FAR WESTERN UNIVERSITY

Mahendranagar, Kanchanpur

Faculty of Science and Technology

Four Years B. Sc. (Physics)
Course of Study 2069

Far Western University
Faculty of Science and Technology
Course Structure of Physics

Course Code	Course Title	Credit
Semester I		
PHY 111	Mechanics TH	3
PHY 111	Mechanics PR	1
Semester II		
PHY 121	Thermodynamics TH	3
PHY 121	Thermodynamics PR	1
Semester III		
PHY 231	Waves and Optics TH	3
PHY 231	Waves and Optics PR	1
Semester IV		
PHY 241	Electronics TH	3
PHY 241	Electronics PR	1
Semester V		
PHY 351	Electricity and Magnetism TH	3
PHY 351	Electricity and Magnetism PR	1
Semester VI		
PHY 361	Atomic, Nuclear and Particle Physics TH	3
PHY 361	Atomic, Nuclear and Particle Physics PR	1
PHY 362	Relativity	3
Semester VII		
PHY 471	Math Physics	4
PHY 472	Classical Physics	4
PHY 473	Physics Lab	2
PHY474	Astronomy	3
PHY 475	Material Science	3
PHY 476	Biophysics	3
Semester VIII		
PHY 481	Quantum Mechanics	4
PHY 482	Solid State Physics	4
PHY 483	Physics Lab	2
PHY 484	Econophysics	2
PHY 485	Entrepreneurship	2
PHY 486	Applied Physics	2

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Mechanics TH**	Credit: **3**
Course Code: **PHY 111**	Number of hours per week: **3**
Nature of the Course: **Theory**	Total hours: **45**
Year: **First**, Semester**: First**	Full Mark: **100**
Level: **B.Sc.**	Pass Mark: **45**

(1). Course Description

The course intends to enable the students to be acquainted with the basic concepts of mechanics in Physics. Students will be familiarized with the fundamentals of Laws of motion, Motion under a central force, Gravitational Field and Potential, Rigid Bodies, Elastic Properties, Fluid Mechanics and Simple harmonic motion.

(2). Course Objectives

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

- to acquire sufficient basic knowledge in Mechanics
- to apply this knowledge base for studying major courses in physics.
- to solve mathematical problems in related topics.
- to deduce mathematical equations and formulas.

(3). Specific Objectives and Contents

Specific Objectives	Contents
• Explain the differences between inertial and noninertial frames • Derive and describe the Newton's laws of motion • Describe the dynamics of particle in rectilinear and circular motion • Distinguish conservative and Non-conservative forces • Describe various conservation laws of mechanics • Explain the motion of variable mass (rockets) • Describe collision	**Unit I: Laws of motion (7)** Newton's laws of motion in inertial reference frame, Dynamics of particle in rectilinear and circular motion, Conservative and Non- conservative forces, Conservation of energy, liner momentum and angular momentum, Single-stage and multi-stage rockets, Collision in one and two dimensions, cross section
• Describe the nature of central forces and derive their equations • Explain two particle central force problem • Explain the methods of , reduced mass, relative and centre of mass motion	**Unit II: Motion under a central force (6)** Central forces, Two particle central force problem, Reduced mass, Relative and centre of mass motion, Law of gravitation, Kepler's laws, Motions of planets and satellites, Geo-stationary satellites

• Understand and use law of gravitation and Kepler's laws to	
describe the motions of planets and satellites	
• Describe a rigid body and its moment of inertia • Explain the difference between translation and rotational motion of a rigid body • Explain Euler's theorem and the Euler angles • Formulate equations and describe the motion of a symmetrical top • Explain and use the Coriolis effect	**Unit III: Rigid Bodies (7)** Rotational motion and moment of inertia, translation and rotational motion of a rigid body, Euler's theorem, the Euler angles, Motion of a symmetrical top, the Coriolis effect.
• Explain the elastic properties of material and the molecular theory • Explain small deformations and Hooke's law • Describe the elastic constants for an isotropic solid • Calculate and explain the bending of beams supported at both ends and Cantilever • Explain torsion of a cylinder • Describe bending moments and shearing force	**Unit IV: Elastic Properties (7)** Elasticity, Small deformations, Hooke's law; Elastic constants for an isotropic solid, beams supported at both ends, Cantilever; Torsion of a cylinder, bending moments and shearing force
• Explain the kinematics of fluid flow • Derive, explain and use continuity equation • Define and use Bernoulli's theorem • Explain streamline and turbulent flow and use Poiseuille's law for determining fluid properties • Describe the Reynold's Number • Understand the Stokes law	**Unit V: Fluid Mechanics (7)** Kinematics of fluid flow, Continuity equation, Bernoulli's theorem, Streamline and turbulent flow, Poiseuille's law, Reynold's Number, Stokes law
• Explain surface tension and its relation to the surface energy • Use molecular theory to describe the surface tension • Formulate the excess pressure on a curved liquid surface • Explain and formulate the capillarity action	**Unit VI: Surface Tension (3)** Surface Tension and surface energy, Molecular theory, Pressure on a curved liquid surface, Capillarity
• Derive and explain the differential equation of simple harmonic	

motion and its solution, • Understand the significance of complex notation • Distinguish damped and forcedvibrations • Use formulations to explain the motion of various SHM: spring and mass system, simple, compound and torsional pendulums, Helmholtz resonator, coupled oscillators	**Unit VII: Simple harmonic motion (8)** Differential equation of simple harmonic motion and its solution, Significance of complex notation, Damped and forced vibrations, Examples: spring and mass system, simple, compound and torsional pendulums, Helmholtz resonator, coupled oscillators

(4). Evaluation System:

Undergraduate Programs							
External Evaluation	**Marks**	**Internal Evaluation**	**Weight age**	**Marks**	**Practical**	**Weight age**	**Mark**
End semester examination	60	Assignments	10 %	20	Practical Note copy	25 %	20
(Details are given in the separate table at the end)		Quizzes	10 %		Viva	25%	
		Attendance	10 %		Experimental	50%	
		Presentation	10 %				
		Term papers	10 %				
		Mid-Term exam	40 %				
		Group work	10 %				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

(I). External evaluation:

End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

External Practical Evaluation:

After completing the end semester theoretical examination, practical examination will be held. External examiner will conduct the practical examination according to the above mentioned evaluation. There will be an internal examiner to assist the external examiner. Three hours time will be given for the practical examination. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of theassignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject

teachers. Suchquizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Term paper: Term paper must be prepared by using computer in a standard format of technical writing and must contain the required number of pages. It should be prepared and submitted individually. The stipulated time for submission of the paper will be seriously taken as one of the major criteria of the evaluation.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in thesession of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroomdiscussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructionaltechniques is as follows:

- ☐ Lecture and Discussion
- ☐ Group work and Individual work
- ☐ Self study
- ☐ Assignments
- ☐ Presentation by Students
- ☐ Term Paper writing
- ☐ Quizzes
- ☐ Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

(5). Prescribed Texts

- Kittel, C., Knight, W. D., Ruderman, M. A. and Helmholz, A. C.,*Berkeley Physics Course, Vol. 1,Mechanics*, McGraw-Hill / Dev Publishers, New Delhi
- Mathur D. S., *Mechanics*, S. Chand (India) Pvt. Limited

(6). References

- Thornton S. T. and MarionJ. B., *Classical Dynamics of Particles and Systems*, Brooks/Cole
- FrenchP., *Newtonian Mechanics*, MIT Introductory Physics Series, Viva Bools Pvt Ltd
- HallidayD., ResnickR., Christman J. R. and WalkerJ., *Fundamentals of Physics*, Wiley
- SmithJ., *General Properties of Matter*, Radha Publishing House
- Feynman, R. P., Leighton, R. B. and Sands, M., *The Feynman Lectures on Physics*, Volume 1, NarosaPublishing House
- Landau L. D. and LifshitzE. M., *Mechanics*, Elsevier

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Mechanics PR** Year: 1

Course No.: PHY 111 Semester: I

Nature of the Course: Practical Credit: 1

(1).Objectives:

By the end of the course the student should be able to:

- measure correctly the basic physical quantities
- determine errors in measurements
- analyze raw data and make valid conclusions
- validate corresponding theoretical component
- develop proper laboratory skills
- design basic physics experiments
- interpret experimental results and draw logical conclusions
- relate theoretical concepts to practical skills

(2).List of Experiments:

1. To verify laws of probability by throwing one coin, two coins and ten coins.
2. From given set of data, calculate the standard deviation, standard error and probable error.
3. By using method of least square, draw the best straight line through a set of given data points and findthe error in slope.
4. To determine the moment of inertia of a flywheel.
5. To determine the value of acceleration due to gravity at that place by using Bar Pendulum
6. To determine the Young's modulus of the material by bending beam method.
7. To determine the surface tension of liquid by Jaeger's method.
8. To determine of modulus of rigidity of wire by torsion pendulum/Maxwell's vibration needle.
9. To determine the coefficient of viscosity of water by Poiseulle's method.
10. Calibration of CRO for the measurement of voltage and frequency

Note:

- Student must perform 6 Hours of lab work (2 Hours x 3 times or 3 Hours x 2 times) every week
- In every semester, at least Eight experiments are to be performed. Additional experiments may be addedsubject to availability of time.
- The practical exam will be graded on the basis of the following marking scheme: In-Semester Evaluation 20 %
  Final Exam Written 60%
  Final Exam Oral 20%

(3). References:

1. Arora, C. L., B.Sc. Practical Physics, S Chand and Company Ltd.
2. Squires, G. L., Practical Physics, Cambridge University Press.
3. Shukla, P. K. and Srivastava, A., 2006, *Practical Physics,* New Age International (P) Limited, Publishers

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Thermodynamics TH** F.M.: 100
Course No.: PHY 121 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: First, Semester: Second Teaching Hours: 45

(1). Course Description

The course intends to enable the students to be acquainted with the basic concepts of Thermodynamics and Statistical Physics. Students will be familiarized with the fundamentals of kinetic theory of gases, laws of thermodynamics and their applications, thermodynamic relations, transport phenomenon, black body radiation and statistical physics.

(2). Course Objectives: At the end of this course the students should be able

- ☐ to acquire sufficient basic knowledge in thermodynamics and statistical physics
- ☐ to apply this knowledge base for studying major courses in physics
- ☐ to solve mathematical problems in related topics
- ☐ to deduce mathematical equations and formulas

(3). Specific Objectives and Contents:

Specific Objectives	Contents in Detail
• Describe the equipartition of energy. • Explain the specific heat of monatomic, di- and triatomic gases. • Describe the adiabatic expansion of an ideal gas. • Deduce Van der Waal's equation. • Explain the Joule expansion and Joule coefficient. • Describe Boyle temperature and inversion temperature. • Explain the principle of regenerative cooling and cascade cooling. • Explain liquefaction of hydrogen and helium gas and refrigeration cycles.	**Unit I: Kinetic Theory of Gases and Fundamental Concepts (9)** Review of kinetic theory, Equipartition of energy, Specific heat of monatomic, di- and triatomic gases, Adiabatic expansion of an ideal gas, Van der Waal's equation, Joule expansion and Joule coefficient Boyle temperature and inversion temperature, Principle of regenerative cooling and of cascade cooling, Liquefaction of hydrogen and helium gas, Refrigeration cycles
• Describe the transport phenomena in gases. • Explain mean free path and collision cross section. • Derive and explain the equations of transport of mass, momentum and energy and their interrelationship.	**Unit II: Transport Phenomenon (5)** Transport phenomena in gases, Mean free path and collision cross sections, Transport of mass, momentum and energy and interrelationship, Dependence on temperature and pressure
• Describe Kirchhoff's law of black body radiation. • Explain the spectrum and energy density of radiation. • Explain Stefan-Boltzmann law, Planck's law, Wien's law and Rayleigh-Jean's law. • Discuss their interrelationships.	**Unit III: Black Body Radiation (3)** Kirchhoff's law of black body radiation, Spectrum and energy density, Stefan-Boltzmann law, Planck's law, Wien's law, Rayleigh-Jean's law

• State and explain the laws of thermodynamics. • Distinguish reversible and irreversible process. • Explain Carnot cycle and its efficiency. • Relate the Carnot theorem and the second law of thermodynamics. • Entropy and second law. • Explain the principle of increase of entropy. • Describe Maxwell's general relationships. • Explain phase transition, Joule-Thomson cooling and adiabatic cooling in a general system, Van der Waal's gas, Clausius-Clapeyron heat equation. • Define thermodynamic potentials and equilibrium of thermodynamical systems. • Derive and explain relationship among the thermodynamical variables.	**Unit IV: Laws of Thermodynamics and Their Applications (12)** The zeroth and first law of thermodynamics, Reversible and irreversible processes, Carnot cycle and its efficiency, Carnot theorem and the second law of thermodynamics, Entropy, Principle of increase of entropy Third law of thermodynamics, Maxwell's general relationships, Phase transition, Joule-Thomson cooling and adiabatic cooling in a general system, Van der Waal's gas, Clausius-Clapeyron heat equation, Thermodynamic potentials and equilibrium of thermodynamical systems, relation with thermodynamical variables
• Explain the basis of statistical mechanics. • Describe probability and thermodynamic probability and principle of equal a prior probabilities. • Describe accessible and inaccessible states. • Explain the concept of μ-space and its properties. • Describe one-dimensional harmonic oscillator. • Explain the concept of probability and entropy. • Explain statistical interpretation of second law of thermodynamics. • Deduce and explain Boltzmann canonical distribution law and its applications. • Explain distribution of speeds and velocities and its experimental verification. • Distinguish between mean rms and most probable speeds. • Explain Doppler broadening of spectral lines. • Describe Bose-Einstein and Fermi-Dirac statistics distributions. • Discuss the transition from classical to quantum statistics. • Describe photons in black body and free electrons in a metal. • Explain Fermi level and Fermi energy.	**Unit V: Statistical Physics (16)** The statistical basis of thermodynamics: Probability and thermodynamic probability, principle of equal a prior probabilities, Accessible and inaccessible states, The μ (mu) – space representation, division of μ-space into energy sheets and into phase cells of arbitrary size, Applications to one- dimensional harmonic oscillator and free particles, Equilibrium before two systems in thermal contact, Bridge with macroscopic physics, Probability and entropy, Boltzmann entropy relation, Statistical interpretation of second law of thermodynamics, Boltzmann canonical distribution law and its applications Maxwellian distribution of speeds in an ideal gas: Distribution of speeds and of velocities, experimental verification, distinction between mean rms and most probable speed values, Doppler broadening of spectral lines, Bose- Einstein and Fermi-Dirac statistics distributions, Photons in black body chamber, Free electrons in a metal, Fermi level and Fermi energy

Note: The figures in the parentheses indicate the approximate periods for respective units.

