FAROOK COLLEGE (AUTONOMOUS)

Farook College PO, Kozhikode-673632

P.G Programme in Physics

Under Choice Based Credit Semester System

SYLLABUS

Master's Programme in PHYSICS

Under Choice based Credit & Semester System

(2022 Admissions Onwards)

Board of Studies in Physics

Farook College (Autonomous)

CERTIFICATE

I hereby certify that the documents attached are the bonafide copies of the syllabus of Core Courses offered to MSc. Physics programme offered by the Department of Physics be effective from 2022 admission onwards.

Principal

Date:

Place: Farook College

CONTENTS

PREAMBLE

The M. Sc. (Physics) program's curriculum is created to meet the requirements of the Choice Based Credit System in accordance with the recommendations of the University Grants Commission (UGC). Core and Elective Courses (Discipline Specific - Physics) as well as Ability Enhancement (Compulsory and Skill Based) Courses are given full consideration in the proposed framework. The CBCS also incorporates continuous evaluation, which will promote systematic and thorough learning for a deeper comprehension of the subject. The methodical and planned curriculum, which is divided into two years (composed of four semesters), will encourage the student to pursue further studies in physics and give them the necessary tools to launch their own business.

Midhun Shah

Chairman, BOS, Physics

MEMBERS OF BOARD OF STUDIES

BOARD OF STUDIES IN PHYSICS

1. CHAIRMAN

	Mr.Midhun Shah	Assistant. Professor & HoD	Dept. of Physics, Farook College(Autonomous)	9995619256 midhunshah@farookcollege.ac.in

2. Members from the Faculty:

1.	Mr.S.A. Bassam	Assistant. Professor	Dept. of Physics, (Faroo;k College(Autonomous)	9526074094 bassam@farookcollege.ac.in
2.	Mr.Muhammed Jubeer E	Assistant. Professor	Dept. of Physics,, Farook College(Autonomous)	9895624945 emjubeer@gmail.com
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6	Dr.N.K. Sulfikarali	Assistant. Professor	Dept. of Physics, Farook College(Autonomous)	9961784970 sulfys@gmail.com

3. Two experts from outside the College to be nominated by the Academic Council:

1.	Dr.Antony Joseph	Professor	Dept. of Physics, University of Calicut	9446164109 ajvar@rediffmail.com
2.	Dr. N.E.Rajeevan	Associate Professor& Head(Rtd)	Zamorins Guruvayoorappan College, Kozhikode	9447415585 rajeevanclt@gmail.com

4. University Nominee:

	Dr.Mohamed Shahin Thayyil	Professor	Dept. of Physics, University of Calicut	9961824725 shahin@uoc.ac.in

5. Representation from Industry or Corporate:

	Dr.Samsheer Ali PT	Optical Engineer	Kimbal Electronics (India) Pvt.Ltd, Trivandrum	9562704586 samsheerali@gmail.com

6. Meritorious Alumnus:

	Dr. P. Saheeda	Associate Professor (Rtd.)Dept. of Physics, Farook College (Autonomous)	'Florence' Farook College Post,Calicut-673632	9400155479 saheedapp@farookcollege.ac.in

Special invitee: Dr. P. Sabira (Chairperson, Physics UG-BOS, University of Calicut)

Dr. Antony Joseph (Chairperson, Physics PG-BOS, University of Calicut)

OUTCOME BASED EDUCATION

Programme Outcome

Physics is ultimately mechanics and it furnishes the official framework. It includes electrodynamics, statistical mechanics, quantum mechanics, and classical mechanics. These four principles serve as the foundation for physics. Despite the fact that there are many disciplines and specializations within physics, mechanics serves as the unifying force that binds them all under one general heading. Any area of physics that has mechanics as its foundation grows as physics; otherwise, it deviates from the principles of physics. The four branches I have named are the basics of physics. Frontier topics are those in which research is currently being conducted, such as atomic, molecular, nuclear, plasma, solid state, materials science, astrophysics, etc. Frontier topics are always based on the fundamentals. And hence gives the authority to plan a career in the physical sciences and to accept positions in other sectors in modern society.

Programme Specific Outcomes (PSO)

P.S.O.1 Gains a thorough understanding of physics.

P.S.O.2 Will get a thorough comprehension of the universe's physical laws.

P.S.O.3 Develops laboratory expertise to plan sophisticated experiments and highly accurate measurements.

P.S.O.4 Should be skilled in coding and interface design.

P.S.O.5 Should be given the tools necessary to think critically and creatively while tackling scientific issues and investigations.

P.S.O.6 Develop sophisticated instrumentation and laboratory procedures for a career in research.

P.S.O.7 Develops independent research skills.

P.S.O.8 Gives the chance to take elective courses to expand their knowledge in frontier areas.

P.S.O.9 Should possess the capacity for excellent teamwork and communication.

COURSE STRUCTURE

Credit and Mark Distribution

Semester I						
Code	**Name of the paper**	**Credit**	**Hours**	**IN**	**EX**	**Total**
MPH1C01	Classical Mechanics	4	4	25	150	175
MPH1C02	Mathematical Physics – I	4	4	25	150	175
MPH1C03	Electrodynamics and Plasma Physics	4	4	25	150	175
MPH1C04	Electronics	4	4	25	150	175
MPH1L01	General Physics Practical -I		4			
MPH1L02	Electronics Practical – I		4			
MPH1A01	Ability Enhancement Course	4*				
Total for Semester I		20	24	100	600	700
Semester II						
Code	**Name of the paper**	**Credit**	**Hours**	**IN**	**EX**	**Total**
MPH2C05	Quantum Mechanics –I	4	4	25	150	175
MPH2C06	Mathematical Physics – II	4	4	25	150	175
MPH2C07	Statistical Mechanics	4	4	25	150	175
MPH2C08	Computational Physics	4	4	25	150	175
MPH2L03	General Physics Practical - II	3	4	50		
MPH2L04	Electronics Practical – II	3	4			
MPH2A02	Professional Competency Course	4*				
Total for Semester II		26	24	150	600	700
Semester III						
Code	**Name of the paper**	**Credit**	**Hours**	**IN**	**EX**	**Total**
MPH3C09	Quantum Mechanics -II	4	4	25	150	175
MPH3C10	Nuclear and Particle Physics	4	4	25	150	175
MPH3C11	Solid State Physics	4	4	25	150	175
MPH3E05	Experimental Techniques	4	4	25	150	175
MPH4P01*	Project		4			
MPH3L05	Modern Physics Practical –I		4			
Total for Semester III		16	24	100	600	700

Semester IV						
Code	**Name of the paper**	**Credit**	**Hours**	**IN**	**EX**	**Total**
MPH4C12	Atomic and Molecular Spectroscopy (4C)	4	4	25	150	175
MPH4E13	Laser Systems, Optical Fibers and Applications	4	4	25	150	175
MPH4E20	Microprocessors, Microcontrollers and Applications	4	4	25	150	175
MPH4L06	Modern Physics Practical –II	3	4	25	150	175
MPH4L07	Computational Physics Practical	3	4	50		
MPH4P02	Project	4	4	20	80	100
MPH4V01	Comprehensive	4				
Total for Semester IV		26	24	170	680	800
Total for the course (including extra credit activities)		88	96	520	2480	2900

EVALUATION AND GRADING

1. Evaluation: The evaluation scheme for each course shall contain two parts; (a) Internal / Continuous Assessment (CA) and (b) External / End Semester Evaluation (ESE). Of the total, 20% weightage shall be given to internal evaluation / Continuous assessment and the remaining 80% to External/ESE and the ratio and weightage between Internal and External is1:4.

Accumulated minimum credit required for successful completion of the course shall be 80.

A project work of 4 credits is compulsory and it should be done in III & IV semesters. Also a comprehensive Viva Voce may be conducted by external examiners at the end of IV Semester and carries 4 credits.

Primary evaluation for Internal and External shall be based on 6 letter grades (A+, A, B, C, D and E) with numerical values (Grade Points) of 5, 4, 3, 2, 1 & 0 respectively.

Grade	Grade Points
A+	5
A	4
B	3
C	2
D	1
E	0

2. Grade Point Average: Internal and External components are separately graded and the combined grade point with weightage 1 for Internal and 4 for external shall be applied to calculate the Grade Point Average (GPA) of each course. Letter grade shall be assigned to each course based on the categorization based on Ten point Scale shown below

The Grade Range for both Internal & External shall be:

Letter Grade	Grade Range	Range of Percentage (%)	Merit /Indicator
O	4.25 – 5.00	85.00 – 100.00	Outstanding
A+	3.75 – 4.24	75.00 – 84.99	Excellent
A	3.25 – 3.74	65.00 – 74.99	Very Good
B+	2.75 – 3.24	55.00 – 64.99	Good
B	2.50 – 2.74	50.00 – 54.99	Above Average
C	2.25 – 2.49	45.00 – 49.99	Average
P	2.00 -2.24	40.00 – 44.99	Pass
F	< 2.00	Below 40	Fail
I	0	-	Incomplete
Ab	0	-	Absent

No separate minimum is required for internal evaluation for a pass, but a minimum P Grade is required for a pass in the external evaluation. However, a minimum P grade is required for pass in a course. A student who fails to secure a minimum grade for a pass in a course will be permitted to write the examination along with the next batch.

3. Semester Grade Point Average (SGPA)

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses taken by a student. After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given below.

Semester Grade Point Average - SGPA (Sj) = Σ (Ci x Gi) / Cr (SGPA= Total Credit Points awarded in a semester / Total credits of the semester)

Where ‘Sj‘is the j^{th} semester, ‘Gi ‘ is the grade point scored by the student in the i^{th} course 'ci ‘ is the credit of the i^{th} course, 'Cr ’ is the total credits of the semester .

4. Cumulative Grade Point Average (CGPA)

Cumulative Grade Point Average (CGPA) = Σ(Ci x Si) / Cr(CGPA= Total Credit points awarded in all semesters/Total credits of the programme)

Where C1 is the credit of the Ist semester S1 is the SGPA of the Ist semester and Cr is the total number of credits in the programme. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme. The SGPA and CGPA shall be rounded off to 2 decimal points.

For the successful completion of a semester, a student should pass all courses and score a minimum SGPA of 2.0. However, the students are permitted to move to the next semester irrespective of their SGPA.

5. Evaluation of Audit Courses:

The examination and evaluation shall be conducted by the college itself either in the normal structure or MCQ model from the Question Bank and other guidelines. The Question paper shall be for minimum 20 weightage and a minimum of 2 hour duration for the examination. The result has to be intimated / uploaded to the Controller of Examinations during the Third Semester as per the notification.

g) INTERNAL EVALUATION / CONTINUOUS ASSESSMENT (CA)

This assessment shall be based on a predetermined transparent system involving periodic written tests, assignments, seminars and viva-voce in respect of theory courses and based on tests, lab skill and records/viva in respect of practical courses. The criteria and percentage of weightage assigned to various components for internal evaluation are as follows

Theory :			
Sl. No	Component	Percentage	Weightage
1	Examination /Test	40%	2
2	Seminars / Presentation	20%	1
3	Assignment	20%	1
4	Attendance	20%	1
Practical :			
1	Lab Skill	40%	4
2	Records/viva	30%	3
3	Practical Test	30%	3

Grades given for the internal evaluation are based on the grades A+, A, B, C, D & E with grade points 5,4,3,2, 1 & 0 respectively. The overall grades shall be as per the Ten Point scale. There shall be no separate minimum Grade Point for internal evaluation.

Project:

Internal evaluation:
a) Monthly progress - wt =2
b) Regularity and attendance -wt =1
c) Seminar and Viva Voce- wt =1

h) PATTERN OF QUESTION PAPERS
a) Theory: Every semester
Directions for question paper setters:
Part A: Set each questions to be answered in 7.5 minutes duration and should extract the critical knowledge acquired by the candidate in the subject.

Part B: 30 minutes answerable questions each may be asked as a single question or parts. Derivation type questions can be also asked.

Part C: 20 minutes answerable questions each and as far as possible avoid numerical type questions.

Division	Type	No. of Questions	Weightage	Total Weightage
Part A	Short Answer	8(No Choice)	1	8
Part B	Essay	2 out of 4	5	10
Part C	Problems	4 out of 7	3	12
Total weightage for a question paper				30

Theory papers must contain at least 4 lectures plus 1 Tutorial. Project is equivalent to one theory paper (4 hours) and one practical (4 hours)

Answer to each question may be evaluated based on

(a) Idea/knowledge – wt =1
(b) Logic/steps – wt =1
(c) Analytic skill – wt =1
(d) Correctness – wt =1

Practical: At the end of II and IV semesters.

Project: At the end of IV semester. Its evaluation is based on:

External evaluation:

a) Presentation-wt= 4
b) Project Report (Novelty, Creativity & work)-wt = 8
c) Project viva-wt = 4

Comprehensive Viva-Voce at the end of IV semester.

DETAILED SYLLABUS

MSc. Physics

SYLLABUS

SEMESTER-I

MPH1C01 : CLASSICAL MECHANICS					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Compare Newtonian systems to simple classical systems by applying the Lagrangian and Hamiltonian formalisms.	Apply	PSO 1, PSO 2
2	Utilizing the proper mathematical formulas, solve problems like motion under a central force, rigid body dynamics, and periodic motions using Lagrangian and Hamiltonian principles.	Analyze	PSO 1, PSO 2, PSO 5
3	Analyze nonlinear nature of many of the simple systems	Analyze	PSO 1, PSO 2, PSO 5

Module 1: Lagrangian and Hamiltonian Formulation	**Hrs 17**
Constraints and Generalized coordinates, D'Alemberts principle and Lagrange's equation, Velocity dependent potentials, Simple applications, Hamilton's Principle, Lagrange's equation from Hamilton's principle, Kepler problem, Scattering in a central force field, Transformation to lab coordinates, Legendre Transformation, Hamilton's canonical equations, Principle of least action, Canonical transformations, examples Text : Goldstein, Sections 1.3 – 1.6, 2.1 – 2.3, 3.10, 3.11, 8.1, 8.5, 8.6, 9.1, 9.2	

Module 2: The classical background of quantum mechanics:	**Hrs 19**
Equations of canonical transformations, Examples, Poisson brackets and other canonical invariants, Equation of motion in Poisson bracket form, Angular momentum Poisson brackets, Hamilton-Jacobi equation, Hamilton's principal and characteristic function, H-J equation for the linear harmonic oscillator, Separation of variables, Action-angle variables, H-J formulation of the Kepler problem, H-J equation and the Schrödinger equation Text : Goldstein, Sections 9.1, 9.2, 9.4 - 9.6, 10.1 – 10.5, 10.7, 10.8	
Module 3: The Kinematics and Dynamics of Rigid Bodies:	**Hrs 14**
Space-fixed and body-fixed systems of coordinates, Description of rigid body motion in terms of direction cosines and Euler angles, Infinitesimal rotation, Rate of change of a vector, Centrifugal and Coriolis forces, Moment of inertia tensor, Euler's equation of motion, Force free motion of a rigid body. Text : Goldstein, Sections 4.1, 4.4, 4.8 – 4.10	
Module 4: Small Oscillations:	**Hrs 9**
Formulation of the problem, Eigen value equation, Eigenvectors and Eigenvalues, Orthogonality, Principal axis transformation, Frequencies of free vibrations, Normal coordinates, Free vibrations of a linear tri atomic molecule. Text : Goldstein, Sections 6.1 – 6.4	
Module 5: Nonlinear Equations and Chaos:	**Hrs 13**
Introduction, Singular points of trajectories, Nonlinear oscillations, Limit cycles, Chaos: Logistic map, Definitions, Fixed points, Period doubling, Universality. (13 hours) Text : Bhatia, Sections10.1, 10.2, 10.3, 10.4, 10.5, 10.51	
Teaching and Learning Methods	**Lecture, Demonstration, Discussion**

Text Books:

1. Goldstein "Classical Mechanics" (Addison Wesley)
2. V. B. Bhatia : "Classical Mechanics" (Narosa Publications, 1997)

Reference:

1. Michael Tabor : "Chaos and Integrability in Nonlinear Dynamics" (Wiley, 1989)
2. N. C. Rana and P. S. Joag : "Classical Mechanics" (Tata McGraw Hill)

3. R.G.Takwale and P.S.Puranik : "Introduction to Classical Mechanics" (Tata McGraw Hill)
4. Atam P. Arya : "Introduction to Classical Mechanics, (2nd Edition)" (Addison Wesley1998)
5. Laxmana : "Nonlinear Dynamics" (Springer Verlag, 2001)
For further reference: Classical Physics Video Prof. V. Balakrishnan IIT Madras http://nptel.iitm.ac.in/video.php?subjectId=122106027
Special Topics in Classical Mechanics Video Prof. P.C. Deshmukh IIT Madras http://nptel.iitm.ac.in/courses/115106068/
Physics I - Oscillations & Waves Video Prof. S. Bharadwaj IIT Kharagpur http://nptel.iitm.ac.in/video.php?subjectId=122105023
Chaos, Fractals & Dynamic Systems Video Prof. S. Banerjee IIT Kharagpur http://nptel.iitm.ac.in/video.php?subjectId=108105054

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks-245**
1	**58**
2	**65**
3	**48**
4	**30**
5	**44**

MPH1C02: MATHEMATICAL PHYSICS – I					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory- 150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Give examples of coordinate systems that are suitable for various physical issues. Use it to resolve the Laplace Equation in various coordinate systems.	Analyze	PSO 1, PSO 2
2	Distinguish the class of objects called tensors, their classifications and use. Perform transformation operations and get the corresponding transformation matrices. Learns procedures for matrix diagonalization.	Evaluate	PSO 1, PSO 2,
3	Identify differential equations of special nature and the ways to solve them.	Analyze	PSO 1, PSO 2, PSO 5
4	Explain special functions as answers to issues in atomic, molecular, and solid state physics, among other areas, and demonstrate how to use them.	Analyze	PSO 1, PSO 2, PSO 5
5	Distinguish Fourier series and integral transforms of different types and their properties. This will enable him/her to analyse or solve different mathematical problems in physical sciences.	Analyze	PSO 1, PSO 2, PSO 5

Module 1: Vectors	Hrs 10
Rotation of coordinates, Orthogonal curvilinear coordinates, Gradient, Divergence and Curl in orthogonal curvilinear coordinates, Rectangular, cylindrical, and spherical polar coordinates, Laplacian operator, Vector integration, Enough exercises.	

