

# Shri Guru Ram Rai University

(Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & Recognized by UGC u/s2(f) of UGC Act 1956)

Patel Nagar, Dehradun -248001, Uttarakhand .



**Minutes of Meeting**

**Board of Studies(Third) in Physics**





**Shri Guru Ram Rai University**  
**DEHRADUN-208001 INDIA**

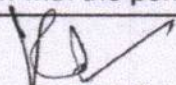
**3<sup>rd</sup> Meeting of the Board of Studies (BoS)**

**School of Basic & Applied Sciences**  
**Department of Physics**

To be held on 26<sup>th</sup> June 2021 at 10 AM in the SBAS Campus, Patelnagar, SGRR University, Dehradun.

**Agenda**

Item No.	Item	Annexure No.
3.1	To confirm the minutes of the 2 <sup>nd</sup> Meeting of the BOS held on 15 <sup>th</sup> May 2020.	3.1
3.2	To report the actions taken on the decisions taken in the 2 <sup>nd</sup> Meeting of the Board of Studies held on 15 <sup>th</sup> May 2020.	3.2
3.3	To deliberate on the Pre-PhD physics course programme in the department of physics as a new course to be included. The syllabus for the following course to be put up for discussions: i. Pre-Ph.D. course programme in Physics as per UGC Regulations 2016	3.3.1
3.4	To review and revise the following: i. Distribution of Courses for all semesters in the revised and new degree Courses (UG/PG and Pre-Ph.D.) for the Academic Session 2021-22. ii. Inclusion of Course Outcomes (COs), Program learning outcomes (POs)/ course objectives etc. in the revised PG course programmes. iii. Inclusion of Course Outcomes (COs), Program learning outcomes (POs)/ course objectives etc. in the revised UG course programmes. iv. Addition, deletion or modification in syllabi if required.	3.4.1- 3.4.5
3.5	To review and revise the following (if any): i. Allotment and description of credits to different courses in the proposed degree Course Programmes for all semesters. ii. Allotment of course codes. iii. Medium of instruction, question paper pattern, medium of Examination, duration of Examination, allotment of marks in Internal and External Exams. iv. Evaluation pattern and distribution of marks	
3.6	Any other item with the permission of the Chair	

  
(Dr. Kumud Saklani)

**CHAIRPERSON BoS**



## MINUTES OF MEETING

### THIRD BOARD OF STUDIES MEETING IN PHYSICS

A meeting of all the members of Third Board of Studies in Physics, SBAS was held on 26<sup>th</sup> June 2021 from 10 a.m. onwards. The following members were present:

1. Prof. (Dr.) Kumud Saklani, Dean, School of Basic & Applied Sciences, SGRRU, Dehradun. (Convener)
2. Dr. O. P. Kulshreshtra, Former Principal and Head, Department of physics, DBS (PG) collage, Dehradun (External Expert).
3. Dr. Arun Kumar, Professor & Dean Research, School of Basic & Applied Sciences, SGRRU, Dehradun. (Member)
4. Dr. Pankaj Chamoli, Associate Professor & Head, Department of Physics, School of Basic & Applied Sciences, SGRRU, Dehradun. (Member)
5. Dr. Parul Goel, Professor, School of CA&IT, SGRRU, Dehradun. (Nominated Member)

#### **PROCEEDINGS AND RESOLUTIONS:**

**Item No. 3.1 & 3.2:** Confirmation of Minutes and action taken of Second BOS Physics.

The members of the BOS discussed the agenda item wise and resolutions were made accordingly.

**Item No. 3.3** Introduction of New Degree Courses in Physics at School of Basic & Applied Sciences, Shri Guru Ram Rai University. It is proposed to introduce the following courses:

**3.3.1** Pre-Ph.D. in Physics as per Regulation 2016 (UGC)

**Resolutions:** All the members of BOS proposed to introduce the courses mentioned above.

**Item No. 3.4.** To review and revise the followings

**Resolutions:** As follows

**Item No. 3.4.1** Distribution of Courses for all semesters in the proposed degree Courses (PG and PhD) for the Academic Session 2021-22.

**Resolutions:**

The distribution of courses for all semesters in the proposed degree Course programmes (PG and PhD) was discussed in detail with the honourable members.



**Item No. 3.4.2** Inclusion of Programme Educational objectives (PEOs), Program learning outcomes (POs)/ course objectives etc. in the revised PG course programmes.

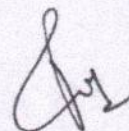
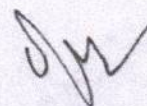
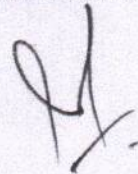
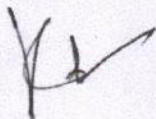
**Resolutions:** The inclusion of Programme Educational objectives (PEOs), Program learning outcomes (POs)/ course objectives etc. in the revised PG course programmes were discussed in detail with the honourable members.

**Item No. 3.4.3** Inclusion of Programme Educational objectives (PEOs), Program learning outcomes (POs)/ course objectives etc. in the revised UG course programmes.

**Resolutions:** The inclusion of Programme Educational objectives (PEOs), Program learning outcomes (POs)/ course objectives etc. in the revised UG course programmes were discussed in detail with the honourable members.

**Item No. 3.4.4** Addition, deletion or modification in syllabi if required.

- i. The Honourable External experts along with the members of the Board of Studies went through the syllabus of respective UG, PG and PhD courses thoroughly and resolved to pass the complete syllabi for all the semesters of all the degree programmes.
- ii. After going through the syllabi, the detailed discussion took place with certain corrections and suggestions from all the members. As recommended by Honourable experts, likewise the corrections were made.
- iii. Details of the suggestions by the members of BOS also included the following:
  - ❖ Some suggested modification at PG level course structure were identified and Seminar (3 credit) were included instead insisted of "Laboratory Course I (MPHL303)" in 3<sup>rd</sup> semester.
  - ❖ Some suggested modification in the syllabus of PG such as Mathematical Physics (MPHC 102), and were included at the M.Sc. course.
  - ❖ Some suggested modification in the syllabus of B.Sc. was included at UG level course.





**Item No. 3.5** To review and revise the following (if any)

**Resolutions:** As follows

**Item No. 3.5.1** Allotment and description of credits to different courses in the proposed degree Course Programmes for all semesters.

**Resolutions:**

The credits for the UG, PG and PhD courses have been proposed. However, the credits would be finalized after discussion of BOS of other subjects to bring uniformity in all subjects and shall be as per SGRR University norms.

**Item No. 3.5.2** Allotment of course codes.

The allotment of course codes have been proposed but would be finalized after discussion of BOS of other subjects and as per SGRR University norms.

**Item No. 3.5.3** Medium of instruction, question paper pattern, medium of Examination, duration of Examination, allotment of marks in Internal and External Exams.

**Resolutions:**

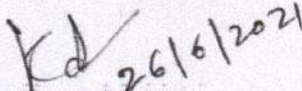
- ❖ The members were of the view that the medium of instruction would be English for UG, PG and PhD course and as per SGRR University norms

**Item No. 3.5.4** Evaluation pattern and distribution of marks

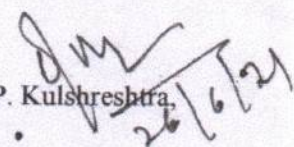
**Resolutions:**

All the members of BOS were of the view that the evaluation pattern and distribution of marks should be at par with other subjects and should follow SGRR University norms to bring uniformity.

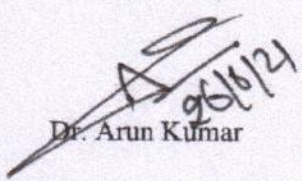
The meeting ended with a vote of thanks to the chair.

  
Prof. (Dr.) Kumud Saklani,

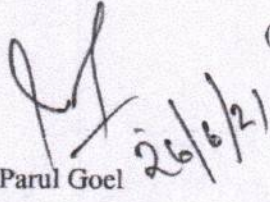
(Convener)

  
Dr. O. P. Kulshrestha,

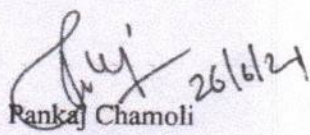
(External expert)

  
Dr. Arun Kumar

(Member)

  
Dr. Parul Goel

(Nominated Member)

  
Dr. Pankaj Chamoli

(Member)

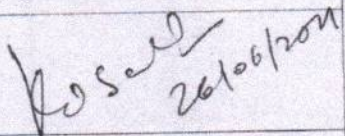
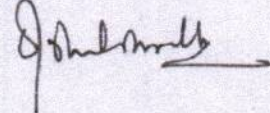
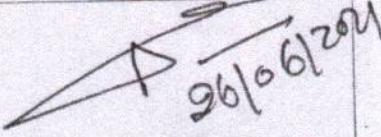
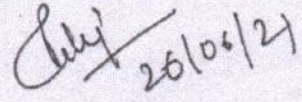
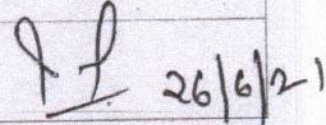


MINUTES OF MEETING

THIRD BOARD OF STUDIES MEETING IN PHYSICS

Attendance Sheet

A meeting of all the members of Third Board of Studies in Physics, SBAS was held on 26<sup>th</sup> June 2021 from 10 a.m. onwards. The following members were present:

S.No	Name	Signature
01	Prof. (Dr.) Kumud Saklani, Dean, School of Basic & Applied Sciences, SGRRU, Dehradun.	 26/06/2021
02	Dr. O. P. Kulshreshtra, Former Principal and Head, Department of physics, DBS (PG) collage, Dehradun	
03	Dr. Arun Kumar, Professor & Dean Research, School of Basic & Applied Sciences, SGRRU, Dehradun	 26/06/2021
04	Dr. Pankaj Chamoli, Associate Professor & Head, Department of Physics, School of Basic & Applied Sciences, SGRRU, Dehradun	 26/06/21
05	<del>Dr. Pankaj Chamoli, Associate Professor &amp; Head, Department of Physics, School of Basic &amp; Applied Sciences, SGRRU, Dehradun</del>	
06	Dr. Parul Goel, Professor, School of CA&IT, SGRRU, Dehradun	 26/6/21



# **SHRI GURU RAM RAI UNIVERSITY**

Patel Nagar, Dehradun-248001, Uttarakhand, India

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]



## **SYLLABUS FOR**

### **Master of Science (M.Sc.)-Physics**

### **School of Basic & Applied Sciences**

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(W.E.F 2021-2022)



**Master of Science (M.Sc.)-Physics****OUTCOME BASED EDUCATION****Programme outcome (POs)**Students will be able to

PO 1	Implement strong theoretical and practical knowledge of physics to solve complex scientific problems.
PO2	Identify the situation-based problems, formulation, and action is taken based on analytical thinking and principles of science.
PO3	Formulate, design, experimental techniques, scientific tools, analysis of scientific data, interpretation of data, and establish a hypothesis for various interdisciplinary research problems.
PO4	Execute effective communication through interactive and presenting skills, technical report writings, and proper documentation of ideas.
PO5	Create a new conceptual, theoretical and operational approach to address various problems in interdisciplinary fields.
PO6	Enables individuals to function effectively in cross-cultural environments as an individual, and as a member or leaders.
PO7	Understand the contribution of scientific knowledge in environmental contexts for sustainable development.
PO8	Understand ethical issues, academic and research ethics, the need and value of lifelong learning, and the scientific misconduct of a scientist to serve society.
PO9	Enhance and adopt employability skills through research, internship, and dissertation.
PO10	Successfully compete in the state level, national level, and international level exams or competitions.
PO11	Lifelong learning of knowledge of physics
PO12	Implement the learning of physics in project management and finance

**Program Specific Outcome (PSOs)**

PSO 1	Associate the fundamental and advanced concepts in diverse branches of physics including classical mechanics, quantum mechanics, electrodynamics, statistical mechanics, atomic, nuclear, and particle physics, condensed matter physics, and electronics.
PSO2	Apply suitable methods to solve a wide range of problems and handle interdisciplinary projects as well as experimental data interpretation independently.
PSO3	Employ experimental skills for multi-disciplinary research work in cutting-edge areas of physics.
PSO4	Develop job-oriented analytical skills needed in research, consultancy, defense, entrepreneurial pursuit, and industry.



**Eligibility for admission:**

Any candidate who has passed graduation with physics as one of the subject by any state from recognized University/Institute with not less than 45% marks in aggregate is eligible for admission, However, SC/ST, OBC and other eligible communities shall be given relaxation as per university rules.