(4). Evaluation System

Undergraduate Programs							
External Evaluation	**Marks**	**Internal Evaluation**	**Weigh tage**	**Marks**	**Viva-voce**	**Weigh tage**	**Mark**

End semester examination	60	Assignments	20%	20	Report and Presentation on any topic	50%	20
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
		Attendance	20%		Viva	25%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

(I).External evaluation:

End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of thecourse.

External Evaluation (Viva):

After completing the end semester theoretical examination, viva examination will be held. External examiner will evaluate report/presentation & take viva exam and will do above mentioned evaluation. Students should make a small report by relating any of the studied topics in the subject to some application areas/examples. Reports can be made in groups. There will be an internal examiner to assist the external examiner. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroomdiscussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

(5). Prescribed Texts:

- Haung K., *Statistical Physics*, Wiley Eastern
- Kittel C. and Kroemer H., *Thermal Physics*, CSB Publishers
- Singhal S., Agrawal J. P. and Prakash S., *Heat, Thermodynamics and Statistical Physics*, Pragati Prakashan

(6). Reference:

- Laud B. B., *Introduction to Statistical Mechanics*, Macmillan
- Reif F., *Statistical Physics*, McGraw Hill
- Sears F. W. and Salinger G. L., *Thermodynamics, Kinetic Theory and Statistical Thermodynamics*, Addison
- Brij Lal and Subrahmanyam N., *Heat and Thermodynamics*, S. Chand and Company

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Thermodynamics PR** Credit: 1
Course No.: PHY 121 Number of hours per week: 3
Nature of Course:
PracticalLevel: B. Sc.
Year: First, Semester: Second

(1). Course Description

(2). Course Objectives

By the end of the course the student should be able to:

- ☐ measure correctly the basic physical quantities
- ☐ determine errors in measurements
- ☐ analyze raw data and make valid conclusions
- ☐ validate corresponding theoretical component
- ☐ develop proper laboratory skills
- ☐ design basic physics experiments
- ☐ interpret experimental results and draw logical conclusions
- ☐ relate theoretical concepts to practical skills

(3). List of Experiments:

To determine the value of Stefan's constant
To determine the ratio of Cp and Cv by Clement and Desorme's apparatus
To find the coefficient of thermal conductivity of a bad conductor by Lee's method
To determine the mechanical equivalent of heat by Callender and Barne's constant flow methodTo determine the sensitivity and constant of Ballistic galvanometer
To determine the capacitance by Ballistic galvanometer
To determine the high resistance by the method of leakageTo determine the low resistance by Carey Foster bridge
To determine the efficiency of an electric kettle (or heating element) under varying input voltagesTo determine the unknown frequency of a given source by using Lissajous figure

Note:

Student must perform 6 hours of lab work (2 hours × 3 times or 3 hours × 2 times) every week.
In every semester, at least eight experiments are to be performed. Additional experiments may be added subject toavailability of time.
The practical exam will be graded on the basis of the following marking scheme:

In-semester Evaluation	20%
Final Exam Written	60%
Final Exam Oral	20%

(4). References:

- Arora C. L., *B. Sc. Practical Physics*, S. Chand and Company
- Squires, G. L., *Practical Physics*, Cambridge University Press
- Shukla P. K. and Srivastava A., *Practical Physics*, New Age International (P) Limited Publishers

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Waves and Optics TH** F.M.: 100
Course No.: PHY231 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Second, Semester: Third Teaching Hours: 45

(1). Course Description

The course intends to enable the students to be acquainted with the basic concepts of waves and optics in Physics. Students will be familiarized with the fundamentals of free, damped and forced oscillations, Fourier analysis, wave motion, ultrasonic waves, acoustics, optics and lasers.

(2). Course Objectives:

At the end of this course the students should be able

- to acquire sufficient basic knowledge in waves and optics
- to apply this knowledge base for studying major courses in physics
- to solve mathematical problems in related topics
- to deduce mathematical equations and formulas

(3). Specific Objectives and Contents:

Specific Objectives	Contents in Detail
• Explain the difference between free and forced oscillation. • Describe free oscillations of systems with one and two degrees offreedom. • Explain superposition principle. • Describe the formation of beats. • Discuss the transverse modes of continuous string. • Explain the general motion of continuous string and its Fourieranalysis.	**Unit I: Free Oscillations (8)** Free oscillations of systems with one degree of freedom, Linearity and superposition principle, Free oscillations of systems with two degrees of freedom, Beats, Free oscillations of systems with many degrees of freedom, Transverse modes of continuous string, General motion of continuous string and Fourier analysis
• Understand forced oscillation. • Describe the nature of damped driven one-dimensional harmonic oscillator. • Explain resonances. • Formulate the resonances in system with two degrees of freedom.	**Unit II: Forced Oscillation (4)** Damped driven one-dimensional harmonic oscillator, Resonances in system with two degrees of freedom
• Describe the properties of travelling waves. • Explain and formulate phase velocity and group velocities. • Explain the dispersion relation. • Formulate equations for the phase velocity of sound – Newton's model andexplain its correction.	**Unit III: Travelling Waves (5)** Phase velocity and group velocity, Dispersion relation, Phase velocity of Sound, Newton's model and its correction
• Explain the characteristics of ultrasonic waves and its importance. • Describe the production of ultrasonic waves by piezoelectric andmagnetostriction methods. • Explain the method for the detection of ultrasonic waves. • Describe the method for measuring the velocity of ultrasonic waves.	**Unit IV: Ultrasonic Waves (5)** Production of ultrasonic waves by piezoelectric and magnetostriction methods, Detection of ultrasonic waves, Velocity of ultrasonic by Sears method
• Explain musical sound and acoustic of buildings. • Understand musical sound and noise. • Explain the characteristics of musical sound. • Define decibel, musical scale and acoustic of buildings. • Derive Sabine's reverberation formula.	**Unit V: Acoustics (3)** Musical sound and acoustic of buildings: musical sound and noise, Characteristics of musical sound, Decibel, Musical scale, Acoustic of buildings, Sabine's reverberation formula

• Explain interference due to the division of wave front and division of amplitude. • Explain the working of Fresnel's biprism, Lloyd's mirror, Newton's ring, Michelson interferometer, Fabry-Perot interferometer and wedge shape. • Derive formulae for the interference.	**Unit VI: Interference (5)** Division of wave front and division of amplitude, Fresnel's biprism, Lloyd's mirror, Newton's ring, Michelson interferometer, Fabry-Perot interferometer, Thin wedge shape interference
• Explain Fresnel and Fraunhofer diffraction. • Explain the working of Zone plate. • Discuss diffraction through single and double slits.	**Unit VII: Diffraction (4)** Fresnel and Fraunhofer diffraction, Zone plate,
• Explain the working of plane diffraction grating. • Obtain expressions for dispersive and resolving power of grating.	Diffraction through single and double slits, Plane diffraction grating, Dispersive and resolving power of grating
• Explain unpolarized, plane, circular and elliptically polarized lights. • Discuss double refraction and the working of Nicol prism. • Explain the working of quarter wave plate and half wave plate. • Describe optical activity and the working of Laurent's half shade polarimeter.	**Unit VIII: Polarization (6)** Plane, circular and elliptical polarization, Double refraction, Nicol prism, Quarter wave plate and half wave plate, Optical activity, Laurent's half shade polarimeter
• Explain the formation of lasers. • Explain the concept of population inversion. • Describe the working of the ruby laser and the He-Ne laser. • Explain the concept of holography.	**Unit IX: Lasers (5)** Population inversion, The Ruby laser, The He-Ne laser, Holography

Note: The figures in the parentheses indicate the approximate periods for respective units.

(4). Evaluation System

Undergraduate Programs							
External Evaluation	**Marks**	**Internal Evaluation**	**Weigh tage**	**Marks**	**Viva-voce**	**Weigh tage**	**Mark**
End semester examination	60	Assignments	20%	20	Report and Presentation on any topic	50%	20
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
		Attendance	20%		Viva	25%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

(I).External evaluation:

End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

External Evaluation (Viva):

After completing the end semester theoretical examination, viva examination will be held. External examiner will evaluate report/presentation & take viva exam and will do above mentioned evaluation. Students should make a small report by relating any of the studied topics in the subject to some application areas/examples. Reports can be made in groups. There will be an internal examiner to assist the external examiner. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignmentwill be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

(5). Prescribed Texts:

- Crawford Jr F. S., *Waves (Berkeley Physics Course Vol 3)*, Tata McGraw Hill India
- Ghatak A. K., *Optics*, Tata McGraw Hill India

(6). Reference:

- Halliday D., Resnick R. and Walker J., *Principles of Physics*, John Wiley and Sons India
- Subrahmanyam N. and Brij Lal, *Textbook of Optics*, S. Chand and Company, New Delhi

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Waves and Optics PR** F.M.: 100
Course No.: PHY231 P.M.: 45%
Nature of Course: Practical Credit: 1
Level: B. Sc. Number of hours per week: 3
Year: Second, Semester: Third Teaching Hours: 45

(1). Course Description

(2). Course Objectives

By the end of the course the student should be able to:

- ☐ measure correctly the basic physical quantities
- ☐ determine errors in measurements
- ☐ analyze raw data and make valid conclusions
- ☐ validate corresponding theoretical component
- ☐ develop proper laboratory skills
- ☐ design basic physics experiments
- ☐ interpret experimental results and draw logical conclusions
- ☐ relate theoretical concepts to practical skills

(3). List of Experiments:

To determine the wavelength of a light source by Newton's Ring method
To determine the wavelength of given source of light using a plane diffraction grating

Note:

Student must perform 6 hours of lab work (2 hours × 3 times or 3 hours × 2 times) every week.
In every semester, at least eight experiments are to be performed. Additional experiments may be added subject toavailability of time.
The practical exam will be graded on the basis of the following marking scheme: In-semester Evaluation 20%
Final Exam Written 60%
Final Exam Oral 20%

(4). References:

- Arora C. L., *B. Sc. Practical Physics*, S. Chand and Company
- Squires, G. L., *Practical Physics*, Cambridge University Press
- Shukla P. K. and Srivastava A., *Practical Physics*, New Age International (P) Limited Publishers

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Electronics TH**

Credit: **3**

Course No.: **PHY 241**

Number of hours per week: **3**

Nature of the Course: **Theory**

Total hours: **45**

Year: **Second**, Semester**: 4th**

Level: **B.Sc.**

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts of Electronics. Students will be familiarized with the fundamentals of Circuit Analysis, Diodes, Transistors, Amplifiers, Oscillators and Digital circuits.

2. Course Objectives

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

- to acquire sufficient basic knowledge in Electronics
- to apply this knowledge base for studying major courses in physics.
- to solve mathematical problems in related topics.
- to deduce mathematical equations and formulas.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Describe the circuit analysis usingvarious network theorems • Explain superposition theorem • Explain and use Thevenin'sandNorton's theorems • Describe maximum power transfer theorem	**Unit I: Network Theorems (4)** Superposition theorem, Thevenin's theorem, Norton's theorem,Maximum power transfer theorem
• Describe the formation and working of P-N junction diode • Explain the characteristics and applications of the diode • Describe the uses of diode as half-wave and full-wave rectifiers • Explain the working of Zener diode	**Unit II: Diodes (6)** P-N junction diode: characteristics and applications, half-wave and full-wave rectifiers, Zener diode and voltage regulation, LED and photodiodes

- Describe voltage regulation
- Explain the working of LED andphotodiodesh

- Describe NPN and PNPcharacteristics
- Explain various transistor biasing and their equivalent circuits
- Explain DC load line, Q point andstability factor
- Derive and explain the relation between currents

Unit III: Transistors (10)

NPN and PNP characteristics, transistor biasing: CB, CC and CE configurations, DC load line, Q point, stability factor, DC and AC equivalent circuits

- Explain the working of transistors as amplifiers
- Explain the classification ofAmplifiers
- Describe class A, B and C amplifiers
- Explain the working of RC-CoupledAmplifiers

Unit IV:Amplifiers (7)

CB, CE and CC amplifiers, Classification of Amplifiers: Class A, Band C amplifiers, RC-Coupled Amplifiers

- Derive and explain the Berkhausen criterion
- Explain the working of Hartley, Colpitts, phase shift and Wien bridge oscillators
- Describe the uses and working of Astable, monostable and bistable of, multivibrators

Unit V: Oscillators (8)

Berkhausen criterion, Hartley, Colpitts, phase shift and Wien bridge oscillators, multivibrators: Astable, monostable and bistable

- Explain various number systems andtheir interconversion
- Describe Boolean algebra
- Explain the De Morgan's theorem
- Describe the construction of logic gates using diodes and transistors
- Explain the working of various gates
- Explain the universal gates
- Explain the construction of half adder, full adder, half subtractor and full subtractor using the gates

Unit VI: Digital circuits (10)

Decimal, binary, octal and hexadecimal number systems, Boolean algebra, De Morgan's theorem, logic gates (OR, AND,NOT,NAND,NOR, X-OR and X-NOR gates using diodes and transistors), half adder and full adder, half subtractor and full subtractor

4. Evaluation System

Undergraduate Programs							
External Evaluation	**Marks**	**Internal Evaluation**	**Weigh tage**	**Marks**	**Practical**	**Weigh tage**	**Mark**
End semester examination	60	Assignments	20%	20	Practical Report copy	25%	20
(Details are given in the separate table at the end)		Quizzes	10%		Viva	25%	
		Attendance	20%		Practical Exam	50%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

5. External evaluation

1. **End semester examination:**
   It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

2. **External Practical Evaluation:**
   After completing the end semester theoretical examination, practical examination will be held. External examiner will conduct the practical examination according to the above mentioned evaluation. There will be an internal examiner to assist the external examiner. Three hours time will be given for the practical examination. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

6. Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluatedaccordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period.