Text : Arfken & Weber , Sections 1.2, 1.6 - 1.9, 1.10, 2.1 – 2.5	
Module 2: Matrices, Tensors & Elementary probability theory:	**Hrs 14**
Orthogonal matrices, Hermitian and Unitary matrices, Similarity and unitary transformations, Diagonalization of matrices, Definition of Tensors, Contraction, Direct products,, quotient rule, Pseudo tensors, Dual tensors, Levi Cevita symbol, Enough exercises. Sample space, Probability Theorems, Methods of Counting random Variables, Continuous Distributions, Binomial Distribution, Gaussian Distribution, The Poisson Distribution Text : Arfken & Weber , Sections 3.2 - 3.5, 2.6 – 2.9 Mathematical methods in the physical sciences, 2nd edn, Mary L Boas, John Wiley & Sons	
Module 3: Second Order Differential Equations:	**Hrs 14**
Partial differential equations of Physics, Separation of variables, Singular points, Ordinary series solution, Frobenius method, A second solution, Self-adjoint differential equation, Eigen functions and values, Boundary conditions, Hermitian operators and their properties, Schmidt orthogonalization, Completeness of functions, Enough exercises. Text : Arfken & Weber , Sections 8.1, 8.3 – 8.6, 9.1 – 9.4	
Module 4: Special functions :	**Hrs 22**
Gamma function, Beta function, Dirac delta function, Bessel functions of the first and second kinds, Generating function, Recurrence relation, Orthogonality, Spherical Bessel function, Legendre polynomials, Generating function, Recurrence relation, Rodrigues‟ formula, Orthogonality, Associated Legendre polynomials, Spherical harmonics, Hermite polynomials, Enough exercises. Text : Arfken & Weber , Sections 10.1, 10.4, 1.15, 11.1 – 11.3, 11.7, 12.1 – 12.4, 12.6, 13.1, 13.2	
Module 5: Fourier Series :	**Hrs 12**
General properties, Advantages, Uses of Fourier series, Properties of Fourier series, Fourier integral, Fourier transform, Properties, Inverse transform, Transform of the derivative, Convolution theorem, Laplace transform, Enough exercises. Text : Arfken & Weber , Sections 14.1 – 14.4, 15.2 – 15.5, 15.8 Textbook :	

Teaching and Learning Methods	Lecture, Demonstration, Discussion, Problem solving

Text Book:

1. G.B.Arfken and H.J.Weber : “Mathematical Methods for Physicists (5th Edition, 2001)” (Academic Press)

Reference books:

1. J. Mathews and R. Walker : “Mathematical Methods for Physics” (Benjamin)
2. L.A. Pipes and L. R. Harvill : “Applied Mathematics for Engineers and Physicists (3rd Edition)" (McGraw Hill)
3. Erwin Kreyzig : "Advanced Engineering Mathematics - 8th edition" (Wiley)
4. M. Greenberg : "Advanced Engineering Mathematics – 2nd edition " (Pearson India 2002)
5. A.W. Joshi : Matrices and tensors
6. Mathematical methods in the physical sciences, 2nd edn, Mary L Boas, John Wiley & Sons
7. Elementary Differential Equations and boundary value problems, William E. Boyce, Richard C. Di Prima, John Wiley & Sons, Inc.
8. Mathematics of Classical and Quantum Physics, F. W. Byron and R. W. Fuller, Dover Publications, Inc., New York

For further reference:

Mathematics I Video Prof. Swagato K. Ray, Prof. Shobha Madan, Dr. P. Shunmugaraj http://nptel.iitm.ac.in/video.php?subjectId=122104017

Mathematics II Video Prof. Sunita Gakkhar, Prof. H.G. Sharma, Dr. Tanuja Srivastava IIT Roorkee http://nptel.iitm.ac.in/video.php?subjectId=122107036

Mathematics III Video Prof. P.N. Agrawal, Dr. Tanuja Srivastava IIT Roorkee http://nptel.iitm.ac.in/video.php?subjectId=122107037

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks**
1	**34**
2	**48**
3	**48**
4	**75**
5	**41**

MPH1C03: ELECTRODYNAMICS AND PLASMA PHYSICS					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory- 150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Solve boundary value problems and wave equations. Carry out multipole expansions and interpret the results	Apply	PSO 1, PSO 2
2	Understand basic concepts related to wave propagation and few of their applications	Understand	PSO 1, PSO 2,
3	Develop a firm understanding on the propagation of electromagnetic waves through waveguides and their storage in cavity resonators. The specific field patterns from antennas will be analysed	Analyze	PSO 1, PSO 2, PSO 5
4	Enables to appreciate the magnificent results of the blending of relativity and electrodynamics and motivates	Analyze	PSO 1, PSO 2, PSO 5

	to take up a course on quantum field theory, the study of fields, interactions and symmetries		
5	Interpret the criteria for a medium to be called plasma and the various properties of it.	Understand	PSO 1, PSO 2, PSO 5

Module 1: Time varying fields and Maxwell's equations :	**Hrs 14**
Time varying fields and Maxwell's equations : Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and their solutions, Time harmonic fields, Multipole expansion of electric scalar potential and magnetic vector potential, Enough exercises. Text : Cheng, Sections 7.3 – 7.7, Griffiths, Sections 3.4, 5.4.2	
Module 2: Plane electromagnetic waves :	**Hrs 14**
Plane waves in lossless media, Plane waves in lossy media, Group velocity, Flow of electromagnetic power and the Poynting vector, Normal incidence at a plane conducting boundary, Oblique incidence at a plane conducting boundary, Normal incidence at a plane dielectric boundary, Oblique incidence at a plane dielectric boundary, Enough exercises. Text : Cheng , Sections 8.2 – 8.10	
Module 3: Transmission lines, Wave guides and cavity resonators:	**Hrs 14**
Transverse electromagnetic waves along a parallel plane transmission line, General transmission line equations, Wave characteristics on finite transmission lines, General wave behaviour along uniform guiding structures, Rectangular wave guides, Cavity resonators (Qualitative ideas only), Enough exercises. Text : Cheng, Sections 9.2 - 9.4 , 10.2, 10.4, 10-7.1	
Module 4: Special functions : Relativistic electrodynamics:	**Hrs 15**
Magnetism as a relativistic phenomenon, Transformation of the field, Electric field of a point charge moving uniformly, Electromagnetic field tensor, Electrodynamics in tensor notation, Potential formulation of relativistic electrodynamics, Enough exercises. (15 hours) Text : Griffiths, Sections 10.3.1 – 10.3.5	
Module 5: Plasma Physics :	**Hrs 16**
Plasma - Definition, concepts of plasma parameter, Debye shielding, Motion of charged particles in an electromagnetic field - Uniform electric and magnetic fields, Boltzmann and Vlasov equations, their moments - Fluid equations, Plasma oscillations, Enough exercises.	

Text : Chen, Sections 1.1 - 1.6, 2.2 - 2.2.2, 3.1 - 3.3.2, 4.3, 4.18, 4.19, 7.2-7.3 1. David K. Cheng : “ Field and Wave Electromagnetics” (Addison Wesley)	
Teaching and Learning Methods	**Lecture, Demonstration, Discussion, Problem solving**

Text Book:

1. David K. Cheng : “ Field and Wave Electromagnetics” (Addison Wesley)
2. David Griffiths : “ Introductory Electrodynamics” (Prentice Hall of India, 1989)
3. F. F. Chen, Introduction to Plasma Physics and Controlled Fusion, Volume I and II, Plenum Press, recent edition

Reference books:

1. K.L. Goswami, Introduction to Plasma Physics – Central Book House, Calcutta
2. J.D.Jackson : “Classical Electrodynamics” (3rd Ed.) (Wiley,1999)

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks**
1	**38**
2	**48**
3	**48**
4	**51**
5	**54**

MPH1C04: ELECTRONICS					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory- 150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Analyse the performance and differentiate voltage and current amplifiers, design a public address system with transistors.	Analyze	PSO 1, PSO 2
2	Analyse the operations of LEDs, explain the working semiconductor lasers	Understand	PSO 1, PSO 2,
3	Students are able to analyse the frequency response, input and output impedances of an Op-Amp	Analyze	PSO 1, PSO 2, PSO 5
4	Students are able to analyse the frequency response, input and output impedances of various Op-Amp based circuits for practical applications.	Apply	PSO 1, PSO 2, PSO 5
5	Students are able to analyse arithmetic logic circuits, differentiate between: A/D and D/A convertors, microprocessor and microcontroller, explain the working of various counters and registers, design a microprocessor based circuit for practical applications Analyse	Analyse	PSO 1, PSO 2, PSO 5

Module 1: Field Effect Transistors:	**Hrs 17**
Construction and V-I characteristics, JFET as VVR, transfer characteristics, construction and device operation of depletion and enhancement MOSFETs. CMOS, Biasing of FETs, FET Amplifiers, small signal model of FETs, analysis of Common Drain and Common Gate amplifiers at low and high frequencies, Text: Electronic devices and Circuit theory, Robert L Boylstead & L. Nashelsky – Pearson Education.	

(Sections 6.1-6.3, 6.7-6.8, 6.11, 7.1, 7.2, 7.4, 8.1, 8.2, 8.5, 8.6, 8.7). Integrated Electronics Millman and Halkias: Tata McGraw Hill ,Micro Electronic Circuits: Sedra/Smith: Oxford University Press	
Module 2: Microwave and Photonic devices:	**Hrs 14**
Tunnel diode, construction and characteristics, negative differential resistance and device operation, radiative ,transitions and optical absorption, Light emitting diodes (LED) – visible and IR, semiconductor lasers, construction and operation, population inversion, carrier and optical confinement, optical cavity and feedback, threshold current density. Photodetectors – Photoconductor (Light dependent resistor- LDR) and photodiode, p-n junction solar cells - short circuit current, fill factor and efficiency Text: Introduction to Semiconductor Materials and devices. By M S TYAGI. Semiconductor Optoelectronic devices: Pallab Bhattacharya: Prentice Hall Reference: Semiconductor Devices- Physics and Technology - S. M. Sze, John Wiley and Sons Principles of semiconductor devices: B. Van Zeghbroeck Principles of semiconductor devices: S.M. Sze: John Wiley & Sons	
Module 3: Operational Amplifier:	**Hrs 12**
Differential amplifiers, analysis of Emitter coupled differential amplifiers, OPAMP parameters: Open loop gain, CMRR, error currents and error voltages, input and output impedances, slew rate and UGB. Frequency response, poles and zeros; transfer functions (derivation not required), expression for phase angle. Need for compensation, dominant pole, pole zero and lead compensation Text: Integrated Electronics: Millman and Halkias: Tata McGraw Hill Reference: OPAMPS and Linear Integrated Circuits: Ramakant A. Gaekwad	
Module 4: OPAMP Applications:	**Hrs 14**

Closed loop inverting, non-inverting and difference OPAMP configurations and their characteristics; OPAMP as inverter, scale changer, summer, V to I converter, practical integrator & differentiator, active low pass , high pass and band pass Butterworth filters, band pass filter with multiple feedback, OPAMP notch filter, OPAMP Wien bridge oscillator, OPAMP astable and monostable multivibrators, Schmidt triggers. Text: Integrated Electronics: Millman and Halkias : Tata McGraw Hill OPAMPS and Linear Integrated Circuits: Ramakant A. Gaekwad Reference: Linear Integrated circuits:D. Roychoudhuri : New Age International Publishers	
Module 5: Digital Electronics:	**Hrs 15**
RS, JK and MSJK and D flip-flops, shift registers using D and JK flip flops and their operations, shift registers as counters, ring counter, design of synchronous and asynchronous counters, state diagram, cascade counters, basic idea of static and dynamic RAM, basics of charge coupled devices. Text: Digital Principles and Applications: Malvino and Leach: Tata McGraw Hill (Sections 8.1-8.5, 8.8, 9.1-9.3, 10.1-10.3) Digital Fundamentals: Thomas. L. Floyd: Pearson Education	
Teaching and Learning Methods	**Lecture, Demonstration, Discussion, Problem solving**

Reference:
Modern Digital Electronics: R.P. Jain: Tata McGraw Hill
For further reference: Electronics Video Prof. D.C. Dube IIT Delhi, http://nptel.iitm.ac.in/courses/115102014/

Digital Integrated Circuits Video Prof. Amitava Dasgupta IIT Madras http://nptel.iitm.ac.in/video.php?subjectId=108106069

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks**
1	**58**
2	**48**
3	**41**
4	**58**
5	**51**

MPH1AO1 Ability Enhancement Course (AEC) (4C)

Each student has to prepare and present a seminar on recent trends in a selected topic in physics. A report has to be prepared and submitted before presenting the seminar. The abstract of the seminar has to be sent to the head of the department through the teacher in charge.

MPH2AO2 Professional Competency Course (PCC) (4C) (See item 4 in section (a)

Latex – scientific document preparation system : Downloading and installing a LATEX distribution, Basic types of LATEX documents, Packages and use of package physics, Format words, lines, paragraphs and pages, Create lists, tables, figures and captions, Citing books and journals.

Typeset complicated equations and formulas, inserting centred and numbered equations and aligning multi-line equations, typesetting mathematical symbols such as roots, arrows, Greek letters, and different mathematical operators, math structures such as fractions and matrices. Enhance the documents by bringing colour.

Activities:

1. Typeset a model question paper for M.Sc. programme
2. Develop a review paper in a format suitable for the journal ”Pramana – Journal of Physics”
3. Create a professional presentation using beamer

References:

1. A document preparation system – Latex: User's guide and Reference manual, 2nd ed. Leslie Lamport, Pearson Education

2. A student's guide to the study, practice and tools of modern mathematics, Donald Bindner and Martin Erickson, CRC Press

Evaluation of this will be based on a multiple choice written examination and an internal practical.

MSc. Physics

SYLLABUS

SEMESTER-II

MPH2C05 : QUANTUM MECHANICS					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domains**	**PSO No**
1	Summarize the formulation of quantum mechanics	Understand	PSO 1, PSO 2
2	Recognize the basic postulates of quantum mechanics, Schrodinger picture, Heisenberg picture and treating with physical problems like simple harmonic oscillator, Particle in a box etc.	Understand	PSO 1, PSO 2, PSO 5
3	Perform angular momenta additions	Apply	PSO 1, PSO 2, PSO 5
4	Treat with special problems involving central potentials	Apply	PSO 1, PSO 2, PSO 5
5	Relate conservation laws and different symmetries	Apply	PSO 1, PSO 2, PSO 5

Module 1: Formulation of Quantum Mechanics	**Hrs 20**
Sequential Stern-Gerlach experiments – Analogy with the polarization of light – Need for representing a quantum mechanical state as a vector in complex vector space. Dirac notation – Ket space, Bra space and Inner products – Operators – Hermitian adjoint – Hermitian operator – Multiplication – Associative axiom – Outer product. Eigenkets and eigenvalues of Hermitian	

operator – Eigenkets as base kets – Completeness relation – Projection operator – Matrix representation of operators, kets and bras. Measurement in a quantum mechanical system – Expectation value –Illustration with spin-1/2 systems – Compatible observables and simultaneous eigenkets – Maximal set of commuting observables – Incompatible observables and general uncertainty relation. Unitary operator – Change of basis and transformation matrix – Similarity transformation – Diagonalization – Unitary equivalent observables. Position eigenkets and position measurements –Infinitesimal translation operator and its properties – Linear momentum as a generator of translation – Canonical commutation relations. Position-space wave function – wave function as an expansion coefficient – Momentum operator in the position basis – Momentum-space wave function – Transformation function or the momentum Eigen function in position basis –Relations between wave functions in position-space and momentum-space. Gaussian wave packet – Computation of dispersions of position operator and momentum operator – Minimum uncertainty product. Generalization to three dimensions. **Text**: Chapter 1, Modern Quantum Mechanics (Edn.2) by J. J. Sakurai	
Module 2: Quantum Dynamics	**Hrs 20**

Time-evolution operator – Schrodinger equation for the time-evolution operator and its solutions according to the time-dependence of the Hamiltonian operator –Energy eigenkets – Time dependence of expectation values – Time evolution of a spin-1/2 system and Spin precession – Correlation amplitude and energy-time uncertainty relation. Schrodinger picture and Heisenberg picture – Behaviour of state kets and observables in Schrodinger picture and Heisenberg picture – Heisenberg equation of motion – Ehrenfest's theorem. Time-evolution of base kets and transition amplitudes. Simple harmonic oscillator – energy eigenkets and energy eigenvalues – Dirac's method – Time development of the oscillator. Schrodinger's wave equation – Time-dependent wave equation – Time-independent wave equation – Continuity Equation – Interpretations of the wave function – Classical limit of wave mechanics. Boundary conditions – Elementary solutions to Schrodinger's wave equation – Free particle in one dimension and three dimensions – Simple harmonic oscillator – Particle in a one-dimensional box – Particle in a finite potential well – One-dimensional potential step – Square potential barrier.

Text : :(1) Chapter 2 – up to section 2.5, Modern Quantum Mechanics (Edn.2) by J. J. Sakurai

(2) Chapter 4 – section 4.3, Quantum Mechanics (Edn.4) by V. K. Thankappan

Module 3: Theory of Angular Momentum	**Hrs 15**

Non-commutative nature of rotations around different axes – Rotation operator – Infinitesimal rotations in quantum mechanics – Fundamental commutation relations for angular momentum operators. Rotation operators for spin-1/2 systems – Spin precession in a magnetic field – Pauli's two component formalism – Representation of the rotation operator as 2 x 2 matrix. Ladder operators and their commutation relations – Eigenvalue problem for angular momentum operators J^2 and J_z – Matrix elements of angular momentum operators and rotation operator. Orbital angular momentum – Orbital angular momentum as generator of rotation – Spherical harmonics – Spherical harmonics as rotation matrices. Addition of orbital angular momentum and spin angular momentum – Addition of angular momenta of two spin-1/2 particles – Formal theory of Angular Momentum addition – Computation of Clebsch-Gordan coefficients – Clebsch-Gordan coefficients and the rotation matrices.