**Duration of the Programme: 2 Years**

**STUDY & EVALUATION SCHEME: Choice Based Credit System (CBCS)**





**Master of Science (M.Sc.)-Physics****First Semester**

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L*	T*	P*	C*	IA*	ESE*	
Theory										
1	Core	MPHC101	Classical Mechanics	4	0	0	4	40	60	100
2	Core	MPHC102	Mathematical Physics	4	0	0	4	40	60	100
3	Core	MPHC103	Electrodynamics and Astrophysics	4	0	0	4	40	60	100
4	Core	MPHC104	Electronics	4	0	0	4	40	60	100
Practical										
1	Core	MPLH105	Laboratory Course I	0	0	6	3	40	60	100
2	Core	MPLH106	Laboratory Course II	0	0	6	3	40	60	100
<b>Total</b>				12	0	12	22	240	360	600

\*L – Lecture, T – Tutorial, P – Practical, C – Credit, IA-Internal Assessment, ESE-End Semester Examination

**Second Semester**

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L*	T*	P*	C*	IA*	ESE*	
Theory										
1	Core	MPHC201	Atomic and Molecular Physics	4	0	0	4	40	60	100
2	Core	MPHC202	Solid State Physics	4	0	0	4	40	60	100
3	Core	MPHC203	Statistical Physics	4	0	0	4	40	60	100
4	Core	MPHC204	Quantum Mechanics	4	0	0	4	40	60	100
Practical										
1	Core	MPLH205	Laboratory Course I	0	0	6	3	40	60	100
2	Core	MPLH206	Laboratory Course II	0	0	6	3	40	60	100
<b>Total</b>				12	0	12	22	240	360	600

\*L – Lecture, T – Tutorial, P – Practical, C – Credit, IA-Internal Assessment, ESE-End Semester Examination



## Third Semester

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L*	T*	P*	C*	IA*	ESE*	
Theory										
1	Core	MPHC301	Advanced Quantum Mechanics	4	0	0	4	40	60	100
2	Core	MPHC302	Nuclear Physics	4	0	0	4	40	60	100
3	Core	MPHC303	Seminar	3	0	0	3	40	60	100
4	Elective -I	MPHE304 OR MPHE306	Condensed Matter Physics OR Laser Physics	4	0	0	4	40	60	100
5	Elective -II	MPHE305 OR MPHE307 OR MPHE308	Digital and Communication Electronics OR Astrophysics OR High Energy Physics	4	0	0	4	40	60	100
Practical										
1	Elective	MPLH309	Laboratory Course	0	0	6	3	40	60	100
Self-Study course										
1	SSC**	MPHS310 OR MPHS311	Physics Of Nano Materials OR Quantum Electrodynamics	0	0	0	3	40	60	100
<b>Total</b>				19	0	06	22	240	360	600

\*L – Lecture, T – Tutorial, P – Practical, C – Credit, IA-Internal Assessment, ESE-End Semester Examination, SSC- Self-Study course

\*\*Self-study course (SSC): Maximum 06 credits (one minimum 03 credits course shall be mandatory but not to be included while calculating grades). Students have to opt self-study courses either in third semester or in fourth semester. This will be conducted and evaluated at Departmental level.



## Fourth Semester

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L*	T*	P*	C*	IA*	ESE*	
Theory										
1	Core	MPHC401	Computational Physics	4	0	0	4	40	60	100
2	Core	MPHC402	Particle Physics	4	0	0	4	40	60	100
Practical										
1	Core	MPL403	Laboratory Course	0	0	6	3	40	60	100
Project/Thesis										
1	Core	MPL404	Dissertation	18	0	0	9	60	240	300**
Self-Study course										
1	SSC***	MPL405 OR MPL406	Environmental Physics OR Bio Physics	0	0	0	3	40	60	100
<b>Total</b>				32	0	06	20	180	420	600

\*L – Lecture, T – Tutorial, P – Practical, C – Credit, IA-Internal Assessment, ESE-End Semester Examination, SSC- Self-Study course

\*\*The distribution of marks for the Dissertation will be as below:

Periodical Presentation	60 Marks
Dissertation	180 Marks
Viva Voce	60 Marks
<b>Total</b>	<b>300 Marks</b>

The dissertation/ project report shall be evaluated jointly by the supervisor and one external examiner.

\*\*\*Self-study course (SSC): Maximum 06 credits (one minimum 03 credits course shall be mandatory but not to be included while calculating grades). Students have to opt self-study courses either in third semester or in fourth semester. This will be conducted and evaluated at Departmental level.



Summary of the Credit

Year	Semester	Max Credit
1	1	22
	2	22
2	3	22
	4	20
Total		86

## Examination Scheme (Except project):

Components	I <sup>st</sup> Internal	II <sup>nd</sup> Internal	External (ESE)
Weightage (%)	20	20	60





## Master of Science (M.Sc.)-Physics

<b>Course code</b>	: MPH101			
<b>Course Name</b>	: Classical Mechanics			
<b>Semester /Year</b>	: I / 1 <sup>st</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

### Course Objective:

The aim and objective of the course on Classical Mechanics is to train the students in Lagrangian and Hamiltonian formalisms for applications in the modern branches of physics such as Quantum Mechanics, Condensed Matter Physics, Astrophysics, etc.

### Course Contents

#### **Unit I**

**Lagrangian formulation and Variational Principle:** Mechanics of particles and system of particles, conservation law, constraints, degree of freedom, generalized coordinates, D'Alembert's principle, Lagrange's equations of motion from D'Alembert's principle, application of Lagrange's equation of motion to a particle and system of particles, conservation theorem, Hamilton's variational principle, Euler-Lagrange's differential equation.

#### **Unit II**

**Hamilton's formalism:** Need of Hamilton's procedure, Legendre's transformation and Hamilton's equation of motion, physical significance of H, cyclic coordinates, Hamilton's equation in cylindrical and spherical coordinates and applications, applications of Hamilton's equation of motion to a particle and system of particles

#### **Unit III**

**Principle of least action:** Canonical or contact transformation, their advantages and examples, condition for a transformation to be canonical, infinitesimal contact transformation (ICT) Poisson brackets: Definition and properties, Invariance with respect to Canonical transformation, equation of motion in Poisson's Bracket form, Jacobian's form.

#### **Unit IV**

**Mechanics of Rigid Bodies and Theory of Small Oscillations:** Coordinates of rigid body motion, Euler's angle, and angular momentum of a rigid body moments and products of inertia, principle axis transformation, Euler's equation of motion of a rigid body, stable and unstable equilibriums. Lagrange's equation of motion for small oscillators, normal coordinates and normal mode frequency of vibrations, free vibration of linear triatomic molecules.

### Text book [TB]:

TB1. Gupta K.C., "Classical Mechanics of particles and Rigid Bodies", Wiley Eastern (2001).

TB2. Goldstein H., Classical Mechanics, Pearson Education Asia Pte Ltd. House (2002).

### Reference books [RB]:

RB1. Rana N. C and Joag P S, Classical Mechanics, Tata McGraw-Hill (1991)



**Course outcomes (COs):**

Upon successful completion of the course a student will be able to

<b>CO1</b>	Define and describe Lagrangian formulation, Variational Principle, Hamilton's formalism, principle of least action and mechanics of Rigid bodies and theory of small Oscillation.
<b>CO2</b>	Understand Lagrange's Equations, Hamilton's Variational Principle, Canonical Transformation, Hamilton's Formulation, principle of least action and mechanics of Rigid bodies, Conservation theorems.
<b>CO3</b>	Apply Lagrange's Equations, Hamilton's Formulation, Canonical transformation, Poisson brackets to various systems
<b>CO4</b>	Analyze constraints, degree of freedom, generalized coordinates, D'Alembert's principle, conservation theorems, Poisson brackets, mechanics of rigid bodies, theory of small Oscillation
<b>CO5</b>	Evaluate angular momentum, energy, moment of inertia, theorems on rigid body and applications of Lagrangian, Hamiltonian, canonical and Poissons bracket formulation
<b>CO6</b>	Solve Problems on Lagrangian, Hamilton's formulation, Canonical transformation, Poissons bracket, mechanics of Rigid bodies and theory of Oscillation.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	2	1	1	2	2	1
CO2	1	2	3	1	1	1	1	2	2	3	2	1	2	2	1	1
CO3	1	2	2	2	1	2	1	2	1	2	2	1	3	3	1	1
CO4	1	2	3	2	1	2	1	1	2	2	2	1	2	2	1	1
CO5	1	2	2	1	1	1	1	1	1	3	2	1	2	2	1	1
CO6	2	2	1	2	2	1	1	1	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHC102			
<b>Course Name</b>	: Mathematical Physics			
<b>Semester /Year</b>	: I / 1 <sup>st</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	4	0	0	4

**Course Objective:**

The main objective of the course on Mathematical Physics is to impart knowledge about various mathematical tools/ techniques employed to study physics problems. Using these tools MSc student would understand and handle theoretical treatments to study physics problems if he/she chooses to pursue research in physics as a career.

**Course Contents****Unit I**

**Differential Equations:** Special equations of Mathematical Physics, Series Solution, Bessel functions of first and second kind, generating function, Integral representation and recurrence relations for Bessel's functions of first kind, orthogonality; Legendre functions: generating function, Recurrence relations and special properties, Orthogonality; Legendre polynomials: recurrence relations, Parity and orthogonality, Hermite functions, Laguerre functions.

**Unit II**

**Complex Variable:** Introduction, Function of complex variable, Analytic functions, Cauchy's integral theorem and Cauchy's integral formula, Taylor and Laurent's expressions, residues at various poles, theorem of residues, Contour integration.

**Unit III**

**Matrix and Tensors:** Inverse and Trace of Matrix, Unitary Matrices, Orthogonality, Eigen values-Eigen vectors and Diagonalisation of matrices, Coordinate transformation, Covariant and contravariant Tensors, addition, multiplication and contraction of tensors, Associated tensors.

**Unit IV**

**Partial Differential Equations:** Partial differential equations, Separation of variables. One dimensional wave and heat equation, two-dimensional heat equation and Laplace equation.

**Unit V**

**Group Theory:** Definition, Classification of groups, subgroup, cyclic group, isomorphism and homomorphism, classes, vector spaces, representation theory of finite groups, Reducible and Ir-reducible representations, Schur's Lemmas and orthogonality theorem, Characters of representations.



**Text book [TB]:**

TB1. Harper C. Analytical Mathematics in Physics, Prentice Hall (1999).

TB2. Boas M.L. Mathematical Methods in the Physical Sciences, John Wiley & Sons, NewYork (1983).

**Reference books [RB]:**

RB1. Arfken G. and Weber H.J., Mathematical Methods for Physicists, Academic Press (2005).

RB2. Dass H.K., Mathematical Physics, S.Chand (2018).

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Describe differential equations, group theory, partial differential equations, matrix and tensors and complex variable
<b>CO2</b>	Illustrate Special function (Bessel's, Legendre, Hermite functions, Laguerre functions), recurrence relations, Parity and orthogonality, Cauchy's integral theorem, Eigen Values-Eigen vectors, for solving definite integral, Laplace equation.
<b>CO3</b>	Understand Taylor and Laurent's expressions, residues at various poles, theorem of residues, Contour integration, partial differential equations using boundary value problems, wave and heat equation, two-dimensional heat equation
<b>CO4</b>	Explain Schur's Lemmas and orthogonality theorem and, isomorphism and homomorphism.
<b>CO5</b>	Distinguish covariant and contravariant Tensors use the group theory, Classification of groups
<b>CO6</b>	Solve the matrix and tensors, Coordinate transformation, vector spaces, representation theory of finite groups

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	1	1	1	1	1	2	2	1	1	2	2	1
CO2	2	3	1	1	2	1	1	2	2	3	2	1	2	2	1	1
CO3	2	2	2	3	2	1	1	2	1	2	2	1	3	3	1	1
CO4	2	3	2	2	2	1	1	1	2	2	2	1	2	2	1	2
CO5	2	2	1	2	2	1	1	1	1	3	2	1	2	2	2	1
CO6	2	2	1	2	2	1	1	1	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHC103			
<b>Course Name</b>	: Electrodynamics and Astrophysics			
<b>Semester /Year</b>	: I / 1 <sup>st</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	4	0	0	4

**Course Objective:**

This course gives an overview on various topic of classical electrodynamics including Maxwell equations, gauge invariance, classical radiation from accelerating charges. To develop observation skills to be able to explain astronomical features and stellar system.

**Course Contents****Unit I**

**Maxwell's equations and Electromagnetic waves:** Maxwell's equations and their physical significance. Equation of continuity and relaxation time, Vector and scalar potentials, Lorentz and Coulomb gauge, electromagnetic energy and Poynting's theorem, electromagnetic wave equations in free space, their plane wave solutions.

**Unit II**

**Radiations from moving charges:** Concept of Retarded potentials, Lienard Wiechert potentials, Multipole expansion of EM fields, Electric dipole radiations. Fields produced by moving charges, radiations from an accelerated charged particle, Radiations from an accelerated charged particle at low velocities in circular orbits-Larmor formula.

**Unit III**

**The Solar System:** Aspects of the sky: Concept of Celestial Coordinates and spherical astronomy. Astronomical telescopes. Study of Planets: Classification of the Planets, Orbits, Laws of planetary motion, Asteroids, Meteors and Meteorites: Discovery of minor planets (Asteroids). Meteors and Meteorites. Meteorites, its types and composition. Meteorite craters. Nature of dust particles and origin of comets.

**Unit IV**

**Sun As a Star:** History of Sun, Sun's interior, the photosphere, the solar atmosphere, Salient features of sunspots, sun's rotation & solar magnetic field, explanation for observed features of sunspots. Magnitude scale and magnitude systems. Atmospheric extinction. Absolute magnitudes and distance modulus.

**Unit V**

**Stellar System:** The Hertzsberg- Russell Diagram: The colour, Brightness or luminosity, the population of star. Elementary idea of Binary & Variable Stars. Nuclear fission, nuclear fusion, condition for nuclear reaction in stars. Types of galaxies, Structure and features of the Milky Way Galaxy.

