller, I. D. Johnston, and D. F. Styer, *Wiley* (1995).
3. Computational Physics: Problem Solving with Computers (2^{nd} edition), Rubin H. Landau, *John Wiley & Sons* (2000).
4. Computational Physics (2^{st} edition), Nicholas J. Giordano, *Prentice Hall* (2005).
5. Computational Physics, Jos Thijssen, *Cambridge University Press* (2007).
6. Applied Computational Physics, J. F. Boudreau and E. S. Swanson, *Oxford University Press* (2017).

Teaching Learning Strategies

1. The instructor will detail out the process/concept of converting the information of quantum mechanical and statistical problems into forms which can be used for computer simulations.
2. The instructor will provide the details about the programming environment of C++/C#/Python etc. for implementation of Monte Carlo method.
3. Students will learn the concept of converting the differential equations, especially Schrodinger equation into iterative form and will practice by solving the exercise problems of main textbooks.
4. Students will practice the process of making algorithms and implementing them in the available arbitrary programming language, for using Monte Carlo method.
5. Students will learn how to analyze the simulation results in order to have better physics understanding.

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. 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 (HONS) Computational Physics	Course Code	COMP 4801	Credit Hours	3 (2+1Lab)
Course Title	Quantum Computing				

Course Introduction

This course is designed to provide the concepts of new era of computing. By explaining the power of quantum computer drawbacks of existing classical computing are also emphasized. Basic difference between classical computing and quantum computing are also discussed through the classical and quantum information and their respective logical gates, architecture, and their limitations. Simulation of basic algorithms and circuits will be implemented using Open quantum computing framework (OpenQCF) in C# and Qiskit. This course will also provide the overview and drawbacks of some of the exiting but important simulators of quantum computing. By developing simulated applications of quantum computing based on available environment of high-performance computing (HPC) students will be able to understand the core concepts of classical and quantum computing. Students will be able to design software that efficiently solves different complex problems of quantum physics.

Learning Outcomes

On the completion of the course, the students will:

1. Understand the basic principle of quantum mechanics and their application to quantum computing.
2. Understand the quantum mechanics of open system and related results. 3. Learn the use of quantum computing software.

Course Content

Week 1	Overview of Quantum Computing, Power of Quantum Computers, Current Status of Quantum Computing
	Classical Information (Bits), Logical Gates, Adder Subtractor, Multiplexer, Register, Memory, 32-64 Bit Register, Limitations of Classical Architecture, Overview of Parallel and Distributed Techniques
Week 2	Postulate of quantum mechanics for isolated system, Qubit: Spin 1⁄2, photon polarization, Linear algebra, Dirac Notation
	Uncertainty, Complex numbers, Dual Vector, Spanning set, Basis, dimensions, inner product
Week 3	Operator, Hermitian operator, normal operator, unitary operator, Pauli operator, Density operator, Observable, Outer product, tensor product, Eigen value and eigen vectors.
	Orthonormality, Superposition, Entanglement (Einstein locality and hidden variables, Bell inequalities), Measurement (Orthogonal measurement, generalized measurement and POVM), Teleportation, No-Cloning Theorem
Week 4	Quantum Gates, Quantum Registers, Quantum Memory
	Difficulties to have Quantum Computers
Week 5	Density matrix, Bloch sphere
	Gleason's theorem, Evolution of density operator.
Week 6	Schmidt decomposition, Convexity

	Quantum erasure, The GHJW theorem
Week 7	The Aspect experiments.
	Nonmaximal entanglement
Week 8	Uses of entanglement, Dense coding
	EPR quantum key distribution
Week 9	Quantum Algorithms and Circuits, OpenQCF and Qiskit libraries for the Simulation of Quantum Algorithms and Circuits
	Quantum Adder and its Simulation
Week 10	Quantum Subtractor and its Simulation.
	Quantum Multiplexer and its simulation.
Week 11	Shor's Factorization Algorithm and its simulation.
	Circuits of Quantum entanglement and Teleportation.
Week 12	Search Algorithm in Quantum Computing and its simulation.
	Artificial Intelligence, Artificial neural networks (ANN)
Week 13	Simulation of ANN, Applications of ANN in Physics (Theory), Applications of ANN in Physics (Experiment)
	Quantum Artificial Intelligence, Basic Introduction of QAI, Advancement from Classical AI to QAI, Problems being faced by QAI, Future of QAI
Week 14	Algorithms of Quantum AI, Quantum neural network (QNN)
	Quantum Genetic algorithms
Week 15	Applications of quantum neural networks, Data Analysis of Physics experiments
	Applications of quantum neural networks, Data Analysis of Physics experiments
Week 16	Solution of differential equation using QNN.
	Solution of integral equation using QNN.