Text : Chapter 3 – sections 3.1, 3.2, 3.5, 3.6 and 3.8, Modern Quantum Mechanics (Edn.2) by J. J. Sakurai

Module 4: Central Potentials	**Hrs 8**

Schrodinger's equation for central potentials – The radial equation – Particle in an infinite spherical well – Isotropic harmonic oscillator – The Coulomb potential and the hydrogen atom problem. **Text:** Chapter 3 – section 3.7, Modern Quantum Mechanics (Edn.2) by J. J. Sakurai.	
Module 5: Invariance Principles and Conservation Laws	**Hrs 9**
Symmetry and conservation laws –Space-time symmetries – Displacement in space and conservation of linear momentum – Displacement in time and conservation of energy – Rotation in space and conservation of angular momentum – Space inversion and conservation of parity – Time reversal symmetry. The indistinguishability principle – Symmetric and antisymmetric wave functions – Eigenvalues and eigenvectors of particle-exchange operator – Spin and statistics – Pauli's exclusion principle and antisymmetric wave function – The ground state of Helium atom. **Text:** Chapter 6 and 9 – relevant sections, Quantum Mechanics (Edn.4) by V. K. Thankappan	
Teaching and Learning Methods	**Lecture, Demonstration, Discussion**

Textbooks:

1. Modern Quantum Mechanics (Edn.2): J. J. Sakurai, Pearson Education.
2. Quantum Mechanics (Edn.4) : V. K. Thankappan, New Age International

References:

1. Principles of Quantum Mechanics (Edn.2): R. Shankar, Springer.
2. Introductory Quantum Mechanics: Richard L. Liboff, Pearson Education .
3. Introduction to Quantum Mechanics (Edn.2): D.J. Griffiths, Pearson Education.
4. A Modern Approach to Quantum Mechanics: J S Townsend, Viva Books.
5. Quantum Mechanics : Non-Relativistic Theory (Course of Theoretical Physics Vol3): L. D. Landau and E. M. Lifshitz, Pergamon Press.
6. The Feynman Lectures on Physics Vol. 3, Narosa .
7. Quantum Mechanics : Concepts and Applications (Edn.2) : Nouredine Zettili, Wiley.
8. Quantum Mechanics Demystified: David McMohan, McGrawHill 2006.
9. Quantum Mechanics (Schaum's Outline): Yoav Peleg*etal*. Tata McGraw Hill Private Limited, 2/e.
10. Quantum Mechanics: 500 Problems with Solutions: G Aruldhas, Prentice Hall of India.
11. www.nptel/videos.in/2012/11/quantum-physics.html
12. https://nptel.ac.in/courses/115106066/

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks-245**
1	**68**
2	**68**
3	**51**
4	**27**
5	**31**

MPH2C06: MATHEMATICAL PHYSICS – II					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Extend the idea of functions of real variables to functions of complex variables and gain the skill for solving and interpreting physical phenomena related problems	Apply	PSO 1, PSO 5
2	Address the class of objects called groups and the symmetry operations expressed as group elements. Recognize group properties and group representations.	Understand	PSO 1, PSO 2
3	Explain the formulation of Calculus of variation and apply calculus of variation in a level suitable for application in various physical problems in physics	Understand, Apply	PSO 1, PSO 2, PSO 5
4	Identify Integral equations to represent Physical phenomena and different solving methods of Integral equation	Analyze	PSO 1, PSO 5
5	Define Greens functions and their applications in physical problems.	Analyze	PSO 1, PSO 2, PSO 5

Module 1: Functions of Complex Variables	**Hrs 15**
Introduction, Analyticity, Cauchy-Reimann conditions, Cauchy's integral theorem and integral formula, Laurent expansion, Singularities, Calculus of residues and applications Text : Arfken & Weber , Sections 6.1 to 6.5, 7.1, 7.2	
Module 2: Group Theory	**Hrs 20**
Groups, multiplication table, conjugate elements and classes, subgroups, direct product groups, isomorphism and homomorphism, permutation groups, distinct groups of given order, reducible and irreducible representations -Sections 1-1.8, A W. Joshi. Elements of Group Theory for Physicists	

Generators of continuous groups, rotation groups SO(2) and SO(3), rotation of functions and angular momentum, SU(2)-SO(3) homomorphism, SU(2) isospin and SU(3) eightfoldway (20 hours) - Arfken & Weber Section 4.2,		
Module 3: Calculus of Variations		**Hrs 14**
One dependent and one independent variable, Applications of the Euler equation, Generalization to several independent variables, Several dependent and independent variables, Lagrange Multipliers, Variation subject to constraints, Rayleigh-Ritz variational technique. Text : Arfken & Weber , Sections 17.1 to 17.8		
Module 4: Integral equations		**Hrs 12**
Integral equations- introduction, Integral transforms and generating functions, Neumann series, separable kernel. Text : Arfken & Weber , Sections 10.1, 10.4, 1.15, 11.1 – 11.3, 11.7, 12.1 – 12.4, 12.6, 13.1, 13.2		
Module 5: Green's function		**Hrs 11**
Green's function, Eigen function expansion, 1-dimensional Green's function, Green's function integral-differential equation, Eigen function, eigenvalue equation Green's function and Dirac delta function, Enough exercises Text : Arfken & Weber , Sections 9.51		
Teaching and Learning Methods	**Lecture, Demonstration, Discussion, Problem solving**	

Text Book:

1. G.B.Arfken and H.J.Weber : “Mathematical Methods for Physicists (5th Edition, 2001)” (Academic Press)
2. A.W.Joshi, Elements of Group theory for Physicists()(New Age International (P).Ltd)

Reference books:

1. J.Mathews and R.Walker : “Mathematical Methods for Physics” (Benjamin)
2. L. A. Pipes and L. R. Harvill : “Applied Mathematics for Engineers and Physicists (3rd Edition)" (McGraw Hill)
3. Erwin Kreyzig : "Advanced Engineering Mathematics - 8th edition" (Wiley)
4. M. Greenberg : "Advanced Engineering Mathematics – 2nd edition " (Pearson India 2002)
5. Mathematical methods in the physical sciences, 2nd edn, Mary L Boas, John Wiley & Sons

6. Elementary Differential Equations and boundary value problems, William E. Boyce, Richard C. DiPrima, John Wiley & Sons, Inc.

7. Mathematics of Classical and Quantum Physics, F. W. Byron and R. W. Fuller, Dover Publications, Inc., New York

For further reference:

Mathematics I Video Prof. Swagato K. Ray, Prof. Shobha Madan ,Dr. P. Shunmugaraj http://nptel.iitm.ac.in/video.php?subjectId=122104017

Mathematics II Video Prof. Sunita Gakkhar, Prof. H.G. Sharma, Dr. Tanuja Srivastava IIT Roorkee http://nptel.iitm.ac.in/video.php?subjectId=122107036

Mathematics III Video Prof. P.N. Agrawal, Dr. Tanuja Srivastava IIT Roorkee http://nptel.iitm.ac.in/video.php?subjectId=122107037

<table>
<tr><th colspan="2">MODE OF ASSESSMENT</th></tr>
<tr><td colspan="2">Internal Assessment (20)</td></tr>
<tr><td colspan="2">External Assessment (80)
Mark distribution for setting Question paper
No of Questions: 19</td></tr>
<tr><td>Module</td><td>Marks</td></tr>
<tr><td>1</td><td>52</td></tr>
<tr><td>2</td><td>69</td></tr>
<tr><td>3</td><td>47</td></tr>
<tr><td>4</td><td>40</td></tr>
<tr><td>5</td><td>37</td></tr>
</table>

MPH2C07: STATISTICAL MECHANICS					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Discuss the connection between statistics and thermodynamics	Analyze	PSO 1, PSO 2
2	Demonstrate an understanding of the terminology, concepts and principles of describing equilibrium properties of physical systems in a statistical mechanical framework	Apply	PSO 1, PSO 2,
3	Derive partition function and compute thermodynamics relations for various physical systems	Create	PSO 1, PSO 2, PSO 5
4	Comprehend the statistical behaviour of ideal Bose and system	Analyze	PSO 1, PSO 2, PSO 5
5	Comprehend the statistical behaviour of ideal Fermi system	Analyze	PSO 1, PSO 2, PSO 5

Module 1: The Statistical Basis of Thermodynamics	**Hrs 13**
The macroscopic and the microscopic states – Contact between statistics and Thermodynamics: Expressing T, P and μ in terms of Ω – The classical Ideal gas - The entropy of mixing and the Gibbs paradox - Phase space of a classical system – Liouville's theorem and its consequences Text : Pathria, Sections 1.1 – 1.6, 2.1 – 2.2	
Module 2: Microcanonical, Canonical and Grand Canonical Ensembles	**Hrs 21**
The micro canonical ensemble – Examples : (1) Classical Ideal gas, (2) Linear harmonic oscillator - Quantum states and the phase space – Equilibrium between a system and a heat	

reservoir- Physical significance of the various statistical quantities in the canonical ensemble- Alternative expressions for the partition function- Examples: (1) The classical systems: Ideal gas, (2) A system of harmonic oscillators, (3) The statistics of paramagnetism - Energy fluctuations in the canonical ensemble -Equipartition theorem - Virial theorem - Equilibrium between a system and a particle-energy reservoir- Physical significance of the various statistical quantities in the grand canonical ensemble- Example : Classical Ideal gas - Density and energy fluctuations in the grand canonical ensemble. Text : Pathria, Sections 2.3 -2.5, 3.1, 3.3 - 3.9, 4.1, 4.3 – 4.5	
Module 3: Formulation of Quantum Statistics:	**Hrs 15**
Quantum-mechanical ensemble theory: The density matrix- Statistics of the various ensembles- Example: An electron in a magnetic field - Systems composed of indistinguishable particles- An ideal gas in a quantum-mechanical micro canonical ensemble- An ideal gas in other quantum-mechanical ensembles-Statistics of the occupation numbers Text : Pathria, Sections 5.1 - 5.4, 6.1 – 6.3	
Module 4: Ideal Bose Systems	**Hrs 10**
Thermodynamic behaviour of an ideal Bose gas- Thermodynamics of the blackbody radiation- The field of sound waves. Text : Pathria, Sections : 7.1 - 7.3	
Module 5: Ideal Fermi Systems	**Hrs 13**
Thermodynamic behaviour of an ideal Fermi gas- Magnetic behaviour of an ideal Fermi Gas : (1) Pauli paramagnetism, (2) Landau diamagnetism – The electron gas in metals (Discussion of heat capacity only), Enough exercises. Text : Pathria, Sections : 8.1 – 8.3	
Teaching and Learning Methods	**Lecture, Demonstration, Discussion, Problem solving**

Text Book:

1. Statistical Mechanics (2nd Edition), R. K. Pathria , Butterworth-Heinemann / Elsevier (1996)

Reference Books:

1. Statistical Mechanics : An Elementary Outline, Avijit Lahiri, Universities Press (2008)
2. An Introductory Course of Statistical Mechanics, Palash. B. Pal, Narosa (2008)
3. Statistical Mechanics : An Introduction, Evelyn Guha, Narosa (2008)

4. Statistical and Thermal Physics: An Introduction, S. Lokanathan and R.S.Gambhir, Prentice Hall of India (2000).

5. Introductory Statistical Mechanics (2nd Edition), Roger Bowley and Mariana Sanchez, Oxford University Press (2007)

6. Concepts in Thermal Physics, Stephen. J. Blundell and Katherine. M. Blundell, Oxford University Press (2008)

7. An Introduction to Thermal Physics, Daniel. V. Schroeder, Pearson (2006)

8. Statistical Mechanics, Donald. A. McQuarrie, Viva Books (2005)

9. Problems and Solutions on Thermodynamics and Statistical Mechanics, Ed. by Yung – Kuo Lim, Sarat Book House (2001)

For further reference:

Basic Thermodynamics Video Prof. S.K. Som IIT Kharagpur

http://nptel.iitm.ac.in/video.php?subjectId=112105123

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks**
1	**44**
2	**72**
3	**51**
4	**34**
5	**44**

MPH2C08: COMPUTATIONAL PHYSICS					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Explain the syntax and other special features of python programming language.	Understand	PSO 1, PSO 2
2	Use modules in python for practical applications	Apply	PSO 1, PSO 2, PSO 3
3	Apply Interpolation, Curve fitting and different numerical methods like trapezoid, Simpson and solutions to nonlinear equations	Apply	PSO 1, PSO 4, PSO 5
4	Analyze ordinary differential equations, boundary value problems and eigen value problems	Analyze	PSO 1, PSO 2, PSO 5
5	Study the evolution of physical systems by developing simulation programs	Create	PSO 1, PSO 2, PSO 4

Module 1: Introduction to Python Programming	**Hrs 6**
Concept of high level language, steps involved in the development of a Program - Compilers and Interpreters - Introduction to Python language: Inputs and Outputs, Variables, operators, expressions and statements - ,Strings, Lists, Tuples, and Dictionaries, Conditionals, Iteration	

and looping, Functions and Modules -. Mathematical functions (math module), File input and Output, Pickling. Formatted Printing	
Module 2: Tools for maths and visualization in Python (The numpy and pylab modules)	**Hrs 14**
Numpy module:- Arrays and Matrices – creation of arrays and matrices (arange, linspace, zeros, ones, random, reshape, copying), Arithmetic Operations, cross product, dot product , Saving and Restoring, Matrix inversion, solution of simultaneous equations, Data visualization- The Matplotlib, Module- Plotting graphs, Multiple plots, .Polar plots, Pie Charts, Plotting mathematical functions, Sine and other functions, Special functions – Bessel & Gamma, Fourier Series.	
Module 3: Numerical Methods-1*	**Hrs 15**
Interpolation: linear and polynomial interpolation, equidistant points - Newton's forward/backward difference, spline interpolation. Curve fitting- Least square fit- linear and exponential. Derivatives: Lagrange polynomials, Newton difference polynomials, finite difference approximations. Numerical integration: simple quadratures (trapezoid, Simpson). Solution of non-linear equations: closed domain methods (bisection and regular falsi. Monte Carlo Method – Simple Integration.	
Module 4: Numerical Methods-2*	**Hrs 15**
Ordinary differential equations: Initial value problems: the first-order Euler method, the second-order single point methods (predictor), and Runge-Kutta methods. Boundary value problems: the shooting method, the equilibrium method, the Numerov's method, the eigenvalue problems - the equilibrium method. Fourier transforms: discrete Fourier transforms, fast Fourier transforms.	
Module 5: Computational methods in Physics and Computer simulations	**Hrs 22**
Classical Mechanics: One Dimensional Motion: Falling Objects: Introduction – Formulation: from Analytical methods to Numerical Methods - Euler Method, Freely falling body, Fall of a body in viscous medium, Two dimensional motion: Projectile motion (by Euler method) and Planetary motion (R-K Method), Accuracy considerations, -, Oscillatory motion – Ideal Simple Harmonic Oscillator (Euler method), Motion of a damped oscillator (Feynman-Newton method)., Logistic maps. Monte-Carlo simulations: value of π, simulation of radioactivity. Quantum Mechanics: 1D Schrodinger equation –wave function and eigen values. Rutherford scattering. Two slit photon interference experiment. Simulation of	

Kepler's orbit and verification of Kepler's laws. Small oscillations in Diatomic molecule/Triatomic molecule. Simulation of the trajectory of a charged particle in a uniform magnetic field. Least square fitting :To obtain the slope and intercept by linear and Non-linear fitting	
Teaching and Learning Methods	**Lecture, Demonstration, Discussion, Problem solving**

(Visualisation can be done with matplotlib/pylab)

*****(Programs are to be discussed in Python)

Text books for Numerical Methods:

1. Introductory methods of numerical analysis, S.S. Shastry , (Prentice Hall of India,1983)
2. Numerical Methods in Engineering and Science, Dr. B S Grewal, Khanna Publishers, New Delhi (or any other book)
3. Numerical Mathematical Analysis, J.B. Scarborough

References:

(For Python any book can be used as reference. Moreover a number of open articles are available freely on the internet. Python is included in default in all GNU/Linux platforms and It is freely downloadable for Windows platform as well. However use of GNU/Linux may be encouraged).

1. www.python.org
2. Python Essential Reference, David M. Beazley, Pearson Education
3. Core Python Programming, Wesley J Chun, Pearson Education
4. Python Tutorial Release 2.6.1 by Guido van Rossum, Fred L. Drake, Jr., editor. This Tutorial can be obtained from website http://www.altaway.com/resources/python/tutorial.pdf
5. How to Think Like a Computer Scientist: Learning with Python, Allen Downey , Jeffrey Elkner , Chris Meyers, http://www.greenteapress.com/thinkpython/thinkpython.pdf
6. Numerical Recipes in C, second Edition(1992), Cambridge University Press
7. Numerical Recipes in Fortran 77, second Edition(1992), Cambridge University Press
8. Numpy reference guide, http://docs.scipy.org/doc/numpy/numpy-ref.pdf (and other free resources available on net)
9. Matplotlib , http://matplotlib.sf.net/Matplotlib.pdf (and other free resources available on net)

10. Numerical Methods, E Balagurusamy, Tata McGraw-Hill

11. Numerical Methods , T Veerarajan, T Ramachandran, Tat MCGraw-Hill

12. Numerical Methods with Programs I BASIC, FORTRAN & Pascal, S Balachandra Rao, C K Shantha. Universities Press

13. Numerical methods for scientists and engineers, K. Sankara Rao, PHI

14. Computational Physics, V.K.Mittal, R.C.Verma & S.C.Gupta-Published by Ane Books,4821,Pawana Bhawan,first floor,24 Ansari Road,Darya Ganj,New Delhi-110 002 (For theory part and algorithms. Programs must be discussed in Python)

15. Numerical Methods in Engineering with Python by Jaan Kiusalaas

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks**
1	**20**
2	**48**
3	**51**
4	**51**
5	**75**

Practical for Semester I & II

Core Course Practical 1 MPH1L01 & MPH2L03 (GENERAL PHYSICS)		
Credit	**Hours/week**	**Marks/Weightage**
2	**8**	**30***

***- Examination will be held at the end of second semester**

Course Outcomes

Course Outcomes	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domain	PSO No
CO1	Recognize and evaluate the mechanical characteristics of materials	Understand ,Apply	PSO1, PSO3, PSO5, PSO6, PSO9
CO2	Understand and analyse material thermal properties	,Understand, Analyze	PSO1, PSO3, PSO5, PSO6, PSO9
CO3	Understand and analyze the electrical and magnetic properties of materials	Apply	PSO1, PSO3, PSO5, PSO6, PSO9
CO4	Learn and analyze the optical properties of materials	Create	PSO1, PSO3, PSO5, PSO6, PSO9

Note:

1. All the experiments should involve error analysis. Internal evaluation to be done in the respective semesters and grades to be intimated to the controller at the end of each semester itself. Practical observation book to be submitted to the examiners at the time of examination.