**Text book [TB]:**

- TB 1. Modern Electrodynamics by A. Zangwill, Cambridge, 2013.  
TB 2. Introduction to Electrodynamics by D. Griffiths

**Reference books [RB]:**



RB 1. P. Puri: Classical Electrodynamics (Tata McGraw Hill, 1990)

RB 2. J.B. Marion: Classical Electromagnetic Radiation

RB 3. Landau and Lifshitz: The Classical theory of Fields (Pergman Press)

### Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe the Maxwell's equations and electromagnetic waves, Radiations from moving charges, stellar System, sun as a star, and the solar system
CO2	Discuss the formulation of Lienard Wiechert, Retarded potential and Hertzberg-Russell Diagram.
CO3	Illustrate Poynting's theorem and Maxwell's equations to solve problems of classical electrodynamics, the orbits Laws of planetary motion
CO4	Classify the concept of modern astrophysical observations, the photosphere, the solar atmosphere, Salient features of sunspot
CO5	Evaluate the understanding of our present picture of stellar system, Meteors and Meteorites, Atmospheric extinction. Absolute magnitudes and distance modulus
CO6	Express Nuclear fission, nuclear fusion, condition for nuclear reaction in stars, Structure and features of the Milky Way Galaxy, accelerated charged particle at low velocities in circular orbits-Larmor formula.

### CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	1	1	2	1	1	2	2	1
CO2	1	2	3	2	3	1	1	2	2	1	2	1	2	2	1	1
CO3	3	1	2	2	2	2	1	2	2	1	2	1	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	1	2	1	2	2	1	1
CO5	2	1	3	2	2	1	1	1	2	1	2	1	2	2	1	2
CO6	2	1	2	2	2	1	1	1	2	1	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b> : MPHC104				
<b>Course Name</b> : Electronics				
<b>Semester /Year</b> : I / 1 <sup>st</sup>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**Course Objective:**

The main objective of the course on electronic is to impart knowledge and keen understanding of the basic power amplifiers components, circuit representations and integrations, device structures, principle of operations, and analysis.

**Course Contents****Unit I**

**Power amplifiers:** Types of power amplifiers-series fed class A amplifier-series fed transformer coupled class B: push pull circuits-harmonic distortion in amplifiers-class C and D amplifiers-design considerations.

**Unit II**

**Feedback in amplifiers:** Feedback principle-effect of feedback on stability-nonlinear distortion input and output impedance-bandwidth-different types of feedback. Criteria for oscillation-phase shift, Wein bridge, crystal oscillator-frequency stability, astable, mono stable and bistable multivibrators, Schmitt trigger-bootstrap sweep circuits.

**Unit III**

**Operational amplifiers:** Differential amplifier-ideal and real op-amp-input and output impedance frequency response-applications: amplifiers, mathematical operations, active filters, waveform generators-analog computations-comparators-S and H circuit-voltage regulator.

**Unit IV**

**Optoelectronics:** Optical fibers: graded index step index fibers-refractive index profiles-propagation of optical beams in fibers-mode characteristics and cut off conditions-losses in fibers-signal distortion group delay material and wave guide dispersion. Optical sources: Light emitting diodes-LED structure internal quantum efficiency-injection laser diode comparison of LED and ILD.

**Unit V**

**Optical detectors:** PN junction photo diodes-PN photo detectors-avalanche photo diode-performance comparison.

**Text book [TB]:**

- TB 1. Millman & Halkias: Integrated Electronics (McGraw Hill)
- TB 2 .Semiconductor Electronics by A.K. Sharma, New Age International Publisher (1996)
- TB 3. Laser and Non-linear optics by B.B. Laud., Wiley Eastern Limited (1985)

**Reference books [RB]:**

- RB 1. Introduction to Semiconductor Devices by M.S. Tyagi, John Wiley & Sons
- RB 2. Semiconductor Devices - Physics and Technology by S.M. Sze, Wiley (1985)
- RB 3. Optical electronics by Ajoy Ghatak and K. Thygarajan, Cambridge Univ. Press.



**Course outcomes (COs):**

Upon successful completion of the course a student will be able to

<b>CO1</b>	Define and describe Power amplifiers, Feedback amplifiers, Operational amplifiers, Optoelectronics and Optical detectors
<b>CO2</b>	Understand about Principle and working of different Power amplifiers, Feedback amplifiers, Operational amplifiers, Optoelectronics and Optical detectors
<b>CO3</b>	Illustrate and Explain various oscillators, multivibrators, optical fibers, LED, ILD, Optical Detectors, and applications of operational amplifiers.
<b>CO4</b>	Analyse the characteristics of power amplifiers, operational amplifiers, feedback amplifiers, various optical fibers and optical detectors.
<b>CO5</b>	Distinguish between different power amplifiers, oscillators, multivibrators operational amplifiers, feedback amplifiers, various optical fibers and optical detectors
<b>CO6</b>	Design various electronic circuits such as power amplifiers, oscillators, multivibrators, operational amplifiers, feedback amplifiers, various optical fibers and optical detectors for practical purposes.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	1	1	2	1	1	1	2	2	1	1	2	2	1
CO2	3	1	2	2	3	1	2	2	2	3	2	1	2	2	1	2
CO3	2	2	2	2	2	2	2	2	1	2	2	1	3	3	1	2
CO4	3	2	2	1	3	2	2	1	2	2	2	1	2	2	2	1
CO5	2	1	2	2	2	1	2	2	1	3	2	1	2	2	2	1
CO6	2	1	2	2	2	1	2	2	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated





<b>Course code</b>	<b>: MPHL105</b>			
<b>Course Name</b>	<b>: Laboratory Course – I</b>			
<b>Semester /Year</b>	<b>: I / 1<sup>st</sup></b>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>6</b>	<b>3</b>

**Course Objective:**

To teach the student's properties of various semiconductor and transistor characteristics by having the students perform hands on experiments supervised by a specialized instructor.

**Course Contents**

**List of experiments:** At least 5 experiments are to be performed:

1. Study of LCR circuit
2. Transistorized LCR bridge
3. Study of UJT
4. Study of MOSFET
5. Study of NPN and PNP transistor characteristics
6. Study of DIAC
7. Study of TRIAC
8. e/m by Zeeman Effect
9. Study of IC- Based Power supply
10. Measurement of wavelength of He-Ne laser using interference and diffraction pattern

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of phenomenon such as of Zeeman effect and interference pattern to calculate several physical parameters.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	2	2	2	1	1	2	2	1
CO2	1	2	2	2	3	1	1	2	2	3	2	2	2	2	2	1
CO3	3	2	2	2	2	2	1	2	2	2	2	1	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2	1	2
CO5	2	2	2	2	2	1	1	1	2	3	2	2	2	2	2	1
CO6	2	2	2	2	2	1	1	1	2	2	2	1	2	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHL106			
<b>Course Name</b>	: Laboratory Course – II			
<b>Semester /Year</b>	: I / 1 <sup>st</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	0	0	6	3

**Course Objective:**

To teach the students properties of semiconductors, oscillator, amplifier and different network theorems by having the students perform hands on experiments supervised by a specialized instructor.

**Course Contents**

**List of experiments:** At least 5 experiments are to be performed:

1. Study of FET
2. R.C. coupled amplifier
3. T.C. coupled amplifier
4. Study of feedback amplifier
5. Study of Hartley oscillator
6. Study of Colpitt oscillator
7. Study of Wien bridge oscillator
8. Design and study of different network theorems
9. Design and study of phase shift oscillator
10. Study of operational amplifier

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of phenomenon such as amplifier and oscillator to calculate several physical parameters.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	2	2	1	1	2	2	2	1	1	2	2	1
CO2	3	2	2	2	3	2	2	2	2	3	2	2	2	2	2	1
CO3	2	2	1	3	2	2	1	2	2	2	2	1	3	2	3	1
CO4	2	2	1	2	2	2	1	1	2	2	2	1	2	1	2	2
CO5	3	2	2	2	3	2	2	1	2	3	2	2	2	2	2	1
CO6	2	2	1	2	2	2	1	1	2	2	2	1	2	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHC201			
<b>Course Name</b>	: Atomic and Molecular Physics			
<b>Semester /Year</b>	: II / 1 <sup>st</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	4	0	0	4

**Course Objective:**

The main objective of the course on atomic and molecular physics is to impart knowledge about various atomic spectroscopy. Using these tools MSc student would understand and handle various spectroscopic concepts to study physics problems if he/she chooses to pursue research in physics as a career.

**Course Contents****UNIT I**

**Atomic Spectroscopy:** Hydrogen, Helium and Alkali spectra, Vector atom model of Hydrogen atom, Relativistic correction, Spin-orbit coupling, Hydrogen fine structure, Spectroscopic terms, LS coupling, Pauli exclusion principle, Interaction energy for LS coupling, Lande interval rule, jj coupling, interaction energy for jj coupling, Hyperfine structure.

**UNIT II**

**Atom in Magnetic and Electric Field:** Zeeman effect, Magnetic moment of a bound electron, Magnetic interaction energy in weak field. Paschen-Back effect, Magnetic interaction energy in strong field, Stark effect, First order Stark effect in hydrogen. Quantum mechanical treatment of both the effects.

**UNIT III**

**Molecular Spectroscopy:** Rotational and vibrational spectra of diatomic molecule, Raman Spectra, Born-Oppenheimer approximation, Vibrational coarse structure, Franck-Condon principle, Condon parabola. Rotational fine structure of electronic-vibration transitions, Electronic spectra.

**UNIT IV**

**Spin Resonance Spectroscopy:** Electron spin resonance and nuclear magnetic resonance spectroscopy

**Text book [TB]:**

TB 1. C.N. Banwell, E.M. McCash, Fundamentals of molecular spectroscopy, Tata McGraw Hill, (2007).

TB 2. R. Kumar, Atomic and Molecular Physics, Campus Books International (2013).

**Reference books [RB]:**

RB 1. B.H. Bransden & C. J. Joachin Physics of Atoms and Molecules. 2nd Edition Prentice Hall (2003).



RB 2. H.E. White, Introduction to Atomic Spectra, McGraw Hill, (1934).

### Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe the atomic spectra, atoms in electric and magnetic field, molecular spectroscopy and spin resonance.
CO2	Understand hydrogen spectra, rotational and vibrational spectra. Rotational and vibrational spectra of diatomic molecule
CO3	Apply coupling jj and L-S, rigid rotator, Zeeman effect, ESR and NMR. Franck-Condon principle, Condon parabola. Rotational fine structure of electronic-vibration transitions.
CO4	Analyse spectroscopic term, hyperfine structure and Raman spectroscopy. Spin-orbit coupling
CO5	Evaluate Born opp. Approximation, Pauli's exclusion principle, Stark effect, First order Stark effect in hydrogen, Parity,
CO6	Formulate Lande interval rule, electronic spectra. Hydrogen, Helium and Alkali spectra

### CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	2	2	1	1	1	1	2	2	1	1	2	2	1
CO2	1	2	2	3	2	1	2	2	2	3	2	1	2	2	1	1
CO3	2	2	1	2	2	1	3	2	1	2	2	1	3	3	2	1
CO4	1	2	2	2	2	1	2	2	2	2	2	1	2	2	1	2
CO5	1	2	1	3	2	1	3	2	1	3	2	1	3	2	2	1
CO6	1	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHC202			
<b>Course Name</b>	: Solid State Physics			
<b>Semester /Year</b>	: II/ 1 <sup>st</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	4	0	0	4

**Course Objective:**

To study the structure and some of the basic properties of the solid materials. This course includes detail description of lattice dynamics, crystal, electronic structure and Brillouin zone of materials.

**Course Contents****Unit I**

**Crystal Structure:** Periodic arrays of atoms, Primitive lattice cell, fundamental types of lattices, index system for lattice planes, Simple crystal structure, Atomic radii, coordination number, Cesium chloride structure. Hexagonal Close Packed Structure, Diamond Structure, cubic Zinc Sulphide structure, point group.

**Unit II**

**Reciprocal lattice:** diffraction waves by crystals, Bragg's law, Scattered wave amplitude, Laue equations. Brillouin zones, reciprocal lattice to SC lattice, B C C lattice, F C C lattice, structure factor of B C C structure, F C C lattice, Atomic form factor.

**Unit III**

**Crystal Binding and Elastic Constants:** Ionic Crystal, Covalent Crystal, Metals, Hydrogen bonds, analysis of elastic springs, elastic compliance and stiffness constants, Elastic waves in cubic crystals, Experimental determination of elastic constants.

**Unit- IV**

**Lattice Vibrations:** Vibrations of crystals with monoatomic basis, First Brillouin zone, Group Velocity, Long wavelength limit, Two atoms per primitive basis, quantization of elastic waves, Phonons, Phonon momentum, Inelastic scattering of photons by phonons.

**Text book [TB]:**

- TB 1. Kittel C., Introduction to Solid State Physics, John Willey (2004).
- TB 2. Dekker A.J., Solid State Physics, Prentice Hall (1965).
- TB 3. Mayers H. P., Introduction to Solid State Physics, Taylor & Francis (1997).

**Reference books [RB]:**

- RB 1. S.O. Pillai, Solid State Physics
- RB 2. Ashcroft N.W. and Mermin N.D., Solid State Physics, Harcourt Asia Pvt. Ltd. (1976).