7. Prescribed Text

- Theraja B. L., Basic Electronics Solid State, S.Chand and Company Ltd, New Delhi

8. Reference

- Malvino A. P., Electronic Principles, Tata McGraw Hil Pub.
- Bogart T. F. , Electronic Devices and Circuits, Universal Book Stall, New Delhi

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Electronics PR** Year: 2

Course No.: **PHY 241** Semester: 4th

Nature of the Course: Practical Credit: 1

Objectives:
By the end of the course the student should be able to:
measure correctly the basic physical
quantitiesdetermine errors in measurements
analyze raw data and make valid
conclusions validate corresponding
theoretical componentdevelop proper
laboratory skills
designbasic physics experiments
interpretexperimental results and draw logical
conclusionsrelate theoretical concepts to practical skills

List of Experiments:
To determine the resonant frequency and quality factor of series LCR
circuitTo verify the maximum power transfer theorem
To verify the Thevenin's and Norton's
theoremsTo study the CB characteristics of a
transistor To study the CE characteristics of a
transistor To study the CC characteristics of a
transistor
To construct a regulated power supply using Zener
diodeTo study OR, AND and NOT gates using DTL
and TTL
To study NOR and NAND gates using DTL and TTL
To verify NAND and NOR gates as the universal gates

Note:
Student must perform 6 Hours of lab work (2 Hours x 3 times or 3 Hours x 2 times) every week In every semester, at least Eight experiments are to be performed.Additional experiments may beadded subject to availability of time.

The practical exam will be graded on the basis of the following marking scheme:

In-Semester Evaluation	20%
Final Exam Written	60%
Final ExamOral	20%

References:

1. Arora, C. L., B.Sc. Practical Physics, S Chand and Company Ltd.
2. Squires, G. L., Practical Physics, Cambridge University Press.
3. Shukla, P. K. and Srivastava, A., 2006, *Practical Physics,* New Age International (P) Limited,Publishers

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: Electricity and Magnetism TH **Credit: 3**
Course No. : PHY351 **Number of hours per week: 3**
Nature of the Course: Theory **Total hours: 45**
Year: Third, Semester: Fifth
Level: B.Sc.

1. Course Description:
The course intends to enable the students to be acquainted with the basic concepts of Electricity and Magnetism. Students will be familiarized with the fundamentals of Coulomb's law, Electric field and Potential, Electric field in dielectric media, Biot-Savart law, Ampere's circuital law, Magnetic properties and magnetic field, A.C. and D.C. circuit and Maxwell's equation.

2. Course Objectives:
At the end of this course the students should be able:

*to acquire sufficient basic knowledge in Electricity and Magnetism.

*to apply this knowledge base for studying major courses in physics.

*to solve mathematical problems in related topics.

*to deduce mathematical equations and formulae.

3. Specific Objective and contents:

Specific Objectives:	Contents:
*Describe point function and field *Define gradient, divergence and curl *Able to know physical meaning of gradient, divergence and curl *Solve mathematical problems related with Gradient, divergence and curl *Explain Gauss's and Stoke's theorems *Define Green's theorem, Laplace and Poisson's equations	**Unit 1.Elementary vector analysis: (6hrs)** Review of vector algebra, Polar and axial vector, Point function and field, Gradient of scalar function, Divergence and curl of vector function in Cartesian co-ordinates, Physical meaning of gradient, divergence and curl, Gauss's and Stoke's theorems, Green's theorem, Laplacian operator, Introduction to Laplace and Poisson's equations.
*State and explain Coulomb's law *Define electric field and electric flux *Apply Gauss law in different cases *Calculate electric field and potential *Define electric potential and equipotential surface *Method of electrical image.	**Unit 2.Electrostatic Potential and Field: (6hrs)** Coulomb's law, Charge densities, Electric field and its calculation(on the axis of ring of charge and uniformly charged disc, Field of a line of charge), Electric flux, Gauss's law and its applications, Differential form of Gauss law, Electric potential and Equipotential surface, Electric field and potential due to electric dipole, Method of electrical image (Charged metallic plate and point charge & Grounded conducting sphere and point charge).

*Define dielectric *Define polar and non-polar molecules *Explain electric polarization *Deduce Gauss law in dielectric medium *Derive Clausius-Mossotti relation *Derive Langevin Debye formula *Define ferroelectric and paraelectric dielectric	**Unit 3.Electric field in dielectrics: (6hr)** Polar and Non-polar dielectrics, Electric polarization, Three electric vectors $\vec{E}$, $\vec{D}$& $\vec{P}$, Gauss's law in dielectric medium, Boundary conditions of field vectors, Clausius-Mossotti relation, Langevin-Debye formula, ferroelectric and paraelectric dielectrics.
*Define magnetic field and magnetic flux *Apply Biot-Savart law in different cases *Define Helmholtz coil *Apply Ameper's circuital law in different cases *Derive forces between current carrying parallel wires *Explain Hall effect	**Unit 4.Magnetic field of moving charges: (6hrs)** Magnetic field and magnetic flux, Biot-Savart law and its applications, Ampere's circuital law and its applications, Magnetic dipole, Curl and divergence of $\vec{B}$, Forces between current carrying parallel wires, Magnetic vector potential, Magnetic scalar potential, Helmholtz coil, Gauss law in magnetostatics, Magnetic bottle, Hall effect.
*Define various types of magnetic materials *Explain magnetization *Derive Langevin theory of dia & para magnetism *Explain Cuire Weiss law *Derive relation between three magnetic vectors *Define ferromagnetic theory * Define hysteresis loss * Derive relation between μ & χ	**Unit5. Magnetic properties and Fields: (6hrs)** Types of magnetic materials, Magnetic dipole moment of a current loop and angular momentum, Magnetization, Langevin's theory of diamagnetism and Paramagnetism, Relation between three magnetic vectors $\vec{B}$, $\vec{H}$& $\vec{M}$, Cuire Weiss law, Ferromagnetic theory, Hysteresis loss, Magnetic permeability (μ) & magnetic susceptibility (χ).
*Explain Faraday's laws *Define self & mutual induction *Calculation of self inductance & mutual inductance *Derivation of energy stored in magnetic field *Describe transformer, Search coil, moving coil galvanometer, Flux meter and Earth inductor	**Unit 6.Electromagnetic Induction: (6hrs)** Faraday's laws, Self induction, Calculation of self inductance of solenoid, Toroid (rectangular and circular cross section), Two long parallel wires, two coaxial cylinders, Mutual induction, Energy stored in magnetic field, Transformer, Search coil, Flux meter Moving coil galvanometer, Earth inductor.
*Define A.C. and D.C. *Explain charging and discharging of condenser through resistance *Growth and decay of current in RL and LC circuit *Describe LCR series circuit *Define sharpness of resonance, quality & power factor *Describe LCR parallel circuit	**Unit7. D.C. and A.C. circuits: (4hrs)** A.C. and D.C. sources, Charging and discharging of capacitor through resistance, Growth and Decay of current in RL and LC circuit, LCR-series circuit, Sharpness of resonance, Quality factor, Power factor, LCR-parallel circuit.
*Derive Maxwell's equations *Derive energy of charged particle in electromagnetic field *Explain Poynting vector *Derive electromagnetic wave equation	**Unit8. Electromagnetic Wave: (5hrs)** Maxwell's equations (General form and for free space), Energy of a charged particle in an electromagnetic field, Poynting vector, Electromagnetic wave equation.

Evaluation System:

<table>
<tr><th colspan="8">Undergraduate Programs</th></tr>
<tr><th>External Evaluation</th><th>Marks</th><th>Internal Evaluation</th><th>Weightage</th><th>Marks</th><th>Practical</th><th>Weightage</th><th>Marks</th></tr>
<tr><td rowspan="4">End Semester Examination (Details are given in the separate table at the end)</td><td rowspan="4">60</td><td>Assignments</td><td>20%</td><td rowspan="4">20</td><td>Practical Report Copy</td><td>25%</td><td rowspan="4">20</td></tr>
<tr><td>Quizzes</td><td>10%</td><td>Viva</td><td>25%</td></tr>
<tr><td>Attendance</td><td>20%</td><td rowspan="2">Practical Exam</td><td rowspan="2">50%</td></tr>
<tr><td>Internal Exams</td><td>50%</td></tr>
<tr><td>Total External</td><td>60</td><td>Total Internal</td><td>100%</td><td>20</td><td></td><td>100</td><td>20</td></tr>
<tr><td colspan="8">Full Marks 60+20+20 = 100</td></tr>
</table>

External Evaluation:
End Semester Examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

External Practical Evaluation:
After completing end semester theoretical examination, practical examination will be held. External examiner will conduct examination according to the above mentioned evaluation. There will be an internal examiner. Three hour time will be given for the practical examination. In this examination students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in te end semester examinations.

Internal evaluation:

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken

Quizzes: Unannounced and announced quizzes/ tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The student will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percentage class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentation on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and Participation: Students will be evaluated on the basis of their active participation in the classroom discussion.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

*Lecture and Discussion

*Group work and individual work

*Assignments

*Presentation by students

*Quizzes

*Guest lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period.

Text Book:

1. Foundation of Electromagnetic Theory, J. R. Reitz, F.J. Milford, R.W. Christy, Narosa Publishing House, New Delhi, 3rd Ed, 1998.

Reference Books:

1. Electricity and Magnetism, Edward M. Purcell (McGraw-Hill Education, 1986).
2. Fundamentals of Electricity and Magnetism, Arthur F. Kip (McGraw-Hill, 1968)
3. Electricity and Magnetism, J. H. Fewkes & John Yarwood. Vol. I (Oxford Univ.Press,1991).
4. Electricity and Magnetism, D. C. Tayal (Himalaya Publishing House, 1988).
5. David J. Griffiths, Introduction to Electrodynamics, 3rd Ed, (Benjamin Cummings, 1998).
6. Electricity and Magnetism with Electronics, K. K. Tiwari, S. Chand & Company LTD.
7. Electricity and Magnetism, V.P. Arora, M.C. Saxena, S. Prakash, Pragati Prakashan, Meerut, 18th Ed,2007.
8. Electromagnetics, B.B. Laud, Wiley Eastern, Ltd, 2nd Ed,1992.

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: Electricity and Magnetism PR **Year: III**
Course No.:PHY351 **Semester: V**
Nature of the Course: Practical **Credit: 1**

Objectives: By the end of the course the student should be able to:
*measure correctly in measurement
*determine errors in measurements
*analyze raw data and make valid conclusions
*validate corresponding theoretical component
*develop proper laboratory skills
*design basic physics experiment
*interpret experimental results and draw logical conclusion
*relate theoretical concept to practical skills

List of experiments:
1. To find out ballistic constant 'K' of a moving coil galvanometer.
2. To find out high resistance by the method of leakage.
3. To study charging of a condenser through resistor and trace charging cuve.
4. To study discharging of a condenser through resistor and trace discharging cuve.
5. To find out impedance of LCR-series circuit.
6. To find out quality factor of LCR-series circuit.
7. To find out impedance of LCR-parallel circuit.
8. To find out time constant of RL-circuit during growth of current.
9. To find out time constant of RL-circuit during decay of current.
10. To find out transformer ratio and percentage efficiency of transformer.
11. To find out Hall voltage and Hall coefficient of given sample.
12. To trace hysteresis loop using oscilloscope.

Note:
*Student must perform 6 hours of lab work (2hours×3times or 3hours ×2times) every week.
*In every semester, at least eight experiments are to be performed. Additional experiments may be added subject to availability of time.
*The practical exam will be graded on the basis of the following marking scheme:In-Semester Evaluation 20%
Final exam written 60%
Final oral exam 20%

References:
*Arora C.L., B.Sc. Practical Physics, S Chand and Company Ltd
*Squires G.L., Practical Physics, Cambridge University Press

*Shukla P.K. and Srivastava, 2006, Practical Physics, New Age International (P) Ltd, Publisher

* Gupta S.L. and Kumar V., Practical Physics, Pragati Prakashan, Meerut.

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Atomic, Nuclear & Particle Physics TH** Credit: **3**
Course Code: **PHY 361** Number of hours per week: **3**
Nature of the Course: **Theory** Total hours: **45**
Year: **Third**, Semester**: 6th**
Level: **B.Sc.**

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts of atomic, nuclear and particle physics. Students will be familiarized with the fundamentals of atomic, sub-atomic and nuclear structures, their model and properties, interaction modes and a few experimental techniques.