2. Eight experiments are to be done by a student in a semester. One mark is to be deducted from internal marks for each experiment not done by the student if the required total of experiments are not done in the semesters.

3. The PHOENIX/expEYES Experimental Kit developed at the Inter University Accelerator Centre, New Delhi, may be used for the experiments wherever possible.

(At least 16 experiments should be done, 8 each for I & II semesters)

COURSE CONTENT

Experiments	Total Hours: 90
1. Y and σ - Interference method (a) elliptical (b) hyperbolic fringes. To determine Y and σ of the material of the given specimen by observing the elliptical and hyperbolic fringes formed in an interference set up 2. Y & σ by Koenig's method 3. Variation of surface tension with temperature-Jaegar's method. To determine the surface tension of water at different temperatures by Jaegar's method of observing the air bubble diameter at the instant of bursting inside water 4. Stefan's constant-To determine Stefan's constant 5. Thermal conductivity of liquid and air by Lee's disc method. 6. Dielectric constant by Lecher wire- To determine the wave length of the waves from the given RF oscillator and the dielectric constant of the given oil by measurement of a suitable capacitance by Lecher wire setup. 7. Viscosity of a liquid - Oscillating disc method. To determine the viscosity of the given liquid by measurements on the time period of oscillation of the disc in air and in the liquid 8. Mode constants of a vibrating strip. To determine the first and second mode constants of a steel vibrating strip; Y to be measured by the Cantilever method and frequency of vibration by the Melde's string method 9. Constants of a thermocouple and temperature of inversion. 10. Study of magnetic hysteresis - B-H Curve using standard toroid / specimen in any form. 11. Maxwell's L/C bridge -To determine the resistance and inductance of the given unknown inductor by Maxwell's L/C bridge OR Anderson's Bridge – L/C and self-inductance. .(The kit developed by Indian Academy of Science can also be used) 12. Susceptibility measurement by Quincke's and Guoy's methods - Paramagnetic susceptibility of salt and specimen	

13. Michelson's interferometer - (a) λ and (b) d λ and thickness of mica sheet.
14. Photoelectric effect. Determination of Plank’s constant

15. Frank Hertz experiment .To measure the ionization potential of Mercury by drawing current versus applied voltage.

16. Fabry Perot etalon -Determination of thickness of air film.

17. Elementary experiments using Laser: (a) Study of Gaussian nature of laser beam (b) Evaluation of beam spot size (c) Measurement of divergence (d) Diameter of a thin wire

18. Diffraction Experiments using lasers (a)Diffraction by single slit/double slit/circular aperture (b)Diffraction by reflection grating

19. Measurement of the thermal and electrical conductivity of Cu to determine the Lorentz number.(The kit developed by Indian Academy of Science can also be used)

20. Passive filters .(The kit developed by Indian Academy of Science can also be used)
21. Microwave experiments - Determination of wavelength, VSWR, attenuation, dielectric constant.

22. Experiments with Lock-in Amplifier(a) Calibration of Lock In Amplifier (b) Phase sensitive detection

(c) Mutual inductance determination (d) Low resistance determination. (The kit developed by Indian Academy of Science can also be used)

23. Cauchy’s constants using liquid prism

24. Forbes method of determining thermal conductivity
25. Zeeman Effect using Fabry-Perot etalon.

Mode of Transaction	**Demonstrations:** helps to illustrate and consolidate theoretical principles outlined in the course. **Experimentation:** This involves learning by doing or hands on experience by operating instruments and studying Mechanical, Magnetic, Optical properties **Observation& Data analysis:** It involves noticing readings and analyzing the data:
Mode of Assessment	**Internal Assessment +External (1:4)**
	External assessment

Practical for Semester I & II

Core Course Practical 1- MPH1L02 & MPH2L04 (ELECTRONICS)		
Credit	**Hours/week**	**Marks/Weightage**
2	**8**	**30***

***- Examination will be held at the end of second semester**

Course Outcomes

Course Outcomes	Expected Course Outcome *Upon completion of this course, students will be able to;*	Learning Domain	PSO No
CO1	Learn about the various transistor properties.	Understand ,Apply	PSO1, PSO3, PSO5, PSO6, PSO9
CO2	Understand the amplification properties of electronic components	,Understand, Analyze	PSO1, PSO3, PSO5, PSO6, PSO9
CO3	Understand and apply properties of OPAMP	Apply	PSO1, PSO3, PSO5, PSO6, PSO9
CO4	Understand and analyze the applications of digital ICs	Create	PSO1, PSO3, PSO5, PSO6, PSO9

(At least 16 experiments should be done, 8 each for I & II semesters)

COURSE CONTENT

Experiments	Total Hours: 90

1. Study the V-I characteristics of a Silicon Controlled Rectifier – Construct half-wave and full-wave circuits using SCR.
2. a). Study the V-I characteristics of UJT. Determine intrinsic stand-off ratio. Design and construct a relaxation oscillator and sharp pulse generator for different frequencies.

   b). Design and construct a time delay circuit to switch ON a suitable load driven by a SCR. Trigger the SCR using UJT.
3. a).Study the V-I characteristics of a JFET. Determine pinch-off voltage, saturation drain current and cut-off voltage of the device.

   b). Design and construct a low frequency common source amplifier using JFET. Study the frequency response, measure the i/p and o/p impedances.
4. Design and construct a d.c voltage regulator using transistors and Zener diode. Study the line and load regulation characteristics for suitable o/p voltage and maximum load current.
5. Design a single stage bipolar transistor amplifier. Compare the characteristics and performance of the circuit without feedback and with suitable negative feedback. Compare theoretical and observed magnitudes of voltage gain, i/p and o/p impedances in both cases.
6. Design and construct a differential amplifier using transistors. Study frequency response and measure i/p, o/p impedances. Also measure CMRR of the circuit.
7. a). Design and construct an amplitude modulator circuit. Study the response for suitable modulation depths.

   b). Design and construct a diode A.M detector circuit to recover the modulating signal from the A.M wave.
8. Design and construct two stage I.F amplifier circuit. Study the response of single and coupled stages.
9. Design and construct a Darlington pair amplifier using medium power transistors for a suitable output current. Study the frequency response of the circuit and measure the i/p and o/p impedances.
10. Design and construct a piezo-electric crystal oscillator to generate square waves of suitable frequencies. Compare designed and observed frequencies.
11. Design and construct an R.F oscillator using tunnel diode. Measure frequency of the output signal.
12. Design and construct OPAMP based summing and averaging amplifier for three suitable inputs. Compare the designed and observed outputs.
13. Design and construct a Wien bridge oscillator using OPAMP for different frequencies.

Compare designed and observed frequencies.

14. Design and construct an astable multivibrator using OPAMP for suitable frequencies.

15. Design and construct a monostable multivibrator using OPAMP for suitable pulse widths.

16. Design and construct a triangular wave generator using OPAMPs for different frequencies.

17. Design and construct OPAMP based precision half and full wave rectifies. Observe the o/p on CRO and study the circuit operation.

18. Design and construct an astable multivibrator using timer IC 555. Measure frequency and duty cycle of the o/p signal. Modify the circuit to obtain almost perfect square waves.

19. Design and construct a monostable multivibrator using timer IC 555, for different pulse widths. Compare designed and observed pulse widths.

20. Design and construct a voltage controlled oscillator using timer IC 555. Study the performance.

21. Design and construct Schmidt triggers using OPAMPS – for symmetrical and non-symmetrical LTP/UTP. Trace hysteresis curve.

22. Design and construct OPAMP based analogue integrator and differentiator. Study the response in each case.

23. a). Design and construct OPAMP based circuit for solving a second order differential equation. Study the performance.

b). Design and construct OPAMP based circuit for solving a simultaneous equation. Study the performance.

24. Design and construct second order Butterworth Low pass, High Pass and Band Pass filters using OPAMPs. Study the performance in each case.

25. Design and construct a narrow band-pass filter for a given centre frequency using a single OPAMP with multiple feedback. Study the frequency response.

26. 4 bit D/A converter using R-2R ladder network. Realization of 4 bit A/D converter using D/A converter.

27. Study of 4 bit binary counter (IC 7493) and 4 bit decade counter(IC 7490) at various modes. Use the counters as frequency dividers.

28. Design and construct a 3 bit binary to decimal decoder using suitable logic gates. Verify the operation.

29. Set up four bit shift register IC 7495 and verify right shift and left shift operations for different data inputs...

Mode of Transaction	**Demonstrations:** helps to illustrate and consolidate theoretical principles outlined in the course. **Experimentation:** This involves learning by doing or hands on experience by operating instruments and studying different electronic components **Designing ,Observation:** It involves designing the circuit for desired practical functionalities
Mode of Assessment	**Internal Assessment +External (1:4)**
	External assessment

MSc. Physics

SYLLABUS

SEMESTER – III

MPH3C09 QUANTUM MECHANICS –II					
Credit	**Hours per week**		**Marks out of 100**		
4	**Theory -4**	**Practical -0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Apply time independent perturbation theory as an approximation method to un-harmonic oscillator, Stark effect and Zeeman effect	Apply	PSO 5
2	Apply variational method and WKB method as approximation methods to L.H.O Solve hydrogen and helium atom problems using variational method.	Apply Analyse	PSO1, PSO 5
3	Apply time dependent perturbation theory to explain interaction of atoms with electromagnetic waves leading to emission and absorption and Born approximation for scattering.	Apply	PSO 1
4	Learning about scattering theory from the perspective of quantum mechanics	Analyse	PSO 5
5	Represent relativistic quantum mechanics concepts	Apply	PSO 1

MPH3C09: QUANTUM MECHANICS –II (4C, 72 hrs)

Module 1: 1.Time-Independent Perturbation Theory	**20 Hrs**
Non-degenerate perturbation theory – First-order theory and Second-order theory – Examples : (1) Linear harmonic oscillator (2) Anharmonic oscillator – Degenerate perturbation theory – Two-fold degeneracy – Higher-order degeneracy – The fine-structure of hydrogen – Relativistic correction – Spin-orbit coupling - Zeeman effect – Weak-field Zeeman effect – Strong-field Zeeman effect – Intermediate-field Zeeman effect – Hyperfine splitting – Linear Stark effect in the hydrogen atom. **Text:** (1) Chapter 6, Introduction to Quantum Mechanics (Edn.2) by David. J. Griffiths, (2) Chapter 8, section 8.3, Quantum Mechanics (Edn.4) by V. K. Thankappan	
Module 2: Variational Method and WKB Method	**12 Hrs**
Bound states (Ritz method) – Linear harmonic oscillator – Helium atom – WKB wave function in classical region – Example: Potential well with two vertical walls – WKB wave function in nonclassical region – Example: Tunneling – Connection formulae – Examples: (1) Potential well with one vertical wall (2) Potential well with no vertical walls. Text : (1) Chapter 8, section 8.2A, Quantum Mechanics (Edn.4) by V. K. Thankappan (2) Chapter 6, Introduction to Quantum Mechanics (Edn.2) by David. J. Griffiths	
Module 3: Time-dependent perturbation theory	**12 Hrs**
First order time-dependent perturbation theory – Constant perturbation – Transition to a continuum – Fermi's Golden rule – Scattering cross section in the Born approximation – Harmonic perturbation – Radiative transitions in atoms. Text : Chapter 8, sections 8.4, 8.4A, 8.4B, Quantum Mechanics (Edn.4) by V. K. Thankappan	
Module 4 :Scattering	**12 Hrs**
Scattering amplitude – Method of partial waves – Scattering by a central potential – Optical theorem – Scattering by a square-well potential Text: Chapter 7, relevant sections, Quantum Mechanics (Edn.4) by V. K. Thankappan	
Module 5:Relativistic Quantum Mechanics	**16 Hrs.**
Klein-Gordon equation – First order wave equations – Weyl equation – Dirac equation – Properties of Dirac matrices – Dirac particle is spin-1/2 particle – Spinor – Equation of continuity – Dirac particle in an external magnetic field : Non-relativistic limit – Hole theory Text: Chapter 10, relevant sections; Quantum Mechanics (Edn.4) by V. K. Thankappan	

Textbooks:	
1. Quantum Mechanics (Edn.4): V. K. Thankappan, New Age International. Introduction to Quantum Mechanics (Edn.2) : D.J. Griffiths, Pearson Education	
Teaching and Learning Methods	Lecture, Demonstration, Discussion

References:

1. Principles of Quantum Mechanics (Edn.2): R. Shankar, Springer.
2. Introductory Quantum Mechanics: Richard L. Liboff, Pearson Education.
3. A Modern Approach to Quantum Mechanics: J S Townsend, Viva Books.
4. Quantum Mechanics : Non-Relativistic Theory (Course of Theoretical Physics Vol3): L. D. Landau and E. M. Lifshitz, Pregamon Press.
5. The Feynman Lectures on Physics Vol3, Narosa.
6. Quantum Mechanics: Concepts and Applications (Edn.2): NouredineZettili, Wiley.
7. Quantum Mechanics Demystified: David McMahon, McGraw-Hill 2006.
8. Quantum Mechanics (Schism's Outline): YoavPelegetal. Tata McGraw Hill Private Limited, 2/e.
9. Quantum Mechanics: 500 Problems with Solutions: G Aruldhas, Prentice Hall of India.
10. www.nptel/videos.in/2012/11/quantum-physics.html
11. https://nptel.ac.in/courses/115106066/

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions:**	
Module	**Marks**
1	**68**
2	**41**
3	**41**
4	**41**
5	**54**

MPH3C10 NUCLEAR AND PARTICLE PHYSICS					
Credit	**Hours per week**		**Marks out of 100**		
4	**Theory -4**	**Practical -0**	**Theory- 150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Explain the basics concepts about the nucleus and analyse its internal structure, properties and the interaction between the nucleons	Analyse	PSO 5
2	Understand and analyse the nuclear decays and their probabilities from any nucleus	Apply Analyse	PSO1, PSO 5
3	Analysis of nuclear models and their reactions	Apply	PSO 1
4	Study of radiation detectors for detection and monitoring radiations	Analyse	PSO 5
5	Study about elementary particles, their interactions, and experimental evidences.	Apply	PSO 1

MPH3C10: NUCLEAR AND PARTICLE PHYSICS (4C, 72 Hrs)

Module 1: Nuclear Properties and forces between nucleons	**12 Hrs**
The nuclear radius, nuclear binding energy, Semi-empirical mass formula, nuclear angular momentum and parity, nuclear electromagnetic moments. The deuteron, nucleon-nucleon scattering, p-p and n-n interactions, properties of the nuclear force and the exchange force model. Text: K.S.Krane : "Introductory Nuclear Physics" (Wiley), (Ch. 3 and 4)	
Module 2: Nuclear Decay	**12 Hrs**
: Beta decay, Energetics of beta decay, Fermi theory of beta decay, Comparative half-life, Allowed and forbidden transitions, Selection rules, Parity violation in beta decay. Neutrino. Energetics of Gamma Decay, Multipole moments, Decay rate, and Angular momentum and parity selection rules, Internal conversion, Lifetimes. (9.1-9.6,9.9, 10.1-10.4,10.6) Text: K.S.Krane : "Introductory Nuclear Physics" (Wiley), (Ch. 8, 9 and 10)	
Module 3: Nuclear Models, Fission and Fusion	**19 Hrs**
Shell model potential, Spin-orbit potential, Magnetic dipole moments, Electric quadruple moments, Valence Nucleons, Collective structure, Nuclear vibrations, Nuclear rotations, Liquid drop Model, Energetics of Fission process, Controlled Fission reactions. Fusion process, Characteristics of fusion, solar fusion, Controlled fusion reactors. Text: K.S.Krane : "Introductory Nuclear Physics" (Wiley), (Ch. 5,13.1-13.5,14)	

Module 4 : Nuclear Radiation Detectors and Nuclear Electronics	12 Hrs
Gas detectors – Ionization chamber, Proportional counter and G M counter, Scintillation detector, Photo Multiplier Tube (PMT), Semiconductor detectors – Ge(Li), Si(Li) and surface barrier detectors, Preamplifiers, Amplifiers, Single channel analyzers, Multi- channel analyzers, counting statistics, energy Measurements. (sections 5.1-5.5,6.1-6.6, 7.1-7.5, 9.1-9.2) Text: K Muraleedhara Varier: "Nuclear Radiation Detection: Measurement and Analysis" (Narosa).	
Module 5: Particle Physics	**17 Hrs**
Four basic forces - Gravitational, Electromagnetic, Weak and Strong - Relative strengths, classification of particles, Yukawa's theory, Conservation of energy and masses, Electric charges, Conservation of angular momentum, Baryon and lepton numbers, Conservation of strangeness, Conservation of isospin and its components, Conservation of parity, Charge conjugation, CP violation, time reversal and CPT theorem. Extremely short-lived particles, Resonances - detecting methods and experiments, Internal symmetry, The Sakata model, SU (3), The eight-fold way, Gellmann and Okubo mass formula, Quarks and quark model, Confined quarks, Experimental evidence, Coloured quarks. **Text Book**: Y.Neeman and Y.Kirsh: "The particle hunters' (Cambridge University Press), Ch 6.1- 3, 3.4, 7.1-10, 8.1, 9. 1-7)	
Teaching and Learning Methods	Lecture, Demonstration, Discussion

Books for Reference:

1. H.S.Hans : "Nuclear Physics – Experimental and theoretical" (New Age International, 2001).

2. G.F.Knoll : "Radiation Detection and Measurement, (Fourth Edition, Wiley, 2011)

3. G.D.Couoghlan, J.E.Dodd and B.M.Gripalos "The ideas of particle physics – an introduction for scientists", (Cambridge Press)

4. David Griffiths – "Introduction to elementary particles" – Wiley (1989)

5. S.B.Patel : "An Introduction to Nuclear Physics" (New Ag e International Publishers)

6. Samuel S.M.Wong: “Introductory Nuclear Physics” (Prentice Hall,India)

7.B.L.Cohen : “Concepts of Nuclear Physics” (Tata McGraw Hill)

8.E.Segre : “Nuclei and Particles” (Benjamin, 1967).

