Curriculum for M. Sc. Physics

POST GRADUATE DEPARTMENT OF PHYSICS

CHRIST UNIVERSITY
BANGALORE - 560 029

January 2009

Curriculum for M.Sc. Physics course for the year 2009-2010

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Course objectives

The postgraduate course in Physics is the final formal training for students and rigorous training is required to provide in depth knowledge of the subject. Hence the regular class room teaching is supplemented with tutorials, brain storming ideas and problem solving efforts, pertaining to each theory and practical course.

The two year (four semesters) course offers 16 theory and 8 laboratory modules, in addition the foundation courses spreading over the three semesters and guided project in the fourth semester. Foundation courses and seminars are introduced to help the students to achieve holistic development and to prepare them to face the world outside in a dignified manner. A study tour will be conducted either in IV semester to visit National Laboratories, Research Institutions and Industries, under the supervision of the department.

Goal: To equip the students to become effective teachers and researchers in Physics, to contribute to the needs of the society, by providing an environment of learning and knowledge creation through academic rigor and innovation.

Teaching methodology

The regular lecture sessions are supported by audio visual aids, charts, demonstration of models, short assignments, problem solving examples, and quiz to create interest and aptitude in the subject. Tutorial sessions are devoted for brain-storming ideas, short tests, discussions and debates on the subject and students' presentations on topics related to the module. Special lectures are arranged regularly to expose the students to the developments in science and to give them a chance to interact with the people dedicated to the field of Physics.

Assessment and Examinations

Continuous internal assessment (CIA) forms 50% and the end semester examination forms the other 50% of the marks in both theory and practical. For the seminar course there is no end semester examination and hence the mark is awarded through CIA. CIA marks are awarded based on their performance in assignments (written material to be submitted and valued), mid-semester test (MST), and class assignments (Quiz, presentations, problem solving etc.). The mid-semester examination and the end semester examination for each theory paper will be for two and three hours duration respectively. The CIA for practical sessions is done on a day to day basis depending on their performance in the pre-lab, the conduct of the experiment, presentation of lab reports and mid semester examination. Only those students who qualify with minimum required attendance and CIA will be allowed to appear for the end semester examination.

Examination pattern for Theory

No.	Component	Schedule	Duration	Marks
CIA 1	Assignment / quiz/ group task / presentations	Before MST	---	10
CIA 2	Mid-Sem Test	[MST]	2 hours (50 marks)	25
CIA 3	Assignment / quiz/ group task / presentations	After MST	--	10
CIA 4	Attendance (75-79 = 1, 80-84 = 2, 85-89 = 3, 90-94 = 4, 95-100 = 5)		--	5
ESE	Centralized		3 hours (100 marks)	50
	TOTAL			100

End-Semester Exam [ESE]

- A Student is eligible to appear for the ESE only if he has put in 75% of attendance and satisfactory performance in the continuous internal assessment.
- The Question paper shall be set for 100 marks. These marks will then be reduced to 50% of the total marks assigned for the paper.

- There is no provision for taking improvement exams. If a student fails in an ESE paper, he can take the exam again the next time when it is offered.
- The Practical examination shall be conducted with one internal and one external examiner. The internal will be the batch teacher, while the external can be from any other institution or another teacher from the same department.

Examination pattern for Practical

No.	Component	Duration	Points	Marks
CIA 1	Mid-Sem Test [MST]*	4 hours	50	25
CIA 2	Class work, Prelab Assignments	---	40	20
CIA 3	Record book	---	10	05
ESE	(Two examiners)	4 Hours	50	50
	TOTAL			100

End Semester Practical Examination- Allotment of Marks

Writing Principle, Procedure, Circuit:		10
Experimental Setup, Wiring	:	10
Taking Readings	:	10
Graph, Calculations, result	:	10
Viva (related to the experiment)	:	10
Total	:	50

Assessment of Seminar / Foundation courses

Presentation	: 20
Report / Test	: 20
Participation	: 10
Total	: 50

Assessment of Holistic education

Report / Test	: 40
Participation	: 10

Total : 50

(Note: The attendance mark is not provided by the office. However the attendance should be considered for awarding marks for participation)

Assessment of project (No End Semester examination)

Project Report	: 20
Guide's assessment	: 20
Presentation	:10
Total	:50

Question Paper setting (Question Bank)

The End semester Examination is conducted for 100 marks of three hours duration. These marks will then be reduced to 50% of the total marks assigned for the paper. The End semester examination question papers will be generated from the Question banks using software. Question paper pattern is as follows. There are three parts:

Part A – Conceptual Questions
Part B – Essay Questions
Part C - Problems/ short derivations

The Following marks distribution is recommended

Part A – Eight out of Eight	8x2 = 16 Marks
Part B – Six out of Eight	6x9 = 54 Marks
Part C – Six out of Eight	6x5 = 30 Marks
Total	= 100 Marks

The Mid semester Examination is conducted for 50 marks of 2 hours duration. The question papers will be generated from the Question banks using software/ by the teachers handling the papers. Question paper pattern is as follows. There are three parts:

Part A – Conceptual Questions
Part B – Essay Questions
Part C - Problems/ short derivations

The Following marks distribution is recommended

Part A – Five out of Five	5x2 = 10 Marks
Part B – Three out of Four	3x8 = 24 Marks
Part C – Four out of Six	4x4 = 16Marks
Total	= 50 Marks

If any student fails in MST, is expected to write the answers for all the questions and submit to the Department within the specified time. Minimum marks (20 for 50marks MST) will be allotted if assignments are found satisfactory.

Valuation

The Valuation will be a centralized one, and the method of evaluation would be done by two examiners. There will be double valuation for all theory papers (One external and One

internal). The average of the marks will be awarded to the candidate. If the difference in marks is more than 15%, the paper will be valued by a third examiner / BOE and the average of the nearest two marks will be awarded to the candidate.

Results and Grading

Carry over

For no papers shall the student be allowed to have more than three attempts. He/she should clear the academic arrears within two years after the completion of the course.

Note: A student should have passed in at least 50% of the total number of papers of the first year (Semester I and Semester II) to become eligible to get admitted to the third Semester.

Minimum marks requirement

Minimum marks for pass / exemption in each paper is 40%

Minimum marks for pass in the semester is 50% aggregate

There is no separate minimum marks requirement for CIA, however in ESE the candidate should score more than 40% marks in the individual papers and 50% aggregate. If a candidate fails to score 50% aggregate in one or more papers, and 50% aggregate in the semester, he can reappear for ESE in those papers. If a candidate scores more than 40% in all papers and 50% aggregate in the semester he will be declared passed, and will not be eligible for improvement examination.

Marks cards

There will be Semester Marks Cards and a consolidated one at the end of the course. The Degree will be awarded during the University Convocation..

Grading:

Percentage	*Grade*	*Grade Point*	*Interpretation*	*Class*

80 & above	A+	4.0	Outstanding	Distinction
70 – 79	A	3.5	Excellent	
65 – 69	B+	3.0	Very good	First Class
60– 64	B	2.5	Good	
55– 59	C+	2.0	Average	Second Class
50 – 54	C	1.5	Below Average	
40 – 49	C-	1.0	Exempted	Exempted
39 and below	F	0	Fail	Fail
	FA	0	Failure due to absence	

The Grade Point Average (GPA) will be calculated as follows: For each subject, multiply the Grade Point (GP) with the Number of Credits (Cr); divide the product by the total number of credits.

The CGPA [Cumulative GPA] is calculated by adding the total number of earned points [GP x Cr] for all semesters and dividing by the total number of credit hours for all semesters.

Course structure for Post Graduate Degree (M. Sc.) in Physics

I SEMESTER

Course	Title	Hrs./week	Marks	Credit
MPH131	Classical Mechanics	4	100	4
MPH132	Analog and digital circuits	4	100	4
MPH133	Quantum Mechanics- I	4	100	4

MPH134	Mathematical Physics	4	100	4
MPH151	Laboratory 1 (General -1)	4	100	2
MPH152	Laboratory 2 (Electronics)	4	100	2
MPH171	Holistic Education-1	1	50	1
	Total	**25**	**650**	**21**

II SEMESTER

Course	Title	Hrs./week	Marks	Credit
MPH231	Statistical Physics	4	100	4
MPH232	Electrodynamics	4	100	4
MPH233	Quantum Mechanics-II	4	100	4
MPH234	Computational methods and C programming	4	100	4
MPH251	Laboratory 3 (General -2)	4	100	2
MPH252	Laboratory 4 (C- programming)	4	100	2
MPH271	Holistic Education-2	1	50	1
	Total	**25**	**650**	**21**

III SEMESTER

Course	Title	Hrs./week	Marks	Credit
MPH331	Nuclear and Particle Physics	4	100	4
MPH332	Solid State Physics	4	100	4
MPH333	Atomic, Molecular and Laser Physics	4	100	4
MPH341a	Special I: Crystal Physics			

MPH341b	Special I: Electronic Instrumentation	4	100	4
MPH351	Laboratory 5 (General - 3)	4	100	2
MPH352a	Laboratory 6 (Crystal Physics Special -1)	4	100	2
MPH352b	Laboratory 6 (Electronics Special -1)			
MPH371	Seminar / Teaching Technology and Research Methodology*	2	50	1
	Total	**26**	**650**	**21**

IV SEMESTER

Course	Title	Hrs./week	Marks	Credit
MPH431	Astrophysics	4	100	4
MPH432	Spectroscopic Techniques	4	100	4
MPH441a	Physics of nano-materials	4	100	4
MPH441b	Physics of semiconductor devices			
MPH441c	Non-conventional energy resources			
MPH442a	Special II: Crystal growth and crystal defects	4	100	4
MPH442b	Special II: Electronic communication			
MPH451	Laboratory 7 (General - 4)	4	100	2
MPH452a	Laboratory 8 (Crystal Physics Special - 2)	4	100	2
MPH452b	Laboratory 8 (Electronics Special - 2)			
MPH471	Educational visit / Project*	4	50	1
* *No end semester examination*	**Total**	**28**	**650**	**21**
For the two year program			**2600**	**84**

Semester I: Modular objectives

P. G. Department of Physics, Christ University, Bangalore-29.

In the first semester students are offered four theory papers and two practical papers. The modular objectives of the first semester are:

MPH 131: Classical Mechanics

This module is intended to make the students familiar with Newtonian mechanics and constraints, Rotating frames of reference and central force, Canonical transformation, Poissons bracket and equations of motion, Small oscillations and rigid body dynamics.

MPH 132: Analog and Digital circuits

This module introduces the students to the applications of analog and digital integrated circuits. First part of the module deals with the operational amplifier, linear applications of op-amp., active filters, oscillators, non-linear applications of op-amp, timer and voltage regulators. The second part deals with digital circuits which exposes to the logic gates, encoders and decoders, flip-flops registers and counters.

MPH 133: Quantum Mechanics-I

Quantum mechanics being an essential component in understanding the behavior of fundamental constituents of matter is divided in to two modules spreading over first and second semesters. The first module is intended to familiarize the students with the Principles of quantum mechanics, Exactly solvable eigen value problems, Time independent perturbation theory and Time dependent perturbation theory.

MPH 134: Mathematical Physics

A sound mathematical background is essential to understand and appreciate the principles of physics. This module is intended to make the students familiar with the applications of tensors and matrices, Special functions, partial differential equations and integral transformations, Green's functions and integral equations.

MPH 151: Lab. 1 (General - 1)

Ten experiments are included in lab.1 (General-1). The experiments are selected from mechanics, properties of matter and thermodynamics. Suitable experimental techniques are adopted to make the students familiar with the use of basic measuring instruments.

MPH 152: Lab. 2 (Electronics)

Electronics being an integral part of Physics, Lab. 2 is dedicated to experiments related to Electronic components and circuits. The experiments are selected to make the students familiar with the commonly used electronic components and their application in electronic circuits. During the course, the students will get to know the use of various electronic measuring instruments for the measurement of various parameters.

MPH 171: Holistic Education -1

The holistic development is a foundation course intended to introduce the students to the various branches of holistic development. The students will be exposed to the basic values and the importance of developing personal, interpersonal and societal skills to make them better human beings, useful to the society.

Semester II: Modular objectives

In the second semester students are offered four theory papers and two practical papers. The modular objectives of the second semester are:

MPH 231: Statistical Physics

This module is intended to make the students familiar with the basic concepts of statistical mechanics, ensembles and partition functions, theory of ideal Bose-Einstein and Fermi-Dirac gases, non-equilibrium states and fluctuations.

MPH 232: Electrodynamics

This module introduces the students to the principles and applications of Electrostatics, Magnetostatics, Electrodynamics and Electromagnetic waves.

MPH 233: Quantum Mechanics-II

This module is a continuation of Quantum mechanics-I, introduced in the first semester. In this module the students will be introduced to General formulation of quantum mechanics, Angular momentum, Symmetry and its consequences, and Relativistic quantum mechanics.

MPH 234: Computational methods and C programming

Computers are being widely used in Physics for data acquisition, and to automate the experimental setups for better efficiency and accuracy in measurements. This module is intended to introduce the students to the fundamentals of computer science, C language and programming, Numerical techniques using C language and its applications to problems in Physics.

MPH 251: Lab. 3 (General - 2)

Ten experiments are included in lab.3 (General-2). This lab module is devoted to experiments in optics. The experiments are selected to introduce the students to various optical phenomena like, reflection, refraction, interference, diffraction and polarization. Suitable experimental techniques are adopted to make the students familiar with the use of various optical equipments and measuring instruments.

MPH 252: Lab. 4 (C- programming)

This module makes the students familiar with the use of computers for applications in Physics. The first few sessions will be used to make the students familiar with the basics of C programming. It is followed by about ten experiments in solving problems using numerical techniques. It is then followed by a few experiments to get the students familiar with the application of computer graphics to describe problems and principles of physics.

MPH 271: Holistic Education-2

This module is the continuation of Holistic Development-1, which is intended to expose the students to the basic values and the importance of developing personal, interpersonal and societal skills to make them better human beings, useful to the society.

Semester III: Modular Objectives

In the third semester students are offered four theory papers and two practical papers. The modular objectives of the third semester are:

MPH 331: Nuclear and Particle Physics

This module is intended to make the students familiar with Nuclear forces, Nuclear reactions, Nuclear forces, Nuclear models, Nuclear decay, interaction of radiation with matter and Physics of Elementary particle.

MPH 332: Solid State Physics

This module introduces the students to some of the properties of matter in the solid state physics. The students are introduced to Electronic properties of solids, Dielectrics and ferroelectrics, Magnetic properties of solids, Semiconductors and superconductors.

MPH 333: Atomic, Molecular and Laser Physics

This module is intended to introduce various aspects of modern physics. The module includes the study of Atomic physics, Molecular structure and molecular spectra, Vibrations of diatomic molecules, Electronic structure and electronic spectra, Laser physics.

MPH 341a: Special I, Crystal Physics

This module offers one of the papers of the specialization, crystal physics. The module introduces to students the geometry of crystalline state, scattering of x-rays, diffraction from a crystal and experimental collection of diffraction data.

MPH 341b: Special I, Electronic Instrumentation

Accurate measurement of physical parameters is an integral part of physics. Electronic instruments are used for accurate measurement of physical quantities. This module

introduces the students to the principles of signal processing, different types of transducers, Physical methods of analysis and techniques involved in PC based instrumentation.

MPH 351: Lab. 5 (General - 3)

Ten general experiments are included in lab. 5. The experiments are selected from nuclear physics, solid state physics and modern physics to introduce the equipments applications of the advanced areas in physics.

MPH 352a: Lab. 6 (Crystal Physics Special -1)

Ten experiments are included in lab. 6. The experiments are selected from areas related to the special paper Crystal Physics.

MPH 352b: Lab. 6 (Electronics Special -1)

This lab module makes the students familiar with the design and working electronic instruments employed for measurement of various physical parameters in a laboratory environment.

MPH 371: Seminar / Teaching technology and Research methodology

During second semester, students will get an opportunity to deliver lecture on their choice of interest. They will be trained how to prepare the subject matter efficiently and hence to present it satisfactorily, so that they will acquire teaching skills.

The research methodology module is intended to assist students in planning and carrying out research projects. The students are exposed to the principles, procedures and techniques of implementing a research project. In this module the students are exposed to elementary scientific methods, design and execution of experiments, analysis and reporting of experimental data.

A good number of students take up teaching profession, after completing their PG course. Hence a good foundation of teaching methodology will help them to become better teachers. The module in teaching methodology makes the students familiar with elements of educational technology, techniques of communication, instructional design and micro-teaching techniques.

Semester IV: Modular objectives

In the fourth semester students are offered four theory papers, including one elective, and one special paper. A guided project equivalent to one lab module is also included in this semester. The modular objectives of the fourth semester are:

MPH 431: Astrophysics

This module introduces the students to the basic concepts of astrophysics,

classification of stars, the solar system, star cluster, Galaxies and the physical universe.

MPH 432: Spectroscopic Techniques

This module introduces the students to Nuclear magnetic resonance spectroscopy, Electron spin resonance spectroscopy, nuclear quadruple resonance spectroscopy, Mossbauer spectroscopy, and Raman spectroscopy.

MPH 441a: Physics of Nano-materials

Nano-materials exhibit fascinating and useful properties, which can be exploited for a variety of structural and non-structural applications. Nanotechnology is a rapidly growing field based on interdisciplinary science. This module introduces the students to different types of nano-materials, methods of making nano-materials, and various analysis techniques with reference to nano-materials. It also includes the study of Structural, thermal, optical and magnetic properties of nano-materials.

MPH 441b: Physics of semiconductor devices

This module introduces the students to the fabrication, principle of working and application of various kinds of electronic components. The components are categorized in to four groups namely: Semiconductor physics, Semiconductor devices, Mosfet and related devices, Microwave and Photonic devices.

MPH 441c: Non-conventional energy resources

In the scenario of depleting stock of fossil fuels and its sky rocketing prices, the study of an alternative source of energy and its extraction in an economic way is very much essential. The present paper focus on various renewable energy sources and it's tapping for the energy needs. The topics included are: Solar energy, Wind and Ocean energy, Biomass and Geothermal energy, and emerging trends in Renewable energy sources.

MPH 442a: Special II, Crystal growth and crystal defects

This module presents the second part of the specialization, crystal physics. It deals with the theory and kinetics of crystal growth, the various techniques such as melt growth, solution growth, vapour growth and the study of defects and crystals.

MPH 442b: Special II, Electronic communication

This module introduces the students to the basic concepts of electronic communication systems. The electronic communication covers a wide range of topics to deal with. This paper covers the important aspects of radio communication. It includes Amplitude modulation, Frequency modulation, AM and FM Radio receivers, Digital communication and principles of television transmission and reception.

MPH 451: Lab. 7 (General - 4)

Ten general experiments are included in lab. 7. The experiments are selected from astrophysics, atomic physics, molecular physics and laser physics.

MPH 452a: Lab. 8 (Crystal Physics, Special - 2)

This lab module makes the students familiar with the x-ray diffraction equipments, photographing x-ray diffraction and analysis of diffraction data. A few experiments are included to determine the physical properties of crystals like density, conductivity, absorption coefficient and thermal expansion.

MPH 452b: Lab. 8 (Electronics, Special - 2)

This lab module makes the students familiar with the advanced level digital electronic devices and the practical aspects of assembly level programming of microprocessor 8085.

MPH 471: Educational Visits/ Project

A study tour will be arranged either in III or IV semester to visit National Laboratories, Research Institutions and Industries, under the supervision of the department. The tour report will be submitted / presented, as per the schedule during the fourth semester.

The guided project is normally executed in the PG lab., making use of the existing facilities and as a part of the on going activities in the department. Group projects are permitted, depending on the nature of the project. (A few students may be allowed to take up projects in other research institutes depending on their performance, commitment and interest in the field of research and satisfying all the other requirements.)

MPH 131: Classical Mechanics

1. **Constraints and Lagrangian formulation**
   Mechanics of a particle, mechanics of a system of particles, constraints and their classification, examples of constraints, principle of virtual work, D'Alembert's principle, Degrees of freedom, Generalized co-ordinates, Lagrange's equations of motion, applications of Lagrangian formulation, invariance under generalized co-ordinate transformations, cyclic co-ordinates, integrals of motion, concept of symmetry, homogeneity and isotropy, invariance under Galilean transformations.

   15hrs
2. **Rotating Frames of Reference and Central Force**
   Rotating frames, inertial forces in the rotating frame, effects of Coriolis force, Foucault's pendulum, Central force: definition and examples, Two-body central force problem, classification of orbits, stability of circular orbits, condition for closure of orbits, integrable power laws of the central force, Kepler's laws, scattering in a conservative central force field, Virial theorem.

   15hrs
3. **Canonical Transformation, Poisson Bracket and Hamilton's Equations of motion**
   Canonical transformations, Generating functions, conditions of canonical transformation, examples, Legandre's dual transformation, Hamilton's function, Hamilton's equation of motion, properties of Hamiltonian and Hamillton's equations of motion, Poisson Brackets, properties of poisson's bracket, elementary PB's, Poisson's theorem, Jacobi-Poisson theorem on PBs, Invariance of PB under canonical transformations, PBs involving angular momentum, principle of Least action, Hamilton's principle, derivation of Euler-Lagrange equations of motion from Hamilton's principle. Hamilton-

Jacobi equation and its solution.

15hrs

4. **Small Oscillations and Rigid Body Dynamics**
   Types of equilibria and the potential at equilibrium, study of small oscillations using generalized Co-ordination, Forced vibrations and resonance, Degrees of freedom of a free rigid body, angular momentum, Euler's equation of motion for rigid body, time variation of rotational kinetic energy, Rotation of a free rigid body, Eulerian angles, Motion of a heavy symmetric top rotating about fixed point in the body under the action of gravity.

   15hrs

Text and references:

1. **N. C. Rana and P. S. Joag, Classical Mechanics, TMH, 1994.**
2. **H.Goldstein, Classical Mechanics, Addison Wesley, 1980**.
3. Takwale and Puranik, Introduction to Classical Mechanics, TMGH, New Delhi, 1983.
4. W.Greiner, Classical Mechanics: System of particles and Hamiltonian Dynamics, Springer-Verlag, New York, 2004.
5. K N Srinivasa Rao, Classical Mechanics, University press, 2002.
6. K C Gupta, Classical Mechanics of Particles and Rigid bodies, Wiley Eastern Ltd, 1988.
7. V. Barger and M. Olsson, Classical Mechanics: A modern Perspective, Second edition, Mc - Graw Hill, 1995.

MPH 132: Analog and digital circuits

1. **Linear applications of op-amp.**
   The ideal op-amp: Characteristics of an op-amp., the ideal op-amp., Equivalent circuit of an op- amp., Voltage series feed back amplifier - voltage gain, input resistance and output resistance, Voltage follower. Voltage shunt feed back amplifier - virtual ground, voltage gain, input resistance and output resistance, Current to voltage converter. Differential amplifier with one op-amp. - voltage gain, input resistance.
   Linear applications: AC amplifier, AC amplifier with single supply voltage, Summing amplifier, Inverting and non-inverting amplifier, Differential summing amplifier, Instrumentation amplifier using transducer bridge, The integrator, The differentiator.

   15hrs

2. **Non-linear applications of op-amp.**
   Active filters and Oscillators: First order low pass filter, Second order low pass filter, First order high pass filter, Second order high pass filter, Phase shift Oscillator, Wien-bridge oscillator, Square wave generator.
   Non-linear circuits: Comparator, Schmitt trigger, Digital to analog converter with weighted resistors and R-2R resistors, Positive and negative clippers, Small signal half wave rectifier, Positive and negative clampers.

   15hrs

3. **Combinational digital circuits**
   Logic gates: The basic gates - OR, AND and NOT, NOR gates, NAND gates, Boolean laws and theorems, Karnaugh map, Simplification of SOP equations. Simplification of POS equations, Exclusive OR gates.
   Combinational circuits: Multiplexer, De-multiplexer, 1-16 decoder, BCD to decimal decoder, Seven segment decoder, Encoder, Half adder, Full adder.

   15hrs

4. **Sequential digital circuits**

Flip flops: RS flip-flop, Clocked RS flip-flop, Edge triggered RS flip-flop, D flip-flop, JK flip-flop, JK master-slave flip-flop.

Registers: Serial input serial output shift register, Serial input parallel output shift register, Parallel input serial output shift register, Parallel input parallel output shift register, Ring counter.

Counters: Ripple counter, Decoding gates, Synchronous counter, Decade counter, Shift counter - Johnson counter.

15hrs

Text and references

1. **R A Gayakwad, Op-amps. and Linear Integrated circuits, PHI, 2002.**
2. **Leach and Malvino, Digital principles and Applications, TMGH, 2002.**
3. R P Jain, Modern Digital Electronics, TMGH, 1997.
4. Hayes and Horowitz, The art of Electronics, Cambridge, 1995.

MPH 133: Quantum Mechanics-I

1. **Wave Mechanics**

Review of origin of quantum mechanics, Schrodinger equation, time evolution of a wave packet, probability current density, continuity equation, orthogonality and normalization of the wave function, box normalization, admissibility condition on the wave function, expectation values, Ehrenfest's theorem. Potential step and rectangular potential barriers, reflection and transmission coefficient, Barrier penetration.

15hrs

2. **Exactly solvable eigen value problems**

Bound states of a system: application of time independent Schrodinger wave equation to (i) particle in a one dimensional box and in a cubical box, (ii) one dimensional linear harmonic oscillator, evaluation of expectation values of x^2 and P_x^2 (iii) Rigid rotator (iv) Hydrogen atom, solution of radial equation.

15hrs

3. **Approximation methods**

Time independent perturbation theory: First and second order perturbation theory applied to non- degenerate case; first order perturbation theory for degenerate case, application to normal Zeeman effect and Stark effect of hydrogen atom

Variational Method: Variation theorem, application to the ground state of hydrogen atom and the helium atom.

WKB Method: WKB method to one-dimensional case, application to barrier penetration and alpha decay.

15hrs

4. **Time dependent perturbation theory**

Time dependent perturbation method, Fermi's golden rule, Harmonic perturbation, Adiabatic approximation method, Sudden approximation method.

Scattering Theory: Scattering cross section, Differential and total cross section, Born approximation for the scattering amplitude, scattering by spherically symmetric potentials, Partial wave analysis for scattering amplitude, expansion of a plane wave

into partial waves, phase shift, cross section expansion, Optical theorem.

15hrs

Text books and References:

1. **Arul Das: Quantum Mechanics, Prentice Hall of India, 2000.**
2. **Mathews and Venkatesan: Quantum Mechanics, TMH Publishers, 1995.**
3. A. K. Ghatak and S. Lokanathan: Quantum Mechanics, McMillan India Ltd, 1997.
4. L. I. Schiff: Quantum Mechanics, McGraw Hill Publishers, 1968.
5. J. J. Sakurai: Modern Quantum Mechanics, Pearon Education Asia, 2002.
6. B. Crasemann and J. H. Powell: Quantum Mechanics, Narosa Publishing House, 1988.
7. R. P. Feynman, R. B. Leighton and Matthew Sands: The Feynman Lecture on Physics, Vol. III, Addison-Wesley Publishing Company, Inc., 1966.

MPH 134: Mathematical Physics

1. Tensors and complex variables

Introduction, indicial and summation conventions, Kronecker delta-symbol, contravariant and covariant vectors, tensors of higher ranks, algebraic operation of tensors, symmetric and antisymmetric tensors, conjugate tensors, line element: metric tensor, fundamental tensors, raising and lowering of indices, associated tensors, simple applications of tensors to non-relativistic physics: Tensors in dynamics of a particle, tensors in elasticity, tensors in rigid body.

Properties of analytic functions, Cauchy's integral theorem, singularities, Cauchy's residue theorem, application.

15hrs

2. Special Functions

Power series method for ordinary differential equations, Beta and Gamma functions, Legendre's equation, Legendre polynomials and their properties, Bessel's equation, Bessel function and their properties, confluent hypergeometric equation, its solution and properties, Laguerre's equation, its solution and properties.

15hrs

3. Partial Differential Equations and Integral Transforms

Method of separation of variables, the wave equation, Laplace equation, heat conduction equations in cartesian, cylindrical and spherical polar coordinates and their solutions in one, two and three dimensions. Review of Fourier series, Fourier integrals, Fourier transform, Properties of Fourier sine and cosine transforms, applications. convolution theorem, applications, Laplace transformations, properties, convolution theorem, inverse Laplace transform, Evaluation of Laplace transforms, solution of differential equations.

15hrs

4. **Green's Functions and Integral Equations**

Dirac-delta function, Three dimensional delta function, Definition of Green's functions, Green's function for one dimensional equations, Green's functions for two and three dimensional equations, Symmetry property of Green's function, eigenfunction expansion of Green's functions, Green's function for poisson's equation, Definition of

integral equations, Methods of solution, Neumann series method**.**

15hrs

Text and Reference:

1. **Sathya Prakash: Mathematical Physics, Sultan Chand and Sons, 1996**.
2. H. K. Dass: Mathematical Physics, S. Chand, 2005
3. Arfken G. B.and Weber, H. J. : Mathematical methods for physicists, Academic Press, 2005.
4. Mathews and Walker: Mathematical Physics. Benjamin, Pearson Education, 2006
5. Chattopadhyaya P.K.: Mathematical Physics, Wiley Eastern, 1980.
6. A.W. Joshi: Tensor analysis, New Age, 1995

MPH 151: Lab. 1, (General -1)

1. Thermal conductivity by Forbe's method.
2. Determination of elastic constants by Cornu's interference method.
3. Study of thermoemf, thermoelectric laws and to determine the neutral and inversion temperature of Iron-Copper thermocouple.
4. Study of iron arc spectral lines using constant deviation spectrometer.
5. Determination of the energy gap of the semi-conducting material used in a PN junction.
6. Study of characteristics of a solar cell.
7. Determination of size of lycopodium particles by diffraction method.
8. Determination of Stefan's constant of radiation.
9. Determination of relaxation time constant of a serial bulb.
10. Experiments using Laser kit –(a) Determination of refractive index of transparent material by finding Brewster angle (b) Polarization of light and verification of Malu's law (c) Study of total internal reflection in solids and critical angle determination.

MPH 152: Lab. 2, (Electronics)

1. Transistor multivibrator.
2. Half wave and full wave rectifier using op-amp.
3. Op-amp. voltage regulator.
4. Wien-bridge oscillator using op-amp.

5. Op-amp. adder and subtractor.
6. Op-amp. inverting and non-inverting amplifier.
7. Phase shift oscillator using op-amp.
8. Timer 555, square wave generator and timer.
9. a) RS flip-flop using NAND gates, b) Decade counter using JK flip-flops.
10. Half adder and full adder using NAND gates.

MPH 171: Holistic Education-1

1. **Personal Skills** **5hrs**

   Creative thinking and problem solving, Critical thinking and decision making.

2. **Interpersonal Skills**

   Leadership skills and Assertiveness. **5hrs**

3. **Societal Skills**

   Equality and gender sensitization. **5hrs**

Texts and References:

1. Modules on Holistic development (Prepared by Core committee, Christ College)
2. Bradley C. McRae: Practical time management, International self-counsel Press Ltd., 2001
3. B. Ronald, Adler &Jeanne M. Elmhorst, Communicating at work – Principles and practice for business and professions, McGraw Hill

MPH 231: Statistical Physics

1. **Basic Concepts**
   Introduction, phase space, ensemble, ensemble average, Liouville theorem, condition for statistical equilibrium, microcanonical ensemble, ideal gas.
   Quantum picture: Microcanonical ensemble, quantization of phase space, basic postulates, classical limit, symmetry of wave functions, effect of symmetry on counting.
   15hrs
2. **Ensembles and Partition Functions**
   Canonical ensemble, entropy of a system in contact with a heat reservoir, ideal gas in canonical ensemble, Maxwell velocity distribution, equipartition of energy, Grand canonical ensemble, ideal gas in grand canonical ensemble, comparison of various ensembles.
   Canonical partition function, molecular partition function, translational partition function, rotational partition function, electronic and nuclear partition functions, application of rotational partition function, application of vibrational partition function to solids.
   15hrs
3. **Ideal Bose-Einstein and Fermi-Dirac gases**
   Bose-Einstein distribution, Bose-Einstein condensation, thermodynamic properties of an ideal Bose-Einstein gas, liquid helium, two fluid model of liquid helium-II, superfluid phases of ^{3}He, Fermi-Dirac(F-D) statistics, properties of ideal Fermi gas, degeneracy, F-D distribution, electrons in metals, thermionic emission, magnetic susceptibility of free electrons. **15hrs**

4. **Non Equilibrium States and Fluctuations**
   Boltzmann transport equation, particle diffusion, electrical conductivity, thermal conductivity, isothermal Hall effect, Quantum Hall effect.
   Introduction, mean square deviation, fluctuations in ensembles, concentration fluctuations in quantum statistics, one dimensional random walk, electrical noise (Nyquist theorem).
   15hrs

***Text and References*:**

1. **B.K. Agarwal and Melvin Eisner: Statistical Mechanics, New Age International, 2nd Edn. 1998**.

2. R.K.Pathria: Statistical Mechanics, Butterworth Heinemann, 2nd Edn, 2006
3. F. Reif; Statistical and Thermal Physics, McGraw Hill International, 1985.
4. K. Huang: Statistical Mechanics, Wiley Eastern Limited, 1991.
5. J. K. Bhattacharjee: Statistical Physics: Equilibrium and Non Equilibrium Aspects, Allied Publishers Limited, 1997.
6. R. A. Salinas: Introduction to Statistical Physics, Springer, Second edition,2006..

MPH 232: Electrodynamics

1. Electrostatics

Review of mathematical foundations. Coulomb's law, Electric field, Gauss's law, Divergence and curl of electric field, applications of Gauss's law. Electric potential, Poisson's equation, Laplace's equation, potential of a charge distribution, Electrostatic boundary conditions. Laplace's equations in one, two and three dimensions, Boundary conditions and Uniqueness Theorem. The method of images, induced surface charge, force and energy. Multipole expansion, Electric field of a dipole. Polarization in dielectrics, Susceptibility, permittivity and dielectric constant.

15hrs

2. Magnetostatics

The Lorentz force law, Biot-Savart law, magnetic field of a steady current. Divergence and curl of B, Ampere's law and applications. Magnetic vector potential, Multipole expansion of the vector potential, diamagnets, paramagnets and ferromagnets, magnetic field inside matter, Ampere's law in magnetized materials, Magnetic susceptibility and permeability. Faraday's law, induced electric field, energy in magnetic fields, Maxwell's equations, Maxwell's equations in matter, Boundary conditions. Poynting's theorem.

15hrs

3. Electromagnetic waves

The wave equation (review), Electromagnetic waves in vacuum, energy and momentum in electromagnetic waves. Electromagnetic waves in matter, Reflection and transmission at normal incidence, Reflection and transmission at oblique incidence. Electromagnetic waves in conductors, reflection at a conducting surface, frequency dependence of permittivity. Wave guides, TE waves in a rectangular wave guide.

15hrs

4. Electromagnetic radiation

Scalar and vector potentials, Gauge transformations, Coulomb and Lorentz gauge, retarded potentials, Lienard-Wiechert potentials, the fields of a moving point charge. Electric dipole radiation, magnetic dipole radiation, Power radiated by a point charge. Review of Lorentz transformations, Transformation of electric and magnetic Fields

. **15 hrs**

Text and Reference:

1. D.J. Griffiths, Introduction to electrodynamics, Prentice hall of India, 2002.

2. R.N. Singh, Electromagnetic waves and fields, Tata McGraw-Hill, 1991.

3. P. Lorrain and D. Corson, Electromagnetic fields and waves, CBS, 1986.
4. D. F. Jackson, Classical electrodynamics3rd edn,1999
5. Panofsky and Phillips, Classical electricity and magnetism, Dover Publications 2nd edn 2008
6. Sadiku, Electromagnetics, oxford, 4th edition, Oxford press, 2009

MPH 233: Quantum Mechanics-II

1. **General formalism of Quantum Mechanics**
   Hilbert space, Dirac's Bra and Ket notation, Hermitian operators, projection operator, unitary transformations, Poisson and commutator brackets.
   Eigen values and Eigen vector: Eigen functions of commuting operators with and without degeneracy, complete set of commuting operators, co-ordinate and momentum representation.
   Equation of motion: Schrodinger picture, Heisenberg picture and Interaction picture.
   Schwartz inequality theorem, Generalized Uncertainty relation. Harmonic Oscillator solved by matrix method.
   15hrs

2. **Angular momentum**
   Angular momentum operator, Commutation relations among components of angular momentum, Angular momentum operator as rotational operator, Concept of intrinsic spin, total angular momentum operator, commutation relations, ladder operators, eigen value spectrum of J^2 and J_z, Eigen values of ladder operators, Pauli spin matrices, Spinors, Matrix representation of J_x, J_y and J_z in $|jm\rangle$ basis, addition of two angular momenta, Clebsch-Gordan coefficients, Evaluation of Clebsch-Gordan coefficients for $j_1 = ½$ & $j_2 = ½$ and $j_1 = 1$ & $j_2 = ½$ **15hrs**

3. **Symmetry and its consequences**
   Translational symmetry and conservation of linear momentum, symmetry and degeneracy, parity (space inversion) symmetry, even and odd parity operators, time reversal symmetry, Antilinear operators.
   Identical particles: Permutation symmetry, symmetric and anti-symmetric wave functions, spin statistics connection (Bosons and Fermions), Pauli exclusion principle, scattering of identical particles. **15hrs**

4. **Relativistic Quantum Mechanics**
   Klein-Gordan equation for a free particle, Dirac equation for a free particle, Dirac matrices, orthonormality and completeness of free particle solutions, spin of the Dirac particle-positron, negative energy sea, Dirac equation for central potentials, magnetic moment of the Dirac particle, Non-relativistic approximation and spin orbit interaction energy.
   15hrs

Texts and References:

1. **Arul Das: Quantum mechanics, PHI, 2000.**
2. **L. I. Schiff: Quantum Mechanics, McGraw Hill Publishers, 1968.**
3. Mathews and Venkatesan: Quantum Mechanics, TMH Publishers, 1995.
4. J. J. Sakurai: Modern Quantum Mechanics, Pearon Education Asia, 2002.
5. A. K. Ghatak and S.Lokanathan: Quantum Mechanics, McMillan India Ltd, 1997.
6. S. Gasiorowicz: Quantum Physics, John Wiley & Sons, 1974.
7. R. P. Feynman, R. B. Leighton and Matthew Sands: The Feynman Lecture on Physics, Vol.III, Addison-Wesley Publishing Company, Inc., 1966.

MPH 234: Computational methods and C programming

1. C-Language and programming

Overview of C, constants, variables, and data types, operators and expressions, managing input and output operations, decision making and branching, decision making and looping, arrays, user defined functions.

15hrs

2. Computer Graphics

Graphics functions: line, lineto, rectangle, setlinestyle, getlinestyle, arc, ellipse, floodfil, setcolor, getimage, putimage, getpixel, putpixel, moveto, pieslice, setviewport. Programming examples. **15hrs**

3. Numerical techniques using C language

Solution of linear algebraic equations using matrix method, Gauss elimination , Gauss Seidel methods, solution of polynomial and transcendental equations by bisection and Newton-Raphson methods, curve fitting by least squares method, Numerical integration by trapezoidal and Simpson's rules, numerical solution of differential equations by Euler's and Runge-Kutta methods. Computer programming for the above numerical methods using C language.

15hrs

4. Applications in Physics

Freely falling body, motion of a projectile, simple harmonic motion, Standing waves, motion of charged particle in an electric field, motion of charged particle in a uniform magnetic field, energy analysis in RL circuit, electromagnetic oscillations in LC circuit, circuit analysis, solution of time independent schrodinger wave equation.

15hrs

Text and Reference books:

1. V. Rajaraman, Computer oriented numerical methods, PHI, 2002.
2. **R C Verma, Computational Physics, New age, 1999.**
3. Yashavant Kanetkar, Let Us C, BPB, 1999.
4. **Byron S Gottfried, Programming with C, TMGH, 1998.**
5. E. Balaguruswamy: Numerical Methods, TMH, New Delhi, 2002.

MPH 251: Lab. 3 (General -2)

(Any ten of the following)

1. Determination of wavelength of LASER by interference and diffraction methods.
2. Determination of thickness of mica sheet by optical method (Edser-Butler method).
3. Study of elliptically polarized light by means of photo-voltaic cell.
4. Determination of velocity of ultrasonic waves in liquid media.
5. Study of absorption of light in liquid different media using photo-voltaic cell.
6. Study of polarized light using Babinet's compensator.
7. Study of thermal expansion of a solid by optical interference method.
8. Determination of Hartmann's constants and study of electronic absorption band of $KMnO_4$.
9. Determination of surface tension of liquids by Jaeger's method.
10. Determination of coefficient of thermal and electrical conductivity of copper and hence to Lorentz number.
11. Determination of dielectric constant of benzene and dipole moment of acetone molecule

MPH 252: Lab. 4 (C- programming)

1. Addition and multiplication of matrices.
2. Successive bisection method to solve a transcendental equation.
3. Euler's method to obtain a numerical differential of a function.
4. Simpson's rules to obtain a numerical integral of a function.
5. Linear regression - Least squares fit method.
6. Problem of free fall using Euler’s method.
7. Problem of simple harmonic motion of a loaded spring using Euler’s method.
8. Problem of electromagnetic oscillations in LC circuit using Runge-Kutta method.
9. Computer graphics - Motion of a projectile.
10. Computer graphics - Standing waves.
11. Computer graphics - Motion of a charged particle in electric field.

MPH 271: Holistic Education -2

1. **Personal Skills**

   Stress Management and time management. **5hrs**

2. **Interpersonal Skills**

   Team work and conflict management. **5hrs**

3. **Societal Skills**

   Bio-diversity, Civil society and Civic sense. **5hrs**

Texts and References:

1. Modules on Holistic development (Prepared by Core committee, Christ University)
2. Bradley C. McRae: Practical time management, International self-counsel Press Ltd., 2001
3. B. Ronald, Adler &Jeanne M. Elmhorst, Communicating at work – Principles and practice for business and professions, McGraw Hill, 2002

MPH 331: Nuclear and Particle Physics

1. **Nuclear Models**
   Liquid drop model, binding energy of nucleus, semi empirical mass formula (Bethe-Weizsacker formula), stability of nuclei against beta decay, mass parabola.
   Fermi gas model, kinetic energy for the ground state, asymmetry energy.
   Nuclear shell model: magic numbers and evidences, prediction of energy levels in an infinite square well potential, spin-orbit interaction (extreme single particle shell model), Prediction of spin parity and magnetic moment of odd-A nuclei, Prediction of spin parity of even-A nuclei, Schmidt diagrams.
   15hrs

2. **Nuclear force and nuclear decay**
   Nuclear force: Characteristics of nuclear force, short rage, saturation, charge independence, spin dependent, exchange characteristics, Ground state of the deuteron using square well potential, relation between the range and depth of the potential, Yukaw's theory of nuclear forces (qualitative only).
   Nuclear decay: Beta decay- Energetics of beta decay processes, Fermi's theory of beta decay, Curie's plots and 'ft' values, selection rules, Experimental detection of neutrino, Non-conservation of parity in beta decay (experimental proof0. Gamma decay: selection rules, multipolarity, Internal conversion (qualitative).
   15hrs

3. **Nuclear reactions**
   Types of nuclear reactions, conservation laws, cross section, differential cross section, energetics of nuclear reactions, threshold energy, direct and compound nuclear reactions, and their mechanisms, Bohr's independence hypothesis, Goshal experiment.
   Nuclear fusion and fission: Energy released in fusion and fission, neutron multiplication and chain reaction in thermal reactor, four factor formula, reactor and its components.
   15hrs

4. **Interaction of radiation with matter and elementary particles**
   Interaction of radiation with matter: Interaction of charged particles with matter-energy loss of heavy charged particles in matter, Bethe-Bloch formula. Energy loss of electrons, absorption coefficient for beta rays, G. M. counter. Interaction of gamma rays with matter- Photoelectric, Compton and Pair production, total interaction cross section and mass attenuation coefficient for gamma rays, scintillation detector spectrometer.
   Elementary particles: Types of interactions between elementary particles, hadrons and leptons, symmetry and conservation laws, eight fold way (qualitative), quarks and building blocks of quarks, recent findings. **15hrs**

***Texts and References*:**

1. **S. N. Goshal : Atomic and Nuclear Physics, Vol. II, S. Chand, 1994.**
2. **D. H. Frisch and A.M.Thorndike: Elementary Particles, D.Van Nostrand, 1964.**
3. K. S. Krane: Introductory Nuclear Physics Wiley, 1987
4. R. D. Evans: The Atomic nucleus, TMH publishing, 1955.
5. R. R. Roy and B. P. Nigam: Nuclear Physics, Wiley Eastern Ltd., 1967.

6. M. A. Preston: Physics of the Nucleus, Addison-Wesley, Inc., 1965.
7. W. R. Leo: Techniques for Nuclear and Particle Physics Experiments, Springer, 1992.

MPH 332: Solid State Physics

1. Atomic vibrations and thermal properties of materials

Introduction, dynamics of the chain of identical atoms, symmetry in k-space, number of modes in the first zone, long wavelength limit, phase and group velocities, dynamics of a diatomic linear chain, dynamics of identical atoms in three dimensions - qualitative, anharmonicity and thermal expansion. Thermal conductivity of solids, thermal conductivity due to electrons, thermal conductivity due to phonons, thermal resistance of solids, phonon-phonon interaction, scattering of phonons by boundaries or grains, scattering by impurities and imperfections. **15hrs**

2. Electronic and super conducting properties of materials

Electrons in a periodic lattice, Bloch theorem, Kronig-Penney model, Brillouin zones, extended, reduced and periodic zone scheme, effective mass of an electron, nearly free-electron model, tight- binding approximation (qualitative), band theory, classification of solids. Superconductivity: Critical temperature, Meissner effect, thermodynamics of super conducting transitions, origin of energy gap, high T_c superconductors, applications.

London equation and penetration of magnetic field, Cooper pairs, and the BCS ground state (Qualitative).

15hrs

3. Dielectric and optical properties of materials

Introduction, dipole moment, polarization, the electric field of a dipole, local electric field at an atom, dielectric constant and its measurement, polarizability, Clausius-Mosotti equation, electronic polarizability, ionic polarizability, classical theory of electronic polarizability, dipolar polarizability. Langevin's theory of dipolar polarizability.

Absorption processes, excess carriers and photoconductivity, photoelectric effect, photovoltaic effect, photoluminescence. **15hrs**

4. Magnetic and ferroelectric properties of materials

Introduction, classification of magnetic materials, Langevin's classical theory of diamagnetism, sources of paramagnetism, Langevin's classical theory of paramagnetism, quantum theory of paramagnetism, ferromagnetism, Weiss molecular (exchange) field, temperature dependence of spontaneous magnetization, the physical origin of Weiss molecular field, ferromagnetic domains, domain theory, anti-ferromagnetism.

Ferroelectric solids: theory of ferro electricity, ferro electric domains and hysteresis, anti ferro electric materials, ferrielectric and piezo-electric solids. **15hrs**

Texts and References:

1. **M. Ali Omar: Elementary solid state physics- Principles and applications, Addison- Wesley, 2000.**
2. **C. Kittel: Introduction to Solid State Physics, 8th edition,Wiley, 2004.**
3. M. A. Wahab: Solid state Physics- Structure and properties of materials, Narosa Publishing House, New Delhi, 1999
4. J. Richard Christman: Fundamentals of solid state physics, John Wiley and sons, New

York, 1988.
5. S. O. Pillai: Solid state physics, New Age International limited-publishers, 1997.
6. A. J. Dekker, Solid State Physics, McMillan, 1958.

MPH 333: Atomic, Molecular and Laser Physics

1. Atomic Physics

Brief review of early atomic models of Bohr and Sommerfield.

One electron atom: Atomic orbitals, spectrum of hydrogen, Rydberg atoms, spin-orbit interaction and fine structure in alkali spectra. Equivalent and non-equivalent electrons. Zeeman effect, Paschen Back effect, Stark effect, Lamb shift in hydrogen (qualitative)

Two electron atom: Ortho and para states, and role of Pauli exclusion principle, level schemes of two electron atoms.

Many electron atoms: Central field approximation. LS and JJ coupling, multiplet splitting and Lande interval rule**.** **20hrs**

2. Microwave Spectroscopy

Diatomic molecules as a rigid rotor, rotational spectra of rigid and non-rigid rotors, intensity of rotational lines, types of rotor-linear, symmetric top, asymmetric top and spherical top molecules **10hrs**

3. Vibrational and Electronic Spectroscopy of Molecules

Diatomic molecules as simple harmonic oscillator, anharmonicity, Morse potential curve, vibrating rotator and spectra

Electronic spectra of diatomic molecules, vibrational coarse structure: progressions, intensity of vibrational-electronic spectra: Franck Condon principle, dissociation energy, rotational fine structure of electronic-vibration transitions, Fortrat diagram, predissociation. **15hrs**

4. Lasers and Optical fibres

Lasers: Coherence of light, coherence of time, coherence length, types of coherence: temporal and spatial, population inversion techniques: electrical and optical pumping, building up of laser action, criteria for lasing, threshold conditions, He-Ne laser: energy level diagram, principle, construction and working. Applications.

Fibre Optics: Importance of fibre optics, fibre materials, Types of optical fibres: single mode and multimode with different refractive index profiles(qualitatively) . Ray theory transmission- total internal reflection, acceptance angle, numerical aperture, transmission characteristics of optical fibres: attenuation and dispersion.optical fibre communication system (qualitative**).** **15hrs**

***Texts and References*:**

1. **C. N. Banwell, Fundamentals of molecular spectroscopy, Tata Mcgraw-Hill, 1994.**
2. **B. H. Bransden and Joachain, Physics of atoms and molecules, Longman, 1983.**
3. **V. Rajendran and A. Marikani, Applied Physics, TMH publication, 4th Edn. 2002.**
4. P. F. Bernath, Spectra of atoms and molecules, Oxford university press, 1995.
5. Raymond Chang, Basic principles of spectroscopy, McGraw-Hill, 1971.
6. P. W. Atkins, Molecular quantum mechanics, Oxford university press, 1983.
7. B. B. Laud, Lasers and non-linear optics, Wiley- Eastern Ltd, 1991.

8. A. Ghatak and Tyagarajan, Introduction to fibre optics, Cambridge Univ. Press, 1999.
9. H. Kau, Spectroscopy, Pragati Prakashan, Meerut 2007.

MPH 341a: Special I, Crystal Physics

1. Geometry of the crystalline state

General features of crystals, space lattices, unit cell, seven crystal systems, Miller indices, interplanar spacing, density of atoms in a crystal plane, crystals structures, thirty-two crystal classes, external symmetry of crystals: symmetry elements, center of symmetry, mirror plane, glide planes, rotation axes, screw axes, inversion axes, rotoreflection axes, rotoinversion axes, space groups, space group and crystal class.

15hrs

2. The Scattering of x-rays and Diffraction from a crystal

A general description of the scattering process, scattering from a pair of points, scattering from a general distribution of point scatterers, Thomson scattering, Compton scattering, scattering of x-rays by atoms.

Diffraction from a crystal: Diffraction from a one dimensional, two dimensional and three dimensional array of atoms, reciprocal lattice, structure factor, Bragg's Law, structure factor in terms of indices of reflection**.** **15hrs**

3. Experimental Collection of diffraction data

The conditions for diffraction to occur, powder camera, oscillation camera, Weissenberg camera, precession camera, photographic measurement of intensities, diffractometers, x-ray sources, image-plate systems, modern Laue method. **15hrs**

4. Factors affecting x-ray intensities

Diffraction from a rotating crystal, absorption of x-rays, primary extinction, secondary extinction, temperature factor, Lorentz factor, polarization factor, multiplicity factor, anomalous scattering, examples of intensity calculations, measurement of x-ray intensity, Symmetry of x-ray photographs, systematic absences due to lattice types and symmetry elements, detection of mirror planes and diad axes. **15hrs**

Texts and references:

1. **M. M. Woolfson, An Introduction to Crystallography, Cambridge Univ. Press, 1997**.
2. M.A. Wahab: Solid state Physics: Structure and properties of materials, Narosa publishing House, New Delhi, 1999
3. L. V. Azaroff: Introduction to solids, Tata Mc-Graw Hill pub. Co. Ltd., New Delhi, 2002.
4. J.A.K. Tareen and T.R.N. Kutty: A basic course in crystallography, University press India, Ltd., 2001.
5. W. Massa: Crystal Structure Determination, Springer - Verlag, second edition, 2004.
6. S. O. Pillai: Solid state Physics, New Age International Pvt. Ltd, New Delhi,1997.
7. B. D. Cullity and S. R. Stock: Elements of x-ray diffraction, 3rd Ed., Prentice-Hall, New Jersey, 2000.
8. B. E. Warren: X-ray diffraction, Dover publications, INC., New York, 1990.

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MPH 341b: Electronic Instrumentation

1. **Transducers**
   Basic characteristics of measuring devices. Types of errors, Electrical transducer, Characteristics of a transducer. Variable inductance transducer, Variable capacitance transducer, variable resistance transducer, Hall effect devices, Digital transducers. Resistance strain gauge, Semiconductor strain gauge, Wheatstone's strain gauge circuit, Piezoelectric pressure transducer, Load cell, Electronic weighing system. Resistance type temperature sensors, Platinum resistance thermometer, Thermistor, Thermo-couple.
   15hrs
2. **Amplifiers & filters and Data Acquisition systems**
   Amplifiers & filters : Instrumentation amplifiers, Isolation amplifiers, Passive and active filters – First order filter, Second order filter, All pass filter, Frequency to voltage and voltage to frequency converters.
   Data Acquisition systems: Characteristics, Signal conditioning, Single channel acquisition system, Multichannel acquisition system, Multiplexer, Digital to analog converter –weighted resistor and R-2R network, Analog to digital converter – Successive approximation and dual slope, Multiplexers – analog and digital, Sample and hold circuits
   15hrs
3. **General purpose electronic test equipments**
   Cathode Ray Oscilloscopes. Digital voltmeters and multimeters, Electronic counters, AC millivoltmeter, Wave and spectrum analyzers. Signal generators – Wien bridge oscillator with amplitude control, Triangular and square wave generators, Function generator, Pulse generator, Noise generator, Frequency synthesiser. Regulated power supplies – CVCL, CVCC. Thermal shutdown, Line operated switching mode power supply. Lock-in amplifier**.** **15hrs**

4. **Computer interfaced instrumentation**
   General form of PC based instrumentation system, Functional blocks of a data acquisition Data acquisition configurations. I/O ports in a computer system, Data acquisition using serial interfaces, serial connection formats, serial communication modes, serial interface standards (RS 232), connection between two DTE, PC serial port, interfacing to the serial port. Features of USB, USB system, USB transfer, USB descriptors. Study of serial port communication (C program), data acquisition using serial port (MAX187ADC).
   15hrs

Text and Reference books

1. **C.S. Rangan, G.R. Sharma, V .S. V. Mani :Instrumentation devices and systems, II Edn., Tata McGraw Hill, New Delhi, 1997.**
2. H.S. Kalsi: Electronic Instrumentation, TMH publishing Co. Ltd, 1997.
3. D. Patranibis: Principles of Industrial Instrumentation, TMH publishing Co. Ltd., 1994.
4. B.C. Nakra, K. K. Chaudhary: Instrumentation measurement analysis, 2004
5. N. Mathivanan: PC based instrumentation, Prentice Hall of India, 2007

MPH 351: Lab. 5 (General -3)

1. Study of characteristics of GM counter and Verification of inverse square law for gamma radiations.
2. Study of absorption of beta particles in Aluminium.
3. Study of Hall effect in semiconductors.
4. Study of emission spectrum of Neon using constant deviation spectrograph.
5. Determination of Lande's g-factor using ESR spectrometer.
6. Analysis of band spectrum of aluminium oxide.
7. Determination of energy band gap of Ge using Four Probe method.
8. Study of attenuation of gamma rays in lead.
9. Study of range and end-point energy of beta particles in Aluminium.
10. Study of spectral lines of Brass using constant deviation spectrograph.

MPH 352a: Lab. 6 (Crystal Physics special -1)

1. Recording and analysis of Au wire by Debye-Scherrer method.
2. Analysis of powder diffractogram of NaCl.
3. Recording and analysis of Tungsten wire by Debye-Scherrer method.
4. Measurement of density of Urea crystals by floatation method.
5. Analysis of front and back reflection x-ray powder photograph of Platinum wire.
6. Study of thermal expansion of a crystal by optical interference method.
7. Recording and analysis of Cu wire by Debye-Scherrer method.
8. Analysis of single crystal rotation photograph of NaCl.
9. Measurement of density of KCl crystal by floatation method.
10. Determination of ratio of Crystallographic axes of a crystal by optical method.

MPH 352b: Lab. 6 (Electronics Special – 1)

(Any ten of the following)

1. Random access memory (RAM)-Using IC 54/7489
2. Analog to Digital conversion (ADC) using AD ADC 0804
3. Digital to Analog conversion (DAC) –R-2R and Weighted resistor network
4. Digital to Analog converter (DAC) -by IC MC1408 and current to voltage converter.
5. Instrumentation amplifier –Using OP-AMP and Transducer bridge
6. Multiplexer and Demultiplexer-(IC 74151,IC74138)
7. Encoder and Priority encoder- (IC74148 and IC74147)
8. Decoder and seven segment display- (IC 74LX138 and IC7447)
9. Adjustable voltage and current regulator using LM317
10. Dual voltage regulator using 78XX and 79XX and bridge rectifier
11. Experiments with Phase sensitive detector-Mutual inductance of a coil and low resistance of copper.
12. Interfacing of an ADC to a COM port

MPH 371: Teaching Technology and research Methodology

1. Teaching Technology

Development of concept of teaching, Teaching skills, Chalk board skills, Teaching practices, Effective teaching, Models of teaching, Teaching aids (Audio-Visual), Teaching aids (Projected & Non projected), Communication skills, Feed back in teaching, Teacher's role and responsibilities, Information technology for teaching. **15hrs**

2. Research Methodology

Introduction to research and research methodology, Scientific methods, Choice of research problem, Literature survey & statement of research problem, Design of experiments, Design of apparatus, Execution of experiments, Sampling and measurements, Data analysis, Errors in measurements, Reporting of results, Roles and responsibilities of research student and guide. **15hrs**

Text and references:

1. R. Verma: *Modern trends in teaching technology*, Anmol publishers Pvt. Ltd. New Delhi 2003.
2. Usha Rao: *Educational teaching*, Himalaya Publishing house, New Delhi 2001.
3. J. Mohanthy: *Educational teaching*, Deep & Deep Publications Pvt. Ltd, New Delhi 2001.
4. K. J. Sree and D. B. Rao: *Methods of teaching science*, Discovery publishing house, Delhi.1981
5. E. B. Wilson Jr: *An Introduction to scientific research*, Dover publications, Inc. New York 1990.
6. Ram Ahuja: *Research Methods*, Rawat Publications, New Delhi 2002.
7. Gopal Lal Jain: *Research Methodology*, Mangal Deep Publications, Jaipur 2003.
8. B. C. Nakra and K. K. Chaudhry: *Instrumentation, measurement and analysis,* TMH publishing Co. Ltd., New Delhi 1985.
9. S. L. Mayers: Data analysis for Scientists, John Wiley & Sons, 1976.

MPH 431: Astrophysics

1. **Basic concepts**
   Celestial objects, Celestial coordinate systems- horizon, celestial equatorial, ecliptic and galactic coordinate systems. Distance and magnitude of stars- trigonometric parallax, stellar magnitude scale, absolute magnitude and distance modulus, magnitude systems, colour index, earth's atmospheric absorption correction, bolometric magnitudes and stellar luminosity, mass luminosity relation, angular radii of stars, Michelson's stellar interferometer, masses of stars. Radial velocities and masses of binary stars. Types of optical telescopes.
   15hrs
2. **Classification of stars**
   The spectra of stars-atomic, molecular, ionic etc., Boltzmann equation, Saha's ionization formula, various spectral broadening processes, spectral sequence of stars, temperature sequence, H-R (Hertzsprung-Russell) diagrams, luminosity classification, period luminosity relation, variable stars, pulsating stars and non-pulsating stars, T Tauri stars, magnetic variable stars, Stellar evolution, white dwarfs, neutron stars and black holes.
   15hrs
3. **Solar system**
   Kepler's laws of planetary motion and their derivation. Structure of sun, photosphere, chromosphere, corona, solar wind, solar activity, sun spots, solar rotation, the interior planets and their atmosphere, the exterior planets and their atmosphere, comets, asteroids, meteoroids, formation of solar system. **15hrs**
4. **Galaxies and Universe**
   Structure of Milky way Galaxy, Star clusters, Hubble's classification of galaxy, galactic dynamics, Kepler's third law and the galaxy's mass. Universe: Galaxies beyond the Milky way, Theories of universe, Olber's paradox, Hubbel's law and the distance scale, expanding universe, Cosmic microwave background radiation, origin and evolution of universe. **15hrs**

Text and References:

1. **M. Zeliek and S. A. Gregory: Introduction to Astronomy and Astrophysics, IV Edn. Saunders College publishing, 1998**.
2. Baidynath Basu: An Introduction to Modern Astrophysics, Prentice Hall of India,2001.
3. V. B. Bhatia: Text book of Astronomy and Astrophysics with elements of cosmology, Narosa publishing house, 2001.
4. K. D. Abhyankar:Astrophysics- Stars and Galaxy, Universities Press, 2001.
5. A. Unsold :The new cosmos, Springer Verlag publishing, 1999.
6. R. H. Baker: Astronomy, VI Edn., D van Nostrand Company, Inc., 1958.

MPH 432: Spectroscopic Techniques

1. **NMR Spectroscopy**
   Nuclear Magnetic Resonance Magnetic properties of nuclei, Resonance condition, NMR instrumentation, relaxation processes, Chemical shift, indirect spin-spin interaction, high resolution Hamiltonian, matrix elements of high resolution Hamiltonian, NMR spectrum of spin ½ AB system, NMR spectra of solids, magic angle spinning NMR-applications of NMR spectroscopy.
   15hrs
2. **Electron Spin Resonance Spectroscopy:**
   Principle of ESR, ESR spectrometer, total Hamiltonian, hyperfine structure, ESR spectra of systems with spin 1/2 and spin 3/2 nucleus, ESR spectra of free radicals in solution, anisotropic systems, anisotropy of g- factor, systems in triplet states, EPR of transition metal ions. **15hrs**
3. **NQR and Mossbauer Spectroscopy**
   Nuclear Quadrupole Resonance: The quadrupole nucleus, principle of nuclear quadrupole resonance, transitions for axially symmetric systems, transitions for non-axially symmetric systems, NQR instrumentation, halogen quadrupole resonance, quadrupole resonance of minerals, nitrogen quadrupole resonance.
   Mossbauer Spectroscopy: Recoilless emission and absorption, experimental techniques, isomer shift, quadrupole interaction, magnetic hyperfine interaction, Applications.
   15hrs
4. **Raman Spectroscopy**
   Theory of Raman scattering, rotational Raman spectra- Linear and symmetric top molecules- vibrational Raman spectra- Mutual exclusion principle, Raman spectrometer, polarization and Raman scattered light, structure determination from Raman and IR spectroscopy, Raman investigation of phase transitions, proton conduction in solids-Raman spectral study, resonance Raman scattering.
   15hrs

Text and References:

1. **G. Aruldhas: Molecular Structure and Spectroscopy, Prentice-Hall of India Private Limited, New Delhi, 2001.**
2. C.P.Slitcher: Principles of magnetic resonance, Springer Verlag, 1980.
3. G.K.Wathaim: Mossbauer effect, Principles and applications, Academic Press, 1964.
4. L.N.B.Colthup, L.H.Daly and S.E. Wiberley: Introduction to IR and Raman Spetroscopy, Academic Press, 1964.
5. Manas Chand: Atomic structure and Chemical bon- including molecular spectroscopy, II Edn., Tata McGraw Hill, 1967.
6. Guptha and Kumar: Elements of Spectroscopy, Pragathi Press, 1984.
7. H. Kaur: Spectroscopy, Pragati Prakashan, Meerut, 2007.

MPH 441a: Physics of Nanomaterials

1. **Special Nanomaterials**
   Carbon nanotubes: types of carbon nanotubes, synthesis and growth, electronic structure; Porous silicon: mechanism of pores formation and factors affecting porous structure, properties; Aerogels: types, properties and applications; Zeolites; Self assembled nanomaterials: self assembly in inorganic materials, self assembly using organic molecules; Core shell particles: silica based core shell particles (synthesis and properties). Applications of nanomaterials. **15hrs**

2. **Synthesis of Nanomaterials**
   Physical methods: Mechanical methods: high energy ball milling and melt mixing; Evaporation methods: PVD with consolidation, ionized cluster beam deposition, laser vapourization, laser pyrolysis; Sputter deposition (dc and rf), magnetron sputtering; CVD, Electric arc deposition, Ion implantation technique, Molecular beam epitaxy.
   Chemical methods: Colloids in solutions: interactions of colloids and medium, effect of charges on colloids, colloid synthesis; LaMer diagram; Synthesis of metal and semiconductor nanoparticles by colloidal route, Langmuir- Blodgette (L-B) method, Sol-Gel method. **15hrs**

3. **Analysis Techniques**
   Microscopes: Optical and confocal, electron microscopes (SEM and TEM) and Scanning Probe Microscopes (STM, AFM and SNOM).
   Diffraction Techniques: X-ray diffraction, diffraction from different types of samples, diffraction from nanoparticles.
   Spectroscopic techniques: (Qualitative) UV-Vis-NIR, Dispersive IR and FTIR Spectrometers; Photoluminescence spectrometer; XPS and Auger electron spectrometry: Ingredients of X-ray photoelectron spectra, surface sensitivity of spectra, experimental set up. **15hrs**

4. **Properties of Nanomaterials and Nanolithography**
   Mechanical properties, Structural properties, Melting of nanoparticles, Electrical conductivity, Optical properties (metallic nanoparticles, semiconductor nanoparticles, luminescence in semiconductor nanoparticles), Magnetic properties (magnetic nanoparticles, magnetic multilayers, Spin Valve and magnetic tunnel junction).
   Nanolithography: Introduction, Lithography using photons (UV-Vis; Lasers or X-rays), Lithography using particle beams, Scanning probe lithography, Soft lithography. **15hrs**

Textbooks and References:

1. **Sulabha K. Kulkarni: Nanotechnology- Principles and Practices, Capital Publishing Company, New Delhi, 2007.**
2. T. Pradeep: Nano - The essentials, Understanding Nanoscience and Nanotechnology, Tata Mc Graw Hill, 2007.
3. Charles P. Poole Jr. and Frank J. Owens, Introduction to Nanotechnology, Wiley Interscience, 2003.
4. S.C.Tjong: Nanocrystalline Materials-.Their Synthesis, Structure, Property Relationships and Applications, Elsevier, 2003.

MPH 441b: Physics of semiconductor devices

1. **Semiconductor physics**

Review of semiconductors-Intrinsic carrier concentration, donors and acceptors, Non degenerate semiconductor, Degenerate semiconductor. Carrier transport phenomena-carrier drift, resistivity, Hall Effect, carrier diffusion-Einstein relation. Current density equations
Generation and Recombination process-direct recombination-Indirect recombination-surface recombination-Auger recombination. Continuity equation. Tunneling process, High field effects. **15hrs**

2. **Semiconductor devices**
Pn junction-thermal equilibrium condition, Depletion region-Abrupt junction-Linearly graded junction. Depletion capacitance -Capacitance-voltage characteristics. Varactor. Current-voltage characteristics. Charge storage and transient behavior-Minority-carrier storage-diffusion capacitance-transient behavior. Junction breakdown-Tunneling effect-Avalanche multiplication. Bipolar transistor- transistor action- Current gain. Static characteristics of bipolar transistor-carrier distribution in each region. Ideal Transistor currents for active mode operation. I-V characteristics of common-base and common-emitter configurations. Frequency response, switching transients. Thyristor – Basic characteristics. Applications. **15hrs**

3. **MOSFET and Related devices**
MOS Diode- Surface depletion region-energy band diagrams and charge distributions.
MOS memory structures-DRAM-SRAM-Nonvolatile Memory, Charge coupled devices. MOSFET-characteristics-Types of MOSFET. Applications. Metal-Semiconductor contacts- Schottky Barrier. Ohmiccontact .MESFET-Principle of operation-I-V characteristics. Applications High frequency performance. MODFET fundamentals, I-V characteristics. Applications. **15hrs**

4. **Microwave and Photonic devices.**
Tunnel diode-Characteristics. IMPATT diode- static and dynamic characteristics. Applications .BARRIT and TRAPATT. Applications. Transferred- electron devices-Gunn diode-negative differential resistance. Application
Photonic devices-Light emitting diodes-Orangic LED, Visible LED, Infrared LED. Semiconductor Laser-Laser operation. Photo detector-Photoconductor-photodiode-Avalanche photo diode. Solar cell-characteristics-maximum output power-efficiency. Applications. **15hrs**

Texts and references:

1. **1. S.M. Sze, Semiconductor devices, Physics and technology, John Wiley, 2nd edition,2002**
2. Ben G Streetman, Solid state electronic devices, PHI, 3rd edition,2000.
3. M.S. Tyagi, Introduction to Semiconductor materials and devices, John Wiley, 2000.
4. 4. Dilip K Roy, Physics of semiconductor devices, Universities press, 2002.

MPH 441c: Non-conventional energy resources

1. Solar Energy

P. G. Department of Physics, Christ University, Bangalore-29.

Review of energy resources, solar energy estimation of intensity of terrestrial radiation, solar radiation on inclined plane surface, estimation of monthly average, daily total radiation and diffused radiation on horizontal surface, solar collectors. Flat plate collector-compound & cylindrical parabolic concentrators- Solar water heater- solar passive space heating & cooling systems, solar cooker & furnaces, solar greenhouse. Solar thermo-mechanical systems- thermal water pump- vapour compression refrigerators, solar cell characteristics, solar cell module, panel and array construction, applications.

15 hrs

2. Wind and Ocean Energy

Origin of winds, Factors affecting wind energy, Nature of winds, Variation of wind speed with height, Major applications of wind power, Wind turbine, Energy available in wind-power extraction- Axial thrust or turbine, Torque developed by turbine, Dynamic matching for maximum power extraction. Wind turbine operation and power versus wind speed characteristics, Wind energy Conversion Systems- Fixed speed drive scheme- Variable speed drive scheme. Wind-Diesel hybrid system. Tidal Energy-range power-tidal energy conversion schemes. Wave energy-Power in waves. Ocean Thermal Energy-OTEC.

15 hrs

3. Biomass and geo-thermal energy

Biofuels .Biomass resources-Biomass conversion Technologies. Urban waste to energy conversion. Biomass gasification. Biomass to Ethanol production. Biogas from waste Biomass. Biogas plants and operational parameters-Constant pressure and constant volume type Biogas plants-Comparison. Landfilvl reactors. Origin and distribution of Geothermal energy.Types of Geothermal resources.Hydro-thermal resources-dry steam system-wet steam system.Geopressured resources- hot dry rock resources-magma resources-exploration and development of Geothermal resources. Environmental aspects.

15 hrs

4. Emerging trends in Renewable Energy Sources.

Fuel cell- Classification of fuel cells –Phosphoric acid Fuel cell(PAFC), Alkaline Fuel Cell(AFC) –Solid polymer Fuel cell(SPFC) Molten carbonate Fuel cell(MCFC) Solid oxide Fuel cell (SOFC) FUEL for FUEL cells-efficiency of a fuel cell- V I characteristics of Fuel cell. Chemical polarization- resistance polarization- concentration polarization-Fuel cell power plant hydrogen energy- production- storage conversion to energy sources and safety issues, Hydropower resources, Magneto Hydrodynamic (MHD) power conversion, MHD generator- MHD system- Thermal electric power conversion, Thermo electric power generator.

15 hrs

Texts and References:

1. B. H. Khan: Non-conventional energy resources, Tata Mc Graw-Hill, 2006.
2. Rai G. D.: Non-conventional energy sources, Khanna Pub., 4th Edn, 2000.
3. Rao S. and B. B. Parulekar: Energy Technology, Non-Conventional, Renewable and Conventional, Khanna Publications, 3rd edn., 1999.
4. Gupta B. R., Generation of electrical energy, Eurasia Publishing house, 1998

MPH 442a: Special II, Crystal Growth and Crystal Defects

1. **Theory of Crystal Growth**

Introduction, nucleation, classical theory of nucleation: Gibb's Thomson equation for vapour, modified Thomson equation for melt, Gibb's Thomson equation for solution, energy formation of a nucleus: spherical nucleus, cylindrical nucleus, Heterogeneous nucleation: cap shaped nucleus, disc shaped nucleus

Kinetics of crystal growth: Introduction, singular and rough faces, models on crystal roughness, Kossel, Stranski, Volmer (KSV) theory, Burton, Cabrera and Frank (BCF) theory, BCF theory of solution growth. **15hrs**

2. **Techniques of crystal growth from melt**

Growth from the melt: Bridgman-Stockbarger technique, container selection, crystal pulling, equilibrium, advantages and disadvantages, Czochralski technique, practice of crystal pulling, controlling parameters, convection in melts, Liquid encapsulated Czochralski technique, zone melting technique, principles of zone refining, techniques of zone refining(float zone system). **15hrs**

3. **Solution growth:** Factors governing growth of crystals from solution, expression for supersaturation, slow cooling, slow evaporation, temperature gradient method, crystal growth system, high temperature solution growth: flux growth.

Vapour growth: Introduction, physical vapour deposition, chemical vapour deposition, chemical vapour transport technique. **15hrs**

4. **Defects in crystals**

Introduction, point imperfections, concentration of point imperfections, Frenkel imperfection, Schottky imperfection, line imperfections, Edge dislocation, screw dislocation, Burger vector and Burgers circuit, presence of dislocation, dislocation motion, energy of dislocation, slip planes and slip directions, perfect and imperfect dislocations, dislocation reaction, surface imperfections: grain boundary, tilt and twist boundary, stacking faults **15hrs**

Text and References:

1. **Santhana Raghavan and Ramaswamy, Crystal growth processes and methods, K. R. U. publications, Kumbakonam.** 2000
2. **M. A. Wahab, Solid State Physics-Structure and properties of materials, Narosa publishing house, New Delhi, 1999.**
3. J.J.Gilman: The art and science of growing crystals, John Wiley and sons, New York, 1963.
4. C. Kittel: Introduction to solid state Physics, 7th Ed. John Wiley and sons, New York, 2002.
5. M. Ali Omar: Elementary solid state Physics, Addison-Wesley, 2000.
6. S. O. Pillai: Solid state Physics, New Age International Private Limited, New Delhi, 1997.
7. K.Byrappa and T Ohachi: Crystal growth technology, William Andrew Publishing, 2002.

MPH 442b: Special II, Electronic communication

1. **Amplitude modulation, Frequency modulation**

Amplitude modulation, frequency spectrum, representation of am, Power radiation in the

am wave. Generation of AM, Modulated transistor amplifiers. Single sideband techniques, Suppression of carrier, The balanced modulator, Suppression of side band filter method and phase shift method. Frequency modulation, Mathematical representation of FM, Frequency spectrum of FM wave. Phase modulation, Intersystem comparison. Pre-emphasis and De-emphasis. Generation of frequency modulation, Reactance modulator, Varactor diode modulator.

15Hrs

2. Radio receivers

Tuned radio-frequency receiver, Superheterodyne receiver. AM receivers, RF section and Characteristics, Intermediate frequency amplifiers, Detection and automatic gain control. FM receivers, Comparison with AM receivers, Amplitude limiter, FM demodulator, Balanced slope detector, Phase discriminator, Ratio detector. SSB receivers, Demodulation of SSB, product modulator and balanced modulator. Block diagrams of pilot carrier receiver and suppressed carrier receiver.

15Hrs

3. Digital communications

Pulse amplitude modulation, Pulse width modulation, Pulse position modulation, Pulse code modulation. Characteristics of data transmission circuits, Digital codes, error detection and correction. Modem classification, Modem interfacing, Interconnection of data circuits to telephone loops. Network organizations, switching systems, network protocols. Multiplexing: frequency division multiplex, time division multiplex. Coaxial cables, Fiber optic links, Microwave links, Satellite communications: uplink and downlink, Geostationary orbit, INTELSAT satellites.

15Hrs

4. Television fundamentals

Principle of television, Television systems and standards. Monochrome television transmitter block diagram, Beam scanning, Blanking and synchronizing pulses, composite video waveforms. Black and white reception: Monochrome television receiver block diagram, common video and sound circuits, Synchronizing circuits, Vertical deflection circuits, Horizontal deflection circuits. Colour transmission and reception: compatibility and colour combinations, colour transmission, colour transmitters, colour reception, picture tube requirements, colour TV receiver circuits block diagram.

15Hrs

Text and References:

1. **Kennedy & Davis, Electronic communication systems, TMGH, Fourth edition, 2005.**
2. B.P Lathi: Modern digital and analog communication systems, Oxford University press, 3rd Edition, 2003.
3. R.P. Singh and S.P.Sapre: Communication systems Analog and Digital, TMGH, 2002.
4. Dennis Roddy, John Coolen: Electronic communication, PHI, 4th Edition, 2000.
5. Frenzel: Communication Electronics, TMGH, 5th Edition, 2002.

MPH 451: Lab. 7 (General -4)

(Any ten of the following)

1. Study of nuclear counting statistics.
2. Analysis of NMR spectrum of 2-3 dibromopropionic acid.

3. Recording and analysis of spectra of NaCl using constant deviation spectrograph
4. Mass of spectroscopic binary stars and distance of Cepheid variable.
5. Study of sun spot motion and solar rotation period.
6. Determination of magnetic susceptibility by Quinke's method.
7. Analysis of hydrogen spectrum and determination of Rydberg constant.
8. Study of light dependent resistors.
9. Rotation vibration spectrum of a diatomic molecule.
10. Laser Raman spectrum of a simple molecule.
11. Study of Zeeman effect- Determination of e/m for an electron.
12. Determination of wavelength of Laser source and thickness of glass plate using Michelson Interferometer.
13. Analysis of stellar spectra.
14. Study of HR diagram

MPH 452a: Lab. 8 (Crystal Physics special -2)

1. Study of variation of dielectric constants with temperature.
2. Recording and analysis of x-ray powder photograph of KCl by Debye-Scherrer method.
3. Recording and analysis of x-ray powder photograph of Ag by Debye-Scherrer method.
4. Study of thermoluminescence in alkali halide crystal.
5. Study of single crystal rotation photograph (Bernal Chart).
6. Analysis of powder diffractogram of KCl.
7. Recording and analysis of x-ray powder photograph of KBr.
8. Measurement of ionic conductivity of crystals.
9. Study of photo-elasticity of a crystal.
10. Thermoelectric power

MPH 452b: Lab. 8 (Electronics Special-2)

1. Amplitude modulation-Using transistor BC107
2. Amplitude demodulation
3. Pulse width modulation-Using transistor SL100
4. Voltage controlled oscillator-Using IC555
5. Frequency modulation-Using IC8038
6. Frequency demodulation- Using PLL circuit-IC565
7. Frequency shift keying (FSK)-Using IC8038
8. Amplitude shift keying (ASK)- Using IC4016
9. Frequency to voltage converter-Using LM2917
10. Multivibrator-Using OP-Amp.
11. Time division multiplexing-Using Counters and FFs
12. Modulated signal transmission through optical fiber &demodulation
13. Pulse amplitude modulation-Using transistor SL100
14. PC communication through optical fiber using MAX-232

MPH 471: Educational visit / Project

1. **Educational visits (Equivalent to 10 Hours)**

Visit to minimum of **two** research Institutes

Submission of report

2. **Project (Equivalent to 40 Hours)**

   Research project under guidance, **Day book**

   Presentations (Proposal, interim, final)

   Report in the specified format