2. Course Objectives

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

- to acquire sufficient basic knowledge in atomic, nuclear and particle physics
- to apply this knowledge base for studying major courses in physics.
- to solve mathematical problems in related topics.
- to deduce mathematical equations and formulas.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Describe Rutherford experiment and discuss its importance to understand atoms and nuclei • Analyse the spectra of H-atom and explain Bohr's idea • Describe Frank-Hertz experiment and itsresult, interpret about its result • Discuss Sommerfeld modification regarding the electronic orbits and its behavior withnucleus.	**Unit I: Atomic Structure (5)** Rutherford scattering: conclusion and limitations, the Bohr's atom, energy level diagram and spectra of hydrogen atom, Frank-Hertz experiment and limitations of Bohr's model, the Sommerfeld atom
• Describe the meaning of spin of an electron inmodern physics • Explain the experimental detail and the hypothesis of Stern-Gerlach experiment,interpret its result. • Explain the reason behind the introduction ofPauli Exclusion principal • Describe the concept of space quantization and intrinsic angular momentum and hence thevector atom model • Derive the expression for velocity, radius, kinetic energy, potential energy and hence thetotal energy of an electron in an atom • Explain the meaning of spin-orbit coupling and hence describe the importance of finestructure constant in the atomic	**Unit II: Many Electron Atom (5)** Electron spin, Stern-Gerlach experiment, Pauli's exclusion principle, shells and subshells of electrons, vector atom model, LS coupling and s, p, d, f notation

spectra	
	Unit III: Atomic Spectra (4) Fine structures of H, Na, He and Hg, Paschen-Back
• Discuss fine structures of given atoms (explainit in the aspect of spin-orbit coupling) • Discuss the effect on such atomic spectra whenuniform magnetic field (weak to strong) is applied. • Work out for the expression for change in energy level (or shift / split) in the presence ofmagnetic field	effect, normal and anomalous Zeeman effect
• Describe a fundamental properties ofelectromagnetic waves • Explain how e.m. wave interact with matter • Explain low (photoelectric) to high energy (Compton, pair production) interaction of e.m.waves with matter	**Unit IV: Particle properties of waves (4)** Electromagnetic waves and its interaction with matter,photoelectric effect, Compton scattering and pair production,
□Describe X-ray spectra and explainits peculiarities over atomic spectra □Discuss X-ray diffraction and its implications □Describe Moseley's law and use it to solve problems.	**Unit V: X-ray Spectrum (3)** Characteristic X-ray, X-ray diffraction, fine structure ofX-ray transitions, Moseley's law and its application
□Explain several hypothesis regarding the nucleus formation □Discuss the observed properties of nuclei and draw a conclusion regarding its mass, charge, density, magnetic and electrical properties □Draw nuclear stability curve and justify it in terms of binding energy of a nuclei □Discuss the meson theory of nuclear forces	**Unit VI: Nuclear Structure (5)** Proton-electron and proton-neutron hypothesis, nuclear composition and its properties (mass, charge, density, magnetic and electric properties), nuclear stability and binding energy, Meson theory of nuclear forces
□Formulate the laws of successive radioactive disintegration with the explanation of half and mean life □Describe all four natural radioactive series □Explain the origin, interaction and propertiesof alpha particle □Discuss neutrino hypothesis in order to explain	**Unit VII: Nuclear Transformations (6)** Law of successive radioactive disintegration, half-life, mean life, natural radioactive series, alpha, beta and gamma ray spectra, absorption of α particles, its range and stopping power, theory of α decay, neutrino hypothesis of β-decay
the reason behind □-decay.	

□Describe all seven conservation laws for elementary particles and use it to solve problem □Describe the reason behind the generation of quark and leptons in the standard model □Explain the properties of meson, baryon, quarks and leptons □Discuss how quark and lepton interacts □Elaborate standard model of particle physics	**Unit VIII: Elementary Particles (7)** Conservation laws: lepton number, baryon number, parity, charge conjugation, Isospin, Strangeness and Hypercharge, Parity violation: examples and explanation, quark and lepton: generations and properties, Baryon and Meson: properties and examples, Interaction of quarks and leptons, Standard Model of particle physics: matter sector
□Explain the principal, working and limitations of particle detectors and its use in understanding behavior of fundamental particles. □Explain the principal, working and limitations of particle accelerators and its use to understand character, interaction and behavior of fundamental and composite particles. □Describe the motives and achievements of LHC project at CERN, Geneva	**Unit XI: Particle Detectors and Accelerators (6)** G. M. counter, bubble chamber, Cerenkov detectors, linear accelerator, cyclotron, synchrocyclotron, betatron, the LHC project

Text and Reference Books

1. *Beiser A., Mahajan S. and Choudhury S. R.* - **Concepts of Modern Physics**, Tata McGrawHill Education, New Delhi (2011)

2. *Marmier, P. and Sheldon E.* - **Physics of Nuclei and Particles**, Academic Press New YorkLondon (1970)

3. *Murugeshan R. and Sivaprasad K.* - **Modern Physics**, S. Chand and Company, New Delhi(2012)

4. *Blatt F. J.* - **Modern Physics**, McGraw Hill International (1992)

5. *Wahr M. R., Richard J. A. and Adir T. W.* - **Physics of the Atom**, Addison Wesley (1984)

6. *Leighton R. B.* - **Principles of Modern Physics**, McGraw-Hill Education (1959)

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Atomic, Nuclear & Particle Physics PR** Credit: **1**
Course No.: **PHY 361** Number of hours per week: **3**
Nature of the Course: **Practical** Total hours: **45**
Year: **Third**, Semester**: 6th**
Level: **B.Sc.**

1. Course Description
The course intends to enable the students to be acquainted with the basic concepts of generalexperiments.

2. Course Objectives
At the end of this course the students should be able:

- To provide students with skill and knowledge in the experimental methods.
- To make them able to apply knowledge to practical applications.
- To make them capable of presenting their results/conclusions in a logical order.

3. Specific Objectives and Contents

Specific Objectives	Contents
' Understand how charge (e) of an electronis determined by using Millikan's oil drop method. ' Understand how charge (e) of an electron is determined by using Thomson's method. ' Develop the skill to analyse the data and perform error analysis ' Understand the resolution time, dead time,recovery time and hence efficiency of G.M. counter that you have in the laboratory.	**Unit I: General Lab (45)** **1.** To determine the charge (e) of an electron by using Millikan's oil drop method. **2.** To determine the specific charge of an electron (e/m) by Thomson's method. **3.** Perform the experiment 1-2 and compile a dataset of specific charge of an electron. Show the histogram and calculate the standard deviation and standard error. Interpret the result. **4.** To study the characteristics of Geiger Muller (G.M.)counter and find its reliability. **5.** To study the platue region of Geiger Muller (G.M.)counter in and outside the laboratory.

' Compare the platue curve inside the lab (almost no cosmic radiation) and outside (terrestrial and cosmic radiation) the lab ' Understanding the radioactive emission from natural background.	**6.** Study the variation in the natural background count along all possible directions (east, west, north and south) using Geiger Muller counter.
' Develop the skill to analyse the data andperform error analysis	**7.** Perform the experiment 6-8 and compile a dataset of count rate at a particular operating voltage. Show the histogram and calculate the standard deviation and standard error. Interpret the result.
' Understanding the ionizing and penetrating power of β-particles in air and in Al absorbers using a G.M. counter.	**8.** To determine the linear absorption coefficient of β-particles in air and in Al absorbers using a G.M. counter.
' Understanding penetrating power of by determining low value of absorption coefficient of □-rays in Al, Cu and brass absorber using a G.M. counter.	**9.** To determine the linear absorption coefficient of □- rays in Al, Cu and brass absorber using a G.M. counter.
' Study the properties of gamma rays as electromagnetic radiation.	**10.** Verify inverse square law using a standard □-ray source and G.M. counter.
' Develop the skill to analyse the data andperform error analysis	**11.** Perform the experiment 10-11 and compile a dataset of count rate at a particular operating voltage. Show the histogram and calculate the standard deviation and standard error. Interpret the result.

Note: Students have to perform at least 6 experiments in 45 working hours. Students need to write a laboratory report on each experiment they perform and get them duly checked and signed by the concerned teacher. They should write their reports in a separate sheet, and to keep them neat and properly filed.

The practical exam will be graded on the basis of the following marking scheme:

In-Semester Evaluation	20%
Final Exam Written	60%
Final Exam Oral	20%

Text Books:

1. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010)

2. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999)

3. Shukla, P. K. and Srivastava, A. - **Practical Physics**, New Age International (P) Limited,Publishers (2006)

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Relativity**

Credit: **3**

Course Code: **PHY 362**

Number of hours per week: **3**

Nature of the Course: **Theory**

Total hours: **45**

Year: **Third**, Semester**: Sixth**

Level: **B.Sc.**

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts theory of relativity. Students will be familiarized with the fundamentals of special theory of relativity and a brief introduction of general relativity.

2. Course Objectives

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

- to acquire sufficient basic knowledge in relativistic mechanics.
- to apply this knowledge base for studying major courses in physics.
- to solve mathematical problems in related topics.
- to deduce mathematical equations and formulas.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Understand the need of special relativitytheory • Understanding about much debated Michelson-Morely experiment and itsinterpretation	**Unit I: Special Relativity (6)** Frame of reference, postulates of special relativity, Ether hypothesis, Michelson-Morely experiments: it result, achievements and limitations
• Understanding the difference between the Newtonian frame of reference and frame ofreference used for relativity • The knowledge of transformation scheme between Galilian and Lorentz and its use to deal the fundamental quantities (length, massand time)	**Unit II: Lorentz Transformation (6)** Galiliean transformation, Lorentz transformation, inverse Lorentz transformation, addition of velocity, relativistic velocity transformation

• Developing the idea of space-time coordinatesystem and its transformation • Knowledge about the time interval in space-time co-ordinate system • Discuss the knowledge about the past, presentand future using light cone • Understanding of space-like, time-like andlight-like interval	**Unit III: Space time (7)** Space time and Lorentz transformation, space time interval between events, past and future light cone in space time, time-like interval, space-like interval, light- like interval, constancy of speed of light
• Use inverse Lorentz transformation to find the	**Unit IV: Time dilation & Length Contraction (8)** Proper time, time dilation, its example in real life and in
expressions for time dilation and lengthcontraction • Use these expressions to solve relativistic realproblems • Understanding of transverse and longitudinalDoppler effect light • Understanding the bridging between electricityand magnetism by the relativity	experiments, ultimate speed limit, Doppler effect in sound, transverse and longitudinal Doppler effect in light, the expanding Universe, simultaneity, twin paradox: examples, Proper length, length contraction, its example in real life and in experiments, electricity and magnetism: relativity as a bridge
• Discuss the difference between classical andrelativistic momentum • Describe conservation of momentum inrelativity • Understanding the concept of relativistic massand conservation of mass	**Unit V: Relativistic momentum and mass (4)** Classical and relativistic momentum: from Newton'slaw, conservation of momentum in relativity, Propermass, second relativistic law, conservation of mass inrelativity
□Understanding the rest energy of relativisticparticle □Formulation of mass-energy formula □Describe the experimental tests of mass-energy relationship. □Understanding kinetic energy at low speeds	**Unit VI: Mass and Energy (5)** Rest energy, kinetic energy, total energy, conservation of energy, kinetic energy at low speeds, mass equivalent energy, mass-energy formula, direct test of mass-energy relationship
□Describe energy momentum relation and itsimplications □Description about mass-less particle regardingrelativity	**Unit VII: Energy and momentum (3)** Total energy, momentum, energy-momentum relation,massless particles

□Understanding the concept of gravity in the special theory of relativity □Description about principle of equivalence □Understanding the relation between gravityand electromagnetic wave □Evidences of verification of general relativity	**Unit VIII: General theory of relativity (6)** Einstein theory of gravitation, principal of equivalence,gravity and light, other findings of general relativity

Text and Reference Books

1. *Beiser A., Mahajan S. and Choudhury S. R*. - **Concepts of Modern Physics**, Tata McGrawHill Education, New Delhi (2011)

2. *Murugeshan R. and Sivaprasad K*. - **Modern Physics**, S. Chand and Company, New Delhi(2012)

3. *Rindler Wolfgang* - **Introduction to Special Relativity**, 2nd ed., Oxford University Press(1991)

4. *Das Anadijiban* - **The Special Theory of Relativity: A Mathematical Approach**, Springer-Verlag (1996)

5. *Schutz Bernard F*. - **A First Course in General Relativity**, Cambridge University Press(1985)

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Math Physics**
Course Code: **PHY471**
Nature of the Course: **Theory**
Year: **Fourth**, Semester**: 7th**
Level: Undergraduate (**B.Sc.)**

Credit: **4**
Number of hours per week: **4**
Total hours: **60**
Full Marks: **100**
Pass Marks: **45**

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts of mathematics that is frequently used in physics. Students will be familiarized with the details of vector analysis, tensors, linear vector space, fourier and laplace transform and differential equation with special functions.