9.S S Kapoor and V S Ramamurthy: “Nuclear Radiation Detectors” (Wiley)

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions:**	
Module	**Marks**
1	**41**
2	**41**
3	**65**
4	**41**
5	**57**

MPH3C11: SOLID STATE PHYSICS (4C, 72 Hrs)

MPH3C11: SOLID STATE PHYSICS					
Credit	**Hours per week**		**Marks out of 100**		
4	**Theory -4**	**Practical -0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Analyse various crystal structures based on X-ray diffraction and interpret it on the basis of the theory understood	Analyse	PSO 5
2	Study of lattice vibrations and how it influencing fundamental properties of materials, Distinguish different excitations in crystals. Properties of quasiparticles could be explained, proper explanation of for specific heat	Apply	PSO1
3	Interpret different theoretical models like free electron model to explain the fundamental properties of metals. Gain a deeper understanding of the energy bands based on the properties of carriers.	Apply	PSO 1
4	Thermal, electrical, and magnetic properties of materials must be properly interpreted. This will enable the student know about current research in relevant areas.	Apply Analyse	PSO 1 PSO 5
5	Studying the many situations in which superconducting characteristics in materials originate	Apply	PSO 1

Module 1: Crystal Structure and binding	**12 Hrs**
Symmetry elements of a crystal, Types of space lattices, Miller indices, Diamond Structure, NaCI Structure, BCC, FCC,HCP structures with examples, Description of X-ray diffraction using reciprocal lattice, Brillouin zones, Vander Waals interaction, Cohesive energy of inert gas crystals, Madelung interaction, Cohesive energy of ionic crystals, Covalent bonding, Metallic bonding, Hydrogen-bonded crystals	
Module 2: Lattice Vibrations	**9 Hrs**

Vibrations of monatomic and diatomic lattices, Quantization of lattice vibrations, Inelastic scattering of neutrons, Einstein and Debye models of specific heat, Thermal conductivity, Effect of imperfection	
Module 3: Electron States and Semiconductors	**17 Hrs**
Free electron gas in three dimensions, Specific heat of metals, Sommerfield theory of electrical conductivity, Wiedemann-Franz law, Hall effect, Nearly free electron model and formation of energy bands, Bloch functions, Kronig Penny model, Formation of energy gap at Brillouin zone boundaries, Number of orbitals in a band, Equation of motion of electrons in energy bands, Properties of holes, Effective mass of carriers, Intrinsic carrier concentration, Hydrogenic model of donor and acceptor states. Direct band gap and indirect band gap semiconductors	
Module 4 : Dielectric, Ferroelectric and magnetic properties	**22 Hrs**
Theory of Dielectrics: polarization, Dielectric constant, Local Electric field, Dielectric polarisability, Polarisation from Dipole orientation, Ferroelectric crystals, Order-disorder type of ferroelectrics, Properties of Ba Ti O3, Polarisation catastrophe, Displasive type ferroelectrics, Landau theory of ferroelectric phase transitions, Ferroelectric domain, Antiferroelectricity, Piezoelectricity, Applications of Piezoelectric Crystals, Diamagnetism and Paramagnetism: Langevin's theory of diamagnetism, Langevin's theory of paramagnetism, theory of Atomic magnetic moment, Hund's rule, Quantum theory of magnetic Susceptibility Ferro, Anti and Ferri magnetism: Weiss theory of ferromagnetism, Ferromagnetic domains, Neel Model of Antiferromagnetism and Ferrimagnetism, Spin waves, Magnons in Ferromagnets (qualitative)	
Module 5: Superconductivity	**12 Hrs.**
Meissner effect, Type I and Type II superconductors, energy gap Isotope effect, London equation and penetration of magnetic field, Cooper pairs and the B C S ground state (qualitative, Flux quantization, Single particle tunneling, DC and AC Josephson effects, High Tc Superconductors(qualitative) description of cuprates, Enough exercises	
Teaching and Learning Methods	Lecture, Demonstration, Discussion

Text Books:

1. 1. C.Kittel,: Introduction to Solid State Physics 5th edition (Wiley Eastern)
2. A.J.Dekker: Solid State Physics (Macmillian 1958) Reference Books:

3. M.Ali Omar, Elementary Solid State Physics, Addison-Wesley Publishing Company

4. N.W.Ashcroft and Mermin : Solid State Physics (Brooks Cole (1976)

5. Elements of Solid State Physics, Srivastava J.P. Prentice Hall of India (2nd edn)

6. Ziman J.H. Principles of Theory of Solids - (Cambridge 1964)

7. Luth – Solid State Physics.

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions:**	
Module	**Marks**
1	**41**
2	**31**
3	**57**
4	**75**
5	**41**

ELECTIVE I:

(Elective-I to be opted from PHY3E01- PHY3E06) MPH3E01: PLASMA PHYSICS (4C, 72 Hrs)

MPH3C11: SOLID STATE PHYSICS					
Credit	**Hours per week**		**Marks out of 100**		
4	**Theory -4**	**Practical -0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOME

CO No	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domains**	**PSO No**

1	Explore the motion of plasma particles in electric and magnetic fields. Enable to identify adiabatic invariants.	Analyse	PSO 5 PSO8
2	Apply the principles of electrodynamics to understand the production and propagation of waves in plasma	Apply	PSO1 PSO8
3	Understands the factors affecting instability of plasma. Understand	Understand	PSO 1 PSO8
4	Analyse Landau damping and its effects in plasma. Analyse	Apply Analyse	PSO 1 PSO 5 PSO8
5	Understand free electron laser action in plasma. Analyses the hurdles in plasma confinement.	Analyse	PSO 5 PSO8

Module 1: Introduction to Plasma Physics	**15 Hrs**
Existence of plasma, Definition of Plasma, Debye shielding 1D and 3D, Criteria for plasma, Applications of Plasma Physics (in brief), Single Particle motions -Uniform E & B fields, Nonuniform B field, Non uniform E field, Time varying E field, Adiabatic invariants and applications	
Module 2: Plasma as Fluids and waves in plasmas	**20 Hrs**
Introduction –The set of fluid equations, Maxwell's equations, Fluid drifts perpendicular to B, Fluid drifts parallel to B, The plasma approximations, Waves in Plasma - Waves, Group velocity, Phase velocity, Plasma oscillations, Electron Plasma Waves, Sound waves, Ion waves, Validity of Plasma approximations, Comparison of ion and electron waves, Electrostatic electron oscillations parallel to B, Electrostatic ion waves perpendicular to B, The lower hybrid frequency, Electromagnetic waves with B0 , Cutoffs and Resonances, Electromagnetic waves parallel to B0, Experimental consequences, Hydro magnetic waves, Magnetosonic waves, The CMA diagrams Text : Chen, Sections 3.1 to 3.6, 4.1 to 4.21	
Module 3: Equilibrium and stability	**13 Hrs**
Hydro magnetic equilibrium, The concept of b, Diffusion of magnetic field into plasma, Classification of instability, Two stream instability, the gravitational instability, Resistive drift waves, the Weibel instability Text : Chen, Sections 6.1 to 6.8	
Module 4 : Kinetic Theory	**12 Hrs**
The meaning of f(v), Equations of kinetic theory, Derivation of the fluid equations, Plasma oscillations and Landau damping, the meaning of Landau damping, Physical	

derivation of Landau damping, Ion Landau damping, Kinetic effects in a magnetic field (12 hours) Text : Chen, Sections 7.1 to 7.6.2	
Module 5: Introduction to Controlled Fusion	**12 Hrs.**
The problem of controlled fusion, Magnetic confinements such as Toruses, Mirrors, Pinches, Laser Fusion, Plasma heating, Fusion Technology Text : Chen, Sections 9.1 to 9.8	
Teaching and Learning Methods	Lecture, Demonstration, Discussion

Text Book : .F. F. Chen, Introduction to Plasma Physics and Controlled Fusion, Volume I and II, Plenum Press, recent edition.

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions:**	
Module	**Marks**
1	**51**
2	**69**

3	**44**
4	**41**
5	**41**

MPH3E02: ADVANCED QUANTUM MECHANICS					
Credit	**Hours per week**		**Marks out of 100**		
4	**Theory -4**	**Practical -0**	**Theory- 150**	**IE 25**	**Practical 0**

Course Outcome

CO No	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domains**	**PSO No**
1	Explore the basics of Advanced Quantum Mechanics.	Analyze	PSO 5 PSO8
2	Apply the EPR and Bell's Theorem	Apply	PSO1 PSO8
3	Understands the Bohm's nonlocal hidden variable theory and some correlations	Understand	PSO 1 PSO8
4	Analyze Decoherence and concepts	Apply Analyze	PSO 1 PSO 5 PSO8
5	Application of the measurement problem in Quantum Mechanics	Apply Analyze	PSO1 PSO 5 PSO8

Module 1: Basic Concepts	**10 Hrs**
Reflections on the uncertainty principle, Complementarity principle, Information, Theory of quantum beats, The Aharonov – Bohm effect. Chapter 3.3, 3.4 and 4.1 to 4.5 of George Greenstein & Arthur G. Zajonc	
Module 2: The EPR Experiment And Bell's Thorem	**15 Hrs**
The EPR argument, The BKS theorem, The hidden variable theories, The Bell's theorem and its proof, Tests of Bell's inequalities, Alain Aspect's experiments. Chapter 5.1 to5.3 and 6.1 of George Greenstein & Arthur G. Zajonc & 12.2 of David J Griffiths	
Module 3: Nonlocality	**12 Hrs**
Bohm's nonlocal hidden variable theory, The Mystery of the EPR correlations, Nonlocality and principle of relativity, Quantum Nonlocality. Chapter 6.2 to 6.5 & 6.7 of George Greenstein & Arthur G. Zajonc	

Module 4 : Decoherence	17 Hrs
Schrödinger's cat, Super positions and mixtures, Non-observation of quantum behaviour in macro systems, Decoherence, Watching decohrence Chapter 7.1 to 7.6 of George Greenstein & Arthur G. Zajonc. Text Book : The Quantum Challenge: Modern Researches on the foundations of Quantum Mechanics - George Greenstein & Arthur G. Zajonc, Narosa	
Module 5: The measurement problem in quantum mechanics	**18 HrS**
The measurement problem, The collapse of wave function, The infinite regress, The active nature of measurement in quantum mechanics, Decoherence and measurement problem, Elementary ideas of quantum cryptography and quantum teleportation. Chapter 8 complete & 9.1 to 9.3 of George Greenstein & Arthur G. Zajonc	
Teaching and Learning Methods	Lecture, Demonstration, Discussion

References:

1. Introduction to Quantum Mechanics: David J Griffiths, Pearson Education

2. Understanding Quantum Mechanics: Roland Omnes, Prentice-Hall, India

3. Quantum Theory and Measurement: J. A. Wheeler and W. H. Zurek, Princeton University Press, Princeton

4. Quantum Mechanics: V.K.Thankappan, Wiley Eastern

For further reference:

Quantum Mechanics and Applications Video Prof. Ajoy Ghatak IIT Delhi

http://nptel.iitm.ac.in/courses/115102023/

Quantum Physics Video Prof. V. Balakrishnan IIT Madras

http://nptel.iitm.ac.in/video.php?subjectId=122106034

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions:**	
Module	**Marks**
1	**34**
2	**52**

3	**41**
4	**58**
5	**60**

MPH3E03: RADIATION PHYSICS					
Credit	**Hours per week**		**Marks out of 100**		
4	**Theory -4**	**Practical -0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOME

CO No	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domains**	**PSO No**
1	Explore the various radiations, accelerators and reactors basics of Advanced Quantum Mechanics.	Analyze	PSO 5 PSO8
2	Discussion about various theories of interactions with matter	Apply	PSO1 PSO8
3	Analysis of radiation quantities	Analyze	PSO 8
4	Explanation of Biological effect of radiations	Apply	PSO 1 PSO8
5	Awareness on radiation protection, shielding and transportation	Apply Analyze	PSO1 PSO 5 PSO8

Module 1: . Radiation source	**12 Hrs**
Types of radiations, ionizing, non-ionizing, electromagnetic, particles, neutral -gamma-neutrino-neutron, charged alpha, beta, gamma, and heavy ion sources, radioactive sources – naturally occurring production of artificial isotopes, accelerators–cyclotrons, nuclear reactors.	
Module 2: Interaction of radiations with matter	**17 Hrs**
Electrons – classical theory of inelastic collisions with atomic electrons, energy loss per ion pair by primary and secondary ionization, specific energy loss, bremsstrahlung, range energy relation, energy and range straggling Heavy charged particles – stopping power, energy loss, range and range – energy relations, Bragg curve, specific ionization, Gamma rays – Interaction mechanism – Photoelectric absorption, Compton scattering, Pair production, gamma ray attenuation, attenuation coefficients, Elastic and inelastic scattering, Cross sections, linear and mass absorption coefficients, stopping power, LET,Neutrons – General properties, fast neutron interactions, slowing down and moderation	

Module 3: Radiation quantities, Units and Dosimeters	**15 Hrs**
Particle flux and fluence, calculation of energy flux and fluence, curie, Becquerel, exposure and its measurements, absorbed dose and its relation to exposure, KERMA, Biological effectiveness, wighting factors, (WR and WT), Equivalent dose, Effective dose, Dosimeters, Primary and secondary dosimeters, Pocket dosimeter, Films and solid dosimeter (TLD and RPL), Clinical and calorimetric devices , Radiation survey meter for area monitoring	
Module 4 : Biological effects	**12 Hrs**
Basic concepts of cell biology, Effects of ionizing radiations at molecular, sub molecular and cellular levels, secondary effects, free radicals, deterministic effects, stochastic effects, Effects on tissues and organs, genetic effects, Mutation and chromosomal aberrations, applications in cancer therapy, food preservation, radiation and sterilization Text Book : The Quantum Challenge: Modern Researches on the foundations of Quantum Mechanics - George Greenstein & Arthur G. Zajonc, Narosa	
Module 5: Radiation protection, shielding and transport	**16 HrS**
Effective radiation protection, need to safeguard against continuing radiation exposure, justification and responsibility, ALARA, concept of radiologic practice. time distance and shielding, safety specifications. method of radiation control, Shielding factor for radiations, Choice of material, Primary and secondary radiations, Source geometry, Beta shielding, Gamma shielding, neutron shielding, Shielding requirements for medical, industrial and research facilities, handling of the source, sealing, transport and storage of sealed and unsealed sources. records, spills. waste disposal, Enough exercises. Reflections on the uncertainty principle, Complementarity principle, Information, Theory of quantum beats, The Aharonov – Bohm effect. Chapter 3.3, 3.4 and 4.1 to 4.5 of George Greenstein & Arthur G. Zajonc	
Teaching and Learning Methods	Lecture, Demonstration, Discussion

Reference Books :

1. G.F.Knoll, Radiation detection and measurement, John Wiley & sons, Newyork, (2000)
2. K.Thayalan, Basic radiological physics, Jaypee brothers medical Publishers, New Delhi, (2003)
3. W.J. Meredith and J.B. Masse, Fundamental Physics of radiology, Varghese publishing house , Bombay (1992)
4. M.A.S. Sherer, P.J.Visconti, E.R Ritenour, Radiation Protection in medical radiography, Mosbey Elsevier,(2006)
5. Lowenthal G.C and Airey P.L., Practical applications of radioactivity and nuclear radiation sources, Cambridge University Press (2005)

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions:**	
Module	**Marks**
1	**41**
2	**58**
3	**51**
4	**41**
5	**54**

MPH3E04: DIGITAL SIGNAL PROCESSING					
Credit	**Hours per week**		**Marks out of 100**		
4	**Theory -4**	**Practical -0**	**Theory- 150**	**IE 25**	**Practical 0**

COURSE OUTCOME

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Explanation of Signals, systems and classification.	Analyze	PSO5 PSO8
2	Apply Techniques of analysis of linear systems	Apply	PSO 1 PSO8
3	Analysis using Z-Transforms.	Analyze	PSO5 PSO8
4	Describe Frequency Analysis of Signals and Systems. Fourier Transform of various signals	Apply	PSO 1 PSO8
5	Describe the Discrete Fourier transform and other transforms.	Apply Analyze	PSO1 PSO 5 PSO8

MODULE 1:Introduction	9 Hrs
Signals and systems, Classification of signals, Concept of frequency in continuous time and discrete– time signals. Theory of A/D and D/A conversion, Sampling of analog signals, sampling theorem. Quantization of continuous amplitude signals. Quantization of sinusoidal	

signal, Coding of quantizedsamples- Digital to analog conversion Text Book : Digital Signal Processing by Proakis & Manolakis, Prentice Hall of India (Fourth edition -2013)– chapter 1 (complete)	
Module 2 : Discrete- time signals and systems	**12 Hrs**
Discrete- time linear time-invariant systems-Techniques of analysis of linear systems, Resolution of a discrete time signal into impulses- Response of LTI systems to arbitrary inputs : Convolution sum-Properties of convolution and the interconnection of LTI systems- Casual LTI systems Stability of LTI systems- Systems with finite duration and infinite duration impulse, response. Discrete- time systems described by difference equations- Recursive and non-recursive discrete, time systems LTI systems characterized by constant coefficient difference equations, Solution to linear constant coefficient difference equations, correlation of discrete-time signals. Text Book : Digital Signal Processing by Proakis & Manolakis, Prentice Hall of India (Fourth edition -2013)Chapter 2 (complete)	
Module 3 : The Z-transform:	**15 Hrs**
The Direct Z-Transform, The Inverse Z-Transform.Properties of Z-transform, Rational Ztransforms, Poles and zeros, Inversion of Z-transforms. The inverse Z-Transform by contour integration, Power series expansion, Partial fraction expansion – Decomposition of rational Z-transform–Analysis of linear time-invariant systems in the Z-domain Text Book : Digital Signal Processing by Proakis & Manolakis, Prentice Hall of India (Fourth edition -2013) (section-3.6- 3.6.2)	
Module 4: Frequency Analysis of Signals and Systems	**24 Hrs**
Frequency analysis of continuous-time signals.- The Fourier Series for continuous Time Periodic signals, Power Density Spectrum of Periodic Signals, The Fourier Transform of Continuous -Time Aperiodic Signals, Energy Density Spectrum of Aperiodic Signals, Frequency analysis of discrete time signals-The Fourier Series for discrete time Periodic Signals, Power Density Spectrum of Periodic Signals, Fourier transform for discrete time aperiodic signal, Convergence of the Fourier Transform, Energy Density Spectrum of aperiodic signals, Relationship of the Fourier Transform to the Z Transform, The Cepstrum. Properties of the Fourier Transform for Discrete Time Signals . LTI systems as Frequency selective filters: Ideal filter characteristics, Lowpass, Highpass and Band pass filters, Digital resonators, Notch filters, Comb filters, All-pass filters – Characteristics of practical frequency-selective filters, Design of linear- phase FIR filters using windows. Text Book : Digital Signal Processing by Proakis & Manolakis, Prentice Hall of India (Fourth edition -2013) Chapter 4-sections 4.1,4.2 and 4.4, chapter 5 section -5.4, chapter10 sections 10.1.2, 10.2.2)	
Module 5 : Discrete Fourier Transform	**12 HrS**
Frequency domain sampling and reconstruction of discrete time signals – The Discrete Fourier transform – DFT as a linear transformation - Relationship of the DFT to the other transforms. Properties of DFT, Multiplication of two DFTs and Circular convolution, Linear filtering methods based on DFT - Frequency analysis of signals using the DFT – Discrete cosine transform - Computation of the Discrete Fourier Transform - Fast Fourier Transform algorithm (basic ideas only) , Enough exercises	

Text Book : Digital Signal Processing by Proakis & Manolakis, Prentice Hall of India (Fourth edition -2013) chapter 7 (complete), sections 8.1.1, 8.1.2	
Teaching and Learning Methods	Lecture, Demonstration, Discussion

Books:

1. Digital Signal Processing by Oppenheim & Schafer, Prentice Hall India –1995
2. Digital Signal Processing by paulo S.R. Piniz, Eduardo A.B. De Silva and Sergio Netto – Cambridge University Press
3. Analog and digital signal processing by Ashok Ambradar
4. Theory and Applications of Digital Signal Processing , Rabiner& Gold, Prentice Hall India -1996.

