ST. JOSEPH'S COLLEGE (AUTONOMOUS)

BENGALURU-27

DEPARTMENT OF

SYLLABUS FOR POSTGRADUATE COURSE

PHYSICS

Re-accredited with 'A++' GRADE and 3.79/4 CGPA by NAAC

Recognised by UGC as College of Excellence

2020 -21 Batch

SEMESTER-I

TOPICS TO BE COVERED:

THEORY PAPERS (4 CREDITS EACH):

1. **CLASSICAL MECHANICS**
2. **MATHEMATICAL PHYSICS**
3. **NUMERICAL TECHNIQUES**
4. **EXPERIMENTAL PHYSICS- I**

BRIDGE COURSE (2 CREDITS)

1. **MATHEMATICAL PRELIMINARIES AND MECHANICS**

LAB PAPERS (2 CREDITS EACH):

1. **ANALOG ELECTRONICS**
2. **NUMERICAL TECHNIQUES**

HYBRID COURSE: THEORY+LAB (2 CREDITS)

1. **ANALYTICAL TOOLS IN MATHEMATICAL PHYSICS I**

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**1**
Title of the paper	**CLASSICAL MECHANICS**
Paper Code	**PH 7119**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning out come.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split ; the time duration for which the mid semester test and SE are conducted.)

PH 7119 - CLASSICAL MECHANICS

Lagrangian formulation :
Mechanics of a particle, Mechanics of a system of particles, Constraints, Generalized coordinates, D'Alembert's principle, Lagrange's equations of motion, Simple applications of the Lagrangian formulation, Galilean invariance of Lagrange's equations 11hrs

Variational principle :
Hamilton's principle; Some techniques of the calculus of variations – applications – shortest distance problem, Brachistochrone; Derivation of Lagrange's equation from Hamilton's principle; Conservation theorems and symmetry properties – integrals of motion, cyclic coordinates, Jacobi's integral 8hrs

Central force :
Two body central force problem – Reduction to the equivalent one body problem; Equations of motion and first integrals; Classification of orbits; The Virial theorem; Differential equation for the orbit, integrable power-law potentials; The Kepler problem – inverse square law of force, motion in time in Kepler problem; Scattering and differential scattering cross-section 15hrs

Hamiltonian formulation :
Legendre transformations, Hamilton's equations of motion – Canonical variables; Cyclic coordinates and conservation theorems in Hamiltonian formulation; Derivation of Hamilton's equations from a variational principle; Canonical transformations – Generating functions, examples; Poisson brackets and other canonical invariants; Equations of motion and conservation theorems in Poisson bracket formulation; Phase-space; Liouville's theorem 10hrs

Continuum Mechanics:
Strings, D'Alembert's solution to the wave equation – Energy density and energy current; Reflection at an interface; Mass point on a string; Interface between strings of different mass density, Finite strings – Bernoulli's solution, Sturm-Liouville Theory – Variational method, Continua in Higher dimensions – Membranes; Helmholtz equation; Rectangles; Circles; Sound in fluids, Dispersion
10hrs

Rotational motion:
Rotating frame of reference, inertial forces in rotating frames, Coriolis force, Foucault pendulum, Deviation due east of a falling body 6hrs

Reference Books :

1. Classical Mechanics by H.Goldstein, Narosa Publishing Home, New Delhi.
2. Classical Dynamics of Particles and Systems by Marion and Thornton, 5th Edition, Cengage
3. Classical Mechanics, John R. Taylor, University Science Books, 2005
4. Classical Mechanics by P.V.Panat, Narosa Publishing Home,, New Delhi.
5. Classical Mechanics by N.C.Rana and P.S.Joag, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.
5. Introduction to Classical Mechanics by R.G.Takwale and P.S.Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi

MODEL BLUEPRINT

(Part of the syllabus)

Code number and Title of the paper : **PH 7119 - CLASSICAL MECHANICS**

Chapter	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
Lagrangian formulation	11	20
Variational principle	8	15
Central force	15	25
Hamiltonian formulation	10	15
Continuum Mechanics	10	15
Rotational motion	6	10
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

The syllabus title must be as given below:
DEPARTMENT OF PHYSICS

Semester	**1**
Title of the paper	**MATHEMATICAL PHYSICS**
Paper Code	**PH 7219**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning outcome.

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PH 7219 - MATHEMATICAL PHYSICS

(4 Credits - 4 Hours/Week)

Linear Algebra: Functions and continuous basis, Functional transformations, Closure condition and completeness, One-One correspondence to vector spaces 5 hrs

Complex analysis: Taylor and Laurent series, calculus of residues, contour integrations, introduction to analytic continuation and Riemann surfaces 12hrs

Fourier analysis: Fourier series, Fourier integral and transform, Dirac Delta Functions, convolution theorem, Parseval's identity, 10hrs

Special functions: Legendre, Laguerre and Hermite Functions, Bessel's function of 1st kind, spherical Bessel function, spherical harmonics generating function, recurrence relations, 15hrs

Tensors: Tensor Analysis, Pseudotensors and Dual Tensors, Tensors in General Coordinates, Jacobians 8 hrs

Differential Equations:

Partial Differential Equations: Helmholtz, Laplace, Poisson equations in all three coordinates, Separation of variables, Integral transforms**,** change of variables, method of characteristics, applications: wave, heat and diffusion equations 10 hrs

Reference Books :

1. Mathematical methods for Physicists - Arfken & Weber - 6 Edition-Academic Press- N.Y.
2. Mathematics for Physical Sciences - Mary Boas, John Wiley & Sons
3. Linear Algebra - Seymour Lipschutz, Schaum Outlines Series- Mc-Graw Hill edition
4. Mathematical Methods of Physics - Mathews & Walker - 2 Edition- Pearson Edition
5. Mathematical Methods in Physics - Butkov Addison Wesley Publishers.
6. Advanced Engineering Mathematics, E. Kreyszig, 7 Edition, New Age International
7. Complex Variables and Applications - J.W.Brown, R.V.Churchill - (7 Edition)-

Mc-Graw Hill - Ch. 2 to 7.
8. Complex Variables - Seymour Lipschutz
9. Fourier Series - Seymour Lipschutz, Schaum Outlines Series
10. Laplace Transform - Seymour Lipschutz, Schaum Outlines Series
11. Mathematics of Classical and Quantum Physics - Byron, Fuller Dover (1992)
12. Mathematical physics, applications and problems - V. Balakrishnan (2017)
13. Differential and Integral Calculus - N. Piskunov (1969)

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(Part of the syllabus)

Code number and Title of the paper: **PH 7219 - MATHEMATICAL PHYSICS**

Chapter	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
Linear algebra	5	10
Complex analysis	15	25
Fourier analysis	10	15
Special functions	12	20
Tensors	8	15
Differential Equations	10	15
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**1**
Title of the paper	**NUMERICAL TECHNIQUES**
Paper Code	**PH 7319**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning outcome.

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PH 7319 - NUMERICAL TECHNIQUES

Interpolation and Curve fitting: Introduction to interpolation, Lagrange approximation, Linear interpolation. Problems

6 hrs

Numerical Differentiation and Integration: Approximating the derivative, numerical differentiation formulas, introduction to quadrature, trapezoidal and Simpson's rule, Applications.

10 hrs

Solutions of ODE: Initial value and boundary value problems, Euler's and Runge-Kutta Methods(up to second order)

6 hrs

Fourier Techniques: Fourier transforms, time series analysis, correlation, convolution applications of FT in various field.

8 hrs

Introduction to probability and statistical methods: Elementary statistical concepts and examples, random walk problem in one dimension, calculation of mean values for the random walk problem, probability distribution for large N, gaussian probability distributions, probability distribution involving several variables.

15 hrs

Statistical Inference: Model fitting and parameter estimation: Least square fits, Mean from least square fits, Multiparameter estimation, Goodness of fit, Confidence regions, Maximum Likelihood Methods:, Goodness of fit and confidence from maximum likelihood, Estimating parameter uncertainty, Hypothesis testing: Bayes Theorem, Updating the probability of a hypothesis, A priori distribution, Monte-Carlo Methods

15 hrs

Reference Books:

1. K. E. Atkinson, Numerical Analysis, John Wiley (Asia) (2004).
2. S. C. Chapra and R. P. Canale, Numerical Methods for Engineers, Tata McGraw Hill (2002).

References:

3. J. H. Mathews, Numerical Methods for Mathematics, Science, and Engineering, Prentice
Hall of India (1998).
4. S. S. M. Wong, Computational Methods in Physics, World Scientific (1992).
5. W. H. Press, S. A. Teukolsky, W. T. Verlling and B. P. Flannery, Numerical Recipes in C,

Cambridge (1998).
6. S. E.Koonin: *Computational Physics,* Benjamin/Cummings (Menlo Park, CA) 1986
7. R. Lupton: Statistics in Theory and Practice, Princeton University Press

Online texts :

Numerical Recipes online:http://library.lanl.gov/numerical/bookfpdf.html
P. Pacheco's User Guide to MPI:ftp://math.usfca.edu/pub/MPI/mpi.guide.ps
MPI online at
NERSC:http://www.nersc.gov/nusers/help/tutorials/mpi/intro/print.php
S. E.Koonin's Computational Physics Fortran codes:
http://www.computationalphysics.info
W. Krauth's Introduction to Monte Carlo:
http://www.lps.ens.fr/~krauth/budapest.pdf

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(Part of the syllabus)

Code number and Title of the paper: **PH 7319 - NUMERICAL TECHNIQUES**

Chapter number	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
Interpolation and curve fitting	6	10
Numerical Differentiation and Integration	10	15
Solution of ODE	6	10
Fourier Techniques	8	15
Probability and Statistics	15	25
Statistical Inference	15	25
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**1**
Title of the paper	**EXPERIMENTAL PHYSICS I**
Paper Code	**PH 7419**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning outcome.

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PH 7419 - EXPERIMENTAL PHYSICS I

Error Analysis: Sources, propagation and analysis.

Transducers and Sensors: Characteristics - sensitivity, reproducibility, selecting a transducer and classification of transducers.
Transducers : Displacement: Resistive,capacitative and inductive. Signal conditioning using constant voltage potentiometric circuit.
Velocity: Linear velocity, Angular velocity: AC, DC and contactless tachometers.
Acceleration
Strain: Strain gauges: wire, metal foil and semiconductor type.
Temperature: RTD, thermister and thermocouple
Pressure: Bellow, Bourdon tube and Diaphram gauge. Diamond anvil cell for very high pressures. 20 Hrs

Measuring physical properties:

Thermal expansion: Interference, capacitance and LVDT methods. Thermal conductivity of good and poor conductors. Thermal diffusivity using periodic heating. Phase transitions using differential scanning calorimeter.

10Hrs

Electrical Properties:
Resistance: Two-probe and four-probe methods. DC and AC methods. High resistance by leakage.
Magnetic field: Search coil, Magnetoresistance- GMR and AMR and Hall probe methods
Magnetic susceptibility: AC susceptibility and Vibration sample magnetometer

10hrs

Signal Conditioning: Introduction, Block diagram of signal conditioning, review of op-amp basics, Integrator, differentiator using IC 741, Schmitt trigger, waveform generators. Practical differentiator, Practical integrator. Basic Instrumentation amplifier-important features, differential instrumentation amplifier using transducer Bridge, Logarithmic amplifier.

10 hrs

Data Acquisition And Conversion, Scalers And Counters: General data acquisition system (DAS), objective of DAS, Single-channel and multi-channel DAS block diagrams, Digital to Analog converter: R-2R ladder and binary-weighted ladder circuits. Analog to Digital converter- Flash and Successive approximation method,block diagram explanation,Scalers and Counters. 10 hrs

Reference Books:

1. Experimental Physics: R.A. Dunlap, Oxford University Press 1988
2. The Art of Experimental Physics, Dietz Preston, Eric S. Dietz, Barnes and Noble, 2001
3. An Introduction to Experimental Physics, Colin Cooke, London; UCL Press (Pennsylvania)
4. Introduction to nuclear science, Bryan J.C., Lavoisier Libraire 2008
5. Electronic Instrumentation and Measuring Techniques, W.D. Cooper, A.D. Helfrick 3rd Edition, PHI, 2000
6. A Course in Electrical, Electronics Measurement and Instrumentation, A.K. Sawhney, Dhanpat Rai & sons, 1996
7. Instrument transducers, Hermann KP Neubert, Second Edition, Oxford University Press, 1988.

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(Part of the syllabus)

Code number and Title of the paper: **PH 7419 - EXPERIMENTAL PHYSICS I**

Chapter	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
Transducers and Sensors	20	35
Measuring physical properties	20	35
Signal Conditioning	10	15
Data Acquisition And Conversion, Scalers And Counters	10	15
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**1**
Title of the paper	**MATHEMATICAL PRELIMINARIES AND NEWTONIAN MECHANICS**
Paper Code	**PHBC 7119**
Number of teaching hours per week	**2**
Total number of teaching hours per semester	**30**
Number of credits	**2**

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PHBC 7119 Mathematical Preliminaries and Mechanics

(2 Credits - 2 Hours/Week)

Vectors and vector spaces:

1. Vector Analysis: Review of basic properties, vector in 3-d spaces, differential vector operators, vector integration, curvilinear coordinates, Coordinate Transformations and Jacobians 5 hrs
2. Vector Spaces: Gram-Schmidt orthogonalization, self-adjoint operators, unitary operators, transformation of operators, vector spaces 3 hrs

Complex Analysis:

Analytic functions, Cauchy-Riemann conditions, Cauchy's theorem 3 hrs

Eigenvalue Problems:

1. Eigenvalue equations, matrix eigenvalue problems, hermitian eigenvalue problems, hermitian matrix diagonalization, normal matrices 4 hrs

Mechanics: Geometric representation of kinematic equations, Vectorial treatment of dynamics, Representative problems: (e.g. inclined plane, simple pendulum, Atwood machine, double pendulum, pendulum with a spring, etc.)

15 hrs

Reference Books :

1. R. S. Aggarwal, Senior Secondary Mathematics
2. Mathematics by R.D. Sharma, Dhanpat Rai Publications
3. A very short introduction to mathematics - Timothy Gowers, Oxford University press
4. Introduction to Classical Mechanics - Takwale, R.G. and Puranik, P.S., McGraw Hill (1978)
5. University Physics Vol. 1 - Young, Hugh D. and Freedman, Roger A., Pearson Education Limited (2016)
6. Concepts of Physics Vol. 1 - Verma, H.C., Bharati Bhavan (1992)
7. Principles of Physics - Halliday, D., Resnick, R. and Walker, J., Wiley (2015)
8. Classical Mechanics - Srinivasa Rao, K.N., University Press (2003)
9. Classical Mechanics - Kagali, B.A. and Shivalingaswamy T., Himalaya Publishing House (2008)

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(Part of the syllabus)

Code number and Title of the paper:

PHBC7119 - MATHEMATICAL PRELIMINARIES AND MECHANICS

Chapter	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
Vector Analysis	6	10
Vector Spaces	4	5
Eigenvalue Problems	5	10
Mechanics	15	25
Total marks excluding bonus questions		35
Total marks including bonus questions		50

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:
DEPARTMENT OF PHYSICS

Semester	**1**
Title of the paper	**Analog Electronics**
Paper Code	**PH7P1**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**50**
Number of credits	**2**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning out-come.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split; the time duration for which the mid-semester test and SE are conducted.)

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**1**
Title of the paper	**Numerical Techniques Lab**
Paper Code	**PH7P2**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**50**
Number of credits	**2**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning out-come.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split; the time duration for which the mid-semester test and SE are conducted.)

Labs for Semester I (4 Credits 8 Hours/Week)	
PH7P1 - Analog Electronics	
Op-amp inverting-non inverting and Summing amplifier	Power Method for Eigenvalues
Integrator and Differentiator	Gauss Elimination
Wien bridge oscillator	Linear Interpolation
Triangular wave generator	Lagrange Interpolation
Precision rectifier (Half and Full wave) Using OP27 and OP37	Numerical Differentiation and Nature of numerical errors
Schmitt trigger and difference amplifier	Trapezoidal Rule
Square wave generator	Simpson's 1/3 and 2/3 method
Design a circuit with real-time application using IC 741 and the concepts learnt in this lab.	Euler's Method for Solving Differential Equations
Triangular Wave generator	Runge Kutta Order 2 method with application to SHO problem
First-order low pass and high pass filter	Runge Kutta Order 4 method with application to SHO problem
Signal conditioning with an instrumentation amplifier	Normal Distributions
Second-order Band Pass and Band Reject filters	Poisson Distributions
	Fitting a Gaussian Function
	Fast Fourier Transform
	Monte Carlo Methods

The syllabus title must be as given below:
DEPARTMENT OF PHYSICS

Semester	**1**
Title of the paper	**Introduction to Analytical Tools for Mathematical Physics**
Paper Code	**PH7519**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**50**
Number of credits	**2**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning out-come.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split; the time duration for which the mid-semester test and SE are conducted.)

Introduction to Analytical Tools for Mathematical Physics (2 Credits, 4 Hours/Week)	
1. Introduction to Core Python Programming and Numpy	10hrs
2. Introduction to Computer Algebra System (CAS) Maxima	8 hrs
3. Vector Spaces Using Maxima a. Bases, Components, Row and Column representations b. Plotting 3d vectors: plot3d, draw3d, vectr and draw packages c. matrix(), ctranspose(), sqrt(), ratsimp(), %i, %pi, unitvector(), realpart(), acos(), rootscontract() d. Linear Independence, orthogonality and Gram-schmidt e. Significance of Eigenvalues and Eigenvectors Gram-Schmidt Orthogonalization f. Equations and their roots in maxima g. Outer products, tensor products, closure condition	32hrs

SEMESTER-II

TOPICS TO BE COVERED:

THEORY PAPERS (4 CREDITS EACH):

1. **ELECTRODYNAMICS**
2. **EXPERIMENTAL PHYSICS II**
3. **STATISTICAL PHYSICS**
4. **QUANTUM MECHANICS**

BRIDGE COURSE (2 CREDITS)

1. **MODERN PHYSICS AND ELECTRICITY**

LAB PAPERS (2 CREDITS EACH):

1. **GENERAL PHYSICS**
2. **DIGITAL ELECTRONICS**

HYBRID COURSE: THEORY+LAB (2 CREDITS)

1. **ANALYTICAL TOOLS IN MATHEMATICAL PHYSICS II**

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**2**
Title of the paper	**ELECTRODYNAMICS**
Paper Code	**PH 8119**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning outcome.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split; the time duration for which the mid-semester test and SE are conducted.)

PH 8119 - ELECTRODYNAMICS

Multipole expansions and material media: Multipole expansions for a localised charge distribution in free space, Magnetostatics-Divergence and curl of a magnetic field, magnetic vector potential, it's multipole expansion, static electric and magnetic fields in material media, Boundary condition

10 hrs

Time-varying fields: Time dependents field, Faraday's law for stationary and moving media, Maxwell's displacement current, Differential and Integral forms of Maxwell's equations, Maxwell's equations for material medium. 6hrs

Energy, Force and Momentum relations in electromagnetic fields: Energy relations in quasi-stationary current systems, Magnetic interaction between two current loops, Energy stored in electric and magnetic fields, Poynting's theorem, General expression for electromagnetic energy, Conservation laws. 6hrs

Electromagnetic wave equations: Electromagnetic wave equations, Electromagnetic plane waves in a stationary medium, Reflection and refraction of electromagnetic waves at plane boundaries (Oblique incidence), Electromagnetic waves in conducting medium, Skin effect and skin depth. 8hrs

Inhomogeneous wave equations: Inhomogeneous wave equations, Lorentz's and Coulomb's gauges, Gauge transformations, Wave equations in terms of electromagnetic potentials, D'Alembertian operator, Retarded Potentials-Jefimenko's equations, Lienard-Wiechert Potentials, Dipole radiation, Electric dipole radiation, point charge,Radiation energy and Radiation resistance.

15 hrs

Relativistic Kinematics: Experimental basis for the special theory of relativity (Michelson - Morley experiment), 2 Lorentz transformations, Relativistic velocity addition, Mass- Energy relation (E=mc2).

4hrs

Covariance and Relativistic Mechanics: Minkowski's space-time diagram, light cone, Four vectors, Lorentz transformation of Four vectors, Some tensor relations useful in special relativity, Minkowski's force. 6hrs

Covariant formulation of electrodynamics: Magnetism as a relativistic phenomenon, Electromagnetic field tensor, Lorentz force on a charged particle. 5hrs

Reference Books:

1. Introduction to Electrodynamics, (3 Edition) by David J.Griffith. Prentice-Hall of India, New Delhi
2. Introduction to Electrodynamics, by A.Z.Capri and P.V.Panat, Narosa Publishing House
3. Classical electricity & Magnetism, by Panofsky and Phillips, Addison Wesley
4. Foundations of Electromagnetic theory, by Reitz & Milford, World student series Edition.
5. Classical Electrodynamics, by J.D.Jackson, 3 Edition John Wiley.
6. Electromagnetic theory and Electrodynamics, by Satya Prakash, Kedar Nath and co.Meerut.
7. Special Theory of Relativity, by Robert Resnick.
8. Electromagnetics by B.B.Laud, Willey Eastern.
9. Matrices and Tensors in Physics, A. W. Joshi, 3 Edition, New Age International
10. Modern Electrodynamics, Andrew Zangwill, Cambridge University Press (2013)
11. Electricity and Magnetism, Purcell, E.M., Morin, D.J., Cambridge University Press (2013)

MODEL BLUEPRINT

(Part of the syllabus)

Code number and Title of the paper: **PH 8119 - ELECTRODYNAMICS**

Chapter	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
Multipole expansions and material media	10	15
Time-varying fields	6	10
Energy, Force and Momentum relations in electromagnetic fields	6	10
Electromagnetic wave equations	8	15
Inhomogeneous wave equations	15	25
Relativistic Kinematics	4	5
Covariance and Relativistic Mechanics	6	10
Covariant formulation of electrodynamics	5	10
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**IV**
Title of the paper	**EXPERIMENTAL PHYSICS-II**
Paper Code	**PH 8219**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

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PH 8219 - EXPERIMENTAL PHYSICS-II

Vacuum techniques: Vacuum hardware, gas flow regimes, pumping speed, conductance.
Pumps for producing vacuum: their classification - rotary vane, oil diffusion, turbomolecular, sputter-ion, cryopump.Getters – their characteristics and types.

10hrs

Vacuum measurement: Gauges for measuring low pressure – mechanical, thermal conductivity and ionization gauge- thermionic and penning.
Leak and leak detection, mass spectrometers. Some typical vacuum systems.

10hrs

Thin-film coating: Evaporative coating, Sputtering – Dynamics of glow discharge plasma, DC or plasma sputtering and AC sputtering, sputter yield. Laser ablation Technique. 10hrs

Techniques to measure the thickness of film and study surface profiles :
Transmission and Scanning Electron Microscopes and applications. Surface probe techniques: AFM, STM, MFM, their applications.

10hrs

Low-temperature techniques: Properties of cryogenic fluids, Cryogens and their applications - Liquid nitrogen, liquid hydrogen, Liquid Helium-I and II(phase diagram and thermodynamics of second-order phase transition), methods of producing low temperature- adiabatic expansion, Joule-Thomson throttling(JT) and Adiabatic Demagnetisation -thermodynamics of these processes; Liquefaction of Hydrogen and Helium using JT method, Bose-Einstein Condensate- laser cooling of atoms, Cryostat - bath and continuous flow cryostat; Cryocoolers- Stirling, Gifford McMahon and pulse tube type; Low-temperature measurement.

20 hrs

Reference Books:

1. Experimental Physics: R.A. Dunlap, Oxford University Press 1988
2. The Art of Experimental Physics, Dietz Preston, Eric S. Dietz, Barnes and Noble, 2001
3. An Introduction to Experimental Physics, Colin Cooke, London; UCL Press (Pennsylvania)
4.Material Science of Thin films, Milton Ohring, Second Edition2001, Academic press.
5.Electron microscopy and analysis, Peter J Goodhew, John Humphreys, Richard Beanland,
3rd edition, 2000.
6.Scanning probe Microscopy and Spectroscopy Theory and Applications, Second Edition

Edited by Dan Bonnell, Wiley VCH, 2001.
7.Scanning Probe Microscopy–The Lab on a tip, Ernst Meyer, Hans J. Hug, Roland Bennewitz, Springer Verlag New York, 2003.
8.Cryogenics and Property Measurements at Low Temperatures, R.Srinivasan, A.K. Ray Chaudhari
and S. Kasturirangan, Allied Publishers.
9.Manual on the Experiments with IAS kit by R.Srinivasan.

MODEL BLUEPRINT

(Part of the syllabus)

Code number and Title of the paper: **PH 8219 - EXPERIMENTAL PHYSICS-II**

Chapter	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
Vacuum techniques	10	15
Vacuum measurement	10	15
Thin-film coating	10	15
Techniques to measure thickness of film and study surface profiles	10	15
Low-temperature techniques	20	40
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**2**
Title of the paper	**STATISTICAL PHYSICS**
Paper Code	**PH 8319**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning outcome.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split; the time duration for which the mid-semester test and SE are conducted.)

PH 8319 - STATISTICAL PHYSICS

Statistical Description of System of Particles: Specification of the state of the system, Macroscopic and Microscopic states, Phase space, Statistical ensemble, Postulate of equal a priori probability, Probability calculations, Behaviour of the density of states, Liouville's theorem(Classical), Quasi-static processes. 5hrs

Statistical Thermodynamics: Equilibrium conditions and constraints, Distribution of energy between systems in equilibrium, Approach to thermal equilibrium, Temperature, Heat reservoir, Sharpness of the probability distribution, Dependence of the density of states on the external parameters, Equilibrium between interacting systems. 6hrs

Classical Statistical Mechanics: Microcanonical ensemble, System in contact with heat reservoir, Canonical ensemble, Applications of canonical ensembles (Paramagnetism, Molecule in an ideal gas, Law of atmosphere), System with specified mean energy, Calculation of mean values and fluctuations in a canonical ensemble, Connection with thermodynamics, Grand-canonical ensemble, Physical interpretation of a chemical potential in the equilibrium state, Mean values and fluctuations in grand canonical ensemble, Thermodynamic functions in terms of the Grand partition function. 8hrs

Applications of Statistical Mechanics: Classical partition functions and their properties, Calculations of thermodynamic quantities, Ideal mono-atomic gas, Gibbs paradox, Equipartition theorem and its Simple applications. i) Mean kinetic energy of a molecule in a gas ii) Brownian motion iii) Harmonic Oscillator iv) Specific heat of solid. Maxwell velocity distribution, Related distributions and mean values. 12hrs

Quantum Statistics of Ideal Gases: Symmetry of wave functions, Quantum distribution functions, Boltzmann limit of Boson and Fermion gases, Evaluation of the partition function, Partition function for diatomic molecules, Equation of state for an ideal gas, The quantum mechanical paramagnetic susceptibility. 11hrs

Ideal Bose System: Photon gas - i) Radiation pressure ii) Radiation density iii) Emissivity iv) Equilibrium number of photons in the cavity. Einstein derivation of Planck's law, Bose-Einstein Condensation, Specific heat, Photon gas - Einstein and Debye's model of solids. 9hrs

Ideal Fermi System: Fermi energy, Mean energy of fermions at absolute zero, Fermi energy as a function of temperature, Electronic specific heat, White - Dwarfs, Compressibility of Fermi gas, Pouli's paramagnetism, A relativistic degenerate electron gas. 9hrs

Reference Books :

1. Fundamentals of Statistical and Thermal Physics, - F.Reif, McGraw - Hill, International Edition (1985)
2. Fundamentals of Statistical Mechanics, B.B.Laud, New Age International Publication (2003)
3. Statistical Mechanics, R.K.Pathria, Bufferworgh Heinemann(2 Edition)
4. An Introduction to Statistical Mechanics and Thermodynamics, Robert H. Swensden, Oxford University Press (2012)
5. Statistical Physics of Particles, Mehran Kardar, Cambridge University Press (2007)
6. Statistical Mechanics, K.Huang, John Willey & Sons (2 Edition)
7. Statistical Mechanics by Lokanathan and Gambhir.

MODEL BLUEPRINT

(Part of the syllabus)

Code number and Title of the paper: **PH 8319 - STATISTICAL PHYSICS**

Chapter	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
Statistical Description of System of Particles	5	10
Thermodynamics	6	10
Classical Statistical Mechanics	8	10
Applications of Statistical Mechanics	12	20
Quantum Statistics of Ideal Gases	11	20
Ideal Bose System	9	15
Ideal Fermi System	9	15
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**2**
Title of the paper	**QUANTUM MECHANICS - I**
Paper Code	**PH 8419**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning outcome.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split; the time duration for which the mid-semester test and SE are conducted.)

PH 8419 - QUANTUM MECHANICS - I

One Dimensional Problem:

Particle in a box problem: Particle in an infinite potential as a prototypical problem in quantum mechanics: Wavefunctions, Energy Eigenvalues, Superposition of Wavefunctions (comparison with Fourier Series).moved to bridge course - comparison with the free particle wavefunction, Momentum Wavefunction (Fourier transform and Parseval's Theorem - normalization in position space and momentum space; use of Contour Integrals). Momentum and position expectation values in Momentum space
Finite wells and barriers
Simple Harmonic Oscillator: Analytical Method

14hrs

Postulates of quantum mechanics: Representation of states and dynamical variables, observables, self-adjoint operators, eigenfunctions and eigenvalues, degeneracy, Dirac delta function, Completeness and closure property, Physical interpretation of eigenvalues, eigenfunctions and expansion coefficients, eigenvalues and eigenfunctions of the momentum operator. Hilbert space, Dirac's bra and ket notation, dynamical variables and linear operators generalized uncertainty principle using Schwarz inequality, projection operators, unit operator, unitary operator, matrix representation of an operator, change of basis, unitary transformation. Eigenvalues and eigenfunctions of a simple harmonic oscillator by operator method. Ehrenfest Theorem

15hrs

Time Evolution of a system: Constants of motion, Schrodinger and Heisenberg picture

3hrs

Quantum Mechanics in Two Dimensions with Particle in a 2-D box as an example. Degeneracies. 2hrs

Quantum Mechanics in Three Dimensions: Separation of variables and orthogonalization; Hydrogen Atom Problem: Radial Solutions (Associated Laguerre functions included).

8hrs

Angular Momentum: Angular momentum equations - separation of variables. Associated Legendre equations. L^2 operator; eigenvalues and eigenfunctions of L^2 and Lz operators, ladder operators L_+ and L_-, Pauli theory of spins(Pauli's matrices), angular momentum as a generator of infinitesimal rotations, matrix representation of J in |jm> basis. Addition of angular momenta, Computation of Clebsch-Gordan coefficients in simple cases (J1=1/2, J2=1/2). (Associated Legendre included) 18hrs

Reference books:

1. Concepts of Modern Physics - A. Beiser
2. Introduction to Quantum Mechanics by David J.Griffiths
3. Introduction to Quantum Physics by Claud Cohen-Tannoudji, Bernard Diu, Frank Laloe, 3rd Edition, Herman and John Weily, Ltd.
4. Introductory Quantum mechanics by Granier, Springer Publication.
5. Introductory Quantum Mechanics, Liboff, 4 Edition, Pearson Education Ltd.
6. A Text-book of Quantum Mechanics by P.M.Mathews and K.Venkatesan.
7. Modern Quantum mechanics by J.J.Sakurai
8. Quantum Physics by R. Eisberg and R.Resnick
9. Quantum Mechanics by L.I.Schiff
10. Quantum mechanics by A.Ghatak and S.Lokanathan
11. Quantum Mechanics: Concepts and Applications by Nouredine Zettili, Wiley (2009)
12. Quantum Mechanics I: The Fundamentals by S. Rajasekar and R. Velusamy, CRC Press, Taylor and Francis Group (2015)

MODEL BLUEPRINT

(Part of the syllabus)

Code number and Title of the paper: **PH 8419 - QUANTUM MECHANICS - I**

Chapter	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
One dimensional problem	14	20
Postulates of quantum mechanics	15	25
Time Evolution	3	5
Quantum Mechanics in two dimensions	2	5
Quantum Mechanics in Three Dimensions	2	5
Hydrogen Atom Problem: Radial Solution	6	10
Angular Momentum	18	30
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:
DEPARTMENT OF PHYSICS

Semester	**1**
Title of the paper	**MODERN PHYSICS AND ELECTRICITY**
Paper Code	**PHBC 8119**
Number of teaching hours per week	**2**
Total number of teaching hours per semester	**30**
Number of credits	**2**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning outcome.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split; the time duration for which the mid-semester test and SE are conducted.)

PHBC 8119 Modern Physics and Electricity
(2 Credits - 2 Hours/Week)

Modern Physics

Inadequacy of Classical Physics

Particle properties of waves: Electromagnetic waves, UV Catastrophe, Black body radiation, Photoelectric effect, Compton effect derivation and problem solving.
Wave properties of particles: De Broglie waves, Phase and group velocities (derivation), particle in a box, Heisenberg's Uncertainty principle.

5 hrs

Quantum Mechanics The wave equation, wave packet, wave function and normalising a wave function, Schrodinger's equation: time-dependent and independent form, Linearity and superposition, Expectation values, operators.

3 hrs

Free Particle Problem: Wavefunction, normalization, Fourier form, Fourier components as amplitude, momentum wavefunction, time derivative and position derivative and diffusion equation

7 hrs

Electricity

Vector Analysis Revision:

Vector Algebra, Differential Calculus - Gradient, Divergence and Curl, Integral Calculus - Fundamental theorem of Gradient, Divergence and Curl, Curvilinear Coordinates - Spherical polar and Cylindrical

5 hrs

Electrostatics:

Electric field, Coulomb's law, field lines, flux, Gauss's law and its applications, Electric potential- Poisson's and Laplace's equations, Boundary value problems, Conductors-basic properties, induced charges-volume and surface and capacitors.

10 Hrs

MODEL BLUEPRINT

(Part of the syllabus)

Code number and Title of the paper: **PHBC8119 - MODERN PHYSICS AND ELECTRICITY**

Title	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
Inadequacies of classical physics	5	5
Quantum Mechanics	3	5
Particle in a box problem	7	10
Vector Analysis Revision	5	10
Electrostatics	10	15
Total marks excluding bonus questions		35
Total marks including bonus questions		50

Formula to calculate the maximum marks for each chapter:

$$\frac{\text{Number of teaching hours allotted for that chapter} \times \text{maximum marks (including marks for bonus questions}}{\text{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**2**
Title of the paper	**General Physics Lab**
Paper Code	**PH8P1**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**50**
Number of credits	**2**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning outcome.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split; the time duration for which the mid-semester test and SE are conducted.)

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**2**
Title of the paper	**Digital Electronics Lab**
Paper Code	**PH8P2**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**50**
Number of credits	**2**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning outcome.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split; the time duration for which the mid-semester test and SE are conducted.)

Labs for Semester II (4 Credits 8 Hours/Week)	
PH8P1 - General Physics	**PH8P2 Digital Electronics**
Comparison of capacitances	RS flip flop and decade counter
Stefan's constant	Astable and monostable multivibrator
Thermal relaxation	DAC: Weighted resistors and R-2R network
Cu-Constantan Thermocouple and Si diode	Amplitude Modulation and demodulation
Thermal and electrical conductivity of copper	Frequency Modulation and demodulation
High resistance by leakage	Pulse amplitude modulation and demodulation
Passive filters	ADC – IC 0804
AC bridges	Multiplexer and demultiplexer
Absorption spectrum of copper sulphate	Voltage-controlled oscillator: IC 555 and phase Lock Loop IC 565
Thermal diffusivity	Frequency multiplication
	DAC – IC 1408
	Design a circuit with a real-world application using the concepts learnt in this lab.

The syllabus title must be as given below:
DEPARTMENT OF PHYSICS

Semester	**2**
Title of the paper	**Introduction to Analytical Tools for Mathematical Physics**
Paper Code	**PH8519**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**50**
Number of credits	**2**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning outcome.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split; the time duration for which the mid-semester test and SE are conducted.)

Introduction to Analytical Tools for Mathematical Physics (2 Credits, 4 Hours/Week)	
1. Complex variables using Maxima and Python a. Meaning of analyticity and Plotting a complex function in maxima b. Contour plots of functions in maxima and python c. Convergence of series using maxima d. Residues of complex functions using maxima	16hrs
2. Integrals in Maxima	8hrs
3. Fourier Analysis: a. Fourier series in maxima b. Convolution example(s) in maxima	10hrs
4. Special functions in maxima a. Comparing Bessel function series to built-in Bessel functions b. Built-in functions: Hermite, Legendre, Laguerre	16hrs

SEMESTER-III

TOPICS TO BE COVERED:

THEORY PAPERS (4 CREDITS EACH):

1. **QUANTUM MECHANICS-II**
2. **SOLID STATE PHYSICS**
3. **MODERN OPTICS**
4. **OPEN ELECTIVE**
5. **SOFT CORE (ASTROPHYSICS)**

LAB PAPERS (2 CREDITS EACH):

1. **SOLID STATE PHYSICS**
2. **OPTICS**

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**III**
Title of the paper	**QUANTUM MECHANICS - II**
Paper Code	**PH 9118**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning out come.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split ; the time duration for which the mid semester test and SE are conducted.)

PH 9118 - QUANTUM MECHANICS - II

Angular Momentum : Angular momentum equations - separation of variables. Associated Legendre equations. L^2 operator ; eigenvalues and eigenfunctions of L^2 and Lz operators, ladder operators L_+ and L_-, Pauli theory of spins(Pauli's matrices), angular momentum as a generator of infinitesimal rotations, matrix representation of J in |jm> basis. Addition of angular momenta, Computation of Clebsch-Gordan coefficients in simple cases (J1=1/2, J2=1/2).

(15hrs)

Symmetry in Quantum Mechanics : Symmetry Parity, Identical particles, symmetric and antisymmetric wave functions, Slater determinant, collision of identical particles, spin functions for system with more than one electron.

(10 hrs)

Approximation Methods :

1. Variational method: Basic principles and applications to particle in a box, SHO, hydrogen atom.

   (5 hrs)

2. WKB approximation : Qualitative development and condition for validity of this approx., Bohr's quantization condition, applications to tunnelling such as a-particle, field emission.

   (5 hrs)

3. Time-independent Perturbation theory: Non degenerate and degenerate cases (upto second order). (4hrs)
   a. Applications: Stark effect, (2hrs)
   b. Applications: Anharmonic oscillator (2hrs)
   c. Applications: Zeeman effect (7hrs)

4. Time-dependent Perturbation theory: Transition amplitude 1 and 2 order, selection rules, constant perturbation(1st order). Fermi's golden rule, Harmonic perturbation, Interaction of atom with em radiation, dipole approx. Einstein coefficient for spontaneous emission
   (10hrs)

Reference Books :

1. Introduction to Quantum Physics by Claud Cohen-Tannoudji, Bernard Diu, Frank

Laloe, 3rd Edition, Herman and John Weily, Ltd.
2. Introduction to quantum mechanics by D.I.Griffiths (Pearson Education)(II Edition)
3. Quantum Mechanics Concepts and Applications, Nouredine Zettili, Wiley
4. A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, Tata McGraw Hill
5. Modern Quantum Mechanics by J.J.Sakurai
6. Quantum Mechanics by L.I.Schiff, McGraw Hill
7. Quantum Physics by R.Eisberg and R.Resnick(Wiley and Sons)
8. Quantum Mechanics by A.Ghatak and S.Lokanathan, Macmillan India Ltd.
9. Quantum Mechanics, G. Aruldhas

MODEL BLUEPRINT

(Part of the syllabus)

Code number and Title of the paper : **PH 9118 - QUANTUM MECHANICS - II**

Chapter number	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
1 Angular Momentum	15	25
2 Symmetry in Quantum Mechanics	10	15
3 Variational method	5	10
4 WKB approximation	5	10
5 Time-independent Perturbation theory	15	25
6 Time-dependent Perturbation theory	10	15
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**III**
Title of the paper	**SOLID STATE PHYSICS**
Paper Code	**PH 9218**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**2**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning out come.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split ; the time duration for which the mid semester test and SE are conducted.)

PH 9218 - SOLID STATE PHYSICS

Crystal physics: Symmetry operations; Bravais lattices; Point and space groups; Miller indices and reciprocal lattice; Structure determination; diffraction; X-ray, electron and neutron; Crystal binding; Defects in crystals; Point and line defects.
10hrs

Lattice vibration and thermal properties: Einstein and Debye models; continuous solid; linear lattice; acoustic and optical modes; dispersion relation; attenuation; density of states; phonons and quantization; Brillouin zones; thermal conductivity of metals and insulators. 10hrs

Electronic properties: Free electron theory of metals; electrons in a periodic potential; Bloch equation; Kronig-Penny model; band theory; metal, semiconductor and insulators; band-gap, intrinsic and extrinsic semiconductors, Hall Effect, p-n junction.
10hrs

Dielectrics: Polarizability; Clausius-Mossotti formula; Dielectric constant; ferroelectrics.
10hrs

Magnetism: Diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism and ferrimagnetism. 10hrs

Superconductivity: Meissner effect; London equations; coherence length; type-I and type II superconductors.
10hrs

Reference Books:

1.H. P. Myers, Introduction to Solid State Physics, Viva books (1998).
2. M.A. Omar, Elementary Solid State Physics, Addison-Wesley (1975).
3. C. Kittel, Introduction to Solid State Physics, John Wiley (1996).
4. A. J. Dekker, Solid State Physics, Macmillan (1986).
5. N. W. Ashcroft and N. D. Mermin, Solid State Physics, HBC Publ., (1976).

MODEL BLUEPRINT

(Part of the syllabus)

Code number and Title of the paper : **PH 9218 - SOLID STATE PHYSICS**

Chapter number	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
1 Crystal physics	10	20
2 Lattice vibration and thermal properties	10	20
3 Electronic properties	10	15
4 Dielectrics	10	15
5 Magnetism	10	15
6 Superconductivity	10	15
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**III**
Title of the paper	**MODERN OPTICS**
Paper Code	**PH 9318**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning out come.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split ; the time duration for which the mid semester test and SE are conducted.)

PH 9318 - MODERN OPTICS

Geometric optics: Fermat's principle and applications to laws of reflection and refraction. Paraxial optics, ABCD matrix description of lenses, mirrors, etc.

Dispersion: phase and group velocity, material dispersion, normal and anomalous dispersion, chromatic aberration. 10hrs

Fourier techniques: Fourier analysis, Fourier transforms, diffraction of light, Kirchoff's scalar diffraction theory. Fourier transformation by propagation, lenses and their description in Fourier transformation and imaging. Spread functions, modulation transfer functions, convolution, etc. 15hrs

Diffraction theory of image formation :Optical data processing, Coherence, classical coherence functions, autocorrelation function and time coherence. Spatial coherence, mutual coherence functions, visibility of fringes. 10hrs

Crystal optics: double refraction. Polarization and anisotropy of wave propagation in crystals, Retarders- Quarter wave and Half wave plates,variable retarder, uniaxial and biaxial crystals. 10hrs

Non-linear Optics: Physical origin of non-linear polarization,electromagnetic wave propagation in non-linear media,optical second harmonic generation, optical mixing, third harmonic generation, self focussing of light, parametric generation of light. 15hrs

Reference Books:

1. Max Born and Emil Wolfe, Principles of Optics, Pergamon Press, 6th Edition (1985).
2. M.V. Klein and T.E. Furtak, Optics, 2nd edition, John Wiley (1986).
3. R.S. Sirohi, Wave Optics and Applications, Orient Longman (1992)
4. A.K. Ghatak and K. Thyagarajan, Contemporary Optics, Plenum Pub. Co. (1978).
5. J.R. Mayer-Arendt M.D. Introduction to Classical and Modern Optics, 2nd Edition, Prentice Hall (1988).
6. R.S. Sirohi and M.P. Kothiyal, Optical Components, Systems and Measurement Techniques, Marcell Dekker (1991).
7. R.D Guenther, Modern Optics, John Wiley (1990)
8. P. Hariharan, Optical Holography, Cambridge University Press (1984).
9. Ghatak, A. K,Modern Optics,
10. D. Casasent, (ed), Optical Data Processing, Springer Verlag (1978).

MODEL BLUEPRINT

(Part of the syllabus)

Code number and Title of the paper : **PH 9318 - MODERN OPTICS**

Chapter number	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
1 Geometric optics+Dispersion	10	20
2 Fourier techniques	15	25
3 Diffraction theory of image formation	10	15
4 Crystal optics	10	15
5 Non-linear Optics	15	25
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**III**
Title of the paper	**ASTROPHYSICS OPEN ELECTIVE**
Paper Code	**PHOE 9418**
Number of teaching hours per week	**2**
Total number of teaching hours per semester	**30**
Number of credits	**2**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning out come.

(iii)The introductory part of the syllabus may have vision and mission statement of the department and the examination pattern (eg: 30% for CA and 70% SE and also how the 30% marks are split ; the time duration for which the mid semester test and SE are conducted.)

PHOE 9418 - ASTROPHYSICS OPEN ELECTIVE

A first glimpse of the universe
What is the universe made up of?; What is light? Picture the Universe; Crowded Skies and
Stardust. (5 hrs)
Birth and death of a star
The Stellar Zoo: nascent stars, adolescents and geriatric stars; immortality and fiery ends
(10 hrs)

Sun and the solar system
Denizens of Sol; Earth glory: seasons, eclipses, lunar phases; In the shadow of the Sun:
sunspots, rotation and vibration, climate on earth; Harbingers of gravity: asteroids, meteoroids,
comets (10 hrs)
Our galaxy and beyond
The cosmos: galaxies; Our backyard: the Milkyway; Evolving Universe: Insight into the origin and
evolution of universe; Fiery Birth: The big-bang (5 hrs)

Books for reference :

1. Astrophysics is easy – An introduction for the amateur astronomer, Mike Inglis
2. Astrophysics in a nutshell, Dan Maoz
3. Fundamental astronomy, Hannu Kartunnen et al.

Online references :
http://www.universe-review.ca/

MODEL BLUEPRINT

(Part of the syllabus)

Code number and Title of the paper : **PHOE 9418 - ASTROPHYSICS OPEN ELECTIVE**

Chapter number	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
1 A first glimpse of the universe	5	10
2 Birth and death of a star	10	15
3 Sun and the solar system	10	15
4 Our galaxy and beyond	5	10
Total marks excluding bonus questions		35
Total marks including bonus questions		50

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

DEPARTMENT OF PHYSICS

Semester	**III**
Title of the paper	**ASTROPHYSICS SOFT CORE**
Paper Code	**PH 9518**
Number of teaching hours per week	**2**
Total number of teaching hours per semester	**30**
Number of credits	**2**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

(ii)The syllabus may have the Statement of Learning out come.

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PH 9518 - ASTROPHYSICS SOFT CORE

1. Motion of Earth and concept of time (5 hrs)
    a. Positions of astronomical objects
    b. Thumb rules of angles and altitude of objects
    c. Why is the sky dark: Olbers paradox
    d. Powers of 10 and scales in the universe
    e. Difference between Lunar Eclipse and Lunar Phases
    f. Equinoxes and Solstices
    g. Parallax and estimate of distance
2. Telescopes (3 hrs)
    a. Diffraction limit
    b. Twinkling of stars and practical limits to diffraction limits (atmosphere)
    c. Resolution and Rayleigh criterion
    d. Field of View
3. Magnitudes and Fluxes (3 hrs)
    a. 1/r^2 law for energy
    b. Solar constant on Mars or Jupiter
    c. Pogson's relationship for magnitude
4. Electromagnetic Spectrum: (4 hrs)
    a. Frequency/Wavelength arrangement
    b. Colors
    c. Additive and Subtractive effects in colors and filters
    d. Obtaining spectrum using photometry and filters
5. Photon interactions and detectors (5 hrs)
    a. Reason for sky being blue and sunsets red
    b. Extinction and reddening
    c. Colors in the universe
    d. Counting statistics and signal detection (Poisson Statistics and Normal distribution)
    e. Errors - dependence on square root of count
6. Time scales in the universe (2 hrs)
    a. Significance of sound crossing time
    b. Gravitational dynamical time scales
    c. Application (e.g. pulsars as rotating stars than pulsating/vibrating stars or extent of the central emitting regions of quasars)
7. Doppler effect of light (2 hrs)
    a. redshift

    b. effect on spectrum and use in distance estimates
8. Thermodynamics (3 hrs)
    a. Color and Temperature
    b. Antennae color temperature
    c. Stellar colors and temperatures
9. Polarization (3 hrs)
    a. Polarizers as filters
    b. Polarized light as an effect of reflection
    c. Reflection nebulae

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(Part of the syllabus)

Code number and Title of the paper : **PH 9518 - ASTROPHYSICS SOFT CORE**

Chapter number	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
1. Motion of Earth and concept of time	5	10
2. Telescopes	3	5
3. Magnitudes and Fluxes	3	5
4. Electromagnetic Spectrum	4	5
5. Photon interactions and detectors	5	10
6. Time scales in the universe 7. Doppler effect of light	2 2	5
8. Thermodynamics	3	5
9. Polarization	3	5
Total marks excluding bonus questions		35
Total marks including bonus questions		50

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**III**
Title of the paper	**Optics Lab**
Paper Code	**PH9P1**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**50**
Number of credits	**2**

Note : (i) Kindly add the List of Reference books towards the end of the syllabus.

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The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**III**
Title of the paper	**Mini Project**
Paper Code	**PH9P2**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**50**
Number of credits	**2**

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Labs for Semester III (4 Credits 8 Hours/Week)	
PH9P1- Optics	**PH9P2 - Mini Project**
Ultrasonic interferometer	
Michelson interferometer to determine the wavelength separation between Sodium D1 and D2 lines.	
Size of Lycopodium particles and thickness of wire using diffraction	
Wavelength of laser using diffraction grating	
Fabry Perot Interferometer	
Refractive Index of Glass and wavelength of light using Michelson Interferometer	
Determine birefringence of Mica sheet using Babinet's Compensator	
Cornu's Fringes and Determination of Young's modulus of given material	
Zeeman effect	
Thickness of Mica using Edser Butler Method	
Study of temperature variation of refractive index of a liquid using hollow prism and laser source.	
Optical coherence of laser light using laser pointer.	
Design your own experiment using the resources available in the optics lab.	

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**III**
Title of the paper	**DISSERTATION PROJECT**
Paper Code	**PH9P3**
Number of teaching hours per week	**8**
Total number of teaching hours per semester	**100**
Number of credits	**4**

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SEMESTER-IV

TOPICS TO BE COVERED:

THEORY PAPERS (4 CREDITS EACH):

1. **EXPERIMENTAL TECHNIQUES-II**
2. **NUCLEAR AND PARTICLE PHYSICS**
3. **ELECTIVE**

HYBRID COURSE (10 CREDITS):

1. **DISSERTATION PROJECT**

LAB PAPERS (2 CREDITS EACH):

1. **GENERAL PHYSICS**
2. **ELECTIVE**

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**IV**
Title of the paper	**EXPERIMENTAL PHYSICS-II**
Paper Code	**PH 0118**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

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PH 0118 - EXPERIMENTAL PHYSICS-II

Vacuum techniques : Vacuum hardware,gas flow regimes,pumping speed,conductance.
Pumps for producing vacuum : their classification - rotary vane , oil diffusion, turbomolecular, sputter-ion, cryopump.Getters – their characteristics and types.
10hrs

Vacuum measurement : Gauges for measuring low pressure – mechanical,thermal conductivity and ionization gauge- thermionic and penning.
Leak and leak detection, mass spectrometers. Some typical vacuum systems. 10hrs

Thin film coating : Evaporative coating, Sputtering – Dynamics of glow discharge plasma, DC or plasma sputtering and AC sputtering, sputter yield.Laser ablation Technique.
10hrs

Techniques to measure thickness of film and study surface profiles :

Transmission and Scanning Electron Microscopes and applications.
Surface probe techniques : AFM, STM, MFM, their applications. 10hrs

Low temperature techniques: Properties of cryogenic fluids, Cryogens and their applications - Liquid nitrogen, liquid hydrogen,Liquid Helium-I and II(phase diagram and thermodynamics of second order phase transition),methods of producing low temperature- adiabatic expansion,Joule-Thomson throttling(JT) and Adiabatic Demagnetisation -thermodynamics of these processes;Liquefaction of Hydrogen and Helium using JT method,Bose-Einstein Condensate- laser cooling of atoms, Cryostat - bath and continuous flow cryostat; Cryocoolers- Stirling, Gifford McMahon and pulse tube type; Low temperature measurement.
20 hrs

Reference Books:
1. Experimental Physics: R.A. Dunlap,Oxford University Press 1988
2. The Art of Experimental Physics, Dietz Preston, Eric S. Dietz, Barnes and Noble, 2001
3. An Introduction to Experimental Physics, Colin Cooke, London; UCL Press (Pennsylvania)
4.Material Science of Thin films,Milton Ohring,Second Edition2001,Academic press.
5.Electron microscopy and analysis, Peter J Goodhew, John Humphreys, Richard Beanland,
3rd edition, 2000.

6.Scanning probe Microscopy and Spectroscopy Theory and Applications, Second Edition
Edited by Dan Bonnell, Wiley VCH, 2001.
7.Scanning Probe Microscopy–The Lab on a tip, Ernst Meyer, Hans J. Hug, Roland Bennewitz, Springer Verlag New York, 2003.
8.Cryogenics and Property Measurements at Low Temperatures, R.Srinivasan, A.K. Ray Chaudhari
and S. Kasturirangan, Allied Publishers.
9.Manual on the Experiments with IAS kit by R.Srinivasan.

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(Part of the syllabus)

Code number and Title of the paper : **PH 0118 - EXPERIMENTAL PHYSICS-II**

Chapter number	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
1 Vacuum techniques	10	15
2 Vacuum measurement	10	15
3 Thin film coating	10	15
4 Techniques to measure thickness of film and study surface profiles	10	15
5 Low temperature techniques	20	40
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**IV**
Title of the paper	**NUCLEAR AND PARTICLE PHYSICS**
Paper Code	**PH 0218**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

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PH 0218 - NUCLEAR AND PARTICLE PHYSICS

Nuclear properties: radius-electron scattering method and mirror nuclei, size, mass, spin, moments, abundance of nuclei, binding energy, excited states.
Nuclear forces: deuteron, n-n and p-p interaction, nature of nuclear force.

10hrs

Nuclear Models: liquid drop, shell and collective models.
Nuclear decay and radioactivity: radioactive decay, detection of nuclear radiation, alpha-Gamow's theory, beta-Ferm's theory of beta decay and gamma decays, radioactive dating. 12hrs

Nuclear reactions: conservation laws, energetics, isospin, reaction cross section, Coulomb scattering, nuclear scattering, scattering cross section, optical model, compound nucleus, direct reactions, resonance reactions, neutron physics, fission, fusion. 10hrs

Particle accelerators and detectors: electrostatic accelerators, cyclotron, synchrotron, linear accelerators, colliding beam accelerators, gas-filled counters, scintillation detectors,semiconductor detectors.

10hrs

Elementary particles: forces, quantum numbers, mesons and Yukawa's hypothesis, pions, CPT theorem, strange mesons and baryons, production and decay of resonances, CP violation in K decay.

9hrs

Particle physics: Symmetries and conservation laws, Feynman diagrams, Gell-MannNishijima relation, Quark model, coloured quarks and gluons, quark dynamics, standard model.9hrs

Reference Books:

1. K. S. Krane, Introductory Nuclear Physics, John Wiley (1988).
2. R. R. Roy and B. P. Nigam, Nuclear Physics: Theory and Experiment, New Age (1967).
3. A. Das and T. Ferbel, Introduction to nuclear and particle physics, John Wiley (1994).
4. I. S. Hughes, Elementary Particles, Cambridge (1991).
5. F. Halzen and A. D. Martin, Quarks and Leptons, John Wiley

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(Part of the syllabus)

Code number and Title of the paper : **PH 0218 - NUCLEAR AND PARTICLE PHYSICS**

Chapter number	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
1 Nuclear properties+ Nuclear forces	10	20
2 Nuclear Models	12	20
3 Nuclear reactions	10	15
4 Particle accelerators and detectors	10	15
5 Elementary particles	9	15
6 Particle physics	9	15
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**IV**
Title of the paper	**ELECTIVE-I (ASTROPHYSICS)**
Paper Code	**PHDE 0418**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

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PHDE 0418 - ELECTIVE-I (ASTROPHYSICS)

A Survey of Astronomy and Astrophysics and the Application of Scientific Process in Physics (with use of images, data analysis software like ds9 and Aladin and simulation softwares like Stellarium, data platforms: Mikulsky Archive, BATSE, Swift, Fermi, X-Ray,SDSS etc. and use of NASA ADS Abstract query forms and astro-ph): Physics of Sun and solar system, Interstellar medium and the Milkyway Galaxy, Star formation regions, Stars and Types - a manifestation of Thermodynamic Equilibrium, Galaxies and Galaxy clusters, Gamma Ray Bursts using BATSE data, X-ray binaries using HEASARC data, Exoplanets, Merging Black-holes and neutron stars, Hubble's Law (using SDSS data), Other very recent discoveries and results in Astrophysics.

(30hrs)

Multiwavelength Astronomy (with special lectures by experts):
Gamma ray, X-ray, UV, Visible, Infrared, Radio and Gravitational Wave Astronomy. (10hrs)

Physics of Astrophysics:

Gravitation: Kepler's Laws, The Electromagnetic Spectrum, Transmission through atmosphere and extinction, Magnitude scale, Color Indices, (2hrs)

Telescope: parameters - Diffraction limit, plate scale, F/D ratio, FOV, brightness and resolution. The specifications of a good telescope. (6hrs)

Radiation: Thermal radiation, Thermal bremsstrahlung, Synchrotron radiation

(5hrs)

Stars and Stellar Evolution: The equation of hydrostatic equilibrium, Virial theorem, the internal temperature of the sun, the energy generation in the centre, nuclear reactions, Eddington's theory of the stars, Mass-luminosity relation, the lifetime of the stars of different masses, the solar neutrinos, The evolution of stars, the end states of stars, white dwarfs, the Chandrasekhar limit, Neutron stars, Supernovae, Black holes. (partially covered in the first part) (2hrs)

Hands-on Activities (using SDSS):
Color-Magnitude Diagram and H-R Diagram
Supernovae
Hubble's Law
Quasars

(5hrs)

References:

1. Physical Universe, Shu F.H., University Science Books, 1982

2. An Invitation to Astrophysics, T. Padmanabhan, World Scientific, 2006
3. Structure and Evolution of Stars, Martin Schwarzschild, Princeton University Press, 1958
4. The Sun, Stix M., Springer-Verlag, 1989
5. The Physics of Fluids and Plasmas, Arnab Rai Choudhuri, Cambridge University Press, 1998
6. An Introduction to Galaxies and Cosmology, Edited by Mark H. Jones and Robert J. Lambourne, Cambridge University Press, 1998
7. Galactic Astronomy, Binney and Merrifield, Princeton Series in Astrophysics, 1998
8. Galaxies in the Universe, Sparke & Gallagher, Cambridge Univ. Press, 2000
9. High Energy Astrophysics Vol-I &II, Longair M., Cambridge Univ. Press, 1992
10. Introduction to Cosmology, Ryden B., Cambridge Univ. Press, 2002

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(Part of the syllabus)

Code number and Title of the paper : **PHDE 0418 - ELECTIVE-I (ASTROPHYSICS)**

Chapter number	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
1 Survey of Astronomy	30	50
2 Multiwavelength Astronomy	10	15
3 Gravitation	2	5
4 Telescope	6	10
5 Radiation	5	10
6 Stars and Stellar Evolution	2	5
7 Hands-on Activities	5	5
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**IV**
Title of the paper	**ELECTIVE II-MATERIALS SCIENCE**
Paper Code	**PHDE 0518**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**60**
Number of credits	**4**

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PHDE 0518- ELECTIVE II-MATERIALS SCIENCE

Semester-IV

Credit: 4

MATERIALS PROPERTIES AND REQUIREMENTS: (5 Hours)

Historical perspective, Introduction to materials, Why study Materials Science, Classification of Materials, Levels of Structure, Structure-Property Relationship, Advanced materials, and Modern Materials needs.

PREPARATIVE TECHNIQUES AND CHARACTERIZATION OF MATERIALS

(10 Hours**)**

SILAR Method, Sol Gel process, hydrothermal and solvothermal method, Slow Evaporation Method, Pallet making process. Stoichiometry study by Energy Dispersive X-ray Analysis, Piezoresponse Microscopy, X-ray Photoelectron Spectroscopy.

PHASE DIAGRAMS AND PHASE TRANSFORMATION (15 Hours)

Introduction to Elastic and plastic behavior of materials - Phase diagrams- the phase rule, One component system, Two-Component system, Three-component condensed systems, Typical phase diagrams and Lever rule.

Phase Transitions - Introduction, Basic concepts, Kinetics of Phase transition, Mechanical behavior of Iron-Carbon Alloys, Shape memory alloys, Martensite and Austenite transformations

THERMAL PROPERTIES OF SOLIDS **(**10 Hours**)**

Introduction, Thermal properties, Thermal Expansion of solids, conduction, kinetics of Thermally Activated process, Kinetic Model of Heat conduction, Thermal Conductivity, Thermal Diffusivity

ELECTRICAL PROPERTIES OF MATERIALS (10 Hours)

Alloying effects on the electrical resistivity in metallic systems. Seebeck coefficient in metals and semiconductors.Vander Paw technique of measuring resistivity in thin sheets. Integral and differential method of measuring Seebeck coefficient of metals, alloys and semiconductors. Materials with high thermoelectric figure of merit.

OTHER ELECTRICAL PROPERTIES OF MATERIALS (5 Hours)

Piezoelectricity in PZT and polymeric materials (PVDF) , Ferroelectricity in Barium Titanate Dielectric materials, Debye relaxation time, Complex dielectric constant

MAGNETIC PROPERTIES OF SOLIDS (15 Hours)

Origin of permanent magnetic moments-Langevin's classical theory of diamagnetism and paramagnetism-Quantum theory of paramagnetism-Ferromagnetism – Weiss molecular field Temperature dependence of spontaneous magnetization-ferromagnetic domain-domain theory, B-H Curve Antiferromagnetism- Ferrimagnetism and ferrites, Multilayer structures , GMR

REFERENCES:

1. Solid State Physics, Charles Kittel , John Willey & sons
2. Material Science & Engineering, V.Raghavan, Prentice -Hall of India, New Delhi (2001)
3. Callister's Materials Science and Engineering by R. Balasubramaniam
4. Solid State Chemistry and its Applications by Anthony R. West
5. Solid state physics by Dekkar

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(Part of the syllabus)

Code number and Title of the paper : **PHDE 0518- ELECTIVE II-MATERIALS SCIENCE**

Chapter number	Number of teaching hours (As mentioned in the syllabus)	Maximum marks for which questions are to be framed from this chapter (including bonus questions)
1 MATERIALS PROPERTIES AND REQUIREMENTS	5	10
2 PREPARATIVE TECHNIQUES AND CHARACTERIZATION OF MATERIALS	10	20
3 PHASE DIAGRAMS AND PHASE TRANSFORMATION	10	15
4 THERMAL PROPERTIES OF SOLIDS	10	15
5 ELECTRICAL PROPERTIES OF MATERIALS	10	15
6 OTHER ELECTRICAL PROPERTIES OF MATERIALS	5	10
7 MAGNETIC PROPERTIES OF SOLIDS	10	15
Total marks excluding bonus questions		70
Total marks including bonus questions		100

Formula to calculate the maximum marks for each chapter:

$$\frac{\textit{Number of teaching hours allotted for that chapter} \times \textit{maximum marks (including marks for bonus questions}}{\textit{Total number of teaching hours (including self study hours)}}$$

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**IV**
Title of the paper	**Nuclear Physics Lab**
Paper Code	**PH0P1**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**50**
Number of credits	**2**

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DEPARTMENT OF PHYSICS

Semester	**IV**
Title of the paper	**ELECTIVE I: Material Science Lab**
Paper Code	**PH0P2**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**50**
Number of credits	**2**

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The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**IV**
Title of the paper	**ELECTIVE II: Astrophysics Lab**
Paper Code	**PH0P3**
Number of teaching hours per week	**4**
Total number of teaching hours per semester	**50**
Number of credits	**2**

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Mandatory Labs for Semester IV (4 Credits 8 Hours/Week)	
PH0P1- Nuclear Physics	
1. Calibration of a gamma ray spectrometer using gamma ray of known energy, finding its resolution and determining the energy of the gamma ray from an unknown source	
2. Determining the linear attenuation coefficient of Fe for gamma ray using a scintillation detector.	
3. Determining the linear attenuation coefficient of Cu and Pb using GM counter.	
4. Measurement of dead time of a GM counter - Two source method	
5. Scintillation detector – Compton edge – Determining the maximum angle for Compton scattering.	
6. Study of back scattering using a GM counter.	
7. Measuring the activity of a radio active sample - Relative method	
8. Measuring the efficiency of a detector.	
9. Studying the counting statistics for a GM counter	

Elective Labs for Semester IV (4 Credits 8 Hours/Week)	
PH0P2-Material Science	**PH0P3- Astrophysics**
Study of percolation using electrical conductivity.	1. Astrophysical Resources and Tools
Measuring superconducting transition in a HTS material.	3. CCDs and Photometry: 10x10 image reduction program development
Resistivity measurement techniques -Vander-paw method	4. Beginning IRAF (Using IRAF for the 10x10 image, Using a 1000x1000 image); *imarith* and *imstat*
Direct measurement of Piezoelectric constant of PVDF film.	5. Basic Photometric Reduction with IRAF - Part I ; *imhead*, *imexamine*, *qphot*
Synthesis and characterization of Zinc chloride Nanoparticles by Chemical precipitation method	6. Observatory Trip
Measurement of absolute seebeck Coefficient of n and P type Bismuth Telluride	7. Basic Photometric Reduction with IRAF - Part 2 ; *imhead*, *imexamine*, *qphot*
B-H Curve in a hard ferromagnetic material and in a soft ferrite	8. Basic Spectroscopic Reduction with IRAF - Part ; *fit1d*, *apall*
B-of Synthesis and Characterization of Zno Thin films Grown by SILAR method	9. Basic Spectroscopic Reduction with IRAF - Part 2 ; *unlearn*, *splot*
Para to Ferroelectric transition in PZT and Barium Titanate	10. Basic Spectroscopic Reduction with IRAF - Part 3; *identify*, *refspec*, *dispcor*
Superconducting Transition in YBCO	

The syllabus title must be as given below:

DEPARTMENT OF PHYSICS

Semester	**IV**
Title of the paper	**DISSERTATION PROJECT**
Paper Code	**PH0P4**
Number of teaching hours per week	**8**
Total number of teaching hours per semester	**100**
Number of credits	**4**

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