2. Course Objectives

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

- to acquire sufficient basic knowledge in mathematical physics
- to apply this knowledge base for studying major courses in physics.
- to solve mathematical problems in related topics.
- to deduce mathematical equations and formulas.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Developing the idea of vector transformationtechniques and its uses. • Delivering the concepts of various types of vectors, e.g., polar, axial, solenoidal, rotationaland irrotational vectors • Students should understand the idea ofcurvilinear coordinate system. • Describe various types of orthogonal curvilinear coordinates for example cylindrical, spherical, ellipsoidal, hyperbolicand parabolic coordinates • Problem solving skill should be developed • Students should learn the idea regarding use of these tools of vector analysis in the theoretical physics.	**Unit I: Vector analysis (12 hrs)** Scalar and vector fields, law of transformation of vectors, polar and axial vectors, solenoidal vectors, rotational and irrotational vectors, vortex lines, Curvilinear coordinates: direction cosines, scale factors, curvature of co-ordinate lines, volume element, rotation of axes, contravarient and covariant vectors, Gradient, divergence, curl and Laplacian in curvilinear co-ordinates, Special orthogonal curvilinear coordinates: cylindrical, spherical, ellipsoidal,hyperbolic and parabolic co-ordinates
• Describe the idea, formulation, properties and important techniques of tensor analysis to the student • Problem solving skill should be developed.	**Unit II: Tensor analysis (13 hrs)** Contravariant, covariant and mixed tensors, Kronecker delta, tensors of rank greater than two, scalars or invariants, Tensor fields, symmetric and skew symmetric tensors, fundamental operations with tensors, stress tensor, Line element and metric tensor, reciprocal tensors, associated tensors, length of a vector, angle

• Students should learn the concept regardinguse of these tools of tensor analysis in the theoretical physics.	between vectors, physical components, Christoffel's symbols, transformation laws of Christoffel's symbols, geodesics, covariant derivatives, Tensor form of gradient,divergence, curl and Laplacian
• Describe the idea, formulation and important techniques of linear vector space to the student • Problem solving skill should be developed. • Students should learn the idea regarding use ofthese tools of linear vector space in the theoretical physics.	**Unit III: Linear vector spaces (10 hrs)** Vectors in n-dimensions, linear independence, inner product, Schwartz inequality, Representation of vectors and linear operators with respect to a basis, change of basis, Schmidt orthogonalization process, Linear operators and their matrix representation: symmetric, Hermitian, orthogonal, unitary (normal) matrices, Determination of eigen values and eigen vectors of the matrix, diagonalization
• Describe the idea, formulation, properties and important techniques of Fourier series, Fouriertransform and Laplace transform to the student • Illustrate the examples of various types of waves, e.g., square, triangular, saw-tooth, etc • Problem solving skill should be developed. • Students should learn the idea regarding use of these tools of Fourier and laplace transforms in the theoretical as well as experimental physics.	**Unit IV: Fourier series and transforms (11 hrs)** Fourier series representation, even and odd functions, Fourier series expansion of square, triangular, saw-toothwaves and out put of full wave rectifier, Complex representation of Fourier series, Dirac delta function, Parseval relation, Fourier transform and convolutiontheorem, Laplace transform, Laplace transform of derivatives and integrals, Use of Fourier and Laplacetransform in solving partial differential equations.
• Describe the idea, formulation, properties andimportant techniques of special functions to the student • Problem solving skill should be developed. • Students should learn the idea regarding use ofthese tools of special functions in the theoretical physics.	**Unit V: Differential equations (8 hrs)** Series solutions of Bassels's, Legendre's, Hermite's, Laguerre's differential equations, Rodrigue's formula, Recurrence relations, associated Legendre and Laguerre polynomials.
• Describe the idea, formulation, properties andimportant techniques of partial differential equations to the student • Problem solving skill should be developed. • Students should learn the idea regarding use ofthese tools of partial differential equation in the theoretical as well as in the experimental physics.	**Unit VI: Partial differential equations (6 hrs)** Wave equations, Laplace, Poisson and diffusion equations, boundary value problems, Method of separation of variables

Prescribed Text Books:

1. *Mathew, J. & Walker, R.* - **Mathematical Methods in Physics**, Benjamin Menlo Park,Second Edition (1970).

2. *Spiegel, Murray R.* - **Vector Analysis (Schaum Series)**, McGraw Hill, London (1992).

3. *Harper C.* - **Introduction to Mathematical Physics**, Prentice Hall of India Pvt. Ltd. (1990).

Reference Books:

1. *Gupta B. D.*- **Mathematical Physics**, Vikas Pub. House Pvt. Ltd., India (1994).

2. *Rajput B. S.*- **Elementary Mathematical Physics**, Pragati Prakashan, India (1997).

3. *Arfken G.*- **Mathematical Methods for Physicists**, Academic Press, New York (1970).

4. *Margenau H. and Murphy G. M.* - **The Mathematics of Physics and Chemistry**, Krieger,New York, (1976).

5. *Pipes L. A.* - **Applied Mathematics for Engineers and Physicists**, McGraw-Hill (1970).

6. *Hinchey F. A*.- **Vectors and Tensors for Engineers and Scientists**, Wiley Eastern (1976).

7. *Joshi W.* - **Matrices and Tensors in Physics**, Wiley Eastern (1995).

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Classical Mechanics**
Course No: **PHY472**
Nature of the Course: **Theory**
Year: **Fourth,** Semester: **7th**
Level: Undergraduate **(B.Sc.)**

Credit: **4**
Number of hours per week: **4**
Total hours: **60**
Full Marks: **100**
Pass Marks: **45**

1. Course Introduction

The course intends to enable the students to be familiar with description and formulation of classicalmechanics.

2. Objectives

At the end of this course the students should be able to understand and apply;

- Basic concepts of main features of central force problem.
- Basic concepts of scattering angles and cross-section in centre of mass and laboratorycoordinate system.
- Basic concept of generalized coordinate system and Lagrangian formulation.
- Basic concept of calculus of variation and Hamilton's principle.
- Basic concept of the kinematics and dynamics of rigid body motion.
- Basic concept of relativistic classical mechanics.

3. Specific Objectives and Contents:

Specific Objectives	Contents
• To understand the basic concept ofone body problem. • To understand the concept of mainfeatures of central force problem. • To gain knowledge aboutclassification of orbits.	**Unit I: Motion Under Central Force (6 hrs)** Reduction to the Equivalent One Body Problem. General Features of Central force Motion. The Equation of Motion and First Integrals. The Equivalent One Dimensional Problem and Classification of Orbits. The Kepler Problem: Inverse Square Law of Force.
• To understand about centre of massand laboratory coordinate systems. • To gain knowledge about Scatteringangle and differential cross section.	**Unit II: Elastic and Inelastic Collision (6 hrs)** Collision of Particles. Centre of Mass and Laboratory Coordinate Systems. Scattering in a Central Force Field: Rutherford Scattering. Transformation of Scattering Problem to Laboratory Coordinates.
• To gain knowledge about generalizedcoordinate systems. • To gain knowledge about Lagrangianformulation.	**Unit III: Elementary Principles (10 hrs)** Constraints. Generalized Coordinates, GeneralizedDisplacement, Generalized Velocity, Generalized Acceleration,Generalized Kinetic Energy, Generalized Momentum, Generalized Force and Generalized Potential, D'Alembert's Principle and Lagrange's Equations.

• To understand how to solve mechanical problem using Lagrange's equation.	
• To understand about the concept of calculus of variations and its application to solve mechanical problem. • To understand about the Lagrangian formulation, conservation theorem and symmetry properties.	**Unit IV: Variational Principles and Lagrange's Equation ofMotion (14 hrs)** Some Techniques of Calculus of Variations: Euler's Differential Equations of Motion and its Applications (Geodesics, Minimum Surface of Revolution, and The Brachistocrone Problem). Hamilton's Variational Principle for Conservative and Holonomic System, Derivation of Lagrange's Equation of Motion. Some Applications of Lagrangian Formulation. Extension of Hamilton's Principle to Non-holonomic System (Method of Lagrange Undetermined Multiplier).Conservation theorems and Symmetry properties. Energy Function and the Conservation of Energy.
• To understand about the translating and rotating coordinate system. • To gain knowledge of the euler's angles, euler's theorem and coriolisforce.	**Unit V: The Kinematics of Rigid Body Motion (10 hrs)** Inertial and Non-Inertial Systems. Translating and rotating Coordinate System. The Euler Angles. Euler's Theorem on theMotion of Rigid Body. Rate of Change of Vector. Effect ofCoriolis Force on the Moving Bodies on Earth. Free Fall of aBody on Earth Surface. Derivation of Coriolis Force fromLagrangian Formulation. Focault Pendulum.
• To understand about the inertia tensor, the moment of inertia and principal axis transformation. • To gain knowledge of the motion of Heavy Symmetrical Top.	**Unit VI: The Rigid Body Equations of Motion (10 hrs)** Angular Momentum and Kinetic Energy of Motion. The Inertia Tensor and the Moment of Inertia. The Eigenvalues of theInertia Tensor and Principal Axis Transformation. Equation ofMotion of a Rigid Body (Euler's equations). Torque Freemotion of a Rigid Body. The Heavy Symmetrical Top With OnePoint Fixed.
• To understand about the basic concept of relativistic classical mechanics.	**Unit VII: Special Relativity in Classical Mechanics (4 hrs)** Basic Postulates of the Special Theory. Lorentz Transformation.Relativistic Generalization of Newton's law. RelativisticGeneralization of Lagrange's Equation of Motion andHamiltonian.

Prescribed Text Books:

1. *Goldstein H., Poole C. and Safko John**, Classical Mechanics,*** Pearson Education (2002).

Reference Books:

1. *Mathur D.S., **Mechanics,*** S. Chand and Company Ltd., New Delhi (2008).
2. *Aruldas G., **Classical Mechanics***, Prentice-Hall of India, Private Limited, New Delhi-110001(2008).
3. *Gupta S.L., Kumar V. and Sharma H.V., **Classical Mechanics,*** Pragati Prakashan (1998).

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Physics Laboratory** Credit: **2**

Course No.: **PHY473** Number of hours per week: **6**

Nature of the Course: **Practical** Total hours: **90**

Year: **Fourth**, Semester**: 7th**

Level: Undergraduate **(B.Sc.)**

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts of general andelectronics experiments.

2. Course Objectives

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

- To provide students with skill and knowledge in the experimental methods of electronics, opticaland semiconductor experiments.
- To make them able to apply knowledge to practical applications.
- To make them capable of presenting their results/conclusions in a logical order.

3. Specific Objectives and Contents

Specific Objectives	Contents
	Unit I: General Lab (45)
• Understand the role of filter whenperforming experiments with the light.	**1.** Calibrate the experimental set-up of photoelectriceffect using yellow filter, standard value of planck's constant and work function of the given photocell. Findcalibration factor.
• Understand how photoelectric effectexperiments can be performed	**2.** Study photoelectric effect and estimate the value of Planck's constant using various color filters.
• How photoelectric effect help us to understand the planck constant.	**3.** Study photoelectric effect and find the wavelength of the unknown color filters using calculated value of planck's constant *h*.
• Develop the skill to analyse the data andperform error analysis	**4.** Use the measured dataset of photoelectric effect and calculate the standard deviation, standard error and probable error with significant figures. Generate theoretical data using photoelectric equation for given filters and photocell. Test how well the measured data agrees with the theoretical data in this experiment. Show the trend of measured and theoretical data in a graph and interpret it.
• Understand the interference effect usingvisible light	**5.** To study the Michelson Interferometer to determine thewavelength of monochromatic light.

• Understand microwave radiation by performing experiments to verify it as a electromagnetic radiation. • Understanding the level (range) of band gap in the semiconductor • Understanding the technique of determination of specific charge of an electron by magnetron method • Understanding the technique of determination of specific charge of an electron by using fine beam method • Develop the skill to analyse the data and perform error analysis *Note: Student should perform the error propagation and hence error analysis in each experiment.*	**6.** To use the microwave source for studying the phenomenon of (a) Refraction, (b) Interference, (c) Diffraction, and (d) Polarization. **7.** To study the band gap of semiconductor using leakage current method. **8.** To determine the specific charge of an electron (e/m) by magnetron tube method. **9.** To determine specific charge of an electron (e/m) by using fine beam method. **10.** Perform the experiment 5 or 6 or 7 and compile a dataset and show the histogram and calculate the standard deviation and standard error. Interpret the result.

• Understand current gain of common emitter amplifier • Understand voltage gain of common emitter amplifier • Understand voltage gain of common collector amplifier • Understand voltage gain of CS amplifier • Understand inverting and non-invertingoperational amplifier and its use • Understand the working of operationalamplifier as a integrator • Understand the working of operationalamplifier as a differentiator • Understand the construction and workingof half adder and subtractor circuit. • Understand the construction and workingof 1 bit digital comparator • Understand the construction and workingof astable multivibrator • Understand the construction and workingof phase shift oscillator	**Unit II: Electronics Lab (45)** **11.** To estimate the current gain (β) in a Common-EmitterConfiguration. **12.** Construct CE amplifier and determine the voltage gainof the amplifier with phase relation. **13.** Construct CC amplifier and determine the voltage gain,input and output impedance with phase relation. **14.** Construct CS amplifier and determine the voltage gainof the amplifier with phase relation. **15.** Study the characteristic of inverting and non-invertingoperational amplifier (Using IC). **16.** To study operational amplifier for integrator (UsingIC). **17.** To study operational amplifier for differentiator (UsingIC). **18.** To study the working of half-adder and half-subtractorcircuit. **19.** Design and constructs the 1-bit digital comparator. **20.** To study the astable multivibrator by using transistorsand find its frequency and duty cycle. **21.** To study the characteristics of phase shift oscillator.
• Understand the construction, working andcharacteristic of JFET. • Understand the construction, working andcharacteristic uni-junction transistor. *Note: Precession test should be performed ineach experiments.*	**22.** To study the drain and transfer characteristics of junction field effect transistor (JFET). **23.** To study the characteristics of uni-junction transistor.

Note: Students have to perform at least 10 experiments in 90 working hours. Students need to cover both sections by performing at least 5 from each group. Students need to write a laboratory report on each experiment they perform and get them duly checked and signed by the concerned teacher. They should write their reports in a separate sheet, and to keep them neat and properly filed.

The practical exam will be graded on the basis of the following marking scheme:In-Semester Evaluation 20%
Final Exam Written 60%
Final Exam Oral 20%

Prescribed Text Books:

1. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010).

2. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999).

3. Shukla, P. K. and Srivastava, A. - **Practical Physics***,* New Age International (P) Limited,Publishers (2006).

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Astronomy** Credit: **3**

Course No: **PHY474** Number of hours per week: **4**

Nature of the Course: **Theory (Elective)** Total hours: **45**

Year: **Fourth,** Semester: **7th**

Level: Undergraduate **(B.Sc.)**

1. Course Introduction

The course intends to enable the students to be familiar with the basic concepts and principles of biophysics related science and technology. This course will focus on the basic principles of molecular biophysics, thermodynamics, cell and membrane physics, nuclear medicine and radiation protection.

2. Objectives

At the end of this course, the students should be able to understand and apply the basic concepts of evolution, molecular biophysics: structures and dynamics, bioenergetics and thermodynamics, cell and membrane physics, nuclear medicine, etc.