For further reference:

Digital Signal Processing Video Prof. T.K. Basu IIT Kharagpur
http://nptel.iitm.ac.in/video.php?subjectId=1081050

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions:**	
Module	**Marks**
1	**30**
2	**42**
3	**51**
4	**80**
5	**42**

MPH3E05: EXPERIMENTAL TECHNIQUES					
Credit	**Hours per week**		**Marks out of 100**		
4	**Theory -4**	**Practical -0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOME

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Explain the working of vacuum unit and find its applications	Analyse	PSO 5 PSO8
2	Basic knowledge of thin film materials and its deposition technique and find its applications	Apply	PSO1 PSO8
3	Distinguish of various particle accelerators and its application	Analyse	PSO 8
4	Analysis the Materials by various nuclear techniques	Apply	PSO 1 PSO8
5	Identify the Structure of the material of by X-ray Diffraction	Apply Analyse	PSO1 PSO 5 PSO8

Module 1: . Vacuum Techniques — **15 Hrs**

Units and basic definitions, Roughing pumps - Oil sealed rotary vacuum pump and Sorption pump, High vacuum pumps-Turbo molecular pump, Diffusion pump, Oilvapour booster pump, Ion pumps-Sputter ion pump and Getter ion pump, Cryo pump,

Vacuum guages - Pirani gauge, Thermocouple gauge, penning guage (Cold cathode Ionization guage) and Hot filament ionization gauge, Vacuum accessories – Diaphragm, Gate valve, Butterfly valve, Baffle and isolation valves, magnetic valves, adjustable valves, air inlet valves, Traps - Liquid nitrogen trap, Sorption traps, and gaskets and O rings

Text: Muraleedhara Varier et al. "Advanced Experimental Techniques in Modern Physics", Sections 1.4, 1.6 – 1.8, 1.9.2.3-1.9.2.5, 1.10.1, 1.10.6, 1.10.3

Reference Books:

1. Scientific foundations of vacuum techniques – S. Dushman and J.M. Laffer, John Wiley New York (1962)
2. Dennis and Heppel – Vacuum system design
3. High Vacuum Techniques -Theory and Practice, J.Yarwood (Chapman and Hall Limited)
4. Vacuum Science and Technology, V.V. Rao, T.B. Ghosh, K.L. Chopra (Allied Publishers Limited, New Delhi)

Module 2: Thin film techniques	12 Hrs
Introduction, Fabrication of thin films, Thermal evaporation in vacuum – Resistive heating, Electron beam evaporation and laser evaporation techniques, Sputter deposition, Glow discharge, Thickness measurement by quartz crystal monitor, optical interference method,electrical conductivity measurement, Thermo electric power, Interference filters - Multi layer optical filters, Technological Applications of thin films. Text : Muraleedhara Varier, et al. "Advanced Experimental Techniques in Modern Physics" Sections 2.1, 2.2.1.1, 2.2.1.4,2.2.1.5, 2.2.2, 2.3.2, 2.3.3, 2.3.1, 2.7, 2.6.1. **Reference Books:** 1. Thin film phenomena – K.L. Chopra, (Mc Graw Hill International) 2. Thin film fundamentals, A. Goswami, (New Age International Publishers, New Delhi) 3. Text Book of Optics, Brijlal, Subrahmaniam, Avadhanulu (S-Chand Company)	
Module 3: Accelerator techniques:	**12 Hrs**
High voltage DC accelerators, Cascade generator, Van de Graaff accelerator, Tandem Van de Graaff accelerator, Linear accelerator, Cyclotron,Synchrotron (Electron and proton), Ion sources – Ionization processes, simple ion source, ion plasma source and RF ion source,Ion implantation – techniques and profiles, Ion beam sputtering-principles and applications. Text: Muraleedhara Varier, et al. "Advanced ExperimentalTechniques in Modern Physics", Sections 4.3, 4.4, 4.5.1, 4.5.4, 4.5.5, 4.6, 4.8.1- 4.8.3, 4.9 4. **Reference Books:** 1. An Introduction to Particle accelerators, E.J.N. Wilson, (Oxford University Press, ISBN 0-19-850829-8) 1. Nuclear and Particle Physics, S. Kakani, Shubhra Kakani, (VIVA Books New Delhi) 2. Introduction to Nuclear and Particle Physics,(Chapter 6) V.K.Mittal, R.C.Verma (PHI Learning Private Limited, New Delhi) 2. Nuclear Physics, S.N. Ghoshal, (S. Chand & Company Ltd, New Delhi)	
Module 4 : Materials Analysis by nuclear techniques	**12 Hrs**
Introduction, Basic principles and requirements, General experimental setup, mathematical basis and nuclear reaction kinematics, Rutherford backscattering-introduction, Theoretical background-classical and quantum mechanical, experimental set up, energy loss and straggling and applications. Neutron activation analysis-principles and experimental arrangement, applications, Proton induced X-ray Emission-principle and experimental set up, applications to water samples, human hair samples and forensic samples, limitations of PIXE. Text: Advanced Experimental Techniques in Modern Physics – K.Muraleedhara Varier, Antony Joseph and P.P.Pradyumnan, Pragati Prakashan, Meerut (2006)	
Module 5: X- Ray Diffraction Technique:	**9 HrS**
Introduction, Lattice planes structure factor form factor, Bragg's Law, Phase transition studies Unit Cell Parameters, Crystallinity, Scherrer equation Awareness on Powder Diffraction File (PDF) of the International Centre for Diffraction Data. Single crystal and Powder diffraction Diffractometer Instrumentation, Applications of XRD. Text: Elements of Modern X-ray Physics, Jens Als Nielsen and Des McMorrow, (John Wiley and Sons 2000) **Reference Books** 1. B.D. Cullity, Elements of X-ray diffraction, Addison Wesley Inc (1978)	

2. Useful Link for XRD-http://pd.chem.ucl.ac.uk/pdnn/powintro/whatdiff.htm Materials Science and Engineering, V.Raghavan, Prentice Hall India Ltd

Teaching and Learning Methods	Lecture, Demonstration, Discussion

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions:**	
Module	**Marks**
1	**61**
2	**46**
3	**46**
4	**46**
5	**46**

MPH3E06: Elementary Astrophysics					
Credit	**Hours per week**		**Marks out of 100**		
4	**Theory -4**	**Practical -0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOME

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Plan the observation, given co-ordinates of a celestial source.	Apply	PSO 1 PSO8
2	Use the results of photometric and spectroscopic observation to study the properties of stars.	Analyze	PSO5 PSO8
3	Apply the principles of physics to understand stellar.	Apply	PSO 1 PSO8
4	Understand various techniques involved in ground-based observations.	Apply	PSO 1 PSO8
5	Describe the techniques involved in the observation of celestial objects using space satellites.	Apply Analyze	PSO1 PSO 5 PSO8

Module 1: The Celestial Co-ordinate systems	**14 Hrs**
Identification of stars- spherical co-ordinates -the Altazimuth system – Local equatorial system – the universal equatorial system – aspects of sky at a given place - Other systems- Stellar parallax and units of stellar distance.	
Module 2: Stellar magnitude sequence	**15 Hrs**
Absolute magnitude and distance modulus, Colour index of a star, Luminosities of stars. Spectral classification of stars, Boltzmanns formula, Saha's equation of thermal ionization, Harward system of classification, Luminosity effect of stellar spectra, Importance of ionization theory, Spectroscopic parallax	
Module 3: Hertzsprung - Russel diagram.	**1Hrs**
Structure and evolution of stars, Observational basis, Equation of state for stellar interior, Mechanical and thermal equilibrium in stars, Energy transport in stellar interior, Energy generation in stars (thermonuclear reactions), Stellar evolution, White dwarfs Neutron stars, pulsars and black holes	
Module 4 : Astronomical Instruments:	**14 Hrs**
Optical properties of telescopes - aberrations – Special purpose telescopes– photometry, photographic & photo-electric - instruments and techniques – radio telescopes.	

Module 5: X- Ray Diffraction Technique:	**14 HrS**
Space Astronomy: Infrared Astronomy, detection and measurement – Ultra- violet astronomy, range and importance – X-ray astronomy – Gamma ray astronomy.	
Teaching and Learning Methods	Lecture, Demonstration, Discussion

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions:**	
Module	**Marks**
1	**60**
2	**41**
3	**48**
4	**48**
5	**48**

Text Books:

1. K. D. Abhyankar: "Astrophysics – stars and galaxies", (Universities press) Relevant sections from Chapters 2, 19 and 20.
2. Baidyanath Basusu M : "An introduction to Astrophysics" (Prentice Hall of India) Relevant sections of Chapters 3,4, 14 and 15.

Books for Reference:

1. Gerald North: "Astronomy explained", (Springer, 2011)

MSc. Physics

SYLLABUS

SEMESTER-IV

MPH4C12 : ATOMIC AND MOLECULAR SPECTROSCOPY					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory- 150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Able to interpret the microwave spectra of the molecule and deduce various parameters	Apply	PSO 1, PSO 2 PSO8
2	Able interpret the IR spectra of molecule and deduce information about the molecule.	Analyze	PSO 1, PSO 2, PSO 5 PSO 8
3	Able to interpret the UV-visible spectra and deduce properties of the molecules in ground and excited states	Analyze	PSO 1, PSO 2, PSO 5 PSO 8

Module 1: Atomic Spectroscopy	**Hrs 12**
Vector Atom model – L S coupling & J J coupling, effect of electric & magnetic field on atoms and molecules; Zeeman effect, Paschen Back effect and stark effect. Text: Sections 10.1 to 10.11, 12.1 to 12.10, 13.1 to 13.9, 20.1 to 20.8 – Introduction to atomic spectra by H E White.	
Module 2: Microwave and Infrared spectroscopy	**Hrs 17**
The spectrum of non rigid rotator, e.g. of HF, spectrum of symmetric top molecule e.g. of CH3Cl, Instrumentation for Microwave Spectroscopy Stark Modulator, Information derived from Rotational Spectrum: I R Spectroscopy: Born –Oppenheimer approximation, Effect of	

Breakdown of Born Oppenheimer approximation, Normal modes and vibration of H_2O and CO_2. Instrumentation for I R Spectroscopy – Fourier transformation I R Spectroscopy.

Text: Sections -6.6 ,6.7,6.8,6.9 6.11,6.13,6.14 7.1 to 7.71,7.12,7.15,7.16,7.17,7.18

Molecular structure and Spectroscopy by G.Aruldas.

Module 3: Raman Spectroscopy	**Hrs 14**

Rotational Raman Spectrum of Symmetric top molecules, e.g. of $CHCL_3$ Combined use of Raman & IR Spectroscopy in structure determination e.g. of CO_2 and NO_3. Instrumentation for Raman Spectroscopy, Non-linear Raman effects, Hyper Raman effect, stimulated Raman effect and Inverse Raman Effect.

Text: Sections -8.3, 8.4, 8.5, 8.6, 8.7, 8.10, 15.1, 15.2, 15.3, 15.4

Molecular structure and Spectroscopy by G.Aruldas

Module 4: Electronic Spectroscopy of molecules	**Hrs 12**

Vibrational Analysis of band systems, Deslander‟s table, Progressions & sequences, Information Derived from vibrational analysis, Franck Condon Principle. Rotational fine structure and P R and R Branches, fortrat Diagram, Dissociation Energy, Example of Iodine molecule.

Text: Sections 9.1 to 9.9

Molecular structure and Spectroscopy by G.Aruldas.

Module 5: Spin Resonance Spectroscopy	**Hrs 17**

Interaction of nuclear spin and magnetic field, level population Larmour precession, Resonance Conditions, Bloch equations, Relaxation times, Spin-spin and spin lattice relaxation. The chemical shift, Instrumentation for NMR spectroscopy, Electron Spin Spectroscopy of the unpaired e, Total Hamiltonian, Fine structure, Electron Nucleus coupling, and hyperfine spectrum ESR spectrometer. Mossbauer Spectroscopy, Resonance fluroscence of γ-rays, Recoilless emission of γ-rays and Mossbauer effect, Chemical shift, effect of magnetic field. Eg. of Fe57 Experimental techniques, Enough exercises.

Text: Sections -10.1 to 10.9, 11.1 to11.5.4, 13.1 to13.5

Molecular structure and Spectroscopy by G.Aruldas.

Teaching and Learning Methods	**Lecture, Demonstration, Discussion**

Text Books :

1. Molecular Structure & Spectroscopy G Aruldas.

2. C N Banwell & E.M. Mccash – Fundamentals of Molecular Spectroscopy
3. Atomic Spectroscopy – White

Reference :

1. Straughan and Walker Spectroscopy Volume I, II and III
2. G.M.Barrow – Introduction to Molecular Spectroscopy
3. H.H. Willard, Instrumental Methods of Analysis,7th Edition , CBS-Publishers, New Delhi.
4. Atomic Spectroscopy –K P Rajappan Nair ,MJP Publishers, Chennai
5. Elements of spectroscopy Gupta &Kumar –Pragati Prakasan ,Meerut.

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks-245**
1	**41**
2	**58**
3	**47**
4	**41**
5	**58**

ELECTIVE –II

MPH4 E13: LASER AND FIBER OPTICS (ELECTIVE II)					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Able to understand basic mechanism behind laser action and important parameters related to the operation	Analyze	PSO 1, PSO 2 PSO 8
2	Able to know various types of lasers, their working and applications	Evaluate	PSO 1, PSO 2, PSO 8
3	Optical fibers, their constructional details, working and different types available	Analyze	PSO 1, PSO 2, PSO 5 PSO 8
4	Losses associated with optical fiber communications and various measurement related with optical fibers	Analyze	PSO 1, PSO 2, PSO 5 PSO 8

Module 1: Basic Laser Theory And Optical Resonators	**Hrs 16**
Einstein coefficients , Evaluation of transition rates, Line broadening mechanisms, Laser rate equations for three level system, Cavity Modes, Q of cavity, Q Switching, Mode locking , Confocal Resonator, Analysis of optical resonators using geometrical optics.	
Module 2: Types Of Lasers And Applications	**Hrs 12**
Ruby laser, Helium-Neon laser, Four level solid state lasers, CO2 lasers Dye lasers, Semiconductor lasers, Spatial frequency filtering and holography, Applications of Holography: Holographic interferometry, microscopy. Laser induced fusion, Second Harmonic Generation.	
Module 3: Optical Fibers	**Hrs 21**
Introduction, What are optical fibers, Importance, propagation of light in optical fibers, Basic structure, Acceptance angle, Numerical aperture, Stepped index monomode fibers, disadvantages, Graded index monomode fibers, Optical fibers as cylindrical waveguides, Scalar wave equation and the modes of a fiber.	
Module 4: Fiber Losses	**Hrs 10**

Attenuation in optical fibers, Absorption losses, Leaky modes, Radiation induced losses, Inherent defect losses, Inverse square losses, and Core and cladding losses. Dispersion, losses, material dispersion		
Module 5: Measurement On Fibers		**Hrs 13**
Measurement of numerical aperture and its related terms, measurement of fiber attenuation, Insertion loss method and by optical time domain reflectometer, Measurement of refractive index by reflection method and transmitted near field method, Enough exercises.		
Teaching and Learning Methods	**Lecture, Demonstration, Discussion, Problem solving**	

Text Book:

1. K.Thyagarajan and Ajoy. K. Ghatak, Lasers : Theory and Application, Macmillan
2. Ajoy Ghatak and K. Thyagarajan, Optical Electronics, Foundation Books (Cambridge University).
3. Optical fiber Communication, Gred Keiser.