**Course outcomes (Cos):**

Upon successful completion of the course a student will be able to

CO1	Describe the crystal structure and system of the solids, Reciprocal lattice, Crystal Binding and Elastic Constants, Lattice Vibrations
CO2	Understand diffraction waves by crystal, Bragg's law, elastic waves in cubic crystals, quantization of elastic waves, analysis of elastic springs, reciprocal lattice
CO3	Apply Laue's equations, Brillouin zones, group velocity. Vibrations of crystals with monoatomic basis, First Brillouin zone, Group Velocity, Long wavelength limit, Two atoms per primitive basis
CO4	Crystal structures, analyse elastic springs, phonon momentum, closed packed structure.
CO5	Evaluate fundamental types of lattice, Two atoms per primitive basis, packing factor
CO6	Express the ionic crystal, covalent crystal, metals, Bonding in solids, hydrogen bonds

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	1	1	2	2	2	2	1	1	2	2	1
CO2	1	2	2	2	1	2	2	2	1	3	2	1	2	2	1	1
CO3	2	2	1	2	2	2	1	2	2	1	2	2	2	2	2	1
CO4	2	2	1	2	2	2	1	2	2	1	2	3	2	1	1	2
CO5	2	2	2	2	2	1	1	2	1	2	2	2	1	1	2	1
CO6	3	2	2	2	2	1	1	2	1	2	2	2	1	1	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b> : MPHC203				
<b>Course Name</b> : Statistical Physics				
<b>Semester /Year</b> : II/ 1 <sup>st</sup>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	4	0	0	4

**Course Objective:**

The main objective of the course on statistical physics is to impart knowledge about macroscopic and mesoscopic systems employed to study physics problems.

**Course Contents****Unit I**

**Basic Postulates-** Phase space, relation between eigen states and phase space volume, Liouville's theorem, ensembles, microcanonical, canonical and grand canonical ensembles, Maxwell's Boltzmann's distribution and Gibb's formulation for canonical and grand canonical ensembles, partition function, their thermodynamic properties, laws of thermodynamics.

**Unit II**

**Application of classical distribution to the ideal gases:** Degrees of freedom, translational motion, Helmholtz free energy, Gibb's free energy, entropy and thermodynamic properties, Gibb's paradox, Sakur-tetrode equation.

**Imperfect gases:** Difference between ideal and real gas, imperfect gases, Vander Waal's equation, virial coefficients, condensation of gases, general properties of liquids, Fermi theory, liquid Helium, phase rule.

**Unit III**

**Quantum Statistics:** Drawbacks of M B distribution, Bose-Einstein's and Fermi-Dirac distribution, symmetric and antisymmetric particles, partition functions, non-degenerate, weakly degenerate and strongly degenerate cases, B.E. condensation, application to He, pressure-energy relationship, electronic specific heat of solids and paramagnetism.

**Unit IV**

**Black Body Radiation:** Planck's distribution, pressure and energy relationship of photons, black body radiation, Rayleigh Jean's formula, Wein's law, Wein's displacement formula, absorption and emission of radiation, Stefan's law, high temperature measurements.

**Text book [TB]:**

- TB 1. Reif F., Fundamentals of Statistical and Thermal Physics, McGraw Hill (1985).  
TB 2. . Landau and Lifshitz: Statistical Physics

**Reference books [RB]:**

- RB 1. Pathria R.K., Statistical Mechanics, Butterworth-Heinemann (1996).  
RB 2. E.S. Raj Gopal: Statistical Mechanics and Properties of Matter.



**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

CO1	Describe Basic Postulates, Application of classical distribution to the ideal gases, Imperfect gases, Quantum Statistics, Black Body Radiation
CO2	Understand statistics, phase space, ensembles, fermi theory, liquid helium phase rule, absorption and emission of radiation, Einstein and Debye's theory of specific heat of solids.
CO3	Examine partition function, Sackur tetrode equation, B.E condensation principle, Wein's displacement formula, Gibb's paradox, Liouville's theorem
CO4	Deduce Stefan's law, ensembles, pressure energy relationship, Rayleigh Jean's formula, general properties of liquids, Statistical equilibrium
CO5	Evaluate partition functions, virial coefficients, Planck's distribution, pressure and energy relationship of photons, Phase space
CO6	Formulate Gibb's paradox, degenerate cases, specific heat of solids, Vander Waal constant and Virial coefficient

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	1	1	1	2	2	1	1	2	2	1
CO2	2	3	1	2	3	1	1	2	2	3	2	1	2	2	1	1
CO3	2	2	2	2	2	2	2	2	1	2	2	1	3	3	2	1
CO4	2	3	2	2	3	2	1	2	2	2	2	1	2	2	1	2
CO5	3	2	2	2	2	1	1	2	1	3	2	1	3	2	2	1
CO6	2	2	1	2	2	1	1	2	1	2	2	1	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



Course code	: MPHC204			
Course Name	: Quantum Mechanics			
Semester /Year	: II/ 1 <sup>st</sup>			
	L	T	P	C
	4	0	0	4

**Course Objective:**

To apprise the students regarding the quantum mechanics and its advanced concepts and their use in various situations pertaining to static and dynamic conditions.

**Course Contents****Unit I**

**Introduction:** A brief review of foundations of quantum mechanics, basic postulates of quantum mechanics, uncertainty relations, Schrodinger wave equation, expectation value and Ehrenfest theorem. Relationship between space and momentum representation. One dimensional potential step, tunnelling, Hydrogen atom, particle in a three-dimensional box.

**Unit II**

**Matrix Formulation of Quantum Mechanics:** Vector representation of states, transformation of Hamiltonian with unitary matrix, representation of an operator, Hilbert space. Dirac bra and ket notation, projection operators, Schrodinger, Heisenberg and interaction pictures. Relationship between Poisson brackets and commutation relations. Matrix theory of Harmonic oscillator.

**Unit III**

**Symmetry in Quantum Mechanics:** Unitary operators for space and time translations. Symmetry and degeneracy. Rotation and angular momentum; Commutation relations, eigenvalue spectrum, angular momentum matrices of  $J_x, J_y, J_z, J^2$ . Concept of spin, Pauli spins matrices. Addition of angular momenta, Clebsch-Gordon coefficients and their properties, recursion relations. Matrix elements for rotated state, irreducible tensor operator, Wigner-Eckart theorem. Rotation matrices and group aspects. Space inversion and time reversal: parity operator and anti-linear operator. Dynamical symmetry of harmonic oscillator, non-relativistic Hamiltonian for an electron with spin included. C. G. coefficients of addition for  $j = 1/2, 1/2; 1/2, 1; 1, 1$ .

**Unit IV**

**Approximation Methods for Bound State:** Time independent perturbation theory for non-degenerate and degenerate systems up to second order perturbation. Application to a harmonic oscillator, first order Stark effect in hydrogen atom, Zeeman effect with electron spin. Variation principle, application to ground state of helium atom, electron interaction energy and extension of variational principle to excited states. WKB approximation: energy levels of a potential well, quantization rules. Time-dependent perturbation theory; transition probability (Fermi Golden Rule), application to constant perturbation and harmonic perturbation. Semi-classical treatment of radiation. Einstein coefficients; radiative transitions.

**Text book [TB]:**

TB 1. David J. Griffiths, Introduction to Quantum Mechanics. 2<sup>nd</sup> ed. Upper Saddle River, NJ: Pearson Prentice Hall (2004).



TB 2. Zettili N., Quantum Mechanics: Concepts and Applications, 2<sup>nd</sup> Ed, John Wiley (2009).

**Reference books [RB]:**

RB 1. Bransden B. H. and Joachain C. J., Quantum Mechanics, 2<sup>nd</sup> Ed, Pearson Education (2000).

RB 2. Schiff L. I., Quantum Mechanics, 3<sup>rd</sup> Ed, McGraw Hill Book Co. (1990).

**Course outcomes (Cos):**

**Upon successful completion of the course a student will be able to**

<b>CO1</b>	Define and describe basic postulates of quantum mechanics, Matrix Formulation and symmetry in Quantum Mechanics, Approximation Methods for Bound State
<b>CO2</b>	Understand Schrodinger equation, potential problems, Time independent and Time-dependent perturbation theory, Matrix Formulation and symmetry in Quantum Mechanics
<b>CO3</b>	Apply Schrodinger equation and different approximation methods in various systems and explain Clebsch-Gordon coefficients,
<b>CO4</b>	Analyse various operators, Fermi Golden Rule, Semi-classical treatment of radiation. Einstein coefficients, Zeeman effect, Pauli spins matrices, Poisson brackets and commutation relations
<b>CO5</b>	Evaluate commutation relations, eigenvalues, first order Stark effect in hydrogen atom, WKB approximation
<b>CO6</b>	Solve the problem One dimensional potential step, tunnelling, Hydrogen atom, particle in a three-dimensional box and applications of Variation principle, time dependent and independent perturbations.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	2	2	2	1	1	2	2	1
CO2	1	2	2	2	3	1	1	2	2	3	2	1	2	2	1	1
CO3	2	2	1	2	2	2	2	2	1	2	2	1	3	3	2	1
CO4	2	2	1	2	3	2	1	2	2	2	2	1	2	2	1	2
CO5	2	2	2	2	2	1	1	2	1	3	2	1	3	2	2	1
CO6	3	2	2	2	2	1	1	2	1	2	2	1	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



Course code	: MPHL205			
Course Name	: Laboratory Course – I			
Semester /Year	: II/ 1 <sup>st</sup>			
	L	T	P	C
	0	0	6	3

**Course Objective:**

To teach the students optics and electronics phenomenon by having the students perform hands on experiments supervised by a specialized instructor.

**Course Contents****List of experiments:**

1. Multivibrator: bistable / monostable / Astable
2. Design and study of FET amplifier
3. Design and study of MOSFET amplifier
4. Ionization potential of Mercury using gas filled diodes
5. Michelson interferometer
6. Fabry Perot interferometer
7. Fresnel's law
8. Determination of absorption coefficient of iodine vapour
9. B-H curve
10. Study of pin connection and biasing of various linear IC's and timers 555

**Course outcomes (Cos):**

Upon successful completion of the course a student will be able to

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of phenomenon such as of amplifier and B-H curve to calculate several physical parameters.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	2	2	2	1	1	2	2	1
CO2	1	2	2	2	3	1	1	2	2	3	2	2	2	2	2	1
CO3	3	2	2	2	2	2	1	2	2	2	2	1	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2	1	2
CO5	2	2	2	2	2	1	1	1	2	3	2	2	2	2	2	1
CO6	2	2	2	2	2	1	1	1	2	2	2	1	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHL206			
<b>Course Name</b>	: Laboratory Course – II			
<b>Semester /Year</b>	: II/ 1 <sup>st</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>6</b>	<b>3</b>

**Course Objective:**

To teach the students modulation and demodulation, CRO, Ultrasonic waves, and Planks constant by having the students perform hands on experiments supervised by a specialized instructor.

**Course Contents****List of experiments:**

1. Study of amplitude modulation and demodulation
2. Study of frequency modulation and demodulation
3. Lecher wire experiment
4. Determination of magnetic susceptibility
5. Study of CRO.
6. Velocity of Ultrasonic waves
7. Linear Air track
8. Determination of Planks constant
9. Logic gate AND/OR /NAND/NOR/NOT gates
10. Design and study of UJT relaxation oscillator

**Course outcomes (Cos):**

Upon successful completion of the course a student will be able to

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of phenomenon such as of modulation and demodulation and magnetic susceptibility pattern to calculate several physical parameters.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	2	2	1	1	2	2	2	1	1	2	2	1
CO2	1	1	2	2	3	2	1	2	2	1	1	2	1	2	3	2
CO3	2	1	2	1	2	2	1	3	3	1	3	2	1	2	2	2
CO4	2	1	1	2	2	2	1	2	2	1	2	2	1	2	3	2
CO5	1	1	1	1	3	2	1	2	2	1	2	2	1	2	2	2
CO6	1	1	1	1	2	2	1	2	2	1	2	2	1	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHC301			
<b>Course Name</b>	: Advanced Quantum Mechanics			
<b>Semester /Year</b>	: III/ 2 <sup>nd</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	4	0	0	4

**Course Objective:** The main objective of the course on Advanced Quantum mechanics is to impart knowledge about various approximation methods in physics and to give them ideas about laboratory and center of mass frame and study the scattering phenomena in both these frames.

### Course Contents

#### Unit I

**Scattering Theory:** General considerations: kinematics, wave mechanical picture, scattering amplitude, differential and total cross section. Green's function for scattering. Partial wave analysis: asymptotic behavior of partial waves, phase shifts, scattering amplitude in terms of phase shifts, cross-sections, Optical theorem. Phase shifts and its relation to potential, effective range theory. Application to low energy scattering; resonant scattering, Breit-Wigner formula for one level and two levels, non-resonant scattering. s-wave and p-wave resonances. Exactly soluble problems; Square-well, Hard sphere, coulomb potential. Born approximation; its validity, Born series.

#### Unit II

**Identical Particles:** The Schrodinger equation for a system consisting of identical particles, symmetric and anti-symmetric wave functions, elementary theory of the ground state of two electron atoms; ortho- and Para-helium. Spin and statistics connection, permutation symmetry and Young tableaux. Scattering of identical particles.

#### Unit III

**Relativistic Wave Equations:** Generalization of the Schrodinger equation; Klein-Gordon equation, plane wave solutions, charge and current densities, interaction with electromagnetic fields, Hydrogen-like atom (to show it does not yield physical spectrum), non-relativistic limit. Extension of Klein-Gordon equation to spin 1 particles. Dirac Equation; relativistic Hamiltonian, probability density, expectation values, Dirac gamma matrices, and their properties, non-relativistic limit of Dirac equation. Covariance of Dirac equation and bilinear covariance, plane wave solution, energy spectrum of hydrogen atom, electron spin and magnetic moment, negative energy sea, hole interpretation and the concept of positron. Spin-orbit coupling, hyperfine structure of hydrogen atom.

**Unit IV Quantization of wave fields:** The quantization of wave fields, Classical and quantum field equations, quantization of non-relativistic Schrodinger equation, second quantization, N-representation, creation and annihilation operators.





**Text book [TB]:**

- TB 1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics (TMH)  
 TB 2. R.P Feynman and A.R.Hibbs; Quantum Mechanics and Path Integrals.  
 TB 3. L. I. Schiff, Quantum Mechanics (McGraw Hill).