3. Specific Objectives and Contents:

Specific Objectives	Contents
• Understanding evolution of Astronomy • Describe about the classifications of star on the basis of their spectra • Explain various types of time scales use in the stellar and galaxy evolution	**Unit I: General Astronomy (8 hrs)** History & developments of Astronomy, great debate, Classification of star, population I, II and III stars, Stellar spectra, Harvard classification, Yerkes classification, Astronomical time scales: nuclear time scale, Thermal and dynamical time scales, binary star
• Understand the magnitude and hence photometry	**Unit II: Stellar Photometry (7 hrs)** Distance-magnitude-extinction relation, Interstellar extinction curve, Opacity in the interstellar medium, distance-magnitude-extinction relation, UVB photometry, Colour index: Reddening of light, Colour excess: Photometry.
• Know about the various types of pressures exerted by the gases and radiation in the stellar interior	**Unit III: Pressure Exerted by the Stellar Interior (6 hrs)** Non-degenerate gas pressure: chemical composition of the star, Degenerate (both relativistic and non-relativistic) gas pressure, Pressure exerted by the photons in the star: radiation pressure.
• Understand the internal equilibrium condition due to which star survives for a very long period • Know the energy transport mechanism in the stellar interior.	**Unit IV: Internal Equilibrium Conditions (6 hrs)** Hydrostatic equilibrium: pressure gradient, Mass-continuity relation: mass gradient, Radiative and convective energy transport: temperature gradient, Luminosity gradient.

• Understand the structure, inner dynamics, kinematics and formation of our own galaxy where solar system exists.	**Unit V: Milky Way (6 hrs)** Structure, bulge, disc, arms, stellar halo, globular clusters, dark matter halo, differential rotation, formation scenario of Milky way: monolithic collapse model, hierarchy model
Knowledge about other galaxies, their type and aggregates	**Unit VI: Galaxies (5 hrs)** Classifications, galaxy rotation curve, dark matter in the galaxy, redshift, Hubble law, clusters of galaxies, superclusters of galaxies, large scale structure formation
Knowledge regarding the origin of Universe and its evolution, its fossils and their impacts for the future.	**Unit VI: Standard Big Bang Model (7 hrs)** Inflation of the Universe, neutrino background, last surface of scattering, cosmic microwave background radiation (CMBR). Fluctuation in CMBR, dark epoch, LCDM model, dark energy

Prescribed Text Books::

1. *Karttunan H., Kröger P., Oja H., Poutanen M., Donner K.J.,* **- Fundamental Astronomy**, fifth edition, Springer (2007).

2. *Harwit Martin* - **Astrophysical Concepts**, fourth edition, Springer (2006).

Reference Books:

1. *Palene S.* - **Schaum Outline Series: Astrophysics,** McGraw Hill (2004).

2. *Choudhuri A. R.* - **Astrophysics for Physicists**, Cambridge University Press (2010).

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Material Science** Credit hour: **3**

Course Code: **PHY475** Number of hours per week: **3**

Nature of the Course: **Theory** Total hours: **45**

Year: **Fourth**, Semester**: 7th**

Level: **B.Sc.**

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts of material science. Students will be familiarized with the fundamentals of properties of materials and their uses in daily life and their industrial applications.

2. Course Objectives

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

- to acquire sufficient basic knowledge in physics of materials
- to apply this knowledge base for studying major courses in physics or apply other course's knowledge to understand this course
- to solve mathematical problems in related topics.
- to deduce mathematical equations and formulas.
- to understand the different materials properties used in daily life

3. Specific Objectives and Contents

Specific Objectives	Contents
• List six different property classifications of materials that determine their applicability. • Describe the four components that are involved in the design, production, and utilization of materials, and briefly describe the interrelationships between these components. • Cite three criteria that are important in the Material selection process. • Discuss significance of materials around us	**Unit I: Introduction (5 hrs)** Historical Perspective, Importance of Materials Science, Classification of Materials, Materials of Importance, Carbonated Beverage Containers, Advanced Materials, Modern Materials' Needs, Processing/Structure Properties/Performance, Correlations
• Define engineering stress and engineering strain. • State Hooke's law and note the conditions under which it is valid. • Define Poisson's ratio. • Given an engineering stress–strain diagram, determine (a) the modulus of elasticity, (b) the yield strength and (c) the tensile strength, and (d) estimate the percent elongation.	**Unit II: Mechanical Properties of metals (10 hrs)** Concept of stress and strain, Elastic deformation, Plastic deformation, Hardness, Fundamentals of fracture, Principles of fracture mechanics, Crack initiation and propagation

• Discuss hardness of metal • Explain fracture and hence principles of fracture mechanics • Describe crack initiation and how does it propagate	
• Distinguish electrical and ionic conduction • Discuss energy band structure and hence its role in electrical properties of a solid • Explain main characteristics of commercial alloys used in house hold wiring • Obtain an expression for variation of concentration of careers in semiconductor as a function of temperature • Describe the factors which affect carrier mobility in a semiconductor hence compare mobility of electrons and holes in various semiconductors • Explain dielectric strength. Also describe the main properties of dielectric materials • Outline main characteristics of Ferroelectric & piezoelectric materials	**Unit III: Electrical Properties of Materials (14 hrs)** Electrical conductivity, Electrical and ionic conduction Energy band structures in solid, Conduction in terms of bands and atomic bonding models, Electrical characteristics of commercial alloys, Materials of importance - Aluminum electrical wires, Semiconductors; Temperature dependence of carrier concentration, factors that affect carrier mobility, Dielectric strengths, Dielectric materials, Ferroelectricity, Piezoelectricity
• Outline main characteristic of dia, para, ferro, antiferro and ferri magnetic materials • Discuss main applications of magnetic materials focusing as storage devices • Distinguish between hard & soft magnetic materials. • Explain magnetic properties of An Iron–Silicon Alloy That Is Used in Transformer Cores and hence describe why it is so suitable in the Transformer cores.	**Unit IV: Magnetic Properties of Materials (6 hrs)** Diamagnetism and paramagnetism, Ferromagnetism and antiferromagnetism, Ferrimagnetism, Magnetic storage, Soft magnetic materials: Materials of Importance—An Iron–Silicon Alloy That Is Used in Transformer Cores, Hard magnetic materials
•Discuss heat capacity of solid •Explain applications of thermal expansion in daily uses of materials •Discuss why Invar and Other Low-Expansion Alloys	**Unit V: Thermal Properties of Materials (4 hrs)** Heat capacity, Thermal expansion: Materials of Importance—Invar, and Other Low-Expansion Alloys, Thermal conductivity, Thermal stress

possess important properties of thermal expansion •What types of materials have high/low thermal conductivity •Outline the significance of thermal stress	
•Outline the significance of optical properties of solid •Discuss the interactions of light with solid •Describe Atomic and electronic interactions with incident light •Explain luminescence and the Materials of Importance—Light-Emitting Diodes •Outline main features of photoconducting materials •Discuss significance of laser •Describe the materials suitable in Optical fibers	**Unit VI: Optical Properties of Materials (6 hrs)** Electromagnetic radiation, Interaction of light with solids Atomic and electronic interactions, Luminescence: Materials of Importance - Light-Emitting Diodes, Photoconductivity, Lasers, Optical fibers in communications

Prescribed Text Books:

1. *Callister W.D., Rethwisch D.G.*, **Callister's Material Science and Engineering**, 2nd Edition, Wiley India, New Delhi (2014).

Reference Books

1. *Tiley R.J.D.,* **Understanding solids**, The Science of Materials, John wiley & Sons, England (2004).
2. *Raghavan V.,* **Materials Science and Engineering**, 4th Edition, , Prentice-Hall of India, New Delhi (2003).

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Biophysics** Credit: **3**

Course No: **PHY476** Number of hours per week: **4**

Nature of the Course: **Theory (Elective)** Total hours: **45**

Year: **Fourth,** Semester: **7th**
Level: Undergraduate **(B.Sc.)**

1. Course Introduction

The course intends to enable the students to be familiar with the basic concepts and principles of biophysics related science and technology. This course will focus on the basic principles of molecular biophysics, thermodynamics, cell and membrane physics, nuclear medicine and radiation protection.

2. Objectives

At the end of this course, the students should be able to understand and apply the basic concepts of evolution, molecular biophysics: structures and dynamics, bioenergetics and thermodynamics, cell and membrane physics, nuclear medicine, etc.

3. Specific Objectives and Contents:

Specific Objectives	Contents
• Know about how the life of living organism starts. • Implement the physicochemical rules in the evolution of cellular life.	**Unit I: Origins and Evolution of Life (4 hrs)** Initiation, Machinery of prokaryotic cells, The photosynthetic revolution, Origins of diploidal eukaryotic cells, Summary: further stages of evolution.
• Understand the macromolecular interactions. • Know about conformations of polypeptide chains: the proteins. • Know about the structures and biophysical principles of nucleic acids and constituents.	**Unit II: Structures of Biomolecules (11 hrs)** Elementary building blocks, Generalized ester bonds, Directionality of chemical bonds, Weaker intratomic interactions: Ionic interactions, Covalent bonds, Free radicals, Van der Waals bonds; Hydrogen bonds and hydrophobic interactions: Polysaccharides, Amphiphilic molecules in water environments. Structures of proteins: Polypeptide chains, Protein folding, Electrophoresis of proteins, Protein interactions with environment, Electron transfers in proteins. Structures of nucleic acids: Electrostatic potential of DNA, DNA-information and damage, Fluorescence in biomolecules.
• Know about the theory of diffusion and transport of molecules and ions. • Introduce the principles of polymer biophysics.	**Unit III: Dynamics of Biomolecules (10 hrs)** Diffusion, Diffusional flow across membranes, Vibrations versus conformational transitions, Stochastic theory of reaction rates, Conformational transitions of proteins, Models of random walks on fractal lattices, Elastic properties of polymers, Bioenergetics, Biological coherence, Ionic currents through electrolytes, Electron conduction and tunneling, Proton transport, Interactions with

	electromagnetic radiation.
• Understand the laws of thermodynamics. • Know about different biophysical states concerning thermodynamics. • Know about chemical kinetics and catalysis of biological systems.	**Unit IV: Nonequilibrium Thermodynamics and Biochemical Reactions (8 hrs)** Second law of thermodynamics, Non-equilibrium thermodynamics, Rates of non-equilibrium thermodynamic processes, Single unimolecular chemical reaction, Bimolecular reactions: protolysi, Redox reactions, The steady state approximation: the theory of reaction rates, Chemical mechanisms of enzymatic catalysis, Michaelis-Menten kinetics, Control of enzymatic reactions
. • Know about the structure and functioning of cell membrane. • Understand the generation and propagation of nerve impulse.	**Unit V: Cellular Biophysics (7 hrs)** General characteristics of a cell, Membrane and membrane proteins: Elastic pressure of membrane, Mass diffusion across membranes, Membrane proteins, Electrical potentials of cellular membranes; Ion channels and ion pumps. Anatomy of a nerve cell, Action potential generation: Hodgkin–Huxley equations,
• Understand the radioactive phenomena concerning living organisms. • Understand the biomedical applications of the nuclear radiations. • Knowledge about the hazardous radiations.	**Unit II: Nucleonics in Biology and Medicine (5 hrs)** Elementary particles, Atomic nucleus, Radioactivity, Detection of nuclear radiation, Radioactive decay, Isotopes, X-ray, Detection and measurement of radioactivity, Biological effects of radiation, Radiation damage in the embryo and fetus during pregnancy, Demerits of different diagnostic and therapeutic methods of nuclear medicine during pregnancy, Atmospheric radiation hazards.

Prescribed Text Books:

1. *Tuszynski J., Kurzynski M.,* ***Introduction to Molecular Biophysics,*** CRC Press LLC, US (2003).

Reference Books:

1. *Volkenstein M. V.,* ***Biophysics,*** Mir Publishers, Moscow (1983).
2. *Roy R. N.,* ***A Textbook of Biophysics,*** New Central Book Agency (P) Ltd., India (2001).
3. *Narayanan, P.,* ***Essentials of Biophysics,*** New Age International (P) Ltd., India (2000).
4. *William H.,* ***Aspects of Biophysics,*** John Wiley and Sons, New York (1979).
5. *Hendee W. R.,* ***Medical Radiation Physics,*** 4th edition, Year Book Medical Publishers INC. London (2002).

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Quantum Mechanics** Credit: **4**

Course Code: **PHY481** Number of hours per week: **4**

Nature of the Course: **Theory** Total hours: **60**

Year: **Fourth**, Semester**: 8th** Full Marks: **100**

Level: Undergraduate (**B.Sc.)** Pass Marks: **45**

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts of non-relativistic quantum mechanics. Students will be familiarized with the details of inadequacy of classical mechanics, postulates of quantum mechanics, its formulation and applications for non-relativistic particle.

