SYLLABUS

MANONMANIAM SUNDARANAR UNIVERISTY, TIRUNELVELI-12

PG COURSES – AFFILIATED COLLEGES

M.Sc. PHYSICS

(Choice Based Credit System)

(with effect from the academic year 2021-2022 onwards)

Semester-I				
Part	**Subject Status**	**Subject Title**	**Subject Code**	**Credit**
III	Core-1	Classical Mechanics	ZPHM11	4
III	Core-2	Mathematical Physics-I	ZPHM12	4
III	Core-3	Integrated Electronics	ZPHM13	4
III	Core-4	Nonlinear Dynamics	ZPHM14	4
III	Core-5 Practical 1	General Physics Experiments – I	ZPHL11	3
III	Core-6 Practical 2	Electronics Experiments -I	ZPHL12	3

CLASSICAL MECHANICS

Preamble:

This course imparts knowledge about Lagrange's equation, Pseudo forces, Hamilton's equation and Maxwell field equations and their applications.

Unit I:

Fundamental Principles and Lagrangian Formulations

Mechanics of a particle and a system of particles - conservation laws - Constraints -Generalized coordinates - Principle of virtual work - D' Alembert's principle and Lagrange's equation - Applications of Lagrange's equation - Hamilton's principle - Lagrange's equation from Hamilton's principle-examples- conservation theorems and symmetry properties.

Unit II:

Central Force and Non-inertial frame

Motion in a central force field in a Lagrangian formalism - Reduction of two body problem to the equivalent one body problem - Classification of orbits for inverse square forces-Virial theorem – Differential equation for the orbits-Two body collisions-Classical scattering in a laboratory and center of mass frames - Non inertial frames - Rotating frame of reference-Pseudo forces-Coriolis force and effects of coriolis force on the moving bodies.

Unit III:

Hamilton's Formulations

Hamilton's equation from variational principle - Principle of least action - applications Legendre transformations – Canonical transformations - Lagrange and Poisson brackets - Equation of motion and conservation theorems in Poisson brackets – Hamilton – Jacobi method, Application to harmonic oscillator - Hamilton's characteristic function – separation of variables action – angle variables – Kepler problem in action angle variable.

Unit IV:

Rigid body dynamics

Mechanics of a rigid body - Displacement of a rigid body - Orthogonal transformation -Eulerian angles - infinitesimal rotation - Coriolis effect - Kinematics of a rigid body – Moments and products of inertia - Kinetic energy of a rigid body - Euler's equation of motion – Torque free motion - Spinning top.

Oscillatory motion: Theory of small oscillation-periodic motion-frequencies of vibration and normal modes-linear triatomic molecules.

Unit V:

Relativity

Postulates of special theory of relativity - Lorentz transformation equation – kinematic effects of Lorentz transformation - Variation of mass with velocity - Equivalence of mass and energy-Relativistic Lagrangian and Hamiltonian - Minkowski's space - Four vectors - Covariant four dimensional formulation of the law of mechanics - Covariance of Maxwell field equations under Lorentz transformation.

Books for study:

1. Classical mechanics -III Edition – Helbert Goldstein, Charles P. Poole, Johnsafko (Pearson, Chennai 2011).

Books for Reference:

1. Classical Mechanics by G. Aruldhas (PHI Learning Private Limited)
2. Classical Mechanics - N. C. Rana and P.S. Joag (Tata Mc – Graw hill, New Delhi1991)
3. Classical Mechanics - T. L. Chow (John-Wiley, NewYork, 1995)
4. Nonlinear Dynamics - M. Lakshmanan and S. Rajasekar (Springer, Berlin 2003)

E-Reference:

https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/
https://freevideolectures.com/course/4077/nptel-theoretical-mechanics/4
https://courses.lumenlearning.com/physics/chapter/6-4-fictitious-forces-and-non-inertial-frames-the-coriolis-force/
https://www.classcentral.com/course/relativity-theory-6543
https://onlinecourses.nptel.ac.in/noc19_ph15/preview
https://onlinecourses.nptel.ac.in/noc20_ph18/preview

MATHEMATICAL PHYSICS-I

Preamble :

This course introduce knowledge about linear vector spaces, tensor concepts and usage of partial differential equation in physics. It also disseminate knowledge on special functions and give basic idea of application statistics and probability.

UNIT I:

Vector Analysis

Introduction – Linear vector space – linearly dependent and independent set of vectors - Basis and expansion theorem – Schmidt's Orthogonalization process – Gradient of a scalar field – Divergence and curl of a vector function – Physical significance - Gauss Divergence theorem and its proof– Deduction of Gauss's law – Stoke's theorem and its proof - Deduction from Stoke's theorem-Green's Theorem and its proof.

UNIT II:

Special Functions –I

Introduction – Second order linear differential equation – Power series method of solution–Linear independence of solution – Legendre's differential equation and solution–Generating function - Rodrigue's formula – Orthogonal properties – Recurrence relations for Pn(x) – Laguerre's differential equation and Laguerre polynomials – generating function – Rodrigue's formula – recurrence relations – orthogonal property of Laguerre polynomials – Beta and Gamma functions.

UNIT III:

Partial Differential Equations

Introduction – Laplace's equation and its solution in Cartesian co-ordinates – Heat flow equation – Examples of two dimensional steady heat flow – Solution of heat flow equation by the method of separation of variables – Variable linear heat flow infinite and infinite bars – Equation of motion for the vibrating string – D' Alembert's solution – Fourier series solution – Waves on strings – Vibrations of rectangular and circular membranes.

UNIT IV:

Tensor Analysis

Introduction – Notations and conventions in tensor analysis-Einstein's summation convention - contravariant and convariant tensors – Tensor of higher ranks –-Algebraic operations of tensors – Symmetric and asymmetric tensors –

Metric and associated tensors – Tensor form of gradient, divergence, Laplacian and curl – Christoffel symbols – kinematics in Riemann space – Riemann – Christoffel tensor – Simple applications of tensors – Hooke's law – Tensors in rigid bodies – Tensors in EM theory – Invariance of Maxwell's equations.

UNIT V:

Probability and Statistics

Probability - Addition rule of Probability – Multiplication Law of Probability – Probability distributions – Binomial distribution – Poisson distribution – Normal or Gaussian distribution – distribution of sum of normal variables – Applications of Binomial, Poisson and Normal distributions – Central limit theorem – Introduction to statistics – measures of central tendency and dispersion – Quartile, mean and standard deviations – Measures of skewness – Karl Pearson's coefficient of skewness – Bowley's coefficient of skewness.

Books for study:

1. Mathematical Physics, Satya Prakash, Sultan Chand & Sons, Reprint 2006.
2. Comprehensive Statistical Methods, P. N. Arora and Sumeet Arora, Sultan Chand & Sons., (2012).

Books for Reference:

1. Essential Mathematical Methods for Physicists, George B. Arfken, Hanes J. Weber, Frank E. Harris, 7th Edition, Elsevier (2012).
2. Mathematical Physics, H. K. Dass and R.Verma, S. Chand & Co Pvt. Ltd.(1997).
3. Matrices and Tensors in Physics, A. W. Joshi, 3rd Edition, New Age International Pub. (1995).
4. Mathematical Physics, B. D. Gupta, Vikas Publishing House Pvt. Ltd. Reprint (2013).
5. Mathematical Physics, S. L. Kakaniand C. Hemarajini, II Edition, CBS Publishers and Distributers Pvt. Ltd., (2010).
6. Vector Spaces and Matrices in Physics, M. L. Jain, Alpha Science International (2001).
7. Special Functions for Scientists and Engineers, W. W. Bell, Dover Publications (2004).
8. Vector and Tensor Analysis, Harry Lass, McGraw Hill Pub, (1950)

E-Reference:

1. https://youtu.be/pMFv6liWK4M
2. https://youtu.be/kj-qTWhH5N4
3. https://youtu.be/9P8T9rnclH4
4. https://youtu.be/rlpziTbJZk0

INTEGRATED ELECTRONICS

Preamble:

This course imparts knowledge about Design of linear ICs, Design of different kinds of filters, op amp systems and their working, designing different kinds of counters, Implement Multiplexers with electronic measurement and control.

Unit I:

Devices, Applications and Integrated Circuits:

FET-Types of FET- Characteristics and applications of FET, MOSFET, SCR, DIAC, TRIAC – High frequency device - Integrated Circuits - IC Fabrication Technology - Steps in Fabrication - Integrated Resistors and Capacitors – VLSI Technology.

Unit II:

Digital Electronics:

Logic Families - DTL, RTL, TTL, ECL, I2L, CMOS, NMOS and PMOS – DTL type AND, OR, NAND and NOR gates - RTL and TTL type NAND - CMOS NOR and CMOS NAND - Flip Flops: RS - RST- D - JK- JK Master/Slave - counters – Asynchronous and Synchronous Counters – Registers: Types of registers, serial in – serial out, serial in –parallel out, parallel in – serial out, parallel in –parallel out.

Unit III:

OP AMP and Applications:

Characteristics and Parameters - DC Analysis of IC OP AMP - Applications of OP AMP – Amplification (OP Amp based feedback Amp)- Instrumentation amplifier - Sample and Hold System - Analog Multiplexer - Integrator - Differentiator - Design of Analog circuits for the solution of Simultaneous and Differential Equations-Filters: First and Second order LOW, HIGH and BAND pass filters.

Unit IV:

Timer, VCO, PLL, and Applications:

Timer-555 Timer IC-Internal Architecture and Working - Modes of Operation: Monostable and Astable operation – Applications –Voltage Control Oscillator – IC 566 – PLL Concept – PLL IC 565 – Application – Frequency multiplier – FSK Modulation and Demodulation.

Unit V:

Electronic Measurement and Control:

Sensors and Transducers - Measurement and Control - Signal Conditioning and Recovery –Impedance Matching – Noise and Noise Sources – Filtering and Noise Reduction – Shielding and Grounding – Fourier Transform – Lock – in Detector/Amplifier - Box-Car Integrator or Averager – Modulation Techniques.

Books for Study:

1. Integrated Electronics Analog and Digital Circuits and Systems, Second Edition, Jacob Millman,
2. Christos C Halkias, Chetan Parikh, Tata Mc Graw Hill Education Private Limited, New Delhi.
3. Analog and Digital Electronics, U.A. Bakshi, A.P.Godse, Technical Publications, Pune.

Books for Reference:

1. Introduction to Semi Conductor Devices M. S. Tyagi, John Wiley and Sons.
2. Electronic instrumentation, P. P. L. Regtien, VSSD Publications, 2005

Online References:

1. https://nptel.ac.in/course.html
2. https://onlinecourses.nptel.ac.in/noc21_ee31/preview
3. http://www.nptelvideos.in/2012/11/digital-integrated-circuits.html
4. https://youtu.be/lpXNCwsnxjM?list=PLuv3GM6-gsE3npYPJJDnEF3pdiHZT6Kj3

NONLINEAR DYNAMICS

Preamble :

This course helps to understand the different behaviors of linear and nonlinear systems.

UNIT I:

Nonlinearity, linear and nonlinear oscillators

Dynamical systems-linear and nonlinear forces - Mathematical implications of nonlinearity -Working definition of nonlinearity - Effects of nonlinearity - Linear oscillators and predictability - Damped and driven nonlinear oscillators.

UNIT II:

Equilibrium points, bifurcations and chaos

Equilibrium points - General criteria for stability – Classification - Some simple bifurcations - Saddle node, pitch fork and trans critical bifurcations - Discrete dynamical systems – Logistic map - Equilibrium points and their stability - period doubling phenomenon in logistic map-chaos.

UNIT III:

Chaos in nonlinear electronic circuits

Linear and nonlinear circuit elements - Nonlinear circuits - Chua's diode - Autonomous case - Bifurcations and chaos - Chaotic dynamics of MLC circuit - Analogue circuit simulation – Some other useful nonlinear circuit - Colpitt's oscillator.

UNIT IV:

Fractals

Self-similarity - Properties and examples of fractals - Fractal dimension - Construction and properties of some fractals - Middle one third cantor set - Koch curve - Sierpinski triangle – Julia set – Mandelbrot set - Applications of fractals.

UNIT V:

Solitons

Linear waves - Linear non dispersive wave propagation - Linear dispersive wave propagation - Nonlinear dispersive systems - An Illustration of the Wave of Permanence - John Scott Russel's Great Wave of Translation - Cnoidal and Solitary waves - Korteweg de vries equation - Properties of solitons - applications of solitons.

Book for Study:

1.Nonlineardynamics, Integrability, Chaos, Patterns, M. Lakshmanan and S. Rajasekar, Springer, Berlin, 2003.

Books for Reference:

1. Chaos in nonlinear oscillator, controlling and synchronization, M. Lakshmanan and K. Murali (World Scientific, Singapore, 1997).
2. Deterministic Chaos, H. G. Schuster, (Verlag, Weinheim, 1998).

Related online resources:

1. https://youtu.be/TRjV9vfDsho
2. https://youtu.be/gB9n2gHsHN4
3. https://youtu.be/56gzV0od6DU
4. https://youtu.be/DFKm0K5O7ak

GENERAL PHYSICS EXPERIMENTS – I

1.Susceptibility

a) Determination of susceptibility of the given paramagnetic solution by Quinke's Method for various normalities,
b) Determination of Magnetic Moment and Bohr Magnetron from graph and by calculation for various normalities.

2. Cauchy's Constant

a) Determination of λ and μ for different lines of mercury spectrum.
b) Calculation of Cauchy's constant using least square fit and graphical method.

3. Michelson's Interferometer

Determination of wavelength of a source and thickness of a thin transparent medium by forming interference pattern.

4. Anderson's Bridge

Determination of self-inductance of

a. Two different coils of self inductance L1, L2
b. When connected in series (Ls)
c. When connected in parallel (Lp)
d. Verification of Ls and Lp using L1 and L2.

5. Thickness of a thin material

a. Determination of thickness of a very thin material using LASER diffraction and by Air wedge method.
b. Determination of thickness of the above material as a function of load using Laser beam.

6. Temperature co-efficient and Band Gap

Determination of Temperature co-efficient and band gap of a given Semiconductor (Thermistor) using Carey-Foster Bridge

7. Refractive index of liquid

a) Determination of refractive index of liquid by forming Newton's Rings.
b) Determination of refractive index of the above liquid by hallow prism.

ELECTRONICS EXPERIMENTS –I

Any **FIVE** Experiments

1. Series Voltage Regulator

Construction of a series voltage regulator using transistor (as an error amplifier) - Study the regulation factors (line regulation, load regulation) -to find out the percentage of regulation.

2. Schmitt Trigger

Designing of a Schmitt trigger circuit using transistors -Trace the input and output waveforms - Draw Hysteresis curve and calculate hysteresis voltage both theoretically and experimentally.

3. Wave Form Generators

Construction of a triangular and a ramp wave generator using OP Amp and construction of 555 timer based square wave generator. Theoretical calculation of the frequency of the output wave for various R and C values with experimental verification.

4. Counters and Decoders

Construction and study of Modulus counters (2 to 9) using IC 7490 or any equivalent IC. Use a 7 segment decoder and a 7 segment display to show output.

5. Analog to Digital Conversion

Construction of ADC converter using Comparator and an Encoder ICs -Measurement of the digital outputs for various input voltages - Resolution measurement.

6. Construction of Constant Current Source

Construction of a constant current source using OP Amp and transistor/FET (floating and grounded load). I-R characteristics.

7. FET Characteristics and Amplifier

Drain and Transfer characteristics of FET - FET parameters from the characteristics. Designing of a voltage amplifier using FET - Frequency response and bandwidth of the amplifier.