Textbooks and Reading Material

1. Quantum Computation and Quantum Information, by M.A. Nielson and I.I Chuang, *Cambridge University Press* (2010).
2. The Temple of Quantum Computing, by Riley T. Perry, Lulu.com (2004).
3. Quantum Computing Explained by David McMahon, Wiley-Interscience (2007).
4. Quantum Computing, by Vishal Sahni, CRC Press (2017).
5. *From Classical to Quantum Shannon Theory*, by Mark M. Wilde, arXiv: 1106:1445 (2019)
6. Quantum Information, from foundation to quantum technology applications (2 Vol. Set), by Dagmar Brub, Gerd Leuchs, *Wiley-VCH* (2019)
7. Introduction to Quantum Information Science, by Vlatko Vedral, *Oxford University Press* (2006)

Teaching Learning Strategies

The instructor is required to make use of FORTRAN/C/C++/Mathematica/Python/C# 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 (HONS) Computational Physics	Course Code	HUM 1102	Credit Hours	2
Course Title	**Islamic Studies**				

Course Introduction

Islamic studies are teachings of Islam as a faith and a practical guide for everyday life. This course involves close study of the Qur'an and the sayings of our holy prophet Hazrat Muhammad (peace be upon him).

Learning Outcomes

1. Study fundamental principles of Islam.
2. Study the life of holy prophet Hazrat Muhammad (peace be upon him)

Course Content

Week 1	Fundaments of Islam
Week 2	Basic Themes of Quran
Week 3	Introduction to Sciences of Hadith

Week 4	Introduction to Islamic Jurisprudence
Week 5	Primary & Secondary Sources of Islamic Law
Week 6	Life of the Prophet -1
Week 7	Life of the Prophet -2
Week 8	Makken & Madnian life of the Prophet-1
Week 9	Makken & Madnian life of the Prophet-2
Week 10	Islamic Economic System
Week 11	Political theories
Week 12	Social System of Islam. Islamic Society
Week 13	Islamic Economic System
Week 14	Political theories-1
Week 15	Political theories-2
Week 16	Social System of Islam

Textbooks and Reading Material

1. Introduction to Islam by Dr Hamidullah, *Papular Library Publishers Lahore*.
2. Principles of Islamic Jurisprudence by Ahmad Hassan, *Islamic Research Institute, IIUI*.
3. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, *Islamic Books Services*.

Teaching Learning Strategies

The students are required work on Islamic Studies and discussions in groups.

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 (HONS) Computational Physics	**Course Code**	**HUM 2402**	**Credit Hours**	2
Course Title	**Pakistan Studies**				

Course Introduction

The main purpose of program is to provide an in-depth understanding of Pakistan through teaching and responsibilities of state and society of the country.

Learning Outcomes

1. Study the historical movements and incidents that lead to creation of Pakistan.
2. Study the ideology of Pakistan.
3. Study of modern state of Pakistan.

Course Content

Week 1	History of Pakistan:
Week 2	Historical background of Pakistan,
Week 3	Religious movements: (role of significant religious persons), educational movements,
Week 4	Sir Syed Ahmed Khan's contributions,
Week 5	Political and constitutional development (1858-1935),
Week 6	Political and constitutional development 1935-1947,
Week 7	Jinnah's 14 points and its significance,

Week 8	Two nations theory, Ideology of Pakistan, Aims and objectives of the establishments of Pakistan, Early difficulties after the creation of Pakistan,
Week 9	Islamization in Pakistan. Geography,
Week 10	Foreign Policy, Productions sectors, and culture of Pakistan:
Week 11	Geography of Pakistan, Pakistan and Muslim world, Determinants foreign policy,
Week 12	objectives of Pakistan's foreign policy, Industrial sector of Pakistan,
Week 13	Agricultural sector of Pakistan, Pakistan and international organizations,
Week 14	Pakistan and regional organizations,
Week 15	Pakistan's relations with neighbor countries education in Pakistan,
Week 16	Features of Pakistan's culture, Iqbal's poetry, Few selected verses of Iqbal.

Textbooks and Reading Material

1. Pakistan Studies by *Qureshi Books*.
2. Pakistan Studies by *Dogger Books*.
3. Pakistan Studies by M. Ikram Rabbani, Latest Edition, *Published by Caravan*.
4. Pakistan Studies by M. D. Zafar, Latest Edition, *Published by Published by Aziz Book*.
5. Pakistan Studies by Dr. Muhammad Sarwar, Latest Edition, *Published by Ilmi Books*.

Teaching Learning Strategies

The instructor will provide in-depth knowledge through class lectures and discussions. The students are required to work on Pakistan Studies and perform discussions in groups.

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 (HONS) Computational Physics	Course Code	HUM 1101	Credit Hours	1
Course Title	**English I**				

Course Introduction

This course introduces students to basic concepts in the study of the English language.