2. Course Objectives

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

- to acquire sufficient basic knowledge in non-relativistic quantum mechanics
- to apply this knowledge base for studying major courses in physics.
- to solve mathematical problems in related topics.
- to deduce mathematical equations and formulas.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Developing the idea of need and development of quantum mechanics • Know the concepts and formulation of matter wave • Understand the meaning of group velocity and phase velocity of particles • Develop the idea about the uncertainty principal • Students should able to solve numerical problems of text and reference books related to this unit.	**Unit I: Introductory Wave Mechanics (6 hrs)** Inadequacy of classical mechanics, Davisson-Germer experiment: result and its interpretation, de Broglie waves, group and phase velocity, Uncertainty principle and its application
• Set up time independent and dependent Schrodinger equation and understand the meaning of wavefunction and its normalization • Understand dynamical and conjugate variables and their expectation values • Derive the general solution of both time dependent and time independent Schrodinger equations and understand their physical	**Unit II: Quantum Mechanical Wave Propagation (6 hrs):** Time dependent and time independent Schrödinger equation, Wave function: explanation, normalization of wave function, Expectation values of dynamical quantities, general solution of Schrodinger equation, time-independent Schrodinger equation in spherical polar coordinates

meaning • Convert Schrodinger equation to polar coordinates and discuss about its requirements in solving various types of quantum mechanical problems. • Students should able to solve numerical problems of text and reference books related to this unit.	
• Describe the idea, needs and use of operators in quantum mechanics • Students should learn the idea regarding importance of various operators in solving problems. • Understand the meaning of hermitian, linear, parity and projection operator. • Understand commutation relation between canonically conjugate variables • Students should able to solve numerical problems of text and reference books related to this unit.	**Unit III: Operator Formalism in Quantum Mechanics (8 hrs):** Commuting and non-commuting operators, Linear Operator, Hermitian operator, Orthogonal functions and orthogonality, Parity operator, Projection operator, Position and momentum operators, Angular momentum operators, Hamiltonian operator, Commutation relations between position, momentum, angular momentum and Hamiltonian operators: physical interpretation, Angular momentum operators in spherical polar coordinates
• Describe the postulates of quantum mechanics. • Discuss conservation of probability in terms of probability density and current density. • Explain the meaning and need of observable in quantum mechanics and develop equation of motion for an observable. • Understanding of first quantization condition is important. Use it to explain Ehrenfest theorem. • Proof Ehrenfest theorem (by verifying it to the level of classical and hence Newtonian mechanics) • Students should able to solve numerical problems of text and reference books related to this unit.	**Unit IV: Postulates of Quantum Mechanics (8 hrs):** statement of the postulates, physical interpretation, Conservation of probability: equation of continuity, probability density and probability current density: their relations with group velocity, equation of motion for an observable, principle of first quantization, Ehrenfest theorem
• Students should solve one dimensional	**Unit V: One Dimensional Quantum Mechanical Problems (10 hrs):** Free particle in a box, box

quantum mechanical problem for a free particle and understand the meaning of the result. • Problem solving skill should be developed by solving potential step, potential barrier problems • Tunneling effect should be rigorously discussed in all cases mentioned in this unit. • Applications of potential barrier problems (e.g, in Ramsauer-Tausand, Cold emission of electron and alpha decay) should be formulated, described and discussed. • Students should able to solve numerical problems of text and reference books related to this unit.	normalization, free particle in an infinite potential well, Particle in a finite potential well, Potential step, Potential barrier, reflection and transmission coefficient, interpretation tunneling effect, Ramsauer-Townsend effect, cold emission of electrons in a metal: scanning tunneling microscope, Alpha decay: Geiger Nuttal law
• Describe the idea, formulation, properties and importance of harmonic oscillator problem in quantum mechanics • Solve harmonic oscillator problem using series method (developing hermite differential equation) as well as operator (creation and annihilation) method. • Students should able to solve numerical problems of text and reference books related to this unit.	**Unit VI: Harmonic Oscillator and Applications (10 hrs):** Linear harmonic oscillator, hermite polynomials, oscillator wave function, even and odd parity states, energy of harmonic oscillator, zero point energy, hamiltonian of harmonic oscillator in terms of creation and annihilation operator, eigenvalue and eigenfunction of harmonic oscillator
• Separate and then solve the angular part and radial part of Schrodinger equation. • Understand the meaning of separation constant • Discuss spherical harmonics in terms of atomic orbitals • Solve radial part for hydrogen atom problem • Students should able to solve numerical problems of text and reference books related to this unit.	**Unit VII: Quantum Mechanical Problems and Solutions (7 hrs):** Schrödinger equation for spherically symmetric potential, Angular part of Schrodinger equation: Spherical harmonics, shapes of orbitals, radial part of Schrodinger equation and its solution for Hydrogen atom, Laguerre polynomials solution of Schrödinger equation for hydrogen atom
• Discuss the Hamiltonian for two interacting particles. • Set up Schrodinger equation for two	**Unit VIII: Central Potential Problems (5 hrs):** Two interacting particles, Schrodinger equation for two interacting particles in spherical coordinates, rigid rotator

interacting particles and find its solution. • Describe the meaning of rigid rotator and its applications in solving molecular problems. • Students should able to solve numerical problems of text and reference books related to this unit.	

Prescribed Text Books:

1. *Agrawal, B.K. and Prakash, H.* – ***Quantum Mechanics,*** Prentice Hall of India, New Delhi (1997).

2. *Powell J. L. and Craseman B.*- ***Quantum Mechanics,*** Narosa, New Delhi (1994).

Reference Books:

1. *Merzbacher, E.* - ***Quantum Mechanics,*** 2nd ed., John Wiley, New York (1969).

2. *Mathews P. M. and Venkatesan K.* - ***A Text Book of Quantum Mechanics,*** Tata McGraw Hill Publishing Co. Ltd, New Delhi (1997).

3. *Prakash S. and Saluja S.*- ***Quantum Mechanics,*** Kedar Nath Ram Nath Publishing Co. (2002).

4. *Singh S. P., Bagde M. K. and Singh K.*- ***Quantum Mechanics,*** S. Chand & Company Ltd. (2002).

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Solid State Physics** Credit: **4**

Course No.: **PHY482** Number of hours per week: **4**

Nature of the Course: **Theory** Total hours: **60**

Year: **Fourth**, Semester**: 8th**

Level: Undergraduate (**B.Sc.)**

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts of solid state physics. Students will be familiarized with the fundamentals of crystal structure, bonding, lattice vibrations, free electron theory and physics behind nanomaterials.

2. Course Objectives

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

- to acquire sufficient basic knowledge in solid state physics.
- to apply basic knowledge of quantum mechanics, thermodynamics etc to understand properties of solid.
- to solve problems in related topics.
- to deduce mathematical equations and formulas related to describe/understand solid state properties.

3. Specific Objectives and Contents

Specific Objectives	Contents
\ • Distinguish amorphous & crystalline structure of solid • Discuss primitive lattice cell of various crystal structures • Construct some common crystal structures like, square, triangular, sc, bcc, fcc, hcp, sodium chloride & diamond	**Unit I: Crystal Structure (8 hrs)** Periodic array of atoms: lattice translation vectors, basis and the crystal structures, primitive lattice cell, Fundamental types of lattices: two & three dimensional lattice types, Index systems for crystal planes, Simple crystal structure: sodium chloride, hexagonal closed-packed & diamond structure, Direct imaging of atomic structure
• Discuss the phenomena of wave diffraction and understand Bragg law, Laue equation • Construct reciprocal lattice vectors & Brillouin zones to sc, bcc & fcc lattices • Able to understand the structure factor & atomic form factor	**Unit II: Wave diffraction and the reciprocal lattice (7 hrs)** Bragg law, Scattered wave amplitude: Fourier analysis, Reciprocal lattice vectors, diffraction conditions, Laue equations, Brillouin zones: Reciprocal lattice to sc, bcc & fcc lattices, Fourier analysis of the basis: structure factor of bcc & fcc lattices, Atomic form factor
• Explain the different types of bonding in solid • Describe the range of interactions in	**Unit III: Crystal binding (4 hrs)** van der Waals: London interaction, Ionic crystals: Madelung energy, Covalent crystals, Metals, Hydrogen bonds

different types of bonding in a solid • Estimate Madelung energy in some crystal structures • Distinguish crystals by the mechanism of their stability	
• Describe vibrations of lattice with monatomic and two atoms per primitive basis • Differences between lattice vibrations in monatomic & diatomic crystals • Discuss how the elastic waves quantize • Describe meaning of normal mode of vibrations and calculate them in a few atom systems • Discuss the differences in Density of states (DoS) in 1 & 3 Dimensions • Describe the differences in (DoS) of Einstein & Debye model also understand the heat capacity of solid • Compare the data with theoretical prediction of both the models	**Unit IV: Lattice vibrations and thermal properties (10 hrs)** Vibrations of crystals with monatomic Basis: First Brillouin zone, Group velocity, long wavelength limit, Two atoms per primitive basis, Quantization of elastic waves, Phonon heat capacity: Planck distribution, normal mode enumeration, density of states in 1 & 3 dimensions, Debye & Einstein model of density of states, Einstein & Debye model of heat capacity of solid
•Discuss the energy levels in one & three dimensional box for electrons •Construct the ground state of N free Fermions, explain the concept of Density of states(DoS), Find its expression, Sketch it, also sketch product of DoS & Fermi-Dirac distribution •Calculate Radius parameter r_n, Fermi wave vector, Fermi velocity, Fermi energy, Fermi temperature from electron concentration •Explain the Fermi-Dirac distribution function and its temperature dependence •Discuss the electronic heat capacity. Sketch it. Plot Cv/T where Cv is heat capacity of solid i.e. electronic plus lattice versus T^2 and compare with experimental	**Unit V: Free electrons in metals (7 hrs)** Energy levels in one dimension, Effect of temperature on the Fermi-Dirac distribution, Free electron gas in 3 dimension, Heat capacity of electron gas, Transport properties: The equation of motion of electrons, the electrical conductivity, the thermal conductivity, The Wiedemann-Franz law, The Hall effect

data. •Obtain electrical conductivity, the thermal conductivity, The Wiedemann-Franz law. Compare obtained Lorentz numbers with experimental data •Obtain Hall coefficient and estimate the number of carriers in metal and semiconductors	
•Discuss the mechanism of origin of the energy gap and estimate its magnitude •State and prove Bloch's theorem and discuss Bloch functions •Discuss Kronig-Penny model •Explain the Tight binding methods of energy bands and use it to calculate band structure of sc crystals	**Unit VI: The effects of the periodic lattice potential – energy bands (5 hrs)** Nearly free electron theory: Origin of the energy gap, Magnitude of the energy gap, Bloch functions, Kronig-Penny model, Calculation of energy bands: Tight binding methods of energy bands
•Discuss various properties of superconductivity •Explain Meissner effect and hence effects of magnetic fields on superconductor •Describe heat capacity of superconductor & compare it to normal metal •Discuss Josephson superconducting tunneling effect	**Unit VII: Superconductivity (4 hrs)** Experimental survey: Occurrence of superconductivity, Meissner effect, Heat capacity, energy gap, Destruction of superconductivity by magnetic fields, Josephson superconducting tunneling
•Describe the dia- & para- magnetism in a solid. •Explain Langevin equation of diamagnetic materials and also discuss its limitations and hence quantum theory of diamagnetism of mononuclear systems. •Discuss quantum theory of paramagnetism and explain Hunds rule with an example. •Explain Paramagnetic susceptibility of conduction electrons. •Describe Curie point & exchange integral.	**Unit VIII: Magnetic properties of materials (8 hrs)** Diamagnetism: Langevin equation, quantum theory of diamagnetism of mononuclear systems, Paramagnetism: Quantum theory of paramagnetism, Rare earth ions, Hund rules, Paramagnetic susceptibility of conduction electrons, Ferromagnetism: Curie point & exchange integral, Temperature dependence of the saturation magnetization, saturation magnetization at absolute zero, Magnons: quantization of spin waves, Antiferromagnetism: Susceptibility below Neel temperature, antiferromagnetic magnons

Also explain saturation magnetization •Give the concept of elementary excitations in solid with an example of magnons •Discuss antiferromganetic properties of solid. Also explain antiferromagnetic magnons	
•Distinction between metal, semiconductor & insulator from band structure •Concept of band gap in a semiconductor •Obtain an expression for Intrinsic carrier concentration in a semiconductor •Discuss impurity conductivity in a semiconductor	**Unit X: Semiconductor (3 hrs)** Band structure: band gap, Intrinsic carrier concentration: intrinsic mobility, Impurity conductivity
•Idea of low dimensional systems (Recent development) •Discuss Density of states of the one, two & three dimensional electron gas •Discuss integral quantum hall effect.	**Unit IX: Low Dimensional systems (4 hrs)** Introduction, The two-dimensional electron gas: The electron states, Density of states of the two dimensional electron gas, The quantum Hall effect

Prescribed Text books:

1. *Kittel C.* – ***Introduction to Solid State Physics*****,** 8th ed., John Wiley & Sons Ltd, India (2005).

Reference Books:

1. *Hook J.R. & Hall H. E.* - ***Solid State Physics*****,** 2nd ed., Wiely India, New Delhi (1974).
2. *Elliot R. J. & Gibson A. F.* – ***An Introduction to Solid state Physics and its Application****,* ELBS (2000).
3. *Dekker A. J.* – ***Solid State Physics***, Macmillan, Students Edition (1991).
4. *Kachhava C.M,* - ***Solid State Physics,*** Tata McGraw Hill Publishing Ltd, New Delhi (2003).
5. *Keer H.V.*,- ***Principle of Solid State Physics,*** Wiley Eastern Ltd., New Delhi (1968).

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Physics Laboratory** Credit: **2**

Course No.: **PHY483** Number of hours per week: **6**

Nature of the Course: **Practical** Total hours: **90**

Year: **Fourth**, Semester**: 8th**

Level: Undergraduate **(B.Sc.)**

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts of general and electronics experiments.

2. Course Objectives

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

- To provide students with skill and knowledge in the experimental methods of electronics, optical and semiconductor experiments.
- To make them able to apply knowledge to practical applications.
- To make them capable of presenting their results/conclusions in a logical order.