**Reference books [RB]:**

- RB 1. Thankappan, V.K., Quantum Mechanics, New Age International (2004).  
 RB 2. Sakurai, J.J., Advanced Quantum Mechanics, Pearson Education (2007).  
 RB 3. S. Davydov, Quantum Mechanics (Pergamon).

**Course outcomes (COs):**

Upon successful completion of the course a student will be able to

CO1	Define and describe scattering theory, identical particles, Relativistic Wave Equations, Quantization of wave fields
CO2	Understand various scattering techniques for low and high energy particles, Klein-Gordon equation, Dirac equation formulation, theory of identical particles, Quantization of wave fields
CO3	Apply partial wave and Born approximation techniques to various systems, K-G and Dirac equation, Pauli's exclusion principle to different systems.
CO4	Analyse theory of identical particles, Pauli's exclusion principle, second quantization, Covariance of Dirac equation, scattering amplitude, differential and total cross section and Green's function for scattering.
CO5	Evaluate the problems based on partial wave and Born approximation. Distinguish between Lab. Frame and center of mass frame
CO6	Formulate and develop understanding on theory of identical particles, N-representation, creation and annihilation operators, electron spin and magnetic moment, negative energy sea, hole interpretation and the concept of positron,

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	2	2	2	1	1	2	2	1
CO2	2	2	2	2	2	2	1	2	2	3	1	2	1	2	2	1
CO3	2	1	3	3	2	2	1	2	2	2	3	2	1	2	2	1
CO4	2	1	2	2	1	2	1	1	2	2	2	2	1	2	1	2
CO5	2	2	2	2	2	2	1	1	2	3	2	2	1	2	2	1
CO6	2	1	2	2	2	2	1	1	2	2	2	2	1	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHC302			
<b>Course Name</b>	: Nuclear Physics			
<b>Semester /Year</b>	: III/ 2 <sup>nd</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	4	0	0	4

**Course Objective:**

The objective of the course is to provide an understanding about the general nuclear properties and knowledge of nuclear models: liquid drop model, shell model and collective model. To provide knowledge and understanding of scattering process and decay phenomenon.

**Course Contents****Unit I**

**General Properties & Models:-** Nuclear size, nuclear angular momentum (Spin), Nuclear magnetic moments, statistics, Binding energy, Liquid drop model, Shell model, Collective model.

**Unit II**

**Nuclear Forces and Detector** – Ground state of deuteron, Low energy neutron-proton scattering and proton-proton scattering, Exchange and tensor forces, G.M. Counter, Electron & Proton Synchrotron.

**Unit III**

**Radioactive decay:** Radioactive decay equation equilibrium units, Gamow's theory of alpha decay and Geiger Nuttal law, Fermi's theory of beta decay, parity violation in beta decay, electromagnetic decays.

**Unit IV**

**Nuclear Reactions-** Q-value of nuclear reaction, Bohr's Theory of compound nucleus, scattering cross section of nuclear reaction (phase shift method), Breit Wigner single level resonance formula for scattering cross section.

**Text book [TB]:**

- TB1. B.R. Martin : Nuclear & Particle Physics
- TB2. Tayal, D.C. , Nuclear Physics, Himalaya Publishing House, Mumbai
- TB3. Nuclear & Particle Physics-B.R. Martin & G. Shaw

**Reference books [RB]:**

- RB1. S.B. Patel : Nuclear Physics
- RB2. M.K. Pal : Theory of Nuclear Structure

**Course outcomes (COs):**

Upon successful completion of the course a student will be able to




CO1	Describe the general properties & models, nuclear forces and detector, radioactive decay, nuclear reactions
CO2	Explain the binding energy, Liquid drop model, Shell model magic number and spin parity related to shell model, Low energy neutron-proton scattering and proton-proton scattering, Exchange and tensor forces
CO3	Illustrate the Gamow's theory of alpha decay and Geiger Nuttal law, Fermi's theory of beta decay, parity violation in beta decay, radioactive decay, various decay phenomena and their process
CO4	Analyze the nuclear size, nuclear angular momentum (Spin), Nuclear magnetic moments, statistic, the principle and application of G.M counter and synchrotron.
CO5	Evaluate the Q-value of nuclear reaction, parity violation in beta decay, electromagnetic decays. Ground state of deuteron
CO6	Express the stimulation Electron & Proton Synchrotron, Nuclear magnetic moments, Binding energy

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2	2	1
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2	1	1
CO3	1	2	1	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	1	2	1	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2	2	1
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated





<b>Course code</b>	: MPHC303			
<b>Course Name</b>	: Seminar			
<b>Semester /Year</b>	: III/ 2 <sup>nd</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>6</b>	<b>3</b>

**Course Objective:** The main objective of this course to analyze, construct and evaluate scientific information and research topics. Students will make a quality scientific presentation and speak in front of a scientific audience.

#### Course Contents

Presentation topic must be related to the student's current research and innovation, nanoscience and technology, any material characterization and analytical techniques, and current thesis or project.

#### Text book [TB]:

1. R. Williams, Non-Designer's Presentation Book, The: Principles for effective presentation design
2. N. Duarte, Slide:The Art and Science of Creating Great Presentations

#### Reference books [RB]:

1. G. Reynolds, Presentation Zen: Simple Ideas on Presentation Design and Delivery

#### **Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

CO1	Remember scientific information.
CO2	Develop and understand quality scientific presentation.
CO3	Present and explain and apply scientific information.
CO4	Classify and analyze scientific work for presentation.
CO5	Evaluate scientific information and then analyse it.
CO6	Develop scientific understanding towards research oriented topics

#### **CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	2	2	1	2	2	1
CO2	1	2	2	2	3	1	2	2	2	3	2	1	2	2	1	2
CO3	3	2	1	2	2	2	1	2	1	2	2	2	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2	1	2
CO5	2	2	1	2	2	1	2	1	1	3	2	2	2	2	2	1
CO6	2	2	1	2	2	1	2	1	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b> : MPHE304				
<b>Course Name</b> : Condensed Matter Physics				
<b>Semester /Year</b> : III/ 2 <sup>nd</sup>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	4	0	0	4

**Course Objective:** The main objective of the course on Condensed Matter Physics is to aware students about the defects in crystal, dielectric and magnetic properties, superconductivity, Nano Material Science and Technology etc.

### Course Contents

#### Unit I

**Defects in crystals and Magnetism:** Point defect, Impurities, Vacancies, Frenkel defects, Schottky defects. Concentration of Schottky defect and Frenkel defects, intrinsic and extrinsic vacancies, Colour centres, F-Centre, V-Centre, dislocation, Line defects, edge dislocation, screw dislocation, Burger vector. Dia, Para and ferromagnetism, Langevin theory of paramagnetic, Ferromagnetism, Weiss molecular theory, Ferromagnetic domains, Antiferromagnetism, Neel's theory, Two sub lattice model, ferrites.

#### Unit II

**Energy Bands:** Origin and Magnitude of the energy gap, Bloch function, Bloch theorem, Kronig penny model, Number of possible wave function in a band, crystal momentum, the concept of effective mass and holes, hole band construction, metal, insulator and semiconductor. Nearly free electron model, One dimensional free electron case, nearly free electron case, energy bands in one-dimension, tight binding approximation, energy surfaces, Wigner Seitz cellular method, Orthogonalized plane wave (OPW) method, Pseudo potential method, Limitations of band theory (Mott Transition).

#### Unit III

**Superconductivity:** Experimental Survey, Occurrence of super conductivity, destruction of superconductivity by magnetic field and temperature, Meissner effects, Type-I and Type-II superconductors, Isotope effect, Thermodynamics of Superconducting transition, London Equations, Coherence length, BCS Theory, Cooper pairs, Josephson superconductor tunneling, AC & DC Josephson effect, High temperature superconductors, critical fields and critical currents.

#### Unit IV

**Dielectrics and ferroelectrics:** Macroscopic description of dielectric constants, static, electronic and ionic, orientational polarizability of molecules, Complex dielectric constant, Dielectric loss and relaxation time, Polarization, Macroscopic electric field, depolarization fields, local electric field and atom, ferroelectric crystals, classification of ferroelectric crystals, soft optical phonons, landau theory of phase transition, Second and first order transition, antiferroelectricity, ferroelectric domains, piezoelectricity.



**Unit V**

**Nano Material Science and Technology:** History, Origin, Quantum dots, Synthesis, Applications and advantages, Quantum wires, Quantum well & application, Fullerenes, Carbon nanobuds, carbon nanotubes as quantum wires, Areas of Nanotechnology, nanomaterials, nanoelectronics, nanobiotechnology, nanofabrication, Micro Electro Mechanical systems (MEMS)

**Text book [TB]:**

TB1. Handbook of Nano Structured Materials and Nano Technology: Nalva

TB2. Nano Technology: Richard Booker and Earl Boysen

**Reference books [RB]:**

RB1. Principle of condensed matter Physics: Chaikimand Luben sky

RB2. Solid State Physics: Kubo and Ngamia

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

CO1	Describe the defects in crystals and magnetism energy bands, Superconductivity Energy, Defects in crystals and Magnetism, dielectrics and ferroelectrics, Nano Material Science and Technology
CO2	Express the magnetic and dielectric properties of the solids, Quantum well & application, Nearly free electron model, One dimensional free electron case,
CO3	Determine the defects present in the crystals, destruction of superconductivity by magnetic field and temperature, Meissner effects, Type-I and Type-II superconductors, Isotope effect, Thermodynamics of Superconducting transition, Classify BCS Theory related to Superconductor.
CO4	Analyse the Complex dielectric constant, History, Origin, Quantum dots, Synthesis, Applications and advantages, Quantum wires, Quantum well
CO5	Evaluate Nanotechnology, ferroelectric domains, piezoelectricity, High temperature superconductors.
CO6	Express the nanobuds, carbon nanotubes as quantum wires, critical fields and critical currents, Colour centres, F-Centre, V-Centre, dislocation.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2	2	1
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2	1	1
CO3	2	2	2	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	1	2	1	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2	2	1
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



Course code	: MPHE305			
Course Name	: Digital and Communication Electronics			
Semester /Year	: III/ 2 <sup>nd</sup>			
	L	T	P	C
	4	0	0	4

**Course Objective:**

The objective of the course is to provide an understanding about Boolean algebra and knowledge of Combinational and Sequential logic circuits, modulation and demodulation techniques used in communication system and to aware students about RADAR system.

**Course content:****Unit I**

**Boolean Algebra ,Logic Gates & Combinational Circuits:** Binary codes (Weighted, BCD,2421, Gray code, Excess 3 code, Error detecting code, Error correcting codes, ASCII, EBCDIC), De-Morgan's Theorem, Sum of Products (SOP), Product of Sums (POS), Minterms & Maxterms, Karnaugh maps and minimization. Logic Gates: AND, OR, NOT, NAND, NOR, XOR, XNOR. Adders, Subtractor, Serial adder/ Subtractor, Parallel adder/ Subtractor, Carry look ahead adder, BCD adder, Magnitude Comparator, Multiplexer, Demultiplexer, Encoder, Decoder, Parity-checker, Code converters

**Unit II**

**Sequential Circuits:** Flip flops: Latches, RS, JK, T, D and Master-Slave, Characteristic table and equation. Edge triggering, Level Triggering. Registers & Counters: Asynchronous/ Ripple counters, Synchronous counters, Modulo-n Counters, Shift registers, Universal shift register, Shift counters, Ring counters.

**Unit III**

**Modulation** -Amplitude Modulation-Theory, Plate Modulated class C amplifier, Balanced Modulator, Single Side Band modulation (phase shift method), Frequency modulation – Theory, Reactance tube modulator, transistor reactance modulator, FET reactance modulator. Digital Modulation, PAM, PPM, PWM, Principle of PCM, **Demodulation-** Envelope diode detector, Foster Seeley phase discriminator, Ratio Detector. **Transmitters & Receivers-** A.M Transmitter, F.M. transmitter, TRF Receiver, Super heterodyne receiver, amplitude limiting.

**Unit IV**

**Transmission Lines-** TL Equations and their solutions, characteristic impedance, lossless open and short-circuited lines, standing wave ratio and reflection coefficient, stub matching, **Antenna** – Radioactive field strength, power and radiation patterns of an elementary electric doublet and linear antenna, effects of ground reflection. Hertz antenna, Yagi antenna, loop antenna, direction finding, Resonant & Non resonant Antenna, Antenna array (Broad side & End fire arrays), Horn Antenna, Parabolic reflectors, Lens Antenna.



**Unit V**

**Radar Systems-** Principle of Radar, Basic arrangement of Radar system, Azimuth and Range measurement, operating, Characteristics of systems, Radar transmitters and Receivers, Duplexers, Indicator unit, maximum range of a Radar set.