Learning Outcomes

1. Learn comprehension skills and related rules of grammar.
2. Learn the comprehension skills by their active use.

Course Content

Week 1	Contextual Use of Tenses (Present, Past & Future) through reading, writing, listening and speaking activities,
Week 2	Introduction of tense combinations in speaking and writing-1
Week 3	Introduction of tense combinations in speaking and writing-2
Week 4	Pronunciation Techniques (focus on c, k & t sounds),
Week 5	Vocabulary Building through reading, Speed Reading Techniques (Skimming & Scanning),
Week 6	Reading Comprehension (Main Idea & Inference),
Week 7	Paragraph Writing (brainstorming, topic sentence, supporting details & use of conjunctions)
Week 8	Summary Writing. Email Writing.
Week 9	Novel Reading.
Week 10	Regular Class Activities:
Week 11	Individual work. Pair work.
Week 12	Group Discussions (only in English).
Week 13	Role play. Reading Aloud.
Week 14	Debate.
Week 15	PowerPoint Presentations.

Week 16	A visit to Readings Bookshop to give students experience and exposure to Reading & Communicating in English.

Textbooks and Reading Material

1. Novel: 'The Secret Seven' by Enid Blyton
2. 'Understanding and Using English Grammar' by Betty Schrampfer Azar
3. Online Resources: Google & Youtube

Teaching Learning Strategies

The instructor will train the students in basic English rules and comprehension through audio/video English conversations (recorded or online during class lectures). The students are required work on English Skills, communication, risk-taking and teamwork and discussing in groups.

Assignments: Types and Number with Calendar

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

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 (HONS) Computational Physics	**Course Code**	**HUM 1201**	**Credit Hours**	3
Course Title	**English II**				

Course Introduction

This course introduces students to basic concepts in the study of the English language.

Learning Outcomes

1. Learn basic rules of grammar related to formal communication.

2. Develop the related skills by their active use.

Course Content	
Week 1	Use of conditionals;
Week 2	Types of Questions;
Week 3	Use of Modals; Types of Paragraph Writing (Narrative, Descriptive, Argumentative);
Week 4	5-Paragraph Essay Writing (brainstorming, hook,
Week 5	thesis statement, introductory paragraph,
Week 6	body paragraphs, concluding paragraph),
Week 7	Pros & Cons essay & Argumentative Essay;
Week 8	Plagiarism and Referencing. Movie Review Writing.
Week 9	Resume Writing. Novel Reading.
Week 10	Regular Class Activities: Individual work.
Week 11	Pair work. Group Discussions (only in English).
Week 12	Reading Aloud.
Week 13	Debate.
Week 14	Structured Writing.
Week 15	Short Video Screening.
Week 16	A Movie Screening: ROOM.

Textbooks and Reading Material

1. Novel: The Famous Five by Enid Blyton.
2. How English Works?" by Swan & Walter.
3. Focus on Writing Ragina L Smalley, Mary K Reutten, Joann Rishel Kozyrev.
4. Online Resources: Google & Youtube.

Teaching Learning Strategies

Teacher will involve the students more and more during class lectures thus training them in language rules and comprehension, etc. The students are required work on English Skills, communication, risk-taking and teamwork and discussing in groups.

Assignments: Types and Number with Calendar			
At least two assignments and two quizzes. A course project may also be assigned.			
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(HONS) Computational Physics	**Course Code**	**HUM 2403**	**Credit Hours**	2
Course Title	**Philosophy of Science**				

Course Introduction

This course introduces views about relation of science to observation, to logic, and to history, humanities, and ethics etc. which are different to science but do not contradict science.

Learning Outcomes

On the completion of the course, the students will:

1. be able to think critically about claims to knowledge.
2. be able to think scientifically.
3. be able to relate science to observations and human experience in general.

Course Content

Week 1	Conditions on science
	A necessary condition on science: nothing against observation or logic
Week 2	Logic
	The law of contrapositive in logic
Week 3	Plato’s theory of forms; universals
	Rationalism

Week 4	Aristotle's modification and nominalism's opposition to Plato
	Empiricism
Week 5	Inductive reason
	Genus-differentia definition of definition; genus and differentia of science
Week 6	Sufficient Conditions for Science: 1-Relating experiences
	2-Refutability and Karl Popper
Week 7	Alternatives to refutation; verification of novel predictions
	Descriptive philosophies of science
Week 8	Naturalism and scientism
	Theory dependence of observation?
Week 9	How science is done: The suggestion of exploratory, concept formation, development and checking stages.
	Forms of science: facts, scientific laws, models and scientific theories.
Week 10	Leaving out details to be able to do science; repeatable, not-repeatable, repeated only observations.
	Combining universal rules with particular observations to predict: logic
Week 11	Contingent facts with respect to rules; incompleteness of rules *alone*; Gell-Mann
	Science, non-science and un-science
Week 12	Judgments; checkability in non-science (otherwiseness with verified expectations etc.)
	Claims about origin of information obtainable by observation only
Week 13	In addition to rules, can particular events be explanations of observations?
	Chance and Darwinism; possible non-scientific start or re-start of a scientific process
Week 14	Conditions of possibility of science: Kant
	Metaphysics and epistemology
Week 15	Uniformity of nature
	Values and ethics; values as conditions of possibility of science
Week 16	The fact-value distinction; normative and descriptive statements
	Science and purpose: role of values in science