4. Specific Objectives and Contents

Specific Objectives	Contents
	Unit I: General Lab (45)
• Understand interference effect due to virtual sources	**1.** To determine the wave length of given source of light by Fresnel's Bi-Prism.
• Understand interference effect due to one real and one virtual sources	**2.** To study Lloyd's mirror for the determination of wavelength of Hg light.
• Find thickness of mica-sheet using interference effect	**3.** To study the formation of fringe pattern by wedge shape and find the thickness of mica sheet.
• Understand the variation of refractive index of water when concentration of sugar is changed.	**4.** To study the variation of refractive index with concentration of sugar solutions using a hollow prism.
• Develop the skill to analyse the data and perform error analysis	**5.** Use the measured dataset of experiment 4 and calculate the standard deviation, standard error and probable error with significant figures. Generate theoretical data and test how well the measured data agrees with the theoretical data in this experiment. Show the trend of measured and theoretical data in a graph and interpret it.
• Know the properties of X-rays when it is passed through materials	**6.** To study the diffraction and absorption of X-ray by the materials.
• Understand the techniques to find the value of half life of an unknown radioactive sample.	**7.** To determine the half-life period of a given radioactive substance using a G.M. counter.
• Understand the properties of beta particles	**8.** To study the phenomenon of Back-Scattering using a

as back scattering and learn the use of this property in further research • Understanding the technique of determination of specific charge of an electron by magnetron method • Understanding the quality factor of AC circuit containing capacitors, inductors and resistors in series and parallel. • Develop the skill to use resonance method to find the dielectric constant of a material • Know the techniques to find specific heat capacity of materials using calorimetric method. *Note: Error propagation and hence analysis should be performed in each experiments.*	thin radioactive beta-source. **9.** To study the phenomenon of hysteresis loss of the material and to determine the hysteresis loss of the material over a cycle. **10.** To design and study the series and parallel LCR circuits for finding the quality factor of the elements. **11.** To find the dielectric constant of a material using resonance method. **12.** To study the specific heat capacity of the materials using Calorimetric method.
• Understand the low frequency response and know the technique to calculate cut off frequencies in an electronic circuit • Understand the high frequency response and know the technique to calculate cut off frequencies in an electronic circuit • Understand the performance of astable multivibrator • Understand the performance of monostable multivibrator • Understand the function of RS flip flop • Understand the function of J-K flip flop • Understand the working of voltage doubler circuit • Understand the working of voltage tripler circuit • Understand the construction and working of Universal gates • Understand the construction, working and use of half adder circuit	**Unit II: Electronics Lab (45)** **1.** Study the low frequency response circuits and calculate their cut-off frequencies. **2.** Study the high frequency response circuits and calculate their cut-off frequencies. **3.** To construct astable multivibrator using 555 timer and study its performance. **4.** To construct monostable multivibrator using 555 timer and study its function. **5.** To construct and to study the characteristics of RS flip-flop. **6.** To construct and to study the characteristics of J-K flip-flop. **7.** To construct a voltage multipliers (doubler) and study its characteristics. **8.** To construct a voltage multipliers (tripler) and study its characteristics. **9.** To construct and study the working of NOT, AND, OR gates using diodes and transistors. **10.** To study the working of half adder.

• Understand the construction, working and use of full adder circuit • Understand the construction and working of D/A converter. *Note: Precession test should be performed in each experiment.*	**11.** To study the working of full adder. **12.** To construct D/A converter and to study its working.

Note: Students have to perform at least 10 experiments in 90 working hours. Students need to cover both sections by performing at least 5 from each group. Students need to write a laboratory report on each experiment they perform and get them duly checked and signed by the concerned teacher. They should write their reports in a separate sheet, and to keep them neat and properly filed.

The practical exam will be graded on the basis of the following marking scheme:

In-Semester Evaluation	20%
Final Exam Written	60%
Final Exam Oral	20%

Text Books:

4. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010)

5. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999)

6. Shukla, P. K. and Srivastava, A. - **Practical Physics***,* New Age International (P) Limited, Publishers (2006)

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Econophysics** Credit: **2**

Course No: **PHY 484** Number of hours per week: **2**

Nature of the Course: **Theory (Elective)** Total hours: **30**

Year: **Third,** Semester: **8th**

Level: Undergraduate **(B.Sc.)**

1. Course Introduction

The course intends to enable the students to be familiar with the basic concepts of economics and finance market and its use in physics. This course will focus on the basic principles market hypothesis, theory of randomness and stochastic process and their applications.

2. Objectives

At the end of this course, the students should be able to understand and apply the basic concepts of physics and its successful applications in finance market.

3. Specific Objectives and Contents:

Specific Objectives	Contents
• Understanding the need of chaos approach in the science and market	**Unit I: Introduction (3 hrs):** Motivation, Pioneering approaches, chaos approach, the present focus
• Know about ideal market hypothesis and its correlation to physical laws	**Unit II: Efficient market hypothesis (5 hrs):** Concepts, paradigms, and variables, arbitrage, efficient market hypothesis, Idealized systems in physics and finance
• Know about the theory of random walk that exists in mathematics and physics	**Unit III: Random walk (6 hrs)** One-dimensional discrete case, continuous limit, central limit theorem, speed of convergence, Berry-Esseen Theorem, Berry-Esseen theorem-2, basin of attraction
• Understanding the use of stochastic process in finance market • Know the details of random variable for the stable process	**Unit IV: Levy stochastic processes and limit theorems (12 hrs):** Stable distributions, scaling and self-similarity, Limit theorem for stable distributions, power-law distributions, St Petersburg paradox, Power laws in finite systems, Price change statistics, Infinitely divisible random processes, stable processes, Poisson process, Gamma distributed random variables, Uniformly distributed random variables
• Understand the market structure and price scales	**Unit V: Scales in financial data (4 hrs):** Introduction, price scales in financial markets, time scales in financial markets, summary

Prescribed Text Books::

1. *Mantegna R. N. and Stanley H. E.* - ***An Introduction to Econophysics: Correlations and Complexity in Finance,*** First Edition, Cambridge University Press (2000).

Reference Books:

1. *Sinha S., Chatterjee A., Chakraborti A., Chakrabarti B. K.* - ***Econophysics: An Introduction,*** Wiley-VCH (2010).

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Entrepreneurship** Credit: **2**

Course No: **PHY 485** Number of hours per week: **2**

Nature of the Course: **Theory (Elective)** Total hours: **30**

Year: **Fourth,** Semester: **8th**
Level: Undergraduate **(B.Sc.)**

Course Introduction
This course aims to prepare the students for the possibility of starting their own entrepreneurial ventures with successful identification of venture opportunities and preparation of a business plan. **2.**

Objectives
- Empowering necessary knowledge and skills to start new business venture
- Preparing consultant or facilitator to individual/institution aspiring for business ventures
- Developing expertise in identifying prospective business ventures and preparing plan
- Promoting self employment and creating new jobs

3. Specific Objectives and Contents:

Specific Objectives	Contents
• Become familiar with the basics of Entrepreneurship *(a couple of lectures should be delivered by the national successful entrepreneurs)*	**Unit I: Overview of the basics of Entrepreneurship (5 hrs):** Concept and elements of entrepreneurship, Entrepreneur and entrepreneurship, Entrepreneurial role in the economy, Emerging challenge and trends in entrepreneurship (internet and e-commerce).
• Understanding of growth of Entrepreneurship *(all lectures should be delivered by the national successful entrepreneurs)*	**Unit II: Entrepreneurship Growth (3 hrs):** Factors affecting entrepreneurship growth, Entrepreneurial thought, process and approaches.
•Understanding the history of famous and successful physics Entrepreneurs	**Unit III: Creativity and Innovation (5 hrs):** Concept and development of creativity, Sources of innovation, History and development of successful physics entrepreneurs
• Understand the meaning of risk stress *(a couple of lectures should be delivered by the national successful entrepreneurs)*	**Unit IV: Entrepreneurial Risk Stress and Management (5 hrs):** Entrepreneurial risk and types, Entrepreneurial stress, types and sources, Management of stress.
. • Know about the evolution of idea.	**Unit V: Business opportunity identification (3 hrs):** Concept, sources and methods of generating new ideas
• Understand the technical aspect of Entrepreneurship *(a couple of lectures should be delivered by the national successful entrepreneurs)*	**Unit VI: Feasibility studies (9 hrs):** Concept and components, Business description, marketing and financial component, Development and production, Organization and management and forms of ownership. Selection of best option. Institutional Support to Entrepreneurship: Need, institutions (government, non-government and others) involved for entrepreneurial

	development, support modus, Present status of institutional support and its strengths and weaknesses.

Prescribed Text Books:

1. *Dollinger, M.J.*- ***Entrepreneurship: Strategies and Resources****,* Pearson Education (2003).

Reference Books:

1. *Hisrich, R.D.,Peters, M.P. and Shepherd, D.A.*- ***Entrepreneurship,*** Tata McGraw Hill Publishing Company (2007).

2. *Kuratko, D.F. and Hodgetts, R.M.* – ***Entrepreneurship: Theory, Process and Practice,*** Thomson Asia Pvt. Ltd (2005).

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Applied Mathematics** Credit: **2**

Course No: **PHY486** Number of hours per week: **2**

Nature of the Course: **Theory (Elective)** Total hours: **30**

Year: **Fourth,** Semester: **8th**
Level: Undergraduate **(B.Sc.)**

Course Introduction
This course aims to prepare the students to apply mathematical tools to solve physical problem.

Objectives
At the end of this course the student should be able to acquire sufficient knowledge of applications of mathematical tools in physics and apply this knowledge for higher studies and research in physics.

3. Specific Objectives and Contents:

Specific Objectives	Contents
• Become familiar with the applications of differential equations	**Unit I: Applications of differential equation (6 hrs):** Differential equation of particle dynamics, Differential equation of electric circuit theory, Differential equation in nuclear physics, Differential equation in geometry
•Understanding the applications of differential equations in electric circuit theory	**Unit II: Electric circuit theory (7 hrs):** Electrical networks, Mechanical analogies, Steady state theory: Impedance, Filter circuits – variation of impedance with frequencies, Oscillator circuit: stability, Impulsive motion
•Understanding dynamics of classical particles	**Unit III: Particle dynamics (5 hrs):** Function of position, Function of velocity, Non-linear problem in electric circuit theory, Oscillation of non-linear systems, Relaxation oscillation, Motion in two or more dimensions
• Understanding the applications of Fourier series and transforms	**Unit IV: Applications of Fourier series (5 hrs):** Fourier series in electric circuit theory, Fourier series in mechanical problems, Fourier series in boundary value problems, Fourier transforms: applications
. • Become familiar with the applications of partial differential equations.	**Unit V: Applications of partial differential equations (7 hrs):** The wave equation in one-dimension: simple solutions, The equations for the uniform transmission line, The Laplace equation in two dimensions, The use of Fourier series, The use of Laplace transformation

Prescribed Text Books:

1. *Jaeger J. C.* - ***Introduction to Applied Mathematics,*** Second Edition, Oxford University Press (1974)

Reference Books:

1. *Nearing J.* - ***Mathematical tools for physics,*** First Edition, University of Miami (2003)
2. *Mulholland H. & Phillips J. H. G.* - ***Applied Mathematics for Advanced level,*** Butterworth & Co. Ltd (1969)
3. *Potter M. C. & Goldberg J.* - ***Mathematical Methods,*** Second Edition, Prentice Hall of India Pvt Ltd. (2000)

Project Work

Course Title: **Project Work (Physical Science)** Credit: **3**

Course No.: **PR W 481** Year: **Fourth**, Semester**: Eighth**

Nature of the Course: **Research/Presentation** Level: **Undergraduate (B.Sc.)**

Course Description

The course intends to enable the students to be acquainted with the original research work under the supervision of supervisor.

Course Objectives

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

- to understand the method of problem identification through literature review
- to acquire sufficient basic knowledge regarding the method of analysis
- to apply this knowledge to interpret the result
- to draw research conclusion and hence recommendation for future works

Guidelines

Thesis, dissertation and/or project work appear as an important component in almost all curricula these days like in Far Western University in order to achieve an academic University degree for its partial fulfillment. This component is understood as research activities in a broader sense. The difference between above terms depends upon the depth of expected knowledge and the duration of involvement in the proposed and registered work in the concerned department/institutions to be undertaken under the guidance of a supervisor.

Research in general is an essential ingredient of all fields of study as well as all professionals in order to become better equipped in the chosen field on interest. Research work increases the some of practical knowledge so far achieved in the area. It may be a replica of some other previous studies to test their findings and relevance, to make decisions about new developments, to redefine previous results or findings.

Research may be based on the search of materials in Journals, books, other publications, field surveys at different sites and samples or carefully defined new set of experiments, etc. But objectives have to be kept always in mind that some newness in results appear irrespective of the method followed to address research questions.

Project work in academic program initially at the level of B.Sc. like in far western University has very high value because it is the first stage involvement of students as research or researcher is concerned. Students learn almost all steps of research training and knowledge about chosen field or topic. It can also generate critical thinking for further research leading to higher academic degree.

All the terms mentioned above are guided research. Supervisors are supposed to be ethically committed to subject the ways and directions works to be performed so that a critical thinking of students about research

develops. These are the reasons the methodology of research are almost the same in all above terms, qualityor level of which may vary.

Methodology of project work begins with the problem identification and ends with its formal presentation in the presence of an interested audience having some knowledge about the subject together with the experts of the field. Dissemination of result findings, discussion and conclusion are equally important and carry a high value of research. Thus, every steps of performance is documented in a written form as per initially planned methodological design in a standard format where all the steps of the project works are discussed anddescribed in systematic ways and clarity.

Activities performed in accordance with planned methodological research design and documented systematically in an approved format is may be called 'A Research Project'. Proper sequential documentation ofmain matter should be done in the following order:

- Title/Topic
- Literature Review
- Motivation and Objectives
- Methodology
- Results
- Discussions
- Conclusion and Future Extension of Works
- References
- Appendix

The front matter should be prepared in this way:

- Acknowledgement
- Recommendation
- Evaluation
- List of Figures
- List of Tables
- Content
- Abstract
- Main Matter

A committee of four examiners including the Head of concerned department, External Examiner, Internal Examiner and the Supervisor(s) be formed. Marking scheme is regulated as approved by the Faculty Board of Science Faculty of FWU.

The eligibility criteria of Supervisor and external examiner will be decided by the concerned faculty board. The faculty board will take opinion from the concerned department.