Reference books :

a) William T. Silfast, Laser Fundamentals
b) Subirkumar Sarkar, Optical Fiber and Fiber Optic Communication Systems, S. Chand &Co.
c) Ajoy Ghatak and K.Thayagarajan, Introduction to Fiber Optics, Cambridge.
d) John. M.Senior, Optical Fiber Communications: Principles and Practice

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks**
1	**55**
2	**41**

3	**71**
4	**34**
5	**44**

ELECTIVE III

MPH4E20: MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS (ELECTIVE III)					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory- 150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domains**	**PSO No**
1	Students are able to design and explain the method of solving a problem with different operations of a microprocessor.	Analyze	PSO 1, PSO 2 PSO 8
2	Students are able to write simple codes for simple general purpose operations which involve data flow between different peripheral devices.	Apply	PSO 1, PSO 2, PSO 8
3	Students are able to write simpler programs for series arithmetic and logical operations and data transfer to and fro from the microprocessor to the peripheral devices.	Apply	PSO 1, PSO 2, PSO 5 PSO 8
4	Students are able to design and explain the method of solving a problem with different operations of a microcontroller and distinguishes it from a microprocessor.	Analyze	PSO 1, PSO 2, PSO 5 PSO 8
5	Students are able to write simpler programs for series arithmetic and logical operations and data transfer to and fro from the microcontroller to the peripheral devices.	Apply	PSO 1, PSO 2, PSO 5 PSO 8

Module 1: Microprocessor and Assembly language programming	**Hrs 12**
Microprocessor as CPU, Internal architecture of Intel 8085, Instruction set, Addressing modes, Examples of Assembly language programming, Addition and subtraction of 2 byte numbers, multiplication and division of 1 byte numbers, Sorting of 1 byte numbers	

Module 2: Microprocessor timings; Interfacing memory and I/O devices	Hrs 10
Instruction cycles, machine cycles and timing diagram, address space partitioning, generation of control signals for memory and I/O device interfacing, memory interfacing, I/O device interfacing, Address decoding using 74LS138	
Module 3: Peripheral devices and interfacing	**Hrs 16**
Programmable Peripheral Interface- Intel 8255, Programmable Interval Timer- Intel 8253, Programmable DMA controller- Intel 8257, Programmable Interrupt controller- Intel 8259. ADC interfacing - General idea with block diagram, 7 segment LED display interfacing – General idea of display and driver	
Module 4: Microcontrollers and Programming	**Hrs 16**
Microcontroller vs microprocessor, microcontrollers in embedded systems. Overview of AVR family of microcontrollers, simplified block diagram of AVR microcontroller, General idea of ROM, RAM, EEPROM, I/O pins and peripherals in microcontroller. AVR architecture and Assembly level programming – General purpose registers, Data memory and instructions, status register and instructions, branch instructions, call and time delay loops; Assembler directives, sample programs. Text : (Relevant sections from chapters 1,2 and 3: Textbook 4) Arithmetic and logical instructions – sample programs. Text : (Relevant sections from chapters 5: The Book 4)	
Module 5: AVR Programming	**Hrs 12**
. I/O programming, I/O port pins and functions, features of ports A, B, C and D, dual role of Ports, sample programs. I/O ports and bit addressability. Text : (Relevant sections from chapter 4: Book 4) Addressing Modes : Register, Direct addressing and register indirect addressing modes Text : (Relevant sections from chapter 7: Book 4)	
Teaching and Learning Methods	**Lecture, Demonstration, Discussion, Problem solving**

Text Book:

1. Introduction to Microprocessors–A.P. Mathur (Tata-McGraw Hill).
2. Fundamentals of Microprocessors and Micro Computers"– B. Ram- Dhanapati Rai
3. Microprocessors – Architecture, Programming and Applications with 8085 – R.S.Gaonkar (Wiley Eastern)
4. The AVR microcontroller and embedded systems – using Assembly and C. Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, Prentice Hall - Pearson

Reference books :

1. Programming and customizing the AVR microcontroller: Dhananjay V Gadre.

2. Embedded C programming and the Atmel AVR: Barnett, Cox, O'Cull.

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks**
1	**41**
2	**35**
3	**54**
4	**54**
5	**41**

MPH4E07 :Advanced Nuclear Physics (ELECTIVE II)					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory- 150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domains**	**PSO No**
1	Explain the basics of nucleus, nuclear properties and necessity of shell model and collective models.	Analyse	PSO 1, PSO 2 PSO 8
2	Apply these models to explain the filling up of neutron and protons inside shells and explain the properties of the nuclei.	Apply	PSO 1, PSO 2, PSO 5 PSO 8
3	Explain the different models of particle accelerators and their use	Analyze	PSO 1, PSO 2, PSO 5 PSO 8

Module 1: Nuclear Shell Model	**Hrs 18**
Shell structure and magic numbers, The nuclear one particle potential, spin-orbit term, realistic one body potentials, Nuclear volume parameter, single particle spectra of closed shell + 1 nuclei, Harmonic oscillator and infinite square well potentials in 3-	

dimensions, coupling of spin and orbital angular momentum, magnetic dipole moment and electric quadrupole moment, Schmidt diagram; Single particle orbitals in deformed nuclei, perturbation treatment, asymptotic wave functions, single particle orbitals in an axially symmetric modified oscillator potential. Text : "Shapes and Shells in Nuclear Structure", S.G. Nilsson and I. Ragnarsson, Sections Chapter 5, 6, 7, 8.1-8.6	
Module 2: Nuclear collective models	**Hrs 12**
Nuclear rotational motion- rotational energy spectrum and wave functions for eveneven and odd A nuclei - Nuclear moments- collective vibrational excitations, Rotational Bands - The particle rotor model, strong coupling- deformation alignment, Decoupled bands - rotational alignment; two particle excitations and back- bending; Fast nuclear rotation- the cranking model; Rotating harmonic oscillator. Texts : • "Nuclear Physics- Theory and Experiment", R.R. Roy and B.P. Nigam (Wiley Eastern) Sections, 8.1 – 8.5 • "Shapes and Shells in Nuclear Structure", S.G. Nilsson and I. Ragnarsson, Sections : 11, 11.1 – 11.3, 12, 12.1, 12.2	
Module 3: Nuclear Reactions	**Hrs 12**
Reactions and Cross-sections, Resonances, Breit-Wigner formula for l = 0, Compound Nucleus formation, continuum theory, statistical theory, evaporation probability, Heavy ion reactions. Texts : a) "Nuclear Physics- Theory and Experiment", R.R. Roy and B.P. Nigam (Wiley Eastern) Sections 6.1, 6.2, 6.4 – 6.8 b) Kenneth Krane – " Introductory Nuclear Physics", (Wiley), Section 11.13	
Module 4: Nuclear Fission	**Hrs 15**
The semi-empirical mass formula , The stability peninsula, nuclear fission and the liquid drop model, some basic fission phenomena, fission barrier .Nuclear Fission- cross-section, spontaneous fission, Mass and energy distribution of fragments, Statistical model of Fission. Text : "Nuclear Physics- Theory and Experiment", R.R. Roy and B.P. Nigam (Wiley Eastern) Sections, Chapter 5 full	
Module 5: Reactor Physics	**Hrs 15**
Fick"s law and its validity, Diffusion equation, diffusion length, Energy loss in elastic collision,Lethargy, Fermi age equation- solutions and measurement of age, Fermi age theory	

of bare thermal reactors, criticality , one region finite thermal reactor, criticality condition for different geometries. Text Book : "Introduction to Nuclear Reactor Theory", B.R. Lamarsh (Addission- Wesley) Sections 5.1, - 5.7, 5.11, 6.1, 6.4, 6.9 – 6.14, 9.1 – 9.8

Teaching and Learning Methods	**Lecture, Demonstration, Discussion**

Text Books :

1."Introductory Nuclear Physics", Samuel M. Wong (Prentice Hall India 1996) Chapter 7)

3. "Nuclear Physics – Experimental and theoretical" – H.S. Hans, New Age International (2001)
4. "Theory of nuclear structure" – M.K Pal, (East West Press Pvt Ltd)

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks-245**
1	**61**
2	**41**
3	**41**
4	**51**
5	**51**

MPH4 E08: Advanced Astrophysics (ELECTIVE II)					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domains**	**PSO No**
1	Connect the observation of radiation in a particular wavelength from a celestial source to its possible nature and state.	Apply	PSO 1, PSO 2 PSO 8

2	Understand the physics involved in the formation of variable stars.	Analyze	PSO 1, PSO 2, PSO 8
3	Compare various models involved in the formation and evolution of galaxies.	Understand	PSO 1, PSO 2, PSO 5 PSO 8
4	Explain how to develop cosmological models.	Analyze	PSO 1, PSO 2, PSO 5 PSO 8

Module 1: Radiative Process	**Hrs 10**
Theory of Black Body Radiation-Photoelectric Effect-Pressure of Radiation - Absorption and Emission spectra - Doppler Effect - Zeeman Effect- Bremsstrahlung - Synchrotron Radiation - Scattering of Radiation - Compton Effect - and Inverse Compton effect. Text : Baidyanath Basu, Ch 2	
Module 2: Variable stars	**Hrs 10**
Classification of Variable stars – Cepheid variables – RV Tauri variables - Mira variables – Red Irregular and Semi-regular variables – Beta Canis Majoris Variables–U Geminorum and Flare stars–Theory of Variable stars. Text : Baidyanath Basu, Ch. 8	
Module 3: Galaxies	**Hrs 24**
The Milkyway galaxy - Kinematics of the Milkyway – Morphology – Galactic Centre – Morphological classification of galaxies – Effects of environment – Galaxy luminosity function – The local group – Surface photometry of galaxies - ellipticals and disk galaxies – Globular cluster systems – Abnormal galaxies-Active galactic nuclei. Text : Binney & Merrifield, Ch.4	
Module 4: General Relativity	**Hrs 16**
General Considerations - Connection Between Gravity and Geometry - Metric Tensor and Gravity - Particle Trajectories in Gravitational field - Physics in curved space-time – Curvature - Properties of Energy and momentum Tensor - Scwarzchild Metric - Gravitational Collapse and BlackHoles – Gravitational Waves. Text : Padmanabhan, Vol 2, Ch.11	
Module 5: Cosmology	**Hrs 12**

Cosmological Principle - Cosmic Standard Coordinates - Equivalent Coordinates – Robertson-Walker Metric - The Red Shift - Measures of Distance - RedShift Versus Distance Relation - Steady State Cosmology. Text : Narlikar, Sections 3.1-3.8	
Teaching and Learning Methods	**Lecture, Demonstration, Discussion, Problem solving**

Text Book:

1. Gravitation & Cosmology-Steven Weinberg- John Wiley (1972) ISBN: 0-471-92567-5
2. Theoretical Astro Physics Vol 1 and 2- T. Padmanabhan- Cambridge University Press (2000) ISBN: 0-521-56240-6, 0-521-56241-4
3. Quasars and Active Galactic Nuclei- Ajit K Kembhavi and Jayat V Narlikar- Cambridge University Press (1999) ISBN:0-521-47477-9
4. The Physical Universe, An Introduction to Astronomy-F. Shu-Oxford University Press-(1982) ISBN: 0-19-855706-X
5. A Different Approach to Cosmology - Fred Hoyle, Geoffrey, Jayant V Narlikar Cambridge University Press (2000) ISBN:0-521-66223-0
6. An Introduction to AstroPhysics - Baidyanath Basu- Prentice Hall India (1997) ISBN:81-203-1121-3
7. Discovering the Cosmos-R.C. Bless - University Science Books (1996) – ISBN:0-935702-67-9
8. Text Book of Astronomy and Astrophysics with Elements of Cosmology- V.B. Bhatia-Narosa publications (2001)ISBN:81-7319-339-8
9. Modern Astrophysics - B.W. Carroll & D.A. Ostille - Addison Wesley (1996) ISBN:0-201-54730-9.
10. Galactic Astronomy – J. Binney & M. Merrifield, Princeton University Press
11. Galactic Dynamics – J. Binney & S. Tremaine, Princeton University Press
12. An Introduction to Cosmology, Third Edition- J. V. Narlikar, Cambridge University Press (2002)

For further reference:

Astrophysics & Cosmology Video Prof. S. Bharadwaj IIT Kharagpur
http://nptel.iitm.ac.in/courses/115105046/

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks**
1	**34**
2	**34**
3	**82**
4	**54**
5	**41**

MPH4E11: Material Science (ELECTIVE II)					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	Define different types of imperfections in crystals.	Analyze	PSO 1, PSO 2 PSO 8
2	Analyse different phase diagrams and elucidate the expected properties.	Apply	PSO 1, PSO 2, PSO 8
3	Define different types of engineering materials and their uses.	Analyze	PSO 1, PSO 2, PSO 5 PSO 8
4	Different characterization techniques for materials	Apply	PSO 1, PSO 2, PSO 5 PSO 8

Module 1: Crystal Imperfections	**Hrs 8**
Point imperfections- The geometry of dislocations- Other properties of dislocations- Surface imperfections Text book: „ Materials Science and Engineering – A First Course" – IV th Edition- V.Raghavan (Prentice-Hall of India- 1988) (Sections: 6.1 to 6.4)	
Module 2: Phase Diagrams & Diffusion In Solids	**Hrs 14**
The phase rule- Single component system- Binary phase diagrams- The Lever rule- Some typical phase diagrams and applications Text book: „ Materials Science and Engineering – A First Course" – IV th Edition- V.Raghavan (Prentice-Hall India- 1988) **(**Sections: 7.1 to 7.7) Fick"s law and solutions- Applications based on the second law solution- The Kirkendall effect- The atomic model of diffusion- Other diffusion processes Text book: „ Materials Science and Engineering – A First Course" – IV th Edition- V.Raghavan (Prentice-Hall of India- 1988) **(**Sections: 8.1 to 8.6)	

Module 3: Plastic Deformation And Fracture Of Materials	Hrs 12

The tensile stress- Strain curve- Plastic deformation by slip- Shear strength of perfect and real crystals-The stress to move a dislocation- Dislocation multiplication-Work hardening- The effect of grain size and precipitate particles on dislocation motion- Mechanism of creep.

Text book: „ Materials Science and Engineering – A First Course‟ – IV th Edition- V.Raghavan (Prentice-Hall India- 1988) (Sections: 11.1, 11.2, 11.3, 11.4, 11.6,11.7, 11.8, 11.10 & 11.11)

Ductile fracture- Brittle fracture- Fatigue fracture- Methods of protection against fracture.

Text book: „ Materials Science and Engineering – A First Course‟ – IV th Edition- V.Raghavan (Prentice-Hall of India- 1988) (Sections: 12.1, 12.2, 12.5 & 12.6

Module 4: Engineering Materials	Hrs 26

Giant molecules-Linear polymers- Three dimensional polymers-Deformation of plastics-Electrical behavior of polymers-Stability of polymers

Text book : „Elements of Materials Science‟ –IIIrd Edition – Lawrence H. Van Vlack (Addison- Wesley Publishing Company Inc.1964.) (Sections : 7.1, 7.2, 7.4, 7.5, 7.6 & 7.7)

Ceramic phases- Silicate structures- Glasses- Electromagnetic behavior of ceramics-Mechanical behavior of ceramic materials.

Text book : „Elements of Materials Science‟ – IIIrd Edition – Lawrence H. Van Vlack (Addison- Wesley Publishing Company Inc. 1964.) (Sections : 8.1, 8.5, 8.6, 8.7 & 8.8) -18 Hours

Growth techniques of nanomaterials- Top-down Vs.Bottom-up technique-Lithographic process and its limitations- Nonlithographic techniques-Plasma arc discharge-Sputtering- Evaporation-Thermal evaporation- e-beam evaporation – Chemical vapor deposition- Molecular beam epitaxy-Other processes.

Text book : „ Introduction to Nanoscience & Technology ‟- K.K.Chathopadhyay, A.N.Banerjee (Prentice-Hall of India -2011.) (Sections 6.2, 6.3, 6.4, 6.4.1, 6.4.2,6.4.3, 6.4.3.1, 6.4.3.2, 6.4.4, 6.4.6 & 6.4.9.)

Module 5: Characterization Of Nanomaterials	Hrs 12

Characterization tools of Nanomaterials-Scanning probe microscopy- Tunnelling current-Local barrier height-Applications of STM- AFM- Scanned –Proximity probe microscopes-Laser beam deflection-AFM cantilevers-piezoceramics-feedback loop-Alternative imaging modes-AFM and biology-Electron microscopy-Resolution vs. magnification-Scanning Electron microscope-SEM techniques-Electron gun-Specimen interactions-Environmental SEM- Transmission electron microscopy-Buckminsterfullerene-Carbon nanotube.

Text book : „ Introduction to Nanoscience & Technology ‟- K.K.Chathopadhyay, A.N.Banerjee (Prentice-Hall of India -2011.) (Sections 7.1.2, 7.1.3.1, 7.1.3.2, 7.1.3.5,

7.2.1,7.2.2, 7.2.3, 7.2.4, 7.2.5, 7.2.6, 7.2.7, 7.3.1, 7.3.2, 7.3.3, 7.3.4, 7.3.5, 7.3.6, 7.3.7, 7.4, 8.2.1 & 8.2.2)	
Teaching and Learning Methods	**Lecture, Demonstration, Discussion, Problem solving**

Text Book:

1. Solid State Physics‟- A.J.Dekker (MacMillan India Ltd.- 1958)

2. "Principles of the Solid State"- H. V.Keer (Wiley Eastern – 1993)

Reference books :

1. "Solid State Physics: Structure and Properties of Materials‟- M.A.Wahab (Narosa- 2007).

2. "Materials Science and Processes‟ – S.K. Hajra Choudhury (Indian Book Publishing Co.- 2009)

3. "Nanotechnology ‟- Richard Booker, Earl Boysen (Wiley Publishing Inc. 2005).

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks**
1	**27**
2	**48**
3	**41**
4	**88**
5	**41**

ELECTIVE III

MPH4 E15:QUANTUM FIELD THEORY (ELECTIVE III)					
Credit	**Hours per week**		**Marks out of 175**		
4	**Theory - 4**	**Practical - 0**	**Theory-150**	**IE 25**	**Practical 0**

COURSE OUTCOMES

CO No	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domains	PSO No
1	the key concept of the use of harmonic oscillators as oscillatory quanta is introduced. Can carry out the canonical quantisation of electromagnetic and Schrodinger field.	Apply	PSO 1, PSO 2 PSO 8
2	Substantiate that for studying the behaviour of identtical many particle system, like atoms, molecules, nuclei, quantisation is a must. Quasi particles are also introduced.	Analyze	PSO 1, PSO 2, PSO 8
3	Understand electron-photon interaction at a more fundamental level. All types of interactions can be analysed as current-current interactions. Nuclear decays can also be explained using this assumption.	Understand	PSO 1, PSO 2, PSO 5 PSO 8
4	Tools like Feynman propagator and Greens functions can be made use of here.	Analyze	PSO 1, PSO 2, PSO 5 PSO 8

Module 1: Classical Field Theory	**Hrs 14**
Harmonic oscillator, The linear chain- classical treatment, the linear chain – quantum treatment, classical field theory, Hamiltonian formalism, Functional derivatives , Canonical quantization of nonrelativistic fields, Lagrangian and Hamiltonian for the Schroedinger field, Quantization of fermions and bosons, Normalization of Fock states. Text Book : "Field Quantization" Greiner and Reinhardt (Spinger-Verlag -1996), Sections 1.3 – 1.5, 2.2, 2.3,– 3.3, Exercise 3.1	
Module 2: Canonical quantization of Klein Gordon and photon fields	**Hrs 20**
The neutral Klein – Gordon field Commutation relation for creation and annihilation operators, Charged Klein – Gordon field, Invariant commutation relations, Scalar Feyman propagator, Canonical quantization of photon field - Maxwells equations, Larangian density for the Maxwell field, Electromagnetic field in the Lorentz gauge, Canonical quantization of the Lorentz gauge – Gupta-Bleuler method, Canonical quantization in the Coulomb gauge. Text Book : "Field Quantization" Greiner and Reinhardt (Spinger-Verlag -1996), Sections 4.1, 4.2, 4.4, 4.5,– 7.4, 7.7	
Module 3: Canonical quantization of spin ½ fields	**Hrs 12**
Lagrangian and Hamiltonian densities for the Dirac field, Canonical quantization of the Dirac field, Plane wave expansion of the field operator, Feyman propagator for the Dirac field. Text Book : "Field Quantization" Greiner and Reinhardt (Spinger-Verlag -1996), Sections 5.1 – 5.4	

Module 4: Interacting quantum fields and Quantum Electrodynamics	Hrs 12
The interaction picture, Time evolution operator, Scattering matrix, Wick"s theorem, Feynman rules for QED, Moller scattering and Compton scattering. Text Book : "Field Quantization" Greiner and Reinhardt (Spinger-Verlag -1996), Sections 8.2 – 8.6, Example 8.4	
Module 5: The path integral method	**Hrs 14**
Path integrals in non-relativistic Quantum Mechanics, Feynman path integral, Multidimensional path integral, Time ordered product and n-point functions, Path integrals for scalar quantum fields, The Euclidian field theory, The Feynman propagator, Generating functional and Green"s function, Generating functional for interacting fields, Enough exercises. Text Book : "Field Quantization" Greiner and Reinhardt (Spinger-Verlag -1996), Sections 11.2 – 11.5, 12.1 – 12.5	
Teaching and Learning Methods	**Lecture, Demonstration, Discussion, Problem solving**

Text Book:

1. Quantum Field theory", Lewis H. Ryder (Cambridge University Press -1995)
2. "Field Theory – A modern primer" – Pierre Ramond (Bengamin – 1996)

Reference books :

13. "Quantum Field theory", Itzyskon and Zuber (McGraw Hill – 1989)
2. Quantum Field theory", Karson Huang (Wiley)

MODE OF ASSESSMENT	
Internal Assessment (20)	
External Assessment (80) **Mark distribution for setting Question paper** **No of Questions: 19**	
Module	**Marks**
1	**48**
2	**67**
3	**41**
4	**41**
5	**48**

MPH4P02 & MPH4VO1: PROJECT AND VIVA VOCE (8 Credits)
(PSO 7)

The project can be experimental or theoretical. The projects may be carried out either utilizing the facilities in the Department or elsewhere. In case they carry out the projects outside the Department, this shall in no way affect their minimum attendance for the theory papers. Also, they should obtain an attendance certificate from the outside institution where the work is carried out and also a certificate in the Project Report that the work had been carried out by the concerned student at that institution. The students shall prepare a detailed report on their work. This shall be attested by the teacher-incharge concerned at the centre (and the relevant authority at the external institution, if the work had been carried out at some other center). The students shall submit the project report before the commencement of the theory examinations. The same will be evaluated by a committee consisting of one external expert and the internal supervisor. A presentation of the project and a comprehensive viva voce on the project and the theory papers will be held and evaluated jointly by the external expert and the supervisor. The Project shall also carry an internal evaluation to the extent of 20%.)

Practical for Semester III & IV

Core Course Practical 2 **a) MPH3L05 & MPH4L06 (MODERN PHYSICS)** **b) MPH4L07: COMPUTATIONAL PHYSICS PRACTICAL**		
Credit	**Hours/week**	**Marks/Weightage**
2	**8**	**30***

Examination will be held at the end of fourth semester Course Outcomes

Course Outcomes	**Expected Course Outcome** *Upon completion of this course, students will be able to;*	**Learning Domain**	**PSO No**
CO1	Recognise and evaluate the mechanical characteristics of materials	Understand ,Apply	PSO1, PSO3, PSO5, PSO6, PSO9

CO2	Understand and analyse material thermal properties	,Understand, Analyze	PSO1, PSO3, PSO5, PSO6, PSO9
CO3	Understand and analyze the electrical and magnetic properties of materials	Apply	PSO1, PSO3, PSO5, PSO6, PSO9
CO4	Learn and analyze the optical properties of materials	Create	PSO1, PSO3, PSO5, PSO6, PSO9

COURSE CONTENT

a) MPH3L05 & MPH4L06 (MODERN PHYSICS)

*At least **10** experiments are to be done from **Part A** and **2** each from the **optional papers**. If no practical have been given for the particular optional papers, two more experiments from Part A should be done. It may be noted that some experiments are given both in Part A and B – of course such experiments can be done only once: either as included in A or in B. Internal evaluation to be done and grades to be intimated to the controller at the end of the semester itself. One mark is to be deducted from internal marks for each experiment not done by the student if the required total of experiments are not done in the semesters. The PHOENIX Experimental Kit developed at the Inter University Accelerator Centre, New Delhi, may be used for experiments wherever possible.*

PART A

1. G.M. Counter plateau and statistics of counting - To obtain the plateau, operating voltage and to verify the distribution law satisfied by the radioactive decay
2. Absorption coefficient for beta & gamma rays -To determine the absorption coefficient of the given materials using a G.M.Counter
3. Feather analysis – End point energy - To determine the end point energy of the beta particles from a given source using Feather analysis
4. Scintillation counter - To calibrate the given gamma ray (scintillation) spectrometer using standard gamma sources and to determine the energy of an unknown gamma ray source
5. Compton scattering - To verify the theoretical expression for the energy of the Compton scattered gamma rays at a given angle using a Scintillation gamma spectrometer / determine the rest mass energy of the electron
6. Half life of Indium – thermal neutron absorption - To determine the half life of In-116 by

irradiation of In foil and beta counting using a GM counter

7. Photoelectric effect in lead - To get the spectrum of X rays emitted form lead target by photo electric effect using Cs-137 gammas
8. Conductivity, Reflectivity, sheet resistance and refractive index of thin films
9. Hall effect in semiconductors-To determine the carrier concentration in the given specimen of semiconducting material
10. ESR spectrometer – Determination of g factor
11. Rydberg constant determination
12. Absorption spectrum of KMnO4 and Iodine. To determine the wavelength of the absorption bands of KMnO4 and to determine the dissociation energy of iodine molecule from its absorption spectrum.
13. Ionic conductivity of KCl/NaCl crystals
14. Curie Weiss law -To determine the Curie temperature
15. To study the Thermoluminescence of F-centres of Alkali halides
16. Variation of dielectric constant with temperature of a ferroelectric material (Barium Titanate)
17. Polarization of light and verification of Malu‟s law.
18. Refractive index measurement of a transparent material by measuring Brewster‟s angle
19. Measurement of the thermal relaxation time constant of a serial light bulb.
20. Dielectric constant of a non polar liquid
21. Vacuum pump – pumping speed
22. Pirani gauge – characteristics
23. Ultrasonic interferometer. To determine the velocity and compressibility of sound in liquids.
24. Study of LED characteristics - Determination of wavelength of emission, I-V characteristics and variation with tempearture, variation of output power vs. applied voltage
25. Optical fibre characteristics - To determine the numerical aperture, attenuation and band width of the given optical fibre specimen
26. Band gap energy of Ge by four probe method.-To study bulk resistance and to determine band gap energy.
27. Thomson‟s e/m measurement.-To determine charge to mass ratio of the electron by Thomson‟s method.
28. Determination of Band gap energy of Ge and Si using diodes.
29. Millikan‟s oil drop experiment .To measure the charge on the electron.
30. Zener voltage characteristic at low and ambient temperatures – To study the variation of the Zener voltage of the given Zener diode with temperature
31. Thermionic work function – To determine the thermionic work function of the material of the cathode of the given vacuum diode/triode from the characteristic at different filament currents

PART B

I . ADVANCED ELECTRONICS

1. Simple temperature control circuit
2. Binary rate multiplier
3. Optical feedback amplifier
4. Frequency modulation and pulse modulation
5. Binary multiplier

6. Write ALP and execute using 8085 kit for generating a square wave of desired frequency using PPI 8255 interfacing. observe the output on CRO and measure frequency.
7. Write ALP to alternately switch on/off a green and a red LED within a given small time interval. Execute using 8085 kit.
8. Write ALP to convert a given d.c voltage (between 0 and 5 V) using ADC 0800/0808 interfaced to 8085 microprocessor. Execute using the given kit and check the result.

II MATERIAL SCIENCE / CONDENSED MATTER PHYSICS

1. Curie-Weiss law – (To determine the Curie temperature)
2. Solid-liquid phase transitions – measurement of resistivity of metals
3. Growth of a single crystal from solution and determination of structural, electrical and optical properties
4. Study of colour centres – Thermoluminiscence glow curves
5. Ionic conductivity in KCl/NaCl crystals
6. Thermoluminiscence spectra of alkali halides
7. Thermo emf of bulk samples (Al/Cu)
8. Electron spin resonance
9. Strain guage – Y of a metal beam
10. Variation of dielectric constant with temperature of a ferro electric material (Barium titanate)
11. Ferrite specimen – variation of magnetic properties with composition

III COMMUNICATION ELECTRONICS

1. Amplitude modulation and demodulation
2. Frequency modulation and demodulation
3. Pulse amplitude modulation and demodulation
4. Pulse code modulation and demodulation
5. Pulse position modulation and demodulation
6. Study of crystal detector
7. L-C transmission line characteristic
8. Tuned RF amplifier
9. Seely discriminators
10. AM transmitter
11. Radiation from dipole antenna
12. Optical fibre characteristics (Numerical aperture, attenuation and bandwidth)
13. Optical feed back circuit (Feedback factor, gain and frequency response)

IV. ADVANCED NUCLEAR PHYSICS and RADIATION PHYSICS

1. Half-life of Indium – thermal neutron absorption - To determine the half-life of In-116 by irradiation of In foil and beta counting using a GM counter
2. Alpha spectrometer - To calibrate the given alpha spectrometer and determine the resolution
3. Photoelectric effect in lead - To get the spectrum of X rays emitted form lead target by photo

electric effect using Cs-137 gammas

4. Inner bremsstrahlung - To study the intensity spectrum of inner bremsstrahlung from given gamma source
5. Coincidence circuits - To construct and study the performance of series and parallel coincidence circuits using transistors and to determine the resolving time
6. Single channel analyzer - Study of characteristics of a SCA using precision pulser
7. Ionization chamber - Study of variation of pulse height with applied voltage and to obtaing the pulse height spectrum of X-rays
8. Proportional counter - Study of variation of pulse height with applied voltage and to obtaining the pulse height spectrum of X-rays
9. Track detector – track diameter distribution - To measure the diameters of the alpha tracks in CR-39 track detector
10. Beta ray spectrometer - To plot the momentum distribution of beta particles from given beta sources
11. Range of alpha particles in air and mylar - To determine the range of alpha particles from Am-241 source in air and in mylar using either a surface barrier detector or a GM counter

V EXPERIMENTAL TECHNIQUES

1. Rydberg constant – hydrogen spectrum
2. ESR – Lande g factor
3. IR spectrum of few samples
4. Vacuum pump – pumping speed
5. Vacuum pump – Effect of connecting pipes
6. Absorption bands of Iodine
7. Vibrational bands of AlO
8. Pirani gauge – characteristics
9. Thin films – electrical properties (sheet resistance)
10. Thin films – optical properties (Reflectivity, transmission, attenuation, refractive index)

VI. ELECTRONIC INSTRUMENTATION

1. Strain gauge
2. Simple servomechanism
3. Temperature control
4. Coincidence circuits
5. Multiplexer
6. IEEE 488 Electrical interface
7. Single channel analyzer
8. Differential voltmeter
9. Frequency synthesizer – Signal generator
10. Silicon controlled rectifier – characteristics
11. Silicon controlled rectifier – power control

VII. DIGITAL SIGNAL PROCESSING

1 (a) Compute and plot the cross and auto correlation coefficients of one dimensional signal (b)Estimate the pitch period of a periodic signal using correlation method. (3 hours).

2 (a) Compute and plot the convolution coefficients of one dimensional signal . (b)Estimate the pitch period of a periodic signal using convolution method. (3 hours).

3 Write a program for determining the Linear and circular Convolution of a finite sequence x(n) and h(n).Accept the sequences x(n) and h(n) from the user. Display the output sequence y(n).Plot all three sequences. (3 hours).

4 Compute the N-point DFT of the following. Vary the value of N and visualize the effect with N=8, 16, 24, 64,128,256. (3 hours).

5 Design an N point FIR low pass filter with cutoff frequency 0.2* pi using i) Rectangular ii) Hamming iii) Kaiser windows. Plot for N=16,32,64,128,256.Compare with N=1024 and record your observations. (3 hours).

(The programs are to be executed in Python/MATLAB)

VIII. LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

1. Optical fibre characteristics (Numerical aperture, attenuation and bandwidth)
2. Optical feed back circuit (Feedback factor, gain and frequency response
3. Determination of size of lycopodium particles by Laser diffraction

Reference Books for PHY 305 & PHY 405 :

1. B.L. Worsnop and H.T. Flint – Advanced Practical Physics for students – Methusen & Co (1950)
2. E.V. Smith – Manual of experiments in applied Physics – Butterworth (1970)
3. R.A. Dunlap – Experimental Physics – Modern methods – Oxford University Press (1988)
4. D. Malacara (ed) – Methods of experimental Physics – series of volumes – Academic Press Inc (1988)
5. A.C.Melissinos, J.Napolitano - Experiments in Modern Physics -Academic Press 2003.

b) MPH4L07: COMPUTATIONAL PHYSICS PRACTICAL

The programs are to be executed in Python. For visualization Pylab/matplotlib may be used. At least ***ten*** *experiments are to be done, opting any* ***five*** *from* ***Part A*** *and another* ***five*** *from* ***Part B****. The Practical examination is of 6 hours duration.*

Part A

1. Interpolation : To interpolate the value of a function using Lagrange‟s interpolating polynomial
2. Least square fitting: To obtain the slope and intercept by linear and Non-linear fitting.
3. Evaluation of polynomials. Bessel and Legendre functions: Using the series expansion and recurrence relations.
4. Numerical integration : By using Trapezoidal method and Simpson's method

5. Solution of algebraic and transcendental equations .Newton Raphson method, minimum of a function
6. Solution of algebraic equation by Bisection method
7. Matrix addition, multiplication, trace, transpose and inverse
8. Solution of second order differential equation- Runge Kutta method
9. Monte Carlo method : Determination of the value of p by using random numbers
10. Numerical double integration
11. Solution of parabolic/elliptical partial differential equations
    (eg: differential equations for heat and mass transfer in fluids and solids, unsteady behaviour of fluid flow past bodies, Laplace equation etc.,)

Part B

1. To plot the trajectory of a particle moving in a Coulomb field (Rutherford scattering) and to determine the deflection angle as a function of the impact parameter
2. Generate phase space plots - To plot the momentum v/s position plots for the following systems : (i) a conservative case (simple pendulum) (ii) a dissipative case (damped pendulum)
3. Simulation of the wave function for a particle in a box - To plot the wave function and probability density of a particle in a box; Schrödinger equation to be solved and eigen value must be calculated numerically.
4. Simulation of a two slit photon interference experiment : To plot the light intensity as a function of distance along the screen kept at a distance from the two slit arrangement.
5. Trajectory of motion of (a) projectile without air resistance (b) projectile with air resistance
6. Logistic map function – Solution and bifurcation diagram
7. Experiment with Phoenix/expEYES kit - Time constant of RC circuits by curve fitting. *
8. Experiment with Phoenix/expEYES kit - Fourier analysis of different waveforms captured using the instrument. * (*If Phoenix is not available, data may be given in tabulated form)
9. Simulation of Keplers‟ orbit and verification of Kepler‟s laws.
10. Simulations of small oscillations in simple molecules:: Diatomic molecule/Triatomic molecule for various lengths(any one case)
11. Simulation of random walk in 1D/2D and determination of mean square distance.
12. Simulation of magnetic field - To plot the axial magnetic field v/s distance due to a current loop carrying current.
13. Simulation of the trajectory of a charged particle in a uniform magnetic field.
14. Simulation of polarisation of electromagnetic waves.
15. Simulation of coupled oscillators - Phase space portraits.

Text Books :

1. Computational Physics -An introduction., R.C.Varma, P.K.Ahluwalia and K.C.Sharma, New Age International Publishers

2. Numpy Reference guide, http://docs.scipy.org/doc/numpy/numpy-ref.pdf (also, free resources available on net)
3. Matplotlib , http://matplotlib.sf.net/Matplotlib.pdf (and other free resources available on net)
4. Numerical Methods in Engineering and Science, Dr. B S Grewal, Khanna Publishers, New Delhi (or any other book)
5. Numerical Methods, E Balagurusamy, Tata McGraw-Hill
6. Numerical Methods , T Veerarajan, T Ramachandran, Tat MCGraw-Hill
7. Numerical Methods with Programs I BASIC, Fortran & Pascal, S Balachandra Rao, C K Shantha. Universities Press
8. Numerical methods for scientists and engineers, K. Sankara Rao, PHI
9. Introductory methods of numerical analysis, S.S.Shastry , (Prentice Hall of India,1983)
10. Numerical Methods in Engineering with Python by Jaan Kiusalaas

Note: Experiments from Part A can be done with data from physical situations where ever possible. For example consider the following cases.

The load W placed on a spring reduces its length L. A set of observations are given below.

a) Calculate force constant and length of the spring before loading

W (kg)	0.28	0.51	0.67	0.93	1.15	1.38	1.60	1.98
L (m)	6.62	5.93	4.46	4.25	3.3	3.15	2.43	1.46

The displacements of a particle at different instants are given below.

b) What is the time instant at which the displacement is 70.2 m

t(s)	1.0	2.2	301	4.5	5.8	6.7	7.6	8.3	9.4
s(m)	3.0	10.56	19.07	37.12	59.16	77.38	98.04	115.78	146.6