Textbooks and Reading Material

1. Textbooks

Book title: *What is This Thing Called Science?* Author: A. F. Chalmers. Publisher: UQP. 2012.

2. Suggested Readings

2.1 Books:

1) Title: *The Golden Age of Philosophy of Science 1945 to 2000*. Author: John Losee. Publisher: Bloomsbury Academic. 2019.
2) Title: *Worldviews, an Introduction to the History and Philosophy of Science.* Author: R. Dewitt. Publisher: Wiley Blackwell. 3rd ed. 2018.
3) Title: *The Quark and the Jaguar*. Author: M. Gell-Mann. Publisher: W. H. Freeman. 1994.
4) Title: *The Marriage of Sense and Soul, Integrating Science and Religion*. Author: Ken Wilber. Publisher: Random House New York Year. 1998.

2.2: Journal Articles/ Reports: Stanford Encyclopedia of Philosophy, plato.stanford.edu

Teaching Learning Strategies

The students are required to work on key Philosophy of Science such as critical thinking, problem-solving, communication, risk-taking and teamwork and discussing in groups.

Assignments: Types and Number with Calendar

At least two assignments and two quizzes.

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 (HONS) Computational Physics	**Course Code**	**HUM 2401**	**Credit Hours**	3
Course Title	**Entrepreneurship Essentials**				

Course Introduction

Introduces entrepreneurial competencies and will help students to understand the role of innovation and creativity in entrepreneurship. Provides an overview of entrepreneurs in the

contexts of start-up ventures; small business, and existing organizations and as agents of social change.
Learning Outcomes
The course introduces the subject of Entrepreneurship Essentials at undergraduate level. After the completion of the course students will be able to: 1. Learn an overarching framework—People, Opportunity. 2. To evaluate opportunities, manage start-ups, and finance ventures. 3. An introduction to critical knowledge and skills related to creating new business and product ideas. 4. To provide an idea that how entrepreneurs run and structured experiments to validate. ideas and refine the possible business strategy. 5. To help potential entrepreneurs to learn about the fundamentals of starting a new venture.
Course Content

Week 1	Ideas and Opportunities
Week 2	Identify an entrepreneurial idea; evaluate an entrepreneurial idea;
Week 3	Gain comfort with twists and turns Building a Business:
Week 4	Apply the POCD (People, Opportunity, Context, and Deal) framework; Manage risk and reward through experimentation;
Week 5	Make decisions with the future in mind. Financing a Business:
Week 6	Determine how investment can help you create value for yourself and your investors;
Week 7	Consider risk and reward through various forms of analysis; discover when to solicit investment and how much you will need to seek out.
Week 8	Sources of Investment:
Week 9	Understand the opportunities and tradeoffs associated with different sources of financing;
Week 10	Defining key financing terms;
Week 11	Apply the tools of valuation to start-up ventures.
Week 12	Entrepreneurship and Building a Business Plan:
Week 13	the Five Parts of a Business Plan – Marketing Plan;
Week 14	Operations Plan;
Week 15	Financial Plan;
Week 16	What Is the Most Important Part of Your Business Plan

Textbooks and Reading Material

1. Built to Sell: Creating a Business That Can Thrive Without You, by John Warrillow, Penguin Publishing Group, (2011).
2. Business Adventures: Twelve Classic Tales from the World of Wall Street; by John Brooks; Open Road Integrated Media; (2014).
3. EntreLeadership: 20 Years of Practical Business Wisdom from the Trenches, Dave Ramsey, Howard Books (2012).
4. The Absolute Essentials of Entrepreneurship, Nerys Fuller-Love, Taylor & Francis, (2020) .
5. Fundamentals of Entrepreneurship; H. Nandan, PHI Learning Private Limited, (2011)

Teaching Learning Strategies

The students are required to work on key entrepreneurial skills such as critical thinking, problem-solving, communication, risk-taking and teamwork and discussing in groups.

Assignments: Types and Number with Calendar

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

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.

Checklist for a New Academic Program

Parameters	YES/NO
1. Department Mission and Introduction	YES
2. Program Introduction	YES
3. Program Alignment with University Mission	YES

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

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Program Coordinator

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Chairperson/Director