MANONMANIAM SUNDARANAR UNIVERISTY,
TIRUNELVELI-12

SYLLABUS

UG - COURSES – AFFILIATED COLLEGES

Course Structure for M. Sc. Physics
(Choice Based Credit System)
(with effect from the academic year 2024-2025 onwards)

Semester-I				
Part	**Subject Status**	**Subject Title**	**Subject Code**	**Credit**
III	CORE I	MATHEMATICAL PHYSICS	WPHM11	5
III	CORE II	CLASSICAL MECHANICS AND RELATIVITY	WPHM12	4
III	CORE PRACTICAL I	PRACTICAL-I: GENERAL PHYSICS AND ELECTRONICS EXPERIMENTS – I	WPHL11	4
III	ELECTIVE I	ENERGY PHYSICS	WPHE11	3
III	ELECTIVE II	LINEAR AND DIGITAL ICS AND APPLICATIONS	WPHE14	3

Total Marks: 100 Internal Exam: 25 marks + External Exam: 75 marks

A. **Scheme for internal Assessment**:
Maximum marks for written test: **20 marks**
3 internal tests, each of **I hour** duration shall be conducted every semester.
To the average of the **best two** written examinations must be added the marks scored in. The **assignment** for 5 marks.

The break up for internal assessment shall be:
Written test- 20 marks; Assignment -5 marks Total - 25 marks

B. Scheme of External Examination
3 hrs. examination at the end of the semester
A – Part : 1 mark question two - from each unit
B – Part : 5 marks question one - from each unit
C – Part : 8 marks question one - from each unit

- **Conversion of Marks into Grade Points and Letter Grades**

S.No	Marks	Letter Grade	Grade point (GP)	Performance
1	90-100	O	10	Outstanding
2	80-89	A+	9	Excellent
3	70-79	A	8	Very Good
4	60-69	B+	7	Good
5	50-59	B	6	Above Average
6	40-49	C	5	Pass
7	0-39	RA	-	Reappear
8	0	AA	-	Absent

- **Cumulative Grade Point Average (CGPA)**

$$\mathbf{CGPA} = \frac{\mathbf{\Sigma\,(GP \times C)}}{\mathbf{\Sigma C}}$$

- **GP** = Grade point, **C** = Credit
- CGPA is calculated only for Part-III courses
- CGPA for a semester is awarded on cumulative basis

- **Classification**
  a) First Class with Distinction : CGPA $\geq$ 7.5*****
  b) First Class : CGPA $\geq$ 6.0
  c) Second Class : CGPA $\geq$ 5.0 and $<$ 6.0
  d) Third Class : CGPA$<$ 5.0

MATHEMATICAL PHYSICS

Learning Objectives

- To equip students with the mathematical techniques needed for understanding theoretical treatment in different courses taught in their program
- To extend their manipulative skills to apply mathematical techniques in their fields
- To help students apply Mathematics in solving problems of Physics

UNIT I:

LINEAR VECTOR SPACE

Basic concepts – Definitions- examples of vector space – Linear independence Scalar product- Orthogonality – Gram-Schmidt orthogonalization procedure – linear operators – Dual space- Ket and Bra notation – orthogonal basis – change of basis – Isomorphism of vector space – projection operator – orthogonal transformations and rotation for R2 Vector space with standard basis.

UNIT II:

COMPLEX ANALYSIS and GROUP THEORY

Review of Complex Numbers -de Moivre's Theorem-Functions of a Complex Variable- Differentiability -Analytic functions- Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula -Taylor's Series Laurent's Expansion- Zeros and poles – Residue theorem.

Concept of groups-Abelian group-cyclic group- subgroups- classes- conjugate subgroups- Isomorphism and homomorphism – reducible and irreducible representations- character tables- construction of character tables for C2V and C3V point groups.

UNIT III:

MATRICES

Types of Matrices and their properties, Rank of a Matrix -Conjugate of a matrix - Adjoint of a matrix - Inverse of a matrix - Hermitian and Unitary Matrices Trace of a matrix- Transformation of matrices - Characteristic equation - Eigen values and Eigen vectors - Cayley–Hamilton theorem –Diagonalization

UNIT IV:

FOURIER TRANSFORMS & LAPLACE TRANSFORMS

Definitions -Fourier series and transform and its inverse – Properties of FT - Fourier transform of derivatives - Cosine and sine transforms – Properties of FT – Simple

Applications. Laplace transform and its inverse - Transforms of derivatives and integrals – Differentiation and integration of transforms – Properties of LT- Simple applications.

UNIT V:

DIFFERENTIAL EQUATIONS

Second order differential equation- Sturm-Liouville's theory - Series solution with simple examples - Hermite polynomials - Generating function Orthogonality properties - Recurrence relations – Legendre polynomials Generating function - Rodrigue formula – Orthogonality properties - Dirac delta function - One dimensional Green's function and Reciprocity theorem.

TEXT BOOKS

1. George Arfken and Hans J Weber, 2012, Mathematical Methods for Physicists – A Comprehensive Guide (7th edition), Academic press.
2. P.K. Chattopadhyay, 2013, Mathematical Physics (2nd edition), New Age, New Delhi
3. AW Joshi, 2017, Matrices and Tensors in Physics, 4th Edition (Paperback), New Age International Pvt. Ltd., India
4. B.D. Gupta, 2009, Mathematical Physics (4th edition), Vikas Publishing House, New Delhi.
5. H.K. Dass and Dr. Rama Verma, 2014, Mathematical Physics, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.

REFERENCE BOOKS

1. E.Kreyszig, 1983, Advanced Engineering Mathematics, Wiley Eastern, New Delhi,
2. D. G. Zill and M. R. Cullen, 2006, Advanced Engineering Mathematics, 3rd Ed. Narosa, New Delhi.
3. S. Lipschutz, 1987, Linear Algebra, Schaum's Series, McGraw - Hill, New York 3. E. Butkov, 1968, Mathematical Physics Addison Wesley, Reading, Massachusetts.
4. P. R. Halmos, 1965, Finite Dimensional Vector Spaces, 2nd Edition, Affiliated East West, New Delhi.
5. C. R. Wylie and L. C. Barrett, 1995, Advanced Engineering Mathematics, 6 th Edition, International Edition, McGraw-Hill, New York

WEB SOURCES

1. www.khanacademy.org
2. https://youtu.be/LZnRlOA1_2I
3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath
4. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlED56gNjVJGO2qaZ
5. https://archive.nptel.ac.in/courses/115/106/115106086/

CLASSICAL MECHANICS AND RELATIVITY

Learning Objectives

- To understand fundamentals of classical mechanics.
- To understand Lagrangian formulation of mechanics and apply it to solve equation of motion.
- To understand Hamiltonian formulation of mechanics and apply it to solve equation of motion.
- To discuss the theory of small oscillations of a system.
- To learn the relativistic formulation of mechanics of a system

UNIT I:

PRINCIPLES OF CLASSICAL MECHANICS

Mechanics of a single particle – conservation laws for a particle – mechanics of a system of particles – conservation laws for a system of particles – constraints – holonomic & non-holonomic constraints – generalized coordinates – configuration space – transformation equations – principle of virtual work.

UNIT II:

LAGRANGIAN FORMULATION

D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine – Lagrange's equations in presence of non-conservative forces – Lagrangian for a charged particle moving in an electromagnetic field.

UNIT III:

HAMILTONIAN FORMULATION

Phase space – generalized momentum and cyclic coordinates – Hamiltonian function and conservation of energy – Hamilton's canonical equations of motion – applications: (i) one dimensional simple harmonic oscillator (ii) motion of particle in a central force field.

UNIT IV:

SMALL OSCILLATIONS

Stable and unstable equilibrium –Formulation of the problem: Lagrange's equations of motion for small oscillations – Properties of T, V and w –Normal co-ordinates and normal frequencies of vibration – free vibrations of a linear triatomic molecule.

UNIT V:

RELATIVITY

Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities – Einstein's mass-

energy relation – Minkowski's space – four vectors – position, velocity, momentum, acceleration and force in four vector notation and their transformations.

TEXT BOOKS

1. H. Goldstein, Classical Mechanics, 3rd Edition, Pearson Edu. 2002.
2. J. C. Upadhyaya, Classical Mechanics, Himalaya Publshing Co. New Delhi.
3. S.L. Gupta,V.Kumar, H.V. Sharma, Classical Mechanics, PrakatiPrakashan, Meerut.
4. R. Resnick, Introduction to Special Theory of Relativity, Wiley Eastern, New Delhi, 1968.
5. N. C. Rana and P.S. Joag, Classical Mechanics - Tata McGraw Hill, 2001

REFERENCE BOOKS

1. R. G. Takwala and P.S. Puranik, Introduction to Classical Mechanics –Tata – McGraw Hill, New Delhi, 1980.
2. K. R. Symon, 1971, Mechanics, Addison Wesley, London.
3. S. N. Biswas, 1999, Classical Mechanics, Books & Allied, Kolkata.
4. T.W.B. Kibble, Classical Mechanics, ELBS.
5. Greenwood, Classical Dynamics, PHI, New Delhi.

WEB SOURCES

1. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
2. https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014editionpdf-pdf-free.html
3. https://nptel.ac.in/courses/122/106/122106027/
4. https://ocw.mit.edu/courses/physics/8-09-classical-mechanicsiii-fall-2014/lecturenotes/
5. https://www.britannica.com/science/relativistic-mechanics

CORE PRACTICAL I:

GENERAL PHYSICS AND ELECTRONICS EXPERIMENTS – I

Learning Objectives

- To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.
- Application of Diffraction and Interference
- Determination of some physical constants
- To calculate the thermodynamic quantities and physical properties of materials.
- To analyze the optical and electrical properties of materials.

Course Details (Choose any SIX experiments from Part A and SIX from Part B)

PART A- General Physics Experiments

1. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes - Cornu's Method
2. Determination of Thickness of the enamel coating on a wire by diffraction
3. Measurement of Band gap energy of the Thermistor material
4. Determination of Planck Constant – LED Method
5. Determination of Compressibility of a liquid using Ultrasonic Interferometer
6. Determination of Wavelength, Separation of wavelengths using Michelson Interferometer
7. Accurate measurement of wavelength of Diode Laser using Diffraction grating.
8. Determination of Diffraction pattern of light with circular aperture using Diode/He-Ne laser.
9. Measurement of Susceptibility of liquid - Quincke's method
10. Determination of Self Inductance of the given coil using Maxwell's method.
11. Determination of Crystallographic Parameters for the given XRD spectrum
    a) Unit cell determination b) W-H plot and interpretation
12. Measurement of RC Time constant (through discharging) and its theoretical verification.

PART B – Electronics Experiments

1. Construction of series voltage regulator and its characteristics
2. FET CS amplifier- Frequency response, input impedance, output impedance
3. Important electrical characteristics of IC 741 (i/p and o/p impedance, Voltage Gain, CMRR).
4. Construction of a Constant current source using Transistor/FET and 741 and I-R characteristics (Floating and Grounded Load)
5. V- I and optical Characteristics of LEDs of different wavelengths.
6. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
7. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
8. To design and construct a Schmitt trigger using IC741
9. Construction of square wave and Triangular wave generator using IC 741
10. Construction of pulse generator using the IC 741 – application as frequency divider
11. Construction of Op-Amp- 4-bit Digital to Analog converter (Binary Weighted and R/2R ladder type
12. BCD addition using IC7483

TEXT BOOKS

1. Practical Physics, Gupta and Kumar, PragatiPrakasan.
2. Kit Developed for doing experiments in Physics- Instruction manual, R.Srinivasan K.R Priolkar, Indian Academy of Sciences.
3. Electronic Laboratory Primer a design approach ,
1. S. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi.
4. Electronic lab manual Vol I, K ANavas, Rajath Publishing.
5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition

REFERENCE BOOKS

1. Advanced Practical Physics, S.P Singh, PragatiPrakasan.
2. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd
3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.
4. A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd.
5. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing.

ENERGY PHYSICS

Learning Objectives

- To learn about various renewable energy sources.
- To know the ways of effectively utilizing the oceanic energy.
- To study the method of harnessing wind energy and its advantages.
- To learn the techniques useful for the conversion of biomass into useful energy.
- To know about utilization of solar energy

UNIT I:

INTRODUCTION TO ENERGY SOURCES

A brief survey of conventional and non-conventional energy sources and their availability–present and future needs-. prospects of Renewable energy sources– Energy from other sources– chemical energy–Nuclear energy– Energy storage and distribution.

UNIT II:

ENERGY FROM THE OCEANS

Energy utilization–Energy from tides–Basic principle of tidal power– utilization of tidal energy – Principle of ocean thermal energy conversion systems.

UNIT III:

WIND ENERGY SOURCES

Basic principles of wind energy conversion–power in the wind–forces in the Blades–

Wind energy conversion–Advantages and disadvantages of wind energy conversion systems (WECS) - Energy storage–Applications of wind energy.

UNIT IV:

ENERGY FROM BIOMASS

Biomass conversion Technologies– wet and dry process– Photosynthesis Biogas Generation: Introduction–basic process: Aerobic and anaerobic digestion – Advantages of anaerobic digestion–factors affecting bio digestion and generation of gas- bio gas from waste fuel– properties of biogas-utilization of biogas.

UNIT V:

SOLAR ENERGY SOURCES

Solar radiation and its measurements–solar cells: Solar cells for direct conversion of solar energy to electric powers–solar cell parameter–solar cell electrical characteristics– Efficiency–solar water Heater –solar distillation– solar cooking–solar greenhouse – Solar pond and its applications.

TEXT BOOKS

1. G.D. Rai, 1996, Non – convention sources of, 4th edition, Khanna publishers, New Delhi.
2. S. Rao and Dr. ParuLekar, Energy technology.
3. M.P. Agarwal, Solar Energy, S. Chand and Co., New Delhi (1983).
4. Solar energy, principles of thermal collection and storage by S.P.Sukhatme, 2ndedition, Tata McGraw-Hill Publishing Co. Lt., New Delhi (1997).
5. Energy Technology by S.Rao and Dr.Parulekar.

REFERENCE BOOKS

1. Renewable energy resources, John Twidell and Tonyweir, Taylor and Francis group, London and New York.
2. Applied solar energy, A.B.MeinelandA.P.Meinal
3. John Twidell and Tony Weir, Renewable energy resources, Taylor and Francis group, London and New York.
4. Renewal Energy Technologies: A Practical Guide for Beginners C.S. Solanki-PHI Learning
5. Introduction to Non-Conventional Energy Resources -Raja et. al., Sci. Tech Publications

WEB SOURCES

1. https://www.open.edu/openlearn/ocw/mod/oucontent/view.php?id=2411&printable=1
2. https://www.nationalgeographic.org/encyclopedia/tidal-energy/
3. https://www.ge.com/renewableenergy/wind-energy/what-is-wind-energy
4. https://www.reenergyholdings.com/renewable-energy/what-is-biomass/
5. https://www.acciona.com/renewable-energy/solar-energy/

LINEAR AND DIGITAL ICs & APPLICATIONS

Learning Objectives

- To introduce the basic building blocks of linear integrated circuits.
- To teach the linear and non-linear applications of operational amplifiers.
- To introduce the theory and applications of PLL.
- To introduce the concepts of waveform generation and introduce one special function ICs.
- Exposure to digital IC‘s

UNIT I:

INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER

Introduction, Classification of IC‘s, Op-Amp 741 and its features, the ideal Operational amplifier, Op-Amp internal circuit diagram, Op-Amp Characteristics – Inverting and Non-Inverting Modes of operation- DC and AC performance Characteristics.

UNIT II:

APPLICATIONS OF OP-AMP

Linear applications of Op-Amp: Solution to simultaneous equations and differential equations, Instrumentation amplifiers, V to I and I to V converters.

Non-linear applications of Op-Amp: Sample and Hold circuit, Log and Antilog amplifier, multiplier and divider, Comparators, Schmitt trigger, Multivibrators, Triangular and Square waveform generators.

UNIT III:

ACTIVE FILTERS & TIMER AND PHASE LOCKED LOOPS

Active filters: Introduction, Butterworth filters – 1st order, 2nd order low and high pass filters, band pass, band reject and All pass filters- Applications.

Timer and Phase Locked Loops: Introduction to IC 555 timer, description of functional diagram, monostable and astable operations and applications, Schmitt trigger, voltage controlled oscillator (IC 566), PLL - introduction, basic principle, phase detector/comparator, monolithic PLL (IC 565) and applications.

UNIT IV:

VOLTAGE REGULATOR & D to A AND A to D CONVERTERS

Voltage Regulators: Introduction, Series Op-Amp regulator, IC Voltage Regulators, IC 723 general purpose regulators, Switching Regulator.

DAC and ADC: Introduction, basic DAC techniques weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A to D converters -parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications.

UNIT V:

CMOS LOGIC, COMBINATIONAL CIRCUITS USING TTL 74XX ICs & SEQUENTIAL CIRCUITS USING TTL 74XX ICs

CMOS Logic: CMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates, CMOS AND-OR-INVERT and OR AND-INVERT gates, implementation of any function using CMOS logic. Combinational circuits using TTL 74xx ICs: Study of logic gates using 74XX ICs, Four-bit parallel adder (IC 7483), Comparator (IC 7485), Decoder (IC 74138, IC 74154)BCD to 7-segment decoder (IC7446/7447), Encoder (IC74147), Multiplexer (IC74151), De multiplexer (IC 74154).

Sequential circuits using TTL 74xx ICs: Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register (IC 74194), 4- bit asynchronous binary counter (IC 7493).

TEXT BOOKS

1. D. Roy Choudhury, Shail B. Jain (2012), Linear Integrated Circuit, 4th edition, New Age International Pvt.Ltd., NewDelhi,India.
2. Ramakant A. Gayakwad, (2012), OP-AMP and Linear Integrated Circuits, 4th edition, Prentice Hall / Pearson Education, NewDelhi.
3. B.L. Theraja and A.K. Theraja, 2004, A Textbook of Electrical technology, S. Chand & Co.
4. V.K. Mehta and Rohit Mehta, 2008, Principles of Electronics, S. Chand & Co, 12th Edition.
5. V. Vijayendran, 2008, Introduction to Integrated electronics (Digital & Analog), S.Viswanathan Printers & Publishers Private Ltd, Reprint. V.

REFERENCE BOOKS

1. Sergio Franco (1997), Design with operational amplifiers and analog integrated circuits, McGraw Hill, New Delhi.
2. Gray, Meyer (1995), Analysis and Design of Analog Integrated Circuits, Wiley International, New Delhi.
3. Malvino and Leach (2005), Digital Principles and Applications 5th Edition, Tata McGraw Hill, New Delhi
4. Floyd, Jain (2009), Digital Fundamentals, 8th edition, Pearson Education, New Delhi.
5. Integrated Electronics, Millman&Halkias, Tata McGraw Hill, 17th Reprint (2000)

WEB SOURCES

1. https://nptel.ac.in/course.html/digital circuits/
2. https://nptel.ac.in/course.html/electronics/operational amplifier/
3. https://www.allaboutcircuits.com/textbook/semiconductors/chpt7/field-effect-controlled-thyristors/
4. https://www.electrical4u.com/applications-of-op-amp/
5. https://www.geeksforgeeks.org/digital-electronics-logic-designtutorials/