Education

NATIONAL INSTITUTE OF TECHNOLOGY, ARUNACHAL PRADESH

(ESTABLISHED BY MINISTRY OF HUMAN RESOURCE DEVELOPMENT, GOVT. OF INDIA)

Ethics

In GOD's own land, a fusion of scholastic students, innovative & motivated researchers & teachers and fast moving visionary leaders.

COURSE STRUCTURE & SYLLABUS
FOR
MATHEMATICAL PHYSICS

Steeping Stone and Sky reaching ladder to success

Research

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Service to Society

NATIONAL INSTITUTE OF TECHNOLOGY

(Established by Ministry of Human Resources Development, Govt. Of India)

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PROPOSED COURSE STRUCTURE FOR MATHEMATICAL PHYSICS

1St SEMESTER						
Subject Code	Subject		L	T	P	Credit
MAP 911	Mathematical Methods		3	0	0	3
MAP 912	Abstract Algebra		3	0	0	3
MAP 913	Advanced Linear Algebra		3	0	0	3
MAP 914	Classical Mechanics		3	0	0	3
MAP 915	Statistical Mechanics		3	0	0	3
MAP 916	**Optics Lab**		0	0	4	2

Total 17

2nd SEMESTER						
Subject Code	Subject		L	T	P	Credit
MAP 921	Special Function and Integral Transform		3	0	0	3
MAP 922	Differential Equation: ODE and PDE		3	0	0	3
MAP 923	Tensor Calculus		3	0	0	3
MAP 924	Quantum Mechanics		3	0	0	3
MAP 925	Electrodynamics		3	0	0	3
MAP 926	**Modern Physics lab**		0	0	4	2

Total 17

3rd SEMSTER						
Subject Code	Subject		L	T	P	Credit
MAP 931	Solid State Physics		3	0	0	3
MAP 932	Advanced Quantum Mechanics		3	0	0	3
MAP 933	Numerical Methods		3	0	0	3
MAP 934	Probability & Statistics		3	0	0	3
MAP 935	Fortan/C/C++ Programming		2	0	2	3
MAP 936	Advanced Materials Technology		3	0	0	3

Total 18

4th SEMESTER						
Subject Code	Subject		L	T	P	Credit
MAP 941	Elective Paper		3	1	0	4
MAP 945	Project		0	0	24	12
XXX	Seminar/Grand Viva		**0**	**0**	**4**	**02**
						Total 18

Total credit: 70

List of Elective Papers:

1. Particle Physics (MAP 941 A) **3.** Condensed Matter Physics (MAP 941 B)

2. Electronics (MAP 941 C) **4.** Fluid Dynamics (MAP 941 D)

Name of the Module: Mathematical Methods
Module Code: MP 911
Semester: I
Credit Value: 3 [L =3, T = 0, P = 0]

Objective:

The course is designed to meet with the objective of:

1. The main objective of this course is to provide basic tools of mathematics which will be helpful to understand the various branches of physics.
2. Mathematical Techniques are required for theoretical physicists and even for Experimentalists.
3. The subject will meet the challenge of theoretical physicists faced.

Learning Outcome:

After completion of this subject:

1. Students will demonstrate competence with a wide variety of mathematical tools and techniques.
2. Students will demonstrate the ability to assess the accuracy, implications and limitations of their mathematical results.
3. Students will master the basic elements of complex mathematical analysis, including the integral theorems; obtain the residues of a complex function and to use the residue theorem to evaluate definite integrals.

Subject Matter:

Unit–I:
Scalar & Vectors, Vector Addition: Triangle law and Parallelogram law, Properties of Vector addition, Dot product and Cross Product of Two Vectors, Triple Product of Vectors.

Unit-II:
Del Operator, Gradient, Divergences, Curl, Line Integral, Surface Integral, Volume Integral, Curvilinear Coordinates: Spherical Polar coordinate, Cylindrical coordinates.

Unit-III:
Complex Number, Addition, Subtraction, Multiplication and Division of Complex Numbers, Modulus of Complex number.

Unit-IV:
Complex integration, Singularity, Pole, residue, Cauchy-Residue theorem, Taylor's series expansion.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:
Theoretical Examination and open book examination.

Reading List:

A. Books:

1. Mathematical Methods for Physicist by Arfken and Weber.
2. Introduction to Mathematical Physics by C. Harper.
3. Mathematical Physics by J. D. Anand, P. K. Mittal and A. Wadhwa.
4. Mathematical Physics by D. H. Menzel.
5. Mathematical Metheods for Physics and Engineering by K. F. Riley, M. P. Hobson and S. J. Bence.

B. Journals & Magazines:

1. Review on mathematical Physics
2. Nuclear Physics B
3. Physical Review D
4. Physical Review Letter
5. Progress in Theoretical Physic
6. International Journal of Modern Physics A
7. Journal of High Energy Physics
8. Journal of Applied Physics.
9. Journal of Mathematical Physics

Name of the Module: Abstract Algebra
Module Code: MAP 912
Semester: I
Credit Value: 3 [P=0, T=0, L=3]

Objectives:
The course is designed to meet the following objectives:
1. This course aims to provide a first approach to the subject of algebra, which is one of the basic pillars of modern mathematics.
2. The focus of the course will be the study of certain structures called groups, rings, fields and some related structures.
3. Abstract algebra gives to student a good mathematical maturity and enables to build mathematical thinking and skill.

Learning outcomes:

Upon completion of the subject:

1. The student will be able to define the concepts of group, ring, field, and will be able to readily give examples of each of these kinds of algebraic structures.
2. The student will be able to define the concepts of coset and normal subgroup and to prove elementary propositions involving these concepts.
3. The student will be able to define the concept of subgroup and will be able to determine (prove or disprove), in specific examples, whether a given subset of a group is a subgroup of the group.
4. The student will be able to define and work with the concepts of homomorphism and isomorphism.

Subject Matter:

Unit I

Review of groups, Subgroups, Normal subgroups, Quotient group, Group Homomorphism.

Unit II

Permutation groups, Cayley theorem, Cyclic group, Direct product of groups, Finite abelian groups, Cauchy theorem and Sylow theorem.

Unit III

Ring, Zero divisor, Integral domain, Ideals, Quotient ring, Isomorphism theorems, Polynomial ring, Euclidean ring, Prime & Irreducible elements & their properties, UFD, PID and Euclidean Domain.

Unit IV

Field, Finite Fields, Field Extensions, Galois theory.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. N. Herstein, Topics in Algebra, Wiley Eastern Ltd, 2008
2. S. Lang, Algebra, Addison Wesley
3. J. B. Fraleigh, A First Course in Abstract Algebra
4. C. Musili, Introduction of Rings and Modules, Narosa Publishing House.
5. M. Artin, Algebra, PHI.
6. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, Cambridge University Press, 1995.
7. J. Fraleigh, A First Course in Abstract Algebra, Pearson, 2003.
8. D. Dummit and R. Foote, Abstract Algebra, Wiley, 2004.

B. Magazine:

1. Current Science (Indian Academy of Science).

2. The Mathematics Student (Math Student) (Indian Mathematical Society)

3. Mathematical Spectrum (The University of Sheffield)

4. Mathematics Magazine (Mathematical Association of America)

5. +Plus magazine (University of Cambridge)

6. Ganithavahini (Ramanujam Mathematical Society)

C. Journals:

1. Ganita Sandesh
2. Ganita Sandesh.
3. Journal of Rajasthan Academy of Physical Sciences.
4. Bulletin of Calcutta Mathematical Society.

Name of the Module: Advanced Linear algebra
Module Code: MAP 913
Semester: I
Credit Value:4 [P=0, T=1, L=3]

Objectives:

The course is design to meet the following objectives:

1. To improve the ability to think logically, analytically, and abstractly.
2. To improve the ability to communicate mathematics, both orally and in writing.
3. Concepts for solving systems of linear equations.

4. Basic ideas of vector spaces.
5. The basic concepts of linear transformations, linear functional and linear operator.
6. Present the concept of and methods of computing determinants.
7. Present methods of computing and using eigenvalue and eigenvector.

