Syllabus and Model Papers

M.Sc. Physics
1st Semester

Under Choice Based Credit System (CBCS)
[Effective from 2021-2022 Admitted Batches]

Department of Physics
College of Science and Technology
Andhra University
Visakhapatnam.

M.Sc. Physics
Course Curriculum under CBCS

M.Sc. Physics – I Semester – FIRST YEAR
[Effective from the admitted batch 2021-2022]

THEORY	P 101	Classical Mechanics
	P 102	Introductory Quantum Mechanics
	P 103	Mathematical Methods of Physics
	P 104	Electronic Devices & Circuits
LABORATORIES	P 105	Modern Physics Lab 1
	P 106	Electronics Lab 1

SCHEME OF INSTRUCTION AND EXAMINATION UNDER CBCS

M.Sc. Physics – I Semester – FIRST YEAR
[Effective from the admitted batch 2021-2022]

Theory Code	Title of the Paper	T	P	Semester End Exam Marks	Mid Exam Marks	Total Marks	Pass Minimum	Credits
P-101	Classical Mechanics	4	-	80	20	100	40	4
P-102	Introductory Quantum Mechanics	4	-	80	20	100	40	4
P-103	Mathematical Methods of Physics	4	-	80	20	100	40	4
P-104	Electronic Devices & Circuits	4	-	80	20	100	40	4
P-105	Modern Physics Lab 1 (Practical-80 & Record-20)	-	3	100		100	50	4
P-106	Electronics Lab 1 (Practical-80 & Record-20)	-	3	100		100	50	4
	Total					**600**		**24**

(**T**- Theory Hrs /Week, **P**- Practical Hrs/Week)

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M.Sc. Degree Examination
Physics

SYLLABUS

First Semester

P 101 – Classical Mechanics
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. To demonstrate knowledge and understanding of the following fundamental concepts in dynamics of particles.
2. To represent the equations of motion for complicated mechanical systems using the Newtonian, D'Alembert, Lagrangian and Hamiltonian formulation of classical mechanics.
3. The course discusses the planetary motion and Kepler's laws, Legendre transformations, canonical transformations, Hamilton's equation of motion, Hamilton-Jacobi equations and its applications.
4. It explains the motion of rigid bodies and Euler's angles, Coriolis effect.
5. The course discusses the special theory of relativity and its applications and also gave the introduction to the general theory of relativity.

Course Outcomes:

1. Students will be able to know the concepts of classical mechanics describe and understand the motion of a mechanical system using Lagrange-Hamilton formalism.
2. They are able to know about canonical transformations, Hamilton's equations of motion.
3. They are able to understand the concept of planar and spatial motion of a rigid body.
4. They are able to differentiate special theory of relativity and general theory of relativity.

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UNIT-I: Mechanics of a particle. Mechanics of a system of particles, constraints, D'Alembert's principle and Lagrange's equations, Velocity Dependent potentials and the Dissipation function Simple applications of the Lagrangian Formulation
Chapter: 1. Section: 1, 2, 3, 4, 5 & 6.
Hamilton's principle, some techniques of the calculus of variations. Derivation of Lagrange's equations from Hamilton's principle. Conservation theorems and symmetry properties, Energy function and the conservation of Energy
Chapter: 2. Section: 1, 2, 3, 5 & 6

UNIT-II: Reduction to the equivalent one body problem. The equation of motion and first Integrals, the equivalent One – Dimensional problem and classification of orbits, the differential equation for the orbit, and Integrable power –law potentials, Conditions for closed orbits (Bertrand's theorem), The Kepler problem inverse square law of force, The motion in time in the Kepler problem, Scattering in a central force field.
Chapter: 3. Section. 1, 2, 3, 5, 6, 7 & 8
Legendre transformations and Hamilton's equations of motion. Cyclic Coordinates, Derivation of Hamilton's equation of motion from variational principle, Principle of Least Action.
Chapter: 7 Section: 1, 2, 3, 4 & 5.

UNIT-III: Equations of canonical transformation, Examples of Canonical transformations, The harmonic Oscillator, Poisson brackets and other Canonical invariants, Equations of motion, Infinitesimal canonical transformations, and conservation theorems in the Poisson bracket formulation, the angular momentum Poisson bracket relations.
Chapter: 8. Section: 1, 2, 4, 5, 6 & 7.
Hamilton – Jacobi equation of Hamilton's principal function, The Harmonic oscillator problem as an example of the Hamilton – Jacobi Method, Hamilton – Jacobi equation for Hamilton's characteristic function. Action – angle variables in systems of one degree of freedom.
Chapter: 9. Section: 1, 2, 3 & 5.

UNIT-IV: Independent coordinates of rigid body. The Euler angles, Euler's theorem on the Motion of a rigid body, Infinitesimal rotations, Rate of change of a vector, The Coriolis Effect.
Chapter: 4. Section: 1, 4, 6, 8 & 9.
The Inertia tensor and the moment of inertia, The Eigenvalues of the inertia tensor and the principal axis transformation, Solving rigid body problems and Euler equations of motion, Torque – free motion of a rigid body
Chapter: 5 Section: 3, 4, 5 & 6.
The Eigenvalue equation and the principal axis transformation, Frequencies of free vibration, and normal coordinates, free vibrations of a linear triatomic molecule
Chapter 10 Section: 2, 3 & 4.

UNIT – V: Special Theory of Relativity, Basic Postulates of the Special Theory, Lorentz Transformations, Velocity Addition and Thomas Precession, Relativistic Kinematics of Collisions and Many-Particle Systems, Relativistic Angular Momentum, Lagrangian Formulation of Relativistic Mechanics, Covariant Lagrangian Formulations, Introduction to the General Theory of Relativity.
Chapter 7 Sections 1 to 11.

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Text Book:

1. Classical Mechanics - H. Goldstein

Reference Books:

1. Classical Mechanics - J. B. Upadhayaya
2. Classical Mechanics - Gupta Kumar Sharma
3. Classical Mechanics - N C Rana and P S Joag
4. Classical Mechanics - Takwale and Puranik
5. Classical Mechanics - G Aruldhas
6. Classical Mechanics - C R Mondal
7. Introduction to Special Relativity - Robert Resnick

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Model Question Paper
Andhra University
M.Sc. Degree Examination
Physics

First Semester
P 101 – Classical Mechanics
(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit
All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

Unit – I

1. a) State and prove D' Alembert's principle.
   b) Derive Lagrange's equation of motion of a particle using D' Alembert's principle.

(OR)

2. a) Obtain Lagrange's equation of motion from Hamilton's principle for conservative systems.
   b) What is meant by conservation of energy?

Unit – II

3. a) What is the first integral of motion?
   b) Show that the orbit of a planet moving around the sun under the inverse square law of force is a conic.

(OR)

4. a) Derive Hamilton's equations of motion using Legendre transformations.
   b) Give the Physical significance of the Hamiltonian.

Unit – III

5. a) Explain the equations of Canonical Transformation?
   b) Give examples to Canonical Transformations.

(OR)

6. a) Derive the Hamilton – Jacobi equation from Hamilton's principle function.
   b) Solve the problem of one-dimensional harmonic oscillator using Hamilton Jacobi Method.

Unit – IV

7. a) Derive the Eigenvalue equation of the inertia tensor and the principal axis transformation.
   b) What is the degree of freedom of linear triatomic molecule?

(OR)

8. a) Define moment of inertia tensor.
   b) Derive Euler's equations of rotational motion of a rigid body.

Unit – V

9. a) What are the basic postulates of the special theory of relativity?
   b) Derive the equations for the velocity addition and Thomas precession.

(OR)

10. a) Explain the Lagrangian formulation of relativistic mechanics
    b) Derive the equation for the covariant Lagrangian.

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M.Sc. Degree Examination
Physics

SYLLABUS

First Semester

P 102 – Introductory Quantum Mechanics
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. It is an experimental fact that often a particle behaves like a wave and a wave behaves like a particle. A wave with a precise wavelength (momentum) does not possess a precise location and vice versa.
2. Such uncertainties in conjugate measurable properties and the consequences there of, constitute the essential content of quantum mechanics.
3. Elementary quantum mechanics is the focus of this course.
4. This course provides an understanding of the formalism and language of non-relativistic quantum mechanics.
5. This course will be helpful in understanding the concepts of time-independent perturbation theory and their applications to physical situations.

Course Outcomes:

1. The students will be able to formulate and solve problems in quantum mechanics using Dirac representation.
2. The students will be able to grasp the concepts of spin and angular momentum, as well as their quantization and addition rules.
3. The students will be familiar with various approximation methods applied to atomic, nuclear and solid-state physics.
4. This course is organized in such a way that a student at the end, is skilled enough to understand the advance level Quantum Mechanics.

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UNIT-I: Failures of classical physics, Origin of Quantum theory, the Conceptual aspect: Modifications needed to the classical concepts of particles and Waves (Wave Particle Duality), Interpretations of Quantum mechanics, Applications of uncertainty principle, Principle of superposition - Wave packets, Schrodinger Wave Equation, wave function interpretation, Problems and admissibility conditions, probability current density, expectation value, Ehrenfest theorem, stationary states.

UNIT-II: Bracket notation, orthonormal functions, linear operators and their properties, Hermitian operator, Schmidt orthogonalization, Postulates of quantum mechanics, simultaneous measurability of observables, commutator algebra, equation of motion of an operator (Schrodinger representation), Momentum representation - Dirac delta function and properties.

UNIT-III: One dimensional problem - Particle in a potential well with (i) infinite walls, (ii) finite walls. Potential step, Potential Barrier. Linear Harmonic Oscillator (Schrodinger method). Free particle. Particle moving in a spherically symmetric potential, spherical harmonics, radial equation. Eigen values and Eigen functions of rigid rotator, hydrogen atom, Hydrogenic orbitals, angular momentum operators, commutation relations, Eigen values and Eigen functions of L^2, L_Z, L_+ and L_- operators, spin angular momentum, general angular momentum.

UNIT-IV: Time- independent perturbation theory for **(i)** non-degenerate systems and application to ground state of helium atom., effect of electric field on the ground state of hydrogen, spin orbit coupling (ii) degenerate systems, application to linear stark effect in hydrogen. Variation method and its application to helium atom, exchange energy and low-lying excited states of helium atom. WKB method, barrier penetration.

UNIT – V: Hidden variables, EPR paradox, Bell's theorem, the problem of measurement, time evaluation of a system, discrete or continuous, Q