**Text book [TB]:**

TB1. A. Anand Kumar : Fundamentals Of Digital Circuit

TB2. Thomas L. Floyd: Digital Fundamentals

**Reference books [RB]:**

RB1. Malvino & Leach: Digital Principles and Applications

RB2. Morris Mano: Digital Design

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

CO1	Describe Boolean Algebra ,Logic Gates & Combinational Circuits, Sequential Circuits, Modulation & Demodulation, Transmission Lines, Modulation, Radar Systems
CO2	Explain the flip flops, counter, register and its logic circuit, antenna, RADAR, TL Equations and their solutions, characteristic impedance
CO3	Determine the application of modulation and demodulation techniques, Principle of Radar, Basic arrangement of Radar system, Registers & Counters, Logic Gates
CO4	Illustrate modulation, Demodulation, Multiplexer, Demultiplexer, Encoder, Decoder, transmitters and receivers, Adder and Subtractor
CO5	Evaluate the Hertz antenna, Yagi antenna, loop antenna, direction finding, Resonant & Non resonant Antenna, Registers, Asynchronous and Synchronous Counters, Adders and Subtractors.
CO6	Express the Logic Gates, Ring counters, use of K-map to simplify the Boolean algebra expression, Excess 3 code

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	1	2	1	1	1	2	2	1	1	2	2	1
CO2	1	2	2	2	3	1	2	2	2	3	2	1	2	2	1	2
CO3	3	3	2	2	2	2	2	2	1	2	2	1	3	3	1	2
CO4	2	2	2	2	3	2	2	1	2	2	2	1	2	2	2	1
CO5	2	2	2	2	2	1	2	2	1	3	2	1	2	2	2	1
CO6	2	2	2	2	2	1	2	2	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHE306			
<b>Course Name</b>	: Laser Physics			
<b>Semester /Year</b>	: III/ 2 <sup>nd</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	4	0	0	4

**Course Objective:** The main objective of the course on Laser physics is to aware students about the laser and its types and phenomena of laser spectroscopy, optical fibres and principles of holography.

**Course contents:**

**Unit I**

**Basic principles and modulators:** Basic principles and theory of absorption and emission of radiation, Einstein's coefficients, line-broadening mechanisms, rate equations for three and four level laser systems, population inversion, spatial and temporal coherence, Electro optic effect, longitudinal and transverse phase modulation, consideration of modulator designs and circuit aspects, acoustic optic effect, Raman and Bragg regimes, acoustic optic modulators, magneto-optic effect, optical directional couplers and optical switches, phase modulators.

**Unit II**

**Types of lasers, Optical sources and detectors:** Gas lasers, He-Ne, argon ion, N<sub>2</sub>, CO<sub>2</sub> lasers; dye lasers, solid state, Semiconductor lasers: Ruby, Nd:YAG and Nd:glass lasers, diode lasers, spin flip lasers, laser spikes, mode locking Q-switching, Laser devices, LED structures, liquid crystal diodes, photoelectric, photovoltaic and photoconductive methods of detection of light, photodiodes: structure, materials and working, PIN photodiodes, avalanche photodiodes, micro channel plates, photo detector, noise responsivity and efficiency, photomultipliers, image intensifier tubes, Videocon and CCD.

**Unit III**

**Non- linear optics and Fiber optics:** Theory of non-linear phenomenon, second and third harmonic generation, phase matching, parametric generation, self-focusing, Basic characteristics of optical fibers, structure and fundamentals of waveguides, step and graded index fibers, signal degradation in optical fibers, absorption scattering, radiation and core cladding losses, Design considerations of a fiber optical communication system, analogue and digital modulation, optical fiber amplifiers.

**Unit IV**

**Laser spectroscopy:** Laser fluorescence spectroscopy using CW and pulsed lasers, Single photon counting. Laser Raman spectroscopy, multiphoton processes, photo acoustic and photon electron spectroscopy, stimulated Raman spectroscopy, Coherent anti-stokes Raman spectroscopy.



**Unit V**

**Holography:** Basic principles, construction and reconstruction of holograms, applications of holography, laser interferometry, laser applications in industry and medicines

**Text book [TB]:**

TB1. K.R. Nambiar: Lasers: Principles, types and Applications

**Reference books [RB]:**

RB1. Lasers: Ghatak and Thyagrajan

RB2. O. Svelto: Principles of Lasers

**Course outcomes (COs):**

Upon successful completion of the course a student will be able to

CO1	Describe the Basic principles and modulators, Types of lasers, Optical sources and detectors, Non- linear optics and Fiber optics, and Laser spectroscopy Holography
CO2	Illustrate the Gas lasers, He-Ne, argon ion, N <sub>2</sub> , CO <sub>2</sub> lasers; dye lasers, solid state, Semiconductor lasers: Ruby, Nd:YAG and Nd:glass lasers, diode lasers
CO3	Explain Laser interferometry, PIN photodiodes and modulator, Basic principles and theory of absorption and emission of radiation, Einstein's coefficients, line-broadening mechanisms, rate equations for three and four level laser systems, population inversion
CO4	Analyse the photo detector, LED etc. for practical purposes, optical fiber, LED structures, liquid crystal diodes, photoelectric, photovoltaic and photoconductive methods of detection of light
CO5	Evaluate Distinguish laser interferometry, PIN photodiodes, Electro optic effect, photo acoustic and photon electron spectroscopy, stimulated Raman spectroscopy, Coherent anti-stokes Raman spectroscopy
CO6	Express various applications of laser in research field, Einstein's coefficients, Design considerations of a fiber optical communication system, analogue and digital modulation, optical fiber amplifiers

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2	2	1
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2	1	1
CO3	1	2	1	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	2	2	1	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2	2	1
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHE307			
<b>Course Name</b>	: Astrophysics			
<b>Semester /Year</b>	: III/ 2 <sup>nd</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	4	0	0	4

**Course Objective:** The main objective of the course on astrophysics is to impart knowledge about the physics of stars and aware students about photometry, spectroscopy, interstellar matter, classification of galaxies and cosmology.

**Course contents:**

**Unit I**

**Physics of the Stars:** Apparent and Mean Position of stars. Effects of atmospheric refraction, aberration, parallax, precession, nutation and proper motion on the coordinates of stars. Reduction from apparent to mean places and vice versa. Spectra of Stars. Distribution of stars in space. Statistical parallaxes. Solar motion and its determination. Peculiar velocities. Single and Two star stream hypothesis. Velocity ellipsoid. Comparison with solar neighborhood. Bottlinger's diagram. HR diagram, HD and MK spectral classification of stellar spectra. Explanation of stellar spectra in terms of Boltzmann and Saha equations. Spectroscopic parallax.

**Unit II**

**Fundamental Equations, Detectors, Photometry and Spectroscopy:** Equation of mass distribution. Equation of hydrostatic equilibrium. Equation of energy transport by radiative and convective processes. Equation of thermal equilibrium. Stellar models: Russell- Voigt theorem. Dimensional discussions of mass-luminosity law. Astronomical photometry and spectroscopy. Simple design of an astronomical photometer. Observing technique with a Photometer. Correction for atmospheric extinction. Radio Astronomy Techniques. Electro-magnetic spectrum. Radio window. Design and construction of a simple radio telescope. Receiver systems. Design and construction of a simple radio interferometer.

**Unit III**

**Galactic System and Extragalactic Systems:** Interstellar Matter, Oort limit. Interstellar extinction. Estimate of color excess. Visual absorption. Interstellar reddening law and Polarisation. Spin temperature. Interstellar magnetic fields. Stromgren's theory of H II regions. Physical processes in planetary nebulae. Galactic Structure: General galactic rotational law. Oort's theory of galactic rotation. Determination of Oort's constants. Spiral structure of our Galaxy from optical and radio Observations. Size and mass of our galaxy. Classification of galaxies and clusters of galaxies. Hubble sequence. Galaxy interactions. Determination of the masses and extragalactic distances. Active Galaxies: Active galaxies and galactic nuclei. Properties of Radio galaxies and Quasar.

**Unit IV**



**Super dense Objects:** Mechanism of Mass transfer in Binary Stars. Use of polytropic models for completely degenerate stars. Mass-radius relation. Non-degenerate upper layers and abundance of Hydrogen. Stability of white dwarfs. Final cooling of white dwarfs. Accretion by white dwarfs and its consequences. Pressure ionisation and mass-radius relation for cold bodies. Formation, features and properties of Neutron stars, Pulsars and black holes.

### Unit V

**Gravitation & Cosmology:** Conceptual foundations of GR and curved space-time: Principle of equivalence, Connection between gravity and geometry, Form of metric in Newtonian, limit Metric tensor and its properties, Einstein's field equations, observational tests of general relativity. Models of the universe: Steady State Models. Standard Model: The expanding universe, Hubble's law. Microwave background radiation Friedman-Robertson-Walker models, the early universe, Elementary ideas on structure formation. Implications of the dark matter in modern cosmology.

### Text book [TB]:

TB 1 W.M.Smart: Text book of Spherical Astronomy

TB2. K.D.Abhyankar: Astrophysics: Stars and Galaxies (Tata McGraw Hill Publication)

### Reference books [RB]:

RB1. D.Mihalas: Galactic Astronomy

RB2. S.Chandrasekhar: Principles of Stellar Dynamics

### **Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

CO1	Describe the Physics of the Stars, Fundamental Equations, Detectors, Photometry and Spectroscopy, Galactic System and Extragalactic Systems, Super dense Objects, Gravitation & Cosmology
CO2	Explain the stellar evolution, the concept of Black holes, Statistical parallaxes. Solar motion and its determination. Peculiar velocities. Single and Two-star stream hypothesis. Velocity ellipsoid. Comparison with solar neighbourhood. Bottlinger's diagram. HR diagram.
CO3	Explain the types of binary stars, Design and construction of telescope Stability of white dwarfs. Final cooling of white dwarfs. Accretion by white dwarfs and its consequences. Pressure ionisation and mass-radius relation for cold bodies
CO4	Analyse the classify stellar energy and mass distribution in research field, Einstein's field equations, observational tests of general relativity. Models of the universe: Steady State Models. Standard Model: The expanding universe, Hubble's law. Microwave background radiation Friedman-Robertson-Walker models, the early universe
CO5	Distinguish Mass and radius relation, Galactic Structure, Mechanism of Mass transfer in Binary Stars. Use of polytropic models for completely degenerate stars. Mass-radius relation.

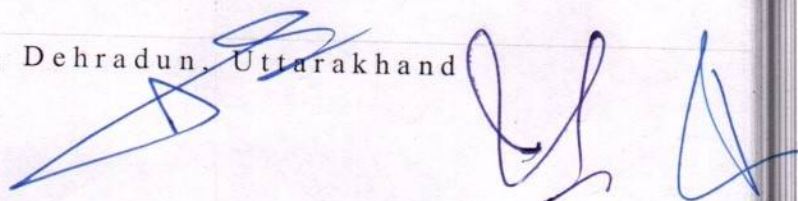


CO6	Express Non-degenerate upper layers and abundance of Hydrogen. Stability of white dwarfs, Determination of the masses and extragalactic distances, Galaxy Interaction
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**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	2	2	1	1	1	2	2	1	2	2	2	1
CO2	3	2	1	2	3	2	1	2	2	3	2	2	1	2	1	1
CO3	2	2	1	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	2	2	1	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	3	2	1	2	3	2	1	2	1	3	2	1	2	2	2	1
CO6	2	2	1	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated





<b>Course code</b>	: MPHE308			
<b>Course Name</b>	: High Energy Physics -			
<b>Semester /Year</b>	: III/ 2 <sup>nd</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	4	0	0	4

**Course Objective:** The main objective of the course on high energy physics is to impart knowledge about the Scattering Matrix and Feynman Rules, Classical and quantum field equations, color gauge invariance and QCD.

**Course contents:**

**Unit I:**

**Classical and Quantum Field Equations:** Coordinates of the field, Classical Lagrangian Equation, Classical Hamiltonian Equations, Quantum Equations for the Field, Fields with more than one component, Complex Field, Quantization of the Non-relativistic Schrodinger Equation, Classical Lagrangian and Hamiltonian Equations, Quantum Equations, The N-representation, Creation and Destruction Operators, Number Operators, Anti-commutation Relations, Equations of Motion, Physical Implications of Anti-commutation, Representation of Anti-commuting operators

**Unit II:**

**Quantization of fields and Renormalization of QED:** Quantization of Dirac field covariant anti-commutation relations, Quantization of electromagnetic field. Interaction Lagrangian for the fields, QED Lagrangian. Self-energy correction, vacuum polarization and vertex correction, classification of Divergences, Renormalization of mass and charge, wave function renormalization.

**Unit III:**

**Scattering Matrix and Feynman Rules:** The S-Matrix reduction of S- Matrix chronological product, Wicks theorem Furry's theorem Covariant perturbation theory interaction Lagrangian for QED, Feynman Diagrams and Feynman rules for QED in configuration and momentum space, Electron- Positron scattering, Coulomb scattering of Electrons, electron – positron annihilation, Compton scattering. Symmetries and conservation laws, Norther's Theorem, U (1) Gauge Invariance, Baryon and Lepton number conservation, the concept of gauge invariance; Global and Local gauge invariance, spontaneous Breaking of Global gauge invariance, Goldstone Bosons, the Higgs mechanism, Generalized local gauge invariance-Abelian and non-Abelian gauge invariance.

**Unit IV**

**Color gauge invariance and QCD:** The standard model of fundamental interaction, general mass terms, Cabibbo Angle, Kobayashi- Maskawa matrix and CP violation, The SU (5) Grand unified theory, The generators of SU (5), The choice of Fermion representations spontaneous breaking of SU (5) symmetry Fermion masses and mixing angles.



**Unit V**

Weinberg- Salam theory of electroweak unification, the matter fields, the gauge fields, the gauging of SU (2) XU (1), The vector bosons, The fermions sector, Helicity states, parity, charge conjugation Fermion masses, Fermion assignments in the electroweak model, spontaneous symmetry break down, Fermion Mass generation. The classic predictions of SU (5) Grand Unified, Theory, quark and Lepton masses, The SO(N), The SO (10) Grand Unified Theory, Fermion Masses in SO (10), Neutrino Mass in SO (10).