Learning outcomes:

Upon completion of the subject:

1. Student is able to solve systems of linear equations.

2. Student is able to work within vector spaces and to distill vector space properties.

3. Student is able to manipulate linear transformations and to distill mapping properties

4. Student is able to manipulate and compute determinants.

5. Student is able to compute eigenvalues and eigenvectors

Subject Matter:

Unit I
Introduction to vector space over a field, Subspace, linear combination, linear dependence and independence, basis and dimension, Properties of finite dimensional vector space, Replacement theorem, Extension theorem, Co-ordinates of vectors, Complement of a subspace, Quotient space.

Unit-II
System of linear equations, Solution of homogeneous and non-homogeneous systems, Application to geometry. Inner-product spaces (real and complex), orthogonal and orthonormal set of vectors, Scalar component of a vector, Gram-Schmidt process.

Unit-III
Linear transformations, matrix representation of linear transformations, linear functional, dual spaces.

Unit-IV
Eigen values and Eigen vectors, rank and nullity, inverse and linear transformation, Cayley-Hamilton Theorem, norms of vectors and matrices, transformation of matrices, adjoint of an operator, normal, unitary, hermitian and skew-hermitian operators, quadratic forms.

Unit-V
Courant- Fishcherminimax and related theorems, Perron-Frobenius theory, Matrix Norm, Matrix stability and Inequality, Generalized inverse.

Teaching/Learning/Practice Pattern:

Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. K. Hoffman and R. Kunze; Linear Algebra; Prentice-Hall of India, Pvt Ltd.
2. A. R. Rao and P. Bhimashankaram; Linear Algebra and Applications; TMH Edn.
3. B. C. Chatterjee; Linear Algebra, Dasgupta& Co., Calcutta, 1967.
4. F. G. Florey ; Elementary Linear Algebra, Prentice Hall Inc, 1979.
5. R. Paul Halmos; Finite Dimensional vector space, Van Nostrand Co., 1974.
6. S. K. Mapa; Higher Algebra, Sarat Book Distributors, 2005.
7. Steven Roman: Advanced Linear Algebra (GTM), springer, 2010.
8. R. A. Horn & C. R. Johnson: Matrix Analysis, Cambridge University press, New York, 1985.
9. R. Bhatia: Matrix Analysis, springer, 1996.

B. Magazines:

1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society)
3. Mathematical Spectrum (The University of Sheffield)
4. Mathematics Magazine (Mathematical Association of America)
5. +Plus magazine (University of Cambridge)
6. Ganithavahini (Ramanujam Mathematical Society)
7. Mathematics Today, London Metropolitan University.

C. Journals:

1. Linear Algebra and its Applications, Elsevier.
2. Linear and Multilinear Algebra, Taylor & Francis.
3. Electronic Journal of Linear Algebra, ILAS-The International Linear Algebra Society.
4. Advances in Linear Algebra & Matrix Theory, Scientific Research Publishing (SCIRP).
5. Proceedings of the American Mathematical Society, American Mathematical Society.
6. Proceedings of the London Mathematical Society, London Mathematical Society.
7. Annals of Mathematics, Princeton University & Institute for Advanced Study.

Name of the Module: Classical Mechanics

Module Code: MP 914

Semester: I

Credit Value: 3 [L =3, T = 0, P = 0]

Objective:

The course is designed to meet with the objective of:

1. To introduce students to classical mechanics and its applications
2. To develop familiarity with the physical concepts and facility with the mathematical methods of classical mechanics.
3. To develop skills in formulating and solving physics problems.
4. To develop self-discipline and work habits necessary to succeed in research or higher learning in the real world.

Learning Outcome:

After completion of the subject:

1. Students will learn sufficient analytical techniques to solve many complicated physics problems in a more effective manner.
2. Students will learn the limitation of Newtonian methods and how it was replaced by more advanced method provided by Lagrange, Hamiltonian and many others.
3. They will also learn some techniques which will help them to understand the quantum physics in a smooth ways.

Subject Matter:

Unit-I: Review of Newtonian Mechanics, Mechanics of a particle and system of particles: Conservation Laws of Momentum, Angular Momentum and Energy. Lagrangian Dynamics: Introduction, Coordinate system, Degrees of Freedom, Constraints, Generalized Coordinates, Principle of Virtual Work, D' Alembert's Principle, Lagrangian Equation of motion for conservative and non-conservative system.

Unit-II: Hamiltonian Dynamics: Generalized momentum and Cyclic Coordinates, Hamiltonian Equation of motion for various physical systems.

Two-Body Central Force Problem: Reduction of two body central force problem to equivalent one-body problem, Equation of motion under central force, Differential equations for an orbit, Inverse square law of force, Kepler's Laws of Planetary motion, Viral Theorem, Scattering Cross section.

Unit-III: Canonical Transformations, Legendre Transformations, Generating Functions and Application of canonical Transformations, Poisson's brackets and Lagrange Brackets. Small Oscillations and Normal modes.

Unit-IV: Dynamics of Rigid body: Generalized coordinates of a Rigid body, Euler's angles, Infinitesimal rotations of a rigid body, Principal Moments of inertia, Euler's equation of motion for a rigid body, Motion of a heavy symmetrical top.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. Classical Mechanics by H. Goldstein.
2. Classical Mechanics by N. C. Rana and P. S. Joag.
3. Introduction to Classical Mechanics by R. Takwale and P. Puranik.
4. Classical Mechanics by R. D. Gregory.

B. Journals & Magazines:

1. Review on mathematical Physics
2. Nuclear Physics B
3. Physical Review D
4. Physical Review Letter
5. Progress in Theoretical Physic
6. International Journal of Modern Physics A
7. Journal of High Energy Physics
8. Journal of applied Physics.
9. Journal of mathematical Physics
10. Journal of nature Physics

Name of the Module: Statistical Mechanics
Module Code: MP 915
Semester: I
Credit Value: 3 [L =3, T = 0, P = 0]

Objective:

The course is designed to meet with the objective of:

1. The main objective of this subject is to develop an understanding of statistical nature of thermodynamics.
2. To provide basic theory of statistical mechanics and to apply this theory wide variety of physical phenomena.
3. To provide basic tools for theoretical physicists or mathematicians for their study of many-body systems or more complicated system.

Learning Outcomes:

After completion of the subject:

1. Students will learn the qualitatively and quantitatively the concept of phase transition, scaling.
2. Students will learn the qualitatively and quantitatively the concept of cooperative phenomena in disorder and equilibrium systems.
3. Students will able to compute various thermodynamic properties of idealized simple classical and quantum mechanical systems using standard techniques, such as the partition function and the grand partition function.
4. Students will be able to model new physical situations using the methods exemplified in the course.
5. Students have gained insights into more advanced methods which touch upon modern research.

Subject Matter:

Unit-I: Phase space, Ensembles, Liouville theorem, Equation of motion, Equal a priori probability, Statistical equilibrium, Micro-canonical ensemble, Quantization of phase space, classical limit, symmetry of wave functions effect of symmetry on counting various distributions using micro canonical ensemble.

Unit-II: Entropy of an ideal gas, Gibbs paradox, Sackur-Tetrode equation, Entropy of a system in contact with a reservoir, Ideal gas in a canonical ensemble, Grand canonical ensemble, Ideal gas in Grand Canonical ensemble, Comparison of various ensembles. Quantum distribution using other ensembles.

Unit-III: Transition from classical statistical mechanics to quantum statistical mechanics, Indistinguishability and quantum statistics, identical particles and symmetry requirements, Bose Einstein statistics, Fermi Dirac statistics, Maxwell Boltzmann statistics. Bose Einstein Condensation, Thermal properties of B.E. gas, liquid Helium, Energy and pressure of F-D gas, Electrons in metals, Thermionic Emission.

Unit-IV: Cluster expansion for a classical gas, virial equation of state, Van der Waals gas, Phase transition of second kind. Ising Model, Bragg Williams Approximation, Fowler Guggenheim Approximation, Ising Model in one and two dimensions, fluctuations in ensembles, Energy fluctuation in quantum statistics, Concentration fluctuation in quantum statistics, One dimensional random walk, Brownian motion.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%
Examination Pattern:

Theoretical Examination and open book examination.

Reading List:
A. Books:

1. Statistical mechanics by K. Haung
2. Statistical Physics by Landau and Lifshitz
3. Statistical Mechanics by R. K. Patharia
4. Statistical Mechanics by R Kubo

B. Journals:

1. Journal of Statistical Mechanics: Theory and experiment.
2. Journal of Statistical Physics.
3. Journal of Nature Physics
4. Review on mathematical Physics
5. Nuclear Physics B
6. Physical Review D
7. Physical Review Letter
8. Progress in Theoretical Physic
9. Physics Letters B
10. International Journal of Modern Physics A
11. Modern Physics letters A

Name of the Module: Special Functions and Integral Transforms
Module Code: MAP 921
Semester: 3rd
Credit Value: 3 [P=0, T=0, L=3]

Objectives:

The course is design to meet the following objectives:
1. To investigate the properties of special functions and integral transforms.
2. To introduce from the point of view of applications to differential and integral equations.

Learning outcomes:

Upon completion of the subject:
1. Students can able to understand the properties of Integral Transforms and Special functions.
2. Student can able to demonstrate a firm understanding of the solution techniques for ordinary and partial differential equations.
3. Student can able to understand the mathematical framework that supports engineering, science, and mathematics.

Subject Matter:

Unit I

Hyper-Geometric functions, Legendres polynomial, Associated Legendres functions, Bessels functions, Recurrence relations, orthogonal properties, Hermite and Laguerre polynomials, their generating functions and general integral properties.

Unit-II

Laplace Transform, definition and properties, Laplace transform of derivatives and integrals, inverse Laplace transform, convolution theorem, complex inversion formula, theorems of Laplace transform.

Unit-III

Fourier sine and cosine transform, convolution theorem, Fourier transform of derivatives, Hankel Transform, definition and elementary properties, inversion theorem, Hankel transform of derivatives, Parsevals theorem.

Unit-IV

Application of Laplace transform to the solution of ordinary differential equations with constant coefficients and with variable coefficients, simultaneous ordinary differential equations, application of Fourier transform to the solution of boundary value problems, partial differential equations.

Teaching/Learning/Practice Pattern:

Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. E. D. Rainville, Special Function, Macmillan, New York.
2. I. N. Sneddon, The Use of Integral Transform, Tata McGraw Hill.
3. M. R. Spigel, Theory and Problems of Laplace transform.
4. Sharma and Vasistha, Integral Transforms, Krishna Prakashan, Meerut.

B. Magazines:

1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society).
3. Mathematical Spectrum (The University of She_eld).
4. Mathematics Magazines (Mathematical Association of America).

5. +Plus Magazines (University of Cambridge).

6. Ganithavahini (Ramanujam Mathematical Society).

C. Journals:

1. Ganita Sandesh.
2. Journal of Rajasthan Academy of Physical Sciences.
3. Bulletin of Calcutta Mathematical Society.
4. Integral Transforms and Special Functions.
5. Journal of Integral Equations and Applications.

Name of the Module: Differential Equations: ODE and PDE
Module Code: MAP 922
Semester: II
Credit Value: 3 [P=0, T=0, L=3]

Objectives:

The course is design to meet the following objectives:

1. Identify an ordinary differential equation and its order.
2. Classify ordinary differential equations into linear and nonlinear equations.
3. Use the method of undetermined coefficients to solve second order, linear homogeneous equations with constant coefficients.
4. Use the method of variation of parameters to find particular solutions of second order, linear homogeneous equations.
5. Use second order linear equations with constant coefficients to model mechanical vibrations.
6. To give the basic ideas about parabolic, hyperbolic and elliptic PDE's and their solution by method of separation of variables and integral transform.

Learning outcomes:

Upon completion of the subject:

1. Students can able to find the solution of the first order ODE’s.
2. Students can able to find solution of higher order linear equation with constant coefficient.
3. Student can able to classify the characteristic of a PDE’s.
4. Student can able to find the solution of a ODE’s or PDE’s by integral transform (Laplace and Fourier).

Subject Matter:

Unit I

Formulation of Differential equations, Geometrical and physical Consideration, First order and first degree ODE’s: Statement of existence theorem, Separable, Homogeneous and Exact equation, Condition of exactness, integrating factor. Rules of finding integrating factor, First order linear equations: Integrating factor, Equations reducible to first order linear equations.

Unit II

Higher order linear equations with constant coefficients: Complementary function, Particular Integral, Method of undetermined coefficients, Symbolic operator D, Method of variation of parameters, Euler’s homogeneous equation and reduction to an equation of constant coefficients, Simple eigen-value problems.

Unit III

First order linear and quasi-linear partial differential equations (PDEs), Cauchy problem, Classification of second order PDEs, characteristics, Well-posed problems, Solutions of hyperbolic, parabolic and elliptic equations, Dirichlet and Neumann problems, Maximum principles, Green's functions.

Unit IV

Solution of ODE, PDE by Laplace and Fourier Transform.

Teaching/Learning/Practice Pattern:

Teaching: 70%

Learning: 30%

Practice: 0%

Examination Pattern:

1. Theoretical Examination and open book examination.

Reading List:

A. Books:

1. E. A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Tata McGraw Hill, 1990.
2. S. L. Ross, Differential Equations, 3rd Edn., Wiley India, 1984.
3. Piskunov : Differential and Integral Calculus, Vol. I and Vol. II
4. I. N. Sneddon, Elements of Partial Differential Equations, Dover Publications, 2006.

5. S. J. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications, 1993.
6. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
7. K. Sankara Rao, Introduction to Partial Differential Equations, PHI, New Delhi, 2010.
8. M.D.Raisinghania, "Ordinary & Partial Differential equations", S.Chand & Co., 2013.

B. Magazines:

1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society).
3. Mathematical Spectrum (The University of Sheffield).
4. Mathematics Magazines (Mathematical Association of America).
5. +Plus Magazines (University of Cambridge).
6. Ganithavahini (Ramanujam Mathematical Society).

C. Journals:

1. Differential Equations, Springer.
2. Journal of Differential Equations, Elsevier.
3. International Journal of Differential Equations, Hindawi.
4. Journal of Hyperbolic Differential Equations, World Scientific.
5. International Journal of Dynamical Systems and Differential Equations, Inderscience Publishers

Name of the Module: Tensor Calculus
Module Code: MAP 923
Semester: II
Credit Value: 3 [P=0, T=0, L=3]

Objectives:

The course is design to meet the following objectives:

1. To understand the concepts of Tensor calculus.
2. To apply the concept using Tensor calculus to Mathematical Physics

Learning outcomes:

Upon completion of the subject:

1. Student is able to understand the concept of Tensor calculus.
2. Student will be able to understand and apply the concept of Tensor Calculus to Mathematical Physics

<u>Subject Matter:</u>

Unit I

Finite-Dimensional Vector Spaces and Linear Mappings : Fields - Finite-Dimensional Vector Spaces – Linear Mappings of a Vector Space - Dual or Covariant Vector Spaces

Unit-II

Tensor Algebra: Second-Order Tensors - Higher-Order Tensors - Exterior or Grassmann Algebra - Inner Product Vector Spaces and the Metric Tensor

Unit-III

Tensor Analysis on a Differentiable Manifold: Differentiable Manifolds - Tangent Vectors, Cotangent Vectors - Parametrized Curves - Tensor Fields over Differentiable Manifolds - Differential Forms and Exterior Derivatives

Unit-IV

Differentiable Manifolds with Connections: The Affine Connection and Covariant Derivative - Covariant Derivatives of Tensors along a Curve - Lie Bracket, Torsion, and Curvature Tensor

Teaching/Learning/Practice Pattern:

Teaching: 70%
Learning: 30%
Practice: 0%

<u>Examination Pattern:</u>

Theoretical Examination

<u>Reading List:</u>

A. Books:

1. Anadijiban Das, Tensors: The Mathematics of Relativity Theory and Continuum Mechanics.
2. Schaums Outline of Tensor Calculus (Schaum's Outline Series) , <u>David C. Kay</u>; Schaum's Outlines; Revised edition edition
3. Tensor Calculus (Dover Books on Mathematics), John L. Synge, <u>A. Schild</u>, Dover Publications Inc.; New edition edition
4. An Introduction to Riemannian Geometry and the Tensor Calculus, <u>C. E. Weatherburn</u>, Cambridge University Press; 1 Reissue edition
5. Vector and Tensor Analysis with Applications (Dover Books on Mathematics), A. I. Borisenko, I. E. Tarapov, R. A. Silverman, Dover Publications Inc.; New edition edition
6. Tensor Calculus and Riemannian Geometry 12th Revised Edition by G.S. Gupta, S.S. Gupta, J.K. Goyal, K.P. Gupta, Pragati Prakashan (Meerut).

B. Magazines:

1. Hamilton, William Rowan (1854–1855). "On some Extensions of Quaternions". In Wilkins, David R. Philosophical Magazine (7–9): 492–499, 125–137, 261–269, 46–51, 280–290.
2. Saunders Mac Lane, Categories for the Working Mathematician, p. 4, "...for example the monoid in the category of abelian groups, is replaced by the usual tensor product...", Springer, 1971

C. Journals:

1. Journal of Fluid Mechanics, Oxford University Press.
2. Physics of Fluids, American Institute of Physics.
3. International Journal of Non-Linear Mechanics, Elsevier.
4. International journal of Heat and Mass Transfer, Elsevier.

Name of the Module: Quantum Mechanics
Module Code: MP 924
Semester: II
Credit Value: 3 [L =3, T = 0, P = 0]

Objective:

The course is designed to meet with the objective of:

1. To learn the limitations of classical physics and how quantum physics successful explain those limitations and agree with experimental results.
2. To learn basics rules of quantum mechanics and how to solve physical problems through quantum mechanics technique.
3. To develop skills in formulating and solving physics problems.
4. To develop self-discipline and work habits necessary to succeed in research or higher learning in the real world.

Learning Outcomes:

After completion of the subject:

1. Students will learn the kinds of experimental results which are incompatible with classical physics and require a new development of quantum theory.
2. Students will learn how a single wave function gives all the information of physical variables like momentum, energy, angular momentum by operator and Schrodinger wave mechanics.
3. Students will learn the role of uncertainty in quantum physics and use the commutation relations of operators to determine whether or not two physical variables can be measured simultaneously.
4. Students will learn the method of separation variables to solve problems in 3D and spherical polar coordinates and will the occurrence of degeneracy in atomic structure.
5. Students will learn some matrix technique to solve physical problems.

Subject Matter:

Unit-I: Review of Classical mechanics, Schrodinger Wave equations for one dimensional and three dimensional, Probability densities and Probability current densities.

One dimensional Schrodinger Equation for: Free particle, Particle in a box, step potential and square-well potential, Harmonic oscillator.

Unit-II: Operator methods in quantum mechanics, raising and lowering operator, commutation relation.

Unit-III: Schrodinger equation in three dimensions: Cartesian coordinates and spherical polar coordinates. Three dimensional central potential, Hydrogen atom, Zeeman and Stark effect.

Unit-IV: Angular momentum, commutation relation of angular momentum, Addition of angular momentum, CG coefficient, time independent perturbation theory.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%
Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. Introduction to quantum Mechanics by D. J. Griffiths.
2. Modern Quantum Mechanics by J. J. Sakurai.
3. Quantum Mechanics: Theory and Applications by A. Ghatak and S. Loknathan.
4. Quantum Physics by S. Gasiorowicz.
5. Lecture on Quantum mechanics by A. Das.

B. Journals & Magazines:

1. Journal of Nature Physics
2. Review on mathematical Physics
3. Nuclear Physics B
4. Physical Review D
5. Physical Review Letter
6. Progress in Theoretical Physic
7. International Journal of Modern Physics A
8. Journal of High Energy Physics

9. Journal of applied Physics.
10. Journal of mathematical Physics
11. Physics Letters A

Name of the Module: Electrodynamics
Module Code: MP 925
Semester: II
Credit Value: 3 [L =3, T = 0, P = 0]

Objective:

The course is designed to meet with the objective of:
1. To enhance students' understanding of the fundamental laws of electrodynamics.
2. To develop the mathematical tools of theoretical physics needed for doctoral-level research.
3. To develop professional habits of problem solving and research needed for success in a doctoral program.

Learning Outcomes:

After completion of the subject:

1. Students will learn the deeper meaning of the Maxwellian field equations and account for their symmetry and transformation properties, domain of validity, and limitations.
2. Students will learn how to formulate and solve electromagnetic problems with the help of electrodynamics potentials and super potentials, and make a detailed account for gauge transformations and their use.
3. They will master the technique of deriving and evaluating formulae for the electromagnetic fields from very general charge and current distributions.
4. They will calculate the electromagnetic radiation from radiating systems (aerials, localised charge and current distributions) at rest.
5. They will formulate and solve electrodynamic problems in relativistically covariant form in four-dimensional spacetime.

Subject Matter:

Unit-I: Maxwell’s equations in free space and in matter, Boundary conditions, Continuity equation, Poynting’s theorem, Maxwell’s stress tensor.

Unit-II: Electromagnetic wave propagation in vacuum, wave propagation in matter, Reflection and Transmission coefficient for normal and oblique incidence.

Wave guide, TE and TEM waves in rectangular wave guide, coaxial transmission line.

Unit-III: Gauge transformations, scalar and vector potentials, Columb and Lorentz Gauge, Retarded potential, Lineard-Wiechert potentials.

Dipole radiation for magnetic and electric dipole, Radiation reaction, power radiated by point charges.

Unit-IV: Special theory of relativity, Lorentz transformation, Relativistic Energy and Momentum, Relativistic Electrodynamics, Field tensors, Electrodynamics in tensor notations.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%
Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. Classical Electrodynamics by J. D. Jackson.
2. Introduction to Electrodynamics by D. J. Griffiths.
3. Electromagnetic by B. B. laud.
4. Fundamentals of Electromagnetic by M. A. Wazed Miah.

B. Journals & Magazines:

1. Journal of Nature Physics
2. Review on mathematical Physics
3. Nuclear Physics B
4. Physical Review D
5. Physical Review Letter
6. Progress in Theoretical Physic
7. Physics Letters A

Name of the Module: Solid State Physics
Module Code: MP 931
Semester: III
Credit Value: 3 [L =3, T = 0, P = 0]

Objective:

The course is designed to meet with the objective of:

1. To provide students with a clear and logical presentation of the basic concepts and principle of solid state physics.
2. Strengthen an understanding of the concepts and principles through a broad range of the interesting applications to the real world.
3. To provide students with the basic physical concept and mathematical tools used to describe solids.

Learning Outcomes:

After completion of the subject:

1. Students will demonstrate and apply the knowledge of crystalline solids.
2. Students will learn the energy band concepts and their applications to the modern electrical devices.
3. They will learn the concepts of lattice plane, miller indices and reciprocal lattice and their utilization in advanced crystallography studies and research.

Subject Matter:

Unit-I: Atomic Bonding and Inter Atomic Forces: Forces between atoms, Cohesive energy, Ionic bond, Covalent bond, metallic bond and Vanderwaal's force.

Unit-II: Crystal Structure: Basis, Lattice, Unit cell, Primitive Unit cell, Lattice parameters, Miller indices, Crystal symmetry, Bravais lattices, Simple cubic, Body centered Cubic, Face Centered Cubic, Packing Fraction, HCP structure, Reciprocal Lattice and Brag's law.

Unit-III: Classical free electron theory of metal and its drawback, Quantum free electron theory for metal, Fermi-Dirac Statistics, Heat capacity, Thermal conductivity of metal. Classifications of metals, semiconductor and insulators in terms of Band theory, Band theory of solids, Bloch theorem and Kronig-Penny model.

Unit-IV: Superconductivity: Magnetic effect of Superconductor, Temperature effect of superconductor, Critical magnetic field and critical temperature, Meissner effect, Type-I and Type-II superconductors, BCS theory, Josephson's effect.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. Introduction to Solid State Physics by C. Kittel.
2. Solid State physics by S. O. Pillai.
3. Elementary Solid State Physics by M. A. Ommar.
4. Solid State Physics by N. David.
5. Solid State Physics by Dekker.

B. Journals:

1. Advanced Materials.
2. American Scientist.
3. Advances in Physics.
4. Applied Physics Letters
5. International journal of nano science.
6. Advanced Materials.
7. American Scientist.
8. Advances in Physics.
9. Applied Physics Letters
10. International journal of nano science.
11. Journal of Physics – Condensed matter
12. Nanotechnology IOP.
13. Nature Nanotechnology.
14. Journal of Superconductivity and Novel magnetism
15. Superconductor Science and technology
16. Journal of nature Physics

Name of the Module: Advanced Quantum Mechanics
Module Code: MP 932
Semester: III
Credit Value: 3 [L =3, T = 0, P = 0]

Objective:

The course is designed to meet with the objective of:

1. To provide basic insights in the field of QFT, High Energy Physics and Particle Physics.
2. To provide knowledge about non-relativistic and relativistic quantum mechanics.
3. To develop skills in formulating and solving physics problems.
4. To develop self-discipline and work habits necessary to succeed in research or higher learning in the real world.

Learning Outcomes:

After completion of the subject:

1. A working knowledge of non-relativistic and relativistic quantum mechanics including time-dependent perturbation theory, scattering theory, relativistic wave equations, and second quantization.
2. The ability to understand concepts and to perform calculations of scattering of particles.
3. The ability to critically understand and evaluate modern research utilizing quantum theory in condensed matter, nuclear and particle physics.

Subject Matter:

Unit-I: Relativistic Schrodinger Equation of motion, Klein-Gorden equation, Klein Paradox, Dirac equation.

Unit-II: Solution to Dirac equation, Dirac's hole theory, Dirac matrices and their properties.

Unit-III: Lorentz and Poincare transformation, Representation of Lorentz group, Free Klein-Gorden theory, field quantization, Nother's theorem.

Unit-IV: Complex scalar field theory: field quantization, charge operator, Green's function and electromagnetic coupling, Dirac field theory, Feynman diagrams.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. Lectures on Quantum Field Theory by Ashok Das.
2. An Introduction to Quantum Field theory by M. E. peskin and D. V. Schroeder.
3. Relativistic Quantum Mechanics by J. D. Bjorken and S. Drell.
4. Quantum Field theory by L. H. Ryder.
5. The Quantum theory of field by Steven Weinberg.

B. Journals:

1. Journal of Nature Physics
2. Review on mathematical Physics
3. Nuclear Physics B
4. Physical Review D
5. Physical Review Letter
6. Progress in Theoretical Physic
7. Physics Report
8. Physics Today

Name of the Module: Numerical Methods
Module Code: MAP 933
Semester: III
Credit Value: 3 [P=0, T=0, L=3]

Objectives:

The course is design to meet the following objectives:

1. Introducing the basic concepts of round-off error, truncation error, numerical Stability and condition, Taylor polynomial approximations; to derive and apply some fundamental algorithms for solving scientific and engineering problems: roots of nonlinear equations, numerical solution of ordinary differential equations.
2. Application of computer oriented numerical methods which has become an integral part of the life of all the modern engineers and scientists. The advent of powerful small computers and workstation tremendously increased the speed, power and flexibility of numerical computing.
3. Injecting future scope and the research directions in the field of numerical methods.

Learning outcomes:

Upon completion of the subject:

1. Students will be skilled to do Numerical Analysis, which is the study of algorithms for solving problems of continuous mathematics.
2. Students will know numerical methods, algorithms and their implementation in Fortran/C++ for solving scientific problems.
3. Students will be substantially prepared to take up prospective research assignments.

Subject Matter:

Unit I:

Errors in computation: Overflow and underflow; Approximation in numerical computation; Truncation and round off errors; Propagation and control of round off errors; Chopping and rounding off errors; Pitfalls (hazards) in numerical computations (ill conditioned and well conditioned problems).

Unit II:

Interpolation: Lagrange's Interpolation, Newton's forward & backward Interpolation Formula. Extrapolation; Newton's Divided Difference Formula; Error; Problems.

Unit III:

Numerical Differentiation: Use of Newton's forward and backward interpolation formula only.
Numerical Integration: Trapezoidal formula (composite); Simson's 1/3rd formula (composite); Romberg Integration (statement only); Problems.

Unit IV:

Numerical Solution of System of Linear Equations: Gauss elimination method; Matrix Inversion; Operations Count; LU Factorization Method (Crout's Method); Gauss-Jordan Method; Gauss-Seidel Method; Sufficient Condition of Convergence.
Numerical Solution of Algebraic and Transcendental Equations: Iteration Method: Bisection Method; Secant Method; Regula-Falsi Method; Newton-Raphson Method.
Numerical solution of Initial Value Problems of First Order Ordinary Differential Equations: Taylor's Series Method; Euler's Method; Runge-Kutta Method (4th order); Modified Euler's Method and Adams-Moulton Method.

List of Practical: (Minimum six experiments are required to be performed)

1. Assignments on Interpolation: Newton forward & backward, Lagrange.
2. Assignments on Numerical Integration: Trapezoidal Rule, Simson's 1/3rd Rule.
3. Assignments on Numerical solution of a system of Linear Equations: Gauss elimination, Gauss Jordan, Matrix Inversion, Gauss Seidel.
4. Assignments on Solution of Algebraic Equations: Bisection, Secant, Regula-Falsi, Newton-Raphson Methods.
5. Assignments on Ordinary Differential Equations: Taylor Series, Euler's Method, Runge-Kutta (4^{th} Order).

Teaching/Learning/Practice Pattern:

Teaching : 40%
Learning : 10%
Practice : 50%

(Teacher is to divide components for T/R/P)

Examination Pattern:

1. Theoretical Examination : Open book and on line.
2. Practical Examination : Conducting Experiments and Viva-Voce.

Reading list:

A. Books:

1. D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing, 3rd Ed., AMS, 2002.
2. K. E. Atkinson, An Introduction to Numerical Analysis, Wiley, 1989.
3. S. D. Conte and C. de Boor, Elementary Numerical Analysis - An Algorithmic Approach, McGraw-Hill, 1981.
4. C.M. Bender and S.A. Orszag, Advanced Mathematical Methods for Scientists and Engineers, McGraw-Hill Book Co., 1978.
5. John H. Mathews, Numerical Methods for Mathematics Sciences and Engineering 2nd ed. Prentice Hall of India, New Delhi 2003.
6. M.K.Jain, S.R.K. Iyengar and R.K. Jain, Numerical method for Scientific and Engineering Computation, New Age International Pvt. Ltd. 3rd edition, 1993,
7. V Rajaraman, Computer Oriented Numerical Methods, Pearson Education 3rd edition , 2013
8. Steven C. Chapra, Numerical Methods for Engineers, 4th Ed., McGraw Hill, 2002.
9. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Prentice Hall, 2006.
10. Günther Hämmerlin and Karl-Heinz Hoffmann, Numerical Mathematics, Springer-Verlag, 1991.

B. Magazines:

1. Current Science (Indian Academy of Sciences)
2. The Mathematics Student (Math Student) (Indian Mathematical Society)
3. Mathematical Spectrum(The University of Sheffield)
4. Mathematics Magazine (Mathematical Association of America)
5. +Plus magazine (University of Cambridge)
6. Ganithavahini (Ramanujan Mathematical Society)

C. Journals:

1. Numerische Mathematik, Springer Link.
2. Acta Numerica, Cambridge University Press.
3. SIAM Review, University of Bristol, UK.
4. Journal of Computational Physics, Elsevier.
5. SIAM Journal on Numerical Analysis, University of Bristol, UK.
6. SIAM Journal on Scientific Computing, University of Bristol, UK.
7. IMA Journal of Numerical Analysis, Oxford Journals.
8. Mathematics of Computation, American Mathematical Society.
9. Foundations of Computational Mathematics, Springer Link.

Name of the Module: Probability and Statistics
Module Code: MAP 934
Semester: III
Credit Value: 3 [P=0, T=0, L=3]

Objectives:

The course is design to meet the following objectives:

1. Imparting theoretical knowledge and practical application to the students in the area of Stochastic Process.
2. Introducing the basic notions of probability theory and develops them to the stage where one can begin to use probabilistic ideas in statistical inference and modeling, and the study of stochastic processes.
3. Providing confidence to students in manipulating and drawing conclusions from data and provide them with a critical framework for evaluating study designs and results.
4. Injecting future scope and the research directions in the field of stochastic process.

Learning outcomes:

Upon completion of the subject:

1. Students will add new interactive activities to gaps that we have identified by analyzing student log data and by gathering input from other college professors on where students typically have difficulties.

2. Students will add new simulation-style activities to the course in Inference and Probability.

3. Students will be substantially prepared to take up prospective research assignments.

Subject Matter:

Unit I

Probability Theory: Random Experiment, Sample space, Event (exclusive & exhaustive), Classical, Frequency and Axiomatic definition of probability Related theorem, Independent events. Bayes theorem, Compound experiment, Bernoulli trial, Binomial Law, Multinomial law. Random variables: Definition of random variables, distribution function (discrete and continuous) and its properties. Probability mass function; Probability density function. Transformation of random variables (One and two variable); Chebychev inequality and problems.

Unit II:

Distributions: Binomial, Poisson, Uniform, Exponential, Normal, Expectation and Variance Moment generating function; Reproductive Property of Binomal; Poisson and Normal Distribution. Binomial approximation to Poisson distribution and Binomial approximation to Normal distribution; Central Limit Theorem; Law of large numbers (Weak law); Simple applications.

Unit III:

Sampling Theory: Population; Sample; Statistic; Estimation of parameters (consistent and unbiased); Sampling distribution of sample mean and sample variance. Estimation Theory: Point estimate, Maximum likelihood estimate of statistical parameters and interval estimation (Binomial, Poisson and Normal distribution). Correlation and Regression: Simple idea of Bivariate distribution; Correlation and Regression; and simple problems

Unit IV:

Testing of Hypothesis: Simple and Composite hypothesis; Critical Region; Level of Significance Type I and Type II Errors; Best Critical Region; Neyman-Pearson Theorem (proof not required); Application to Normal Population; Likelihood Ratio Test (proof not required); Comparison of Binomial Populations; Normal Populations; Testing of Equality of Means; -Test of Goodness of Fit (application only).

Stochastic Process: Random Process, Poisson Process, Discrete and Continuous Parameters Markov Chains, Birth and Death Process, Concept of Queues, M/G/I queuing system.

Teaching/Learning/Practice Pattern:

Teaching: 70%

Learning: 30%

Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2000.

2. Khazanie, Ramakant. Basic Probability Theory and Applications Santa Monica, CA: Goodyear, 1976.

3. Ross, Sheldon M. Introduction to Probability Models, New York, NY: Academic Press, 1972, 1985. Third Edition.

4. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

5. Cramer, Harald. Random Variables and Probability Distributions, New York, NY: Cambridge University Press, 1970. Third Edition.

6. Parzen, Emanuel. Modern Probability Theory and Its Applications New York, NY: John Wiley, 1960.

7. Rothschild, V. and Logothetis, N. Probability Distributions New York, NY: John Wiley, 1986.

8. Bailey, Norman T.J. The Elements of Stochastic Processes with Applications to the Natural Sciences New York, NY: John Wiley, 1990.

9. Bhat, U. Narayan. Elements of Applied Stochastic Processes, New York, NY: John Wiley, 1984. Second Edition.

10. Karlin, Samuel and Taylor, Howard M. A First Course in Stochastic Processes, New York, NY: Academic Press, 1975. Second Edition.

11. Karlin, Samuel and Taylor, Howard M. A Second Course in Stochastic Processes NewYork, NY: Academic Press, 1981.

12. J. Medhi, Stochastic Processes, 3rd Ed., New Age International, 2009.

13. Ross, Sheldon M. Stochastic Processes New York, NY: John Wiley, 1983.

14. N.G. Das, Statistical Methods, Vol-I & Vol-II, Mc Graw Hill.

15. Murray R. Spiegel, Probability and Statistics, McGrawHll, Schaums Outline Series.

B. Magazines:

1. Current Science (Indian Academy of Science).

2. The Mathematics Student (Math Student) (Indian Mathematical Society).

3. Mathematical Spectrum (The University of She_eld).

4. Mathematics Magazines (Mathematical Association of America).

5. +Plus Magazines (University of Cambridge).

6. Ganithavahini (Ramanujam Mathematical Society).

C. Journals:

1. Advances in Probability and Related Topics (Marcel Dekker).

2. Annals of Applied Probability (Institute of Mathematical Statistics).

3. Annals of Probability (Institute of Mathematical Statistics).

4. Communications on Stochastic Analysis.

5. Electronic Journal of Probability.

6. Sminaire de Probabilits (Lecture Notes in Mathematics, Springer-Verlag).

7. Stochastic Modelling and Applied Probability (Springer-Verlag).

8. Stochastic Processes and their Applications.

9. Stochastics: An International Journal of Probability and Stochastic Processes (Taylor & Francis).

10. Theory of Probability and its Applications (SIAM).

11. Stochastic Processes and their Applications, Elsevier.

12. Stochastics: An International Journal of Probability and Stochastic Processes, Taylor Francis Online.

13. International Journal of Stochastic Analysis, Hindwai Publishing Corporation.

14. Journal of the American Statistical Association.

15. Journal of the Royal Statistical Society, Series A, Statistics in Society.

Name of the Module: FORTRAN/ C/C++Programming
Module Code: MAP 935
Semester: III
Credit Value: 4 [P=2, T=0, L=2]

Objectives:

The course is design to meet the following objectives:

1. To improve the ability to think logically, analytically, and abstractly.
2. To improve the ability to communicate mathematics, both orally and in writing.
3. Concepts for programming in FORTRAN AND CPP.
4. Linking Applied Mathematics, Physics and Programming

Learning outcomes:

Upon completion of the subject:

1. Student is able to solve Mathematical and Physical problems in FORTRAN AND CPP.

2. Student is able to work with the application part of programming.

3. Student is able to link FORTRAN AND CPP together.

Subject Matter:

FORTRAN

Unit I

BASIC FORTRAN: Creating and Compiling a Fortran Program •Print •Variables, Types, Arrays, Arithmetic Functions, Order of Operations •Logical Operators•Conditional statements•Looping options•Subroutines and Functions•Intro to Recursion

Unit-II

ADVANCED FORTRAN:Makefiles & Modules•Strings, strings, strings•Reading/Writing Formatted and Unformatted Data•Pointers•Higher dimensional arrays•User Defined Data Types•Modules and organizing big programs•Reading/writing scientific data•Debugging, Debugging, Debugging•Class requested topics

CPP

Unit-III

C++ Programming basics : Output using cout. Directives. Input with cin. Type bool. The setw manipulator. Type conversions. Functions :Returning values from functions. Reference arguments. Overloaded function. Inline function. Default arguments. Returning by reference. Object and Classes : Making sense of core object concepts (Encapsulation, Abstraction,Polymorphism, Classes, Messages Association, Interfaces) Implementation of class in C++, C++ Objects as physical object, C++ object as data types constructor.

Unit-IV

Arrays and string arrays**;** . Operator overloading; Inheritance; Pointer ; Virtual Function; Streams and Files; Templates and Exceptions ; The Standard Template Library

Teaching/Learning/Practice Pattern:

Teaching: 70%

Learning: 30%

Practice: 0%

Examination Pattern:

Lab Examination

Reading List:

A. Books:

1. C++ for FORTRAN Programmers, Ira Pohl (Addison-Wesley, ISBN 0201924838, 7/97)
2. C for FORTRAN Programmers, T. D. Brown (Silicon Press, ISBN 0929306015, 1/90)
3. Schaum's Outline of Programming with FORTRAN, William E. Mayo, Martin Cwiakala McGraw-Hill, ISBN 0070411557, 10/94)
4. Understanding FORTRAN 77 & 90, Gene Zirkel, Eli Berlinger P.W S.
5. Object Oriented Programming via Fortran 90/95, Ed Akin (Cambridge University Press, ISBN: 0521524083 , 4/03)
5. Fortran 90 and 95 for Scientists and Engineers, Stephen J. Chapman (McGraw-Hill, ISBN 0835956717, 10/97)
6. Applied FORTRAN 77: Featuring Structured Programming, Roy Ageloff, Richard Mojena (Wadsworth, ISBN 0534009611, 1981)
7. Computing for Engineers & Scientists with FORTRAN 77, Daniel D. McCracken, W. Salmon (John Wiley & Sons, ISBN 0471625523, 11/90)
8. The C++ Programming Language and by Bjarne Stroustrup
9. C++ How to Program by Deitel and Deitel
10. The C++ Cookbook by D. Ryan Stephens, Christopher Diggins, Jonathan Turkanis, and Jeff Cogswell
11. Practical Programming in C++ by Steve Oualline.
12. Numerical Recipes in Fortran by Press.

B. Magazines and References:

1. C++ Users, CMP Media LLC publication, United States.

2. http://www.fortranlib.com

3. www.cprogramming.com

4. http://en.wikibooks.org

C. Journals:

1. The Mathematica Journal.

Name of the Module: Advanced Material & Technology
Module Code: MP 936
Semester: III
Credit Value: 3 [L =3, T = 0, P = 0]

Objective:

The course is designed to meet with the objective of:

1. To provide science, engineering and technology graduates with a competitive edge for a career in high technology manufacturing industries.
2. To provide graduates with analytical skills and knowledge which prepare them for careers in manufacturing, R & D or product or process design
3. To develop graduates with excellence in Materials Science and Engineering capability to underpin National and International Industrial development.

Learning Outcomes:

After completion of the subject:

1. Students will learn basic physics behind the semiconductor materials and their characterization and applications in industry.
2. They will able to learn how the various electrical, thermal and optical properties vary with concentrations of doping atoms.
3. Students will learn basic principle of Laser and their various industrial applications.
4. They will also learn more advanced nano material, preparation, synthesis and characterization of nano materials.
5. They will able to learn sufficient physics such that they can carry out their research in these fields.

Subject Matter:

Unit-I: Semiconductor devices: Energy Band Gap, Fermi energy, semiconductor materials, PN-junction, Transistor, FET, MoSFET.

Unit-II: Laser, Laser principle, Population Inversion, Einstein's coefficient for stimulated and spontaneous emission.

Types of Laser: He-Ne Laser, Ruby Laser, CO_2-Laser and Laser Application.

Unit-III: Non-linear optics, Fiber Optics and its Application.

Unit-IV: Introduction to Nano Materials, Synthesis of Nano Materials, Characterization of nano materials by various techniques and application of nanomaterials.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. Laser and Non-Linear Optics by B. B. Laud.
2. Handbook of Nonlinear Optics by Richard L. Sutherland.
3. Nano particles and Nano structures films; preparation and characterization and applications by J. H. Fendler.
4. An Introduction to Fiber Optics by A. Ghatak and K. Thyagarajan
5. Lasers: Fundamental and Applications by K. Thyagarajan and A. Ghatak.
6. Introduction to Solid State Physics by C. Kittel.
7. Semiconductor Physics and Devices by S. S. Islam.

B. Journals:

1. Advances in Physics.
2. Advances in Physics.
3. Applied Physics Letters
4. International journal of nano science.
5. Nanotechnology IOP.
6. Nature Nanotechnology.
7. Journal of Superconductivity and Novel magnetism
8. Superconductor Science and technology

LIST OF PRACTICAL PAPERS:

Name of the Module: Optics Lab
Module Code: MP 916
Semester: I
Credit Value: 2 [L =0, T = 0, P = 4]

Objective:

1. The main objective of this subject is to verify experimentally various laws of optical phenomena.

Learning Outcomes:

1. Students will learn that practical results are not always agree with theoretical value.
2. They will able to learn the source of error of their experiments and how to minimize these errors
.

The List of Experiments:

1. Determination of wavelength of Na light by Newton's Ring Method.
2. Determination of Wavelength of Light by Michelson-Morley Experiment.
3. Determination of Wavelength of light by single slit diffraction.
4. Determination of Wavelength of light by diffraction grating.
5. Verification of Brewster's law by Polarization method.
6. Determination of specific rotation of sugar solution.

Reference Books:

1. Optics by Ajoy Ghatak.

Name of the Module: Modern Physics Lab
Module Code: MP 926
Semester: II
Credit Value: 2 [L =0, T = 0, P = 4]

Objective:

The main objective of this subject is to verify experimentally various modern physics phenomena.

Learning outcome:

1. Students will learn that practical results are not always agreed with theoretical value.

2. They will able to learn the source of error of their experiments and how to minimize these errors.

<u>The List of Experiments:</u>

1. Verification's of Bohr's law by Franck-Hertz method.
2. Verification of Hall effect.
3. Measurement of band gap of semiconductor by four-probe method.
4. Determination of Planck's constant.
5. Verification of Boolean algebra by digital circuit method.

Reference Books:

1. Concepts of Modern Physics by A. Beiser.

Elective Papers:

Name of the Module: Particle Physics
Module Code: MP 941 A
Semester: IV
Credit Value: 4 [L =3, T = 1, P = 0]

<u>Objective:</u>

The course is designed to meet with the objective of:

1. To familiar with basic building bulk of particle physics and how they are related.
2. To learn about the fundamental forces and fundamental particles.
3. To provide many advanced mathematical technique so that students will able to carry out their research in the field of high energy physics.

<u>Learning Outcomes:</u>

After completion of the subject:

1. Students will able to learn about Feynman diagrams and using to calculate scattering cross section of various fundamental particles interactions.
2. They will able to learn various unifying theory of fundamental interactions.
3. They will able to learn how different particles have different masses and spins.
4. They will able to compute tree-level radiative corrections for, e.g. $e^+e^- \rightarrow \mu^+\mu^-$ interaction.
5. They will able to compute the renormalization of the electromagnetic, weak and strong charge.

Subject Matter:

Unit-I: Review of Field Quantization: canonical quantization, path integral formalism, Renormalization technique, φ^4 Interaction.

Unit-II: Elements of Group theory, SU(2) and SU(3) group theory, Quark Model.

Unit-III: Yukawa Interaction, strong, weak and Electroweak Interaction, Invariance Principle and Conservation laws, CPT violation.

Unit-IV: Lepton and quark Interaction, elastic and inelastic scattering, $e^+e^- \rightarrow {}^{\mu+\mu-}$ interaction.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%
Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. Introduction to High Energy Physics by D. H. Perkins.
2. Gauge theory of elementary particle physics by Cheng and Li.
3. An Introduction to Particle Physics by M. leon.
4. Introduction to particle physics by D. Griffiths.

B. Journals and magazines:
1. Journal of Nature Physics
2. Review on mathematical Physics
3. Nuclear Physics B
4. Physical Review D
5. Physical Review Letter
6. Progress in Theoretical Physic
7. Physics Report
8. Physics Today
9. International journal of Modern Physics A
10. Modern Physics letters A
11. www. arXiv.org

Name of the Module: Condensed Matter Physics
Module Code: MP 941 B

Semester: IV
Credit Value: 4 [L =3, T = 1, P = 0]

Objective:

The course is designed to meet with the objective of:

1. To provide students with a clear and logical presentation of the basic concepts and principle of solid state physics.
2. Strengthen an understanding of the concepts and principles through a broad range of the interesting applications to the real world.
3. To provide students with the basic physical concept and mathematical tools used to describe solids.

Learning Outcomes:

After completion of the subject:

4. Students will demonstrate and apply the knowledge of crystalline solids.
5. Students will learn the energy band concepts and their applications to the modern electrical devices.
6. They will learn the concepts of lattice plane, miller indices and reciprocal lattice and their utilization in advanced crystallography studies and research.

Subject Matter:

Unit-I:
Vibration of one dimensional mono- and diotonic- chains, phonon momentum, density of normal modes in one and three dimensions, quantization of lattice vibrations, measurement of phonon dispersion using inelastic neutron scattering. Point defects, line defects and planer (stacking) faults, Fundamental ideas of the role of dislocation in plastic deformation and crystal growth, the observation of imperfection in crystals, x-rays and electron microscopic techniques.

Unit-II:
Electron in periodic lattice, block theorem kronig-penny model and band theory, classification of solids, effective mass, weak-binding method and its application to linear lattice, tight-binding method and its application to cubic bcc and fcc crystals, concepts of holes, Fermi surface : construction of Fermi surface in two- dimension, de Hass van alfen effect, cyclotron resonance, magnetoresistanc.

Unit-III:

Langevin theory for Diamagnetism and Paramagnetism, Weiss Theory of Ferromagnetism Heisenberg model and molecular field theory of ferromagnetism of spin waves and magnons, Curie-weiss law for susceptibility. Ferri and Anti Ferro-magnetic order. Domains and Block wall energy.

Unit-IV:
Dielectric and Ferroelectrics, Landau theory of phase transition for first order and second order transition, Antiferroelectricity, Piezoelectricity, Plasmons, Polaritons and Polarons.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%
Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. Crystallography for Solid State Physics by Verma and Srivastav.
2. Solid State Physics by Aschroft & Mermin.
3. Introduction to Solid State Physics by C. Kittel.
4. Solid State physics by S. O. Pillai.
5. Elementary Solid State Physics by M. A. Ommar.
6. Solid State Physics by N. David.
7. Solid State Physics by Dekker.

B. Journals:

1. Advanced Materials.
2. American Scientist.
3. Advances in Physics.
4. Applied Physics Letters
5. Advanced Materials.
6. Applied Physics Letters
7. Journal of Physics – Condensed matter
8. Nature Nanotechnology.
9. Journal of Superconductivity and Novel magnetism
10. Superconductor Science and technology

Name of the Module: Electronics
Module Code: MP 941 C
Semester: IV
Credit Value: 4 [L =3, T = 1, P = 0]

Objective:

The course is designed to meet with the objective of:

1. An understanding of how complex devices such as semiconductor diodes and field-effect transistors are modeled and how the models are used in the design and analysis of useful circuits.

2. An understanding of basic EE abstractions on which analysis and design of electrical and electronic circuits and systems are based, including lumped circuit, digital and operational amplifier abstractions.

3. To understands principles, characteristics and operations of combinational & sequential logic circuits.

4. To design combinational circuits by using logic gates.

5. To design and analyze, asynchronous and synchronous sequential circuit using flip flops.

Learning Outcomes:

After completion of the subject:

1. Learn how the primitives of Boolean algebra are used to describe the processing of binary signals and to use electronic components such as MOSFET's as building blocks in electronically implementing binary functions.

2. Learn how operational amplifiers are modeled and analyzed, and to design Op-Amp circuits to perform operations such as integration, differentiation and filtering on electronic signals.

3. Learn how negative feedback is used to stabilize the gain of an Op-Amp-based amplifier and how positive feedback can be used to design an oscillator;

Subject Matter:

Unit-I: Network Theorem, T and Pi diagram, Norton’s and Thevenin’s theorem, Oscillating circuits, Amplification and Modulation.

Unit-II: Operation Amplifiers: Op-AMP as Differentiator, Integrator, Adder, Logarthmic Amplifier, Antilog amplifier.

Unit-III: Digital Electronics: Boolean algebra, AND, NOR, OR and NAND circuits. A/D converter, D/A converter, Multiplexer and De-Multiplexer, FLIP-FLOP: R-S, J-K, J-K master flip-flop, encoder and decoder.

Unit-IV: Microprocessor and Its Application.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. Networks, Lines and Fields by J. D. Ryder.
2. Handbooks of Electronics by Gupta and Kumar.
3. Modern Digital Electronics by R. P. Jain.
4. Digital Electronics and Microprocessor by Aroras and Chhabra.

B. Journals and Magazines:

1. IEEE journals
2. Journal of Physics – Condensed matter
3. Nanotechnology IOP.
4. Nature Nanotechnology.
5. Journal of Superconductivity and Novel magnetism
6. Advanced Materials.
7. American Scientist.
8. Advances in Physics.
9. Applied Physics Letters
10. Physical review letters.

Name of the Module: Fluid Mechanics
Module Code: MAP 941 D
Semester: IV
Credit Value: 4 [P=0, T=1, L=3]

Objectives:

The course is design to meet the following objectives:

1. The purpose of this course is to introduce the main ideas of fluid.
2. Student will get basic idea about the mass conservation equation, momentum conservation equation and energy conservation equation.
3. Student gets the ideas to analyze the different problem associate in fluid motion.

Learning outcomes:

Upon completion of the subject:

1. Students can able to visualize the different flow problem.
2. Student can able to draw the stream line, path line, vortex line associate different flow problem.
3. Students can able to derive the boundary layer solution of boundary layer equation.

Subject Matter:

Unit I

Introduction: Basic concept of fluid, Unit of Measurement, solid, Liquids and Gases, Continuum Hypothesis, Transport Phenomena, surface Tension, Inviscid and Incompressible fluid: Lagrangian and Eulerian specifications, Streamline, Path line and Streak line. Vorticity and circulation. Stream function. Conservation of Mass, Euler Equation of motion along Streamline. Bernoullis equations and its applications.

Unit-II

Two-dimensional motion. Stream function, complex potential and velocity, sources, sinks. Doublets and their images. Circle theorem, Blasiuss theorem. Vortex motion, vortex lines and filaments, strength of a vortices, systems of vortices, rectilinear vortices, vortex pair and doublets. A single infinite row of vortices, Karmans vortex sheet.

Unit-III

Viscous incompressible fluid: Basic equation of conservation of mass, momentum and energy. Law of similarity, Reynolds numbers. Exact solutions of the Navier-Strokes equations: Flow through parallel walls, flow through circular pipe, Strokes first and second problems.

Unit-IV

Prandtls concept of boundary layer. Boundary layer approximation. Derivation of boundary-layer equations for two-dimensional flow, different measures of boundary layer on a at plate Blasius solution.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. H. Schlichting, Boundary-Layer theory, McGraw-Hill,Inc. 2003
2. L.M Milne-thomson, theoretical hydrodynamics. The Macmilan Co. 1960
3. L.D Landau and E.M Lifshitz, Fluid mechanics. Course of Theoretical Physics, Vol.6 Pergamon Press, 1959
4. H. Lamb, Hydrodynamics. Cambridge Mathematical Library. Cambridge University Press, 1993
5. W.H. Besant and A.S. Ramsey, A treatise of Hydro-mechanics, Part II, ELBS 2000.

B. Magazines:

1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society).
3. Mathematical Spectrum (The University of She_eld).
4. Mathematics Magazines (Mathematical Association of America).
5. +Plus Magazines (University of Cambridge).
6. Ganithavahini (Ramanujam Mathematical Society).

C. Journals:

1. Journal of Fluid Mechanics, Oxford University Press.
2. Physics of Fluids, American Institute of Physics.
3. International Journal of Non-Linear Mechanics, Elsevier.
4. International journal of Heat and Mass Transfer, Elsevier.
5. Journal of Heat Transfer, ASME.
6. International Journal of Non-Newtonian Fluid Mechanics, Elsevier.
7. International Journal of Heat and Fluid Flows, Elsevier.