**Text book [TB]:**

- TB 1. Donald H. Perkins: Introduction to High energy physics  
 TB 2. Quantum electrodynamics , A.I. Akhiezer and Berestetski

**Reference books [RB]:**

- RB1. Theory of photons and electrons, J.M. Jauch and E. Rohrlich  
 RB2. Relativistic Quantum field, J.D. Bjorken and S. D. Drell.

**Course outcomes (COs):**

Upon successful completion of the course a student will be able to

CO1	Describe the classical and quantum field equations, quantization of fields and Renormalization of QED, Scattering Matrix and Feynman Rules, Color gauge invariance and QCD, Weinberg- Salam theory of electroweak unification
CO2	Discuss the application of scattering Matrix and Feynman Rules the quantization of fields, Global and Local gauge invariance, Electron- Positron scattering, Coulomb scattering of Electrons, electron – positron annihilation, Compton scattering. Symmetries and conservation laws, Norther's Theorem
CO3	Compute Classical Lagrangian and Hamiltonian Equations Quantum Equations, Fermion Mass generation. The classic predictions of SU (5) Grand Unified, Theory, quark and Lepton masses, Kobayashi- Maskawa matrix and CP violation
CO4	Analyze area of high energy physics, classical predictions of SU The SO(N), The SO (10) Grand Unified Theory, Fermion Masses in SO (10), Neutrino Mass in SO (10)
CO5	Discriminate Cabibbo Angle, Complex Field, Quantization of the Non-relativistic Schrodinger , Fermions Masses , quark and Lepton masses, Creation and Destruction Operators, Number Operators, Anti-commutation Relations, Equations of Motion, Physical Implications of Anti-commutation, Representation of Anti-commuting operators
CO6	Express Interaction Lagrangian for the fields, QED Lagrangian, Number Operators, Symmetries and conservation laws



**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2	2	1
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2	1	1
CO3	1	2	1	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	1	2	1	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2	2	1
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b> : MPHL 309				
<b>Course Name</b> : Laboratory Course				
<b>Semester /Year</b> : III/ 2 <sup>nd</sup>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	0	0	6	3

**Course Objective:** The main objective of this Lab. course is to impart practical knowledge in different fields such as solid state physics, electronics, Laser physics etc. to the students.

**Course contents:**

**Condensed Matter Physics:**

**List of experiments:** At least 5 experiments are to be performed

1. Determination of elastic constant of crystals by optical methods
2. Study of fluorescence spectra of a given compound
3. Study of color centers
4. Determination of lattice parameters using powder method.
5. Determination of hall coefficient using Hall effect
6. Determination of Energy gap of a semiconductor by four probe method
7. ESR
8. Dielectric constant

**Electronics:**

**List of experiments:** At least 5 experiments are to be performed

1. Study of regulated power supply (723).
2. Study of Timer (555).
3. A to D and D to A convertor
4. 1 of 16 Decoder/Encoder
5. Study of Multiplexer/Demultiplexer
6. Study of Comparator and Decoder
7. Study of different flip- flop circuits (RS, JK, D type, T-type, Master slave).
8. Study of Digital combinational and sequential circuits
9. Study of Microprocessor (8085)
10. Study of SCR, DIAC, TRIAC
11. Study of IC- Based Power supply



12. Microwave experiment.
13. Shift Registers
14. Fiber Optics communication

**Laser Physics:**

**List of experiments:** At least 5 experiments are to be performed

1. Study of the vibrational levels of Iodine.
2. Measurement of the fluorescence spectra of Uranyl Nitrate Hexahydrate.
3. Determination of the intrinsic life time for a dye molecule.
4. Determination of change in dipole moment in excited state using Solvatochromic shift method.
5. Measurement of non-radiative decay rate for a known sample.
6. Determination of the quantum yield of known samples using steady state spectroscopy.
7. Study of electro optic effect
8. Study of Acousto-optic effect

**Astrophysics:**

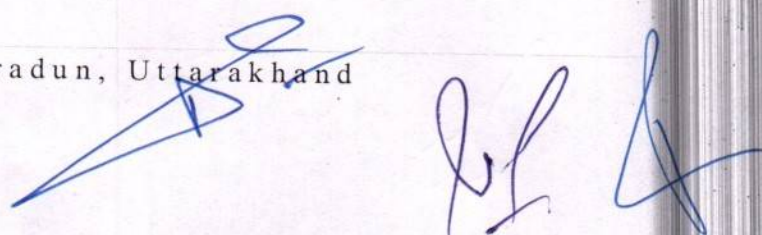
**List of experiments:** At least 5 experiments are to be performed

1. Study of Hubble's law (from given data)
2. Study of constant density neutron star
3. Study of the static parameters of a Neutron Star model with inverse square density distribution
4. Study of star cluster from a given data
5. Study of Extinction coefficients
6. Study of variability of stars

**High Energy Physics:**

**List of experiments:** At least 5 experiments are to be performed

1. Characteristic curve of a GM Detector and Absorption coefficient of a using aluminum GM Detector.
2. Energy spectrum of gamma rays using gamma ray spectrometer.
3. Absorption coefficient of aluminum using gamma-ray spectrometer.
4. Characteristics of Scintillation Detector.





5. Study of gamma-gamma unperturbed angular correlations.
6. Study of particle tracks using a Nuclear Emulsion Detector.
7. Classification of tracks in interaction with Nuclear Emulsion and determination of excitation energy.
8. Mossbauer spectrometer

**Note:** Students have to perform those experiments which are related to their chosen elective Paper

### Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of phenomenon such as Condensed Matter Physics Electronics/ Laser Physics/ Astrophysics to calculate several physical parameters.

### CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	2	2	2	1	1	2	2	1
CO2	1	2	2	2	3	1	1	2	2	3	2	2	2	2	2	1
CO3	3	2	2	2	2	2	1	2	2	2	2	1	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2	1	2
CO5	2	2	2	2	2	1	1	1	2	3	2	2	2	2	2	1
CO6	2	2	2	2	2	1	1	1	2	2	2	1	2	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHS310			
<b>Course Name</b>	: Physics of Nano Materials			
<b>Semester /Year</b>	: III/ 2 <sup>nd</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Objective:** The main objective of the course on Physics of Nano Materials is to impart knowledge about the physics in quantum well, quantum wire and quantum dot and to aware the students about size, shape-controlled synthesis of nanomaterials and their future applications in industry.

**Course contents:**

**Unit I**

**Nanoparticles: Synthesis and Properties:** R F Plasma Chemical Methods, Thermolysis, Pulsed laser Methods, Biological Methods, Synthesis using micro-organisms, Synthesis using Plant extract, Metal Nanoclusters, Magic Numbers, modeling of Nano Particles, Bulk of Nano Transitions.

**Unit II**

**Carbon Nano Structures:** Nature of Carbon Clusters, Discovery of C<sub>60</sub>, Structure of C<sub>60</sub> and its crystal, Superconductivity in C<sub>60</sub>, Carbon Nano Tubes: Synthesis, structure, Electrical and Mechanical Properties. Graphene: Discovery, Synthesis and Structural Characterization through TEM, Elementary concept of its applications

**Unit III**

**Quantum Wells, Wires and Dots:** Preparation of Quantum Nano Structures, Size Effects, Conduction Electrons and Dimensionality, Properties Dependent on Density of States. Analysis Techniques for Nano Structures/Particles: Scanning Probe Microscopes (SPM), Diffraction Techniques, Spectroscopic Techniques, Magnetic Measurements.

**Unit IV**

**Bulk Nano Structure Materials:** Methods of Synthesis, Solid Disorders Nano Structures, Mechanical Properties, Nano Structure Multilayers, Metal Nano Cluster, Composite Glasses, Porous Silicon.

**Text book [TB]:**

TB1. Edward L. Wolf: Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, 2nd ed., Wiley-VCH (2015)

TB 2. Handbook of Nano Structured Materials and Nano Technology: Nalva



**Reference books [RB]:**

RB1. Introduction to Nano Technology: Poole and Owners

RB2. Quantum Dots: Jacak, Hawrylak and Wojs

**Course outcomes (COs):****Upon successful completion of the course a student will be able to**

CO1	Describe the nanoparticles: Synthesis and Properties, carbon nano structures, carbon nano Structures, Quantum Wells, Wires and Dots, Bulk Nano Structure Materials
CO2	Understand the synthesis and properties of nanomaterials, Carbon Nano Structures, Quantum Wells, Wires and Dots, Bulk Nano Structure Materials
CO3	Apply Nanoscience and Nanotechnology in modern device applications and in various fields
CO4	Analysis of various properties of nanomaterial by using different techniques
CO5	Evaluate the Different properties of nanomaterial for various fields.
CO6	Develop nanomaterials for various field applications, Methods of Synthesis, Solid Disorders Nano Structures, Mechanical Properties, Nano Structure Multilayers

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2	2	1	2	1	1	1	2	2	1	2	2	2	1
CO2	2	2	3	2	2	2	1	2	2	3	2	2	1	2	1	1
CO3	2	1	2	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	2	2	2	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	2	1	3	2	1	2	1	2	1	3	2	1	2	2	2	1
CO6	2	1	2	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b> : MPHS 311				
<b>Course Name</b> : Quantum Electrodynamics				
<b>Semester /Year</b> : III/ 2 <sup>nd</sup>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	0	0	0	3

**Course Objective:** The main objective of the course on Quantum Electrodynamics is to impart knowledge about the relativistic quantum mechanical equations, namely, Dirac equation and to aware students about second quantization and related concepts.

**Course contents:**

**Unit I**

Dirac equations, Properties of Dirac Matrices, Projection Operators, Traces, Feynman's theory of Position.

**Unit II**

Second quantization of Klein Gordon field, Creation and annihilation operators, commutation relations, Quantisation of electromagnetic field, Creation and annihilation operators, commutation relation, Fock space representation, interaction fields.

**Unit III**

Dirac (interaction) picture, S-matrix and its expansion. Ordering theorems, Feynman graph and Feynman rules. Application to some problems.

**Unit IV**

Rutherford Scattering and Compton scattering, calculations of cross sections using Feynman graphs.

**Text book [TB]:**

TB1. Mathews, P.M. and Venkatesan K.A., Textbook of Quantum Mechanics, Tata McGraw Hill (2004).

TB 2. Schweber, Bethe and Hoffman: Mesons and Fields

**Reference books [RB]:**

RB1. Bjorken and Drell: Relativistic Quantum Fields

RB2. Muirhead: The Physics of Elementary Particles



**Course outcomes (COs):****Upon successful completion of the course a student will be able to**

CO1	Define and describe Dirac equations, operators, K-G Equation, Second quantization Rutherford Scattering and Compton scattering, matrix Mechanics.
CO2	Understand Quantisation of electromagnetic field Rutherford Scattering and Compton scattering,
CO3	Explain Feynman graphs for different interactions, -matrix and its expansion
CO4	Classify scattering phenomenon, Feynman's theory of Position, Second quantization of Klein Gordon field, interaction fields.
CO5	Evaluate Matrix and Feynman Rules, Dirac (interaction) picture, Properties of Dirac Matrices
CO6	Solve Creation and annihilation operators, commutation relation, Projection Operators, Traces, cross sections using Feynman graphs.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	1	1	2	2	1	1	2	2	1	1	2	2	1
CO2	1	2	2	1	2	2	2	2	2	3	2	2	2	2	1	2
CO3	3	2	2	2	3	3	2	2	1	2	2	1	3	3	2	1
CO4	2	2	2	1	2	2	2	1	2	2	2	1	2	2	1	1
CO5	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2	1
CO6	2	2	2	1	2	2	2	1	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHC401			
<b>Course Name</b>	: Computational Physics			
<b>Semester /Year</b>	: IV/ 2 <sup>nd</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	4	0	0	4

**Course Objective:** The main objective of the course on computational physics is to impart knowledge about how to solve physics problems through different numerical techniques and use computer programming for analysis of data.

**Course contents:**

**Unit I**

Roots of functions, interpolation, extrapolation, integration by trapezoidal and Simpson's rule, Runge-Kutta Method, Least square fitting method.

**Unit II**

Eigenvalues and eigenvectors of matrices, power and Jacobi method, solution of simultaneous linear equations Gaussian elimination, Pivoting, Iterative method, matrix inversion.

**Unit III**

Flowchart and algorithms-Problem analysis flowchart of some basic problems. The concept and properties of algorithmic languages, elementary algorithm development algorithm involving decision and loops.

**Unit IV**

C-Programming: selection of C programming loops and control, constructs, arithmetic and logic operators, Strings, arrays, pointers, floats and other types, input, output, control constructs, recursion structures, sub Programmes and modules.

**Text book [TB]:**

- TB1. MK Jain, S.R.K. Iyengar, RK Jain: Numerical Methods
- TB2. Reema Thereja: Programming in C

**Reference books [RB]:**

- RB1. V Rajaraman: Computer Programming in c.
- RB2. Let us C: Yashwant Kanetkar

**Course outcomes (COs):**

Upon successful completion of the course a student will be able to



CO1	Define and describe Roots of functions, Eigenvalues and eigenvectors of matrices, interpolation, Flowchart and algorithms, basics of C-Programming.
CO2	Understand interpolation, numerical integration methods, Flowchart and algorithms, C-Programming. Eigenvalues and eigenvectors of matrices,
CO3	Apply Roots of functions, Runge-Kutta Method, numerical integration, C-Programming methods to various problems.
CO4	Analyse the various interpolation methods, matrix inversion methods, Flowchart and algorithms, C-Programming to apply in various problems
CO5	Evaluate problems based on Roots of functions, Runge-Kutta Method, numerical integration, interpolation, Flowchart and algorithms, C-Programming
CO6	Formulate data types, operators, loops, arrays, pointers, Strings, input-output in C-Programming. Solve problems based on Gauss Jordan, Jacobi, Gaussian elimination, Gauss-Seidel method

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	1	1	1	2	2	1	2	2	2	1
CO2	2	2	2	2	3	2	1	2	2	3	2	2	1	2	1	1
CO3	1	2	1	2	2	2	1	2	1	2	2	2	2	3	2	1
CO4	1	2	1	2	2	2	1	2	2	2	2	2	1	2	1	2
CO5	2	2	2	2	3	2	1	2	1	3	2	1	2	2	2	1
CO6	2	2	2	2	2	2	1	2	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course Code</b> : MPHC402				
<b>Course Name</b> : Particle Physics				
<b>Semester /Year</b> : IV/ 2 <sup>nd</sup>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	4	0	0	4

**Course Objective:** The objective of the course is to provide an understanding about the elementary particles and knowledge of conservation laws, interaction and its properties and Quark structure of the particles.

**Course contents:**

**Unit I**

**Classification and Properties of Elementary Particles:** Elementary Particles, their classification on the basis of their mass and spins (Leptons, Mesons, Baryons) and field quanta. Their general properties (mass, spins, life time and their production and decay modes), Antiparticles.

**Unit II**

**Conservation Laws and Gauge Invariances:** Conservation of Energy, Linear and Angular momentum, Spin, Charge, Lepton No., Baryon No. Isospin, Hypercharge, Parity, Strangeness, Charge conjugation, Time Reversal, CP, CPT theorem, Global and Local gauge invariances.

**Unit III**

**Fundamental Interaction:** Qualitative ideas (Relative strengths, Ranges, Characteristic times and Mediators) of Gravitational, Electromagnetic, Strong and Weak Nuclear interactions. General idea of Electro-weak and Grand unifications.

**Unit IV**

**Quark Model:** Eight fold way, Quarks as building blocks of hadrons, six quarks (u,d,s,c,t and b), Antiquarks, General properties of quarks (Charge, Mass, Color – A new degree of freedom, quark confinement, Asymptotic freedom) Evidences for Quarks (Lepton scattering, Hadron Spectroscopy, Jet production), Quark compositions of Mesons and Baryons. General idea of Standard Model. Idea of Higgs Boson.

**Text book [TB]:**

TB1. Nuclear & Particle Physics-B.R. Martin & G. Shaw

TB2. Introduction to Elementary Particle Physics-D. Griffiths (John Wiley & sons)

**Reference books [RB]:**

RB1. Introduction to Nuclear & Particle Physics-VK Mittal, R.C. Verma&

S.C.Gupta (Prentice Hall of India, Pvt.Ltd., New Delhi, 2009) (All units 54pprox..)

RB2. Elementary Particle Physics-Gasiorowicz (John Wiley & sons,).



**Course outcomes (Cos):**

Upon successful completion of the course a student will be able to

CO1	Define Elementary Particles, Conservation of Energy, Fundamental Interaction Quark Model
CO2	Illustrate classification of elementary particles, CPT theorem, Global and Local gauge invariances, Evidences for Quarks, field quanta. Their general properties
CO3	Determine Quarks as building blocks of hadrons, Lepton No., Baryon No. Isospin, Hypercharge, Parity, Strangeness, Charge conjugation
CO4	Analyse Electromagnetic, Strong and Weak Nuclear interactions. General idea of Electro-weak and Grand unifications.
CO5	Evaluate Quark compositions of Mesons and Baryons. General idea of Standard Model. Idea of Higgs Boson.
CO6	Formulate Eight fold way, six quarks (u,d,s,c,t and b), Antiquarks.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSC4
CO1	1	2	2	1	1	2	2	1	1	2	2	1	2	1	1	1
CO2	2	2	1	1	2	2	2	2	2	3	2	2	2	2	2	2
CO3	3	3	2	2	3	3	2	2	1	2	2	1	2	2	1	1
CO4	2	2	1	1	2	2	2	1	2	2	2	1	2	1	2	1
CO5	2	2	2	2	2	2	2	2	1	3	2	2	2	2	1	1
CO6	2	2	1	1	2	2	2	1	1	2	2	1	2	1	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



Course code : MPHL 403				
Course Name : Laboratory Course				
Semester /Year : IV/ 2 <sup>nd</sup>				
	L	T	P	C
	0	0	6	3

**Course Objective:** The main objective of the course is to impart knowledge about the use of algorithm, flowchart and C programming in solving different problems of physics.

**Course contents:**

**List of experiments:**

1. Study of computational softwares.
2. Study of numerical techniques.
3. Computer programming.

**Course outcomes (COs):**

Upon successful completion of the course a student will be able to

CO1	Recognize the set up and calibrate the experimental setup.
CO2	Describe the basic principles of experiments.
CO3	Illustrate the experiment, tabulate the readings and interpret the data by drawing graphs.
CO4	Analyse the readings and interpret the data.
CO5	Find errors in interpret the data
CO6	Examine the verification of in the study of phenomenon such as of modulation and demodulation and magnetic susceptibility pattern to calculate several physical parameters.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	1	2	1	1	1	2	2	1	1	2	2	1
CO2	3	1	1	2	2	1	1	2	2	3	2	1	2	2	1	1
CO3	2	2	1	2	1	2	1	2	1	2	2	1	3	3	1	1
CO4	3	2	1	1	2	2	1	1	2	2	2	1	2	2	1	1
CO5	2	1	1	1	1	1	1	1	1	3	2	1	2	2	1	1
CO6	2	1	1	1	1	1	1	1	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b> : MPHD404				
<b>Course Name</b> : Dissertation				
<b>Semester /Year</b> : IV/ 2 <sup>nd</sup>				
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	0	0	18	9

**Course Objective:** The main objective of the course is to carry out extensive research. Student will able to identify gap, development of methodology for problem solving, interpretation of findings, presentation of results and discussion of findings in context of national and international research.

**Course contents:**

This course will be based on preliminary research-oriented topics both in theory and experiment. The teachers who will act as supervisors for the projects will float projects and any one of them will be allocated to the students. At the completion of the project by the semester end, the student will submit Project Report in the form of dissertation which will be examined by the examiners. The examinations shall consist of presentation and comprehensive viva-voce.

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

CO1	Observe practical experience of the research process.
CO2	Understands the principles of research.
CO3	Apply principles of research design to solve the problems in the field of research.
CO4	Create, analyse and critically evaluate various research solutions.
CO5	Evaluate links between theory and methods within their field of study
CO6	Create various research solution.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	1	1	2	2	2	1	1	2	2	1
CO2	1	2	2	2	3	1	1	2	2	3	2	2	2	2	2	1
CO3	3	2	2	2	2	2	1	2	2	2	2	1	3	3	2	1
CO4	2	2	2	2	3	2	1	1	2	2	2	1	2	2	2	1
CO5	2	2	2	2	2	1	1	1	2	3	2	2	2	2	2	1
CO6	2	2	2	2	2	1	1	1	2	2	2	1	2	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHS 405			
<b>Course Name</b>	: Environmental Physics			
<b>Semester /Year</b>	: IV/ 2 <sup>nd</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	0	0	0	3

**Course Objective:** The main objective of the course on environmental physics. is to impart knowledge about the environmental changes like pollution and degradation etc. It also deals with remote sensing and interaction of light with matter.

**Course contents:**

**Unit I**

**Essentials of Environmental Physics:** Structure and thermodynamics of the atmosphere. Composition of air. Green House Effect, Transport of Matter, Energy and momentum in Nature. Stratification and stability of atmosphere. Laws of motion, hydrostatic equilibrium.

**Unit II**

**Solar and Terrestrial:** Physics of Radiation, Interaction of light with matter, Rayleigh and Mie scattering, laws of radiation (Kirchhoff's law, Plank's law, Wien's displacement law etc.), solar and terrestrial spectra, and UV radiation. Ozone depletion problem, I R absorption.

**Unit III**

**Environmental Pollution and Degradation:** Elementary fluid dynamics, Diffusion, Turbulence and turbulent diffusion, Factors Governing air, water and noise Pollution, Air and water quality standards. Waste Disposal. Gaseous and particulate matters, wet and dry deposition.

**Unit IV**

**Environmental Changes and Remote Sensing:** Energy sources and combustion processes. Renewable Sources of energy: Solar energy, wind energy, bioenergy, hydropower, fuel cells, Nuclear energy.

**Unit V**

**Global and regional Climate:** Elements of whether and climate. Stability and vertical motion of air, Horizontal motion of air and water, Pressure gradient forces, viscous forces. Inertia forces, Reynolds number, enhanced Greenhouse effect, Global Climate Models.

**Text book [TB]:**

TB1. Clare Smith : Environmental Physics

TB2. J. Haltiner and R.T. Williams : Numerical Weather Prediction (John Wiley)

**Reference books [RB]:**



RB1. Egbert Boeker & Rienk Van Groundelle : Environmental Physics (John wiley)

RB2. J.T. Houghton : The Physics of Atmosphere (Cambridge Univ.Press. )

**Course outcomes (COs):**

**Upon successful completion of the course a student will be able to**

CO1	Define the essentials of environmental physics, solar and terrestrial, Environmental Pollution and Degradation, Environmental Changes and Remote Sensing, Laws of motion. Global and regional Climate
CO2	Describe Energy and momentum in Nature, Ozone depletion problem, I R absorption, Elementary fluid dynamics, Physics of Radiation, Interaction of light with matter, Rayleigh and Mie scattering, laws of radiation (Kirchhoff's law, Plank's law, Wien's displacement law etc.)
CO3	Apply laws of radiation, Waste Disposal, Physics of Radiation, Energy sources and combustion processes. Renewable Sources of energy: Solar energy, wind energy
CO4	Analyse and deduce hydrostatic equilibrium, Diffusion, hydropower, fuel cells, Solar energy, wind energy, bioenergy.
CO5	Evaluate Gaseous and particulate matters, wet and dry deposition, Green House Effect,
CO6	Develop understanding and Express Energy sources and combustion processes, Turbulence and turbulent diffusion.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	1	1	2	2	1	1	1	2	1	1	2	2	1
CO2	3	2	2	1	2	2	2	2	2	2	2	2	2	2	1	2
CO3	2	2	2	2	3	3	2	2	1	3	3	1	3	3	2	1
CO4	2	2	1	1	2	2	2	1	2	2	2	1	2	2	1	2
CO5	3	2	2	2	2	2	2	2	1	2	2	2	2	2	2	1
CO6	2	2	2	1	2	2	2	1	1	2	2	1	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated



<b>Course code</b>	: MPHS 406			
<b>Course Name</b>	: Bio Physics			
<b>Semester /Year</b>	: IV/ 2 <sup>nd</sup>			
	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	0	0	0	3

**Course Objective:** The main objective of the course is to impart knowledge about the organization of molecule like protein and separation and characterization of bio molecules using centrifugal, electrophoretic and chromatographic techniques.

**Course contents:**

**Unit I**

**Introduction to Bio Physics:** Molecular Organization, Different levels, Organization of Proteins- Primary, Secondary, tertiary and quaternary structures, Osmosis, Diffusion and Donnan Equilibrium.

**Unit II**

**Conformational Analysis:** Nucleic acids and their organization in living cells; interactions of Nucleic acids.

**Unit III**

**Methods in Biophysical Analysis:** CD, ORD & Fluorescence Spectroscopy, Raman Spectroscopy, Separation and Characterization of bio molecules using centrifugal, electrophoretic and chromatographic techniques. Absorption and Emission Spectroscopy- Principles and applications of visible, UV, IR, NMR, ESR and MS Spectroscopy.

**Unit IV**

**Characterization of macromolecules** using X-ray diffraction analysis. Use of analytical microscopy in elucidating the structure function relationship in- Prokaryotes: Electron Microscopy, Phase Contrast and Fluorescence microscopy and scanning tunneling microscopy. Radio Isotope Techniques: Detection and measurement of radioactivity, Geiger Muller Counters, Scintillation counting, Autoradiography and RIA; Applications of isotopes in biological studies

**Text book [TB]:**

- TB1. Vasantha Pattabhi: Biophysics
- TB2. B.S. Yadav: Textbook of Biophysics

**Reference books [RB]:**

- RB1. David Freifelder: Physical Biochemistry
- RB2. Willard Merrit, Dean and Settle: Instrumental methods of analysis

**Course outcomes (COs):**



**Upon successful completion of the course a student will be able to**

CO1	Describe Molecular Organization, Nucleic acids and their organization in living cells.
CO2	Understand about absorption and emission Spectroscopy of bio molecules.
CO3	Illustrate about separation and Characterization of bio molecules using centrifugal, electrophoretic and chromatographic techniques.
CO4	Establishes the applications of isotopes in biological studies.
CO5	Evaluate applications of visible, UV, IR, NMR, ESR and MS Spectroscopy.
CO6	Formulate CD, ORD & Fluorescence Spectroscopy, Raman Spectroscopy, Separation.

**CO- PSO-PO Mapping:**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	2	2	1	2	2	1
CO2	1	2	2	2	3	1	2	2	2	3	2	1	2	2	1	2
CO3	2	2	1	2	2	2	1	2	1	2	2	2	3	3	2	1
CO4	3	2	1	1	3	2	1	1	2	2	2	1	2	2	1	2
CO5	2	1	2	1	2	1	2	1	1	3	2	2	2	2	2	1
CO6	2	1	2	1	2	1	2	1	1	2	2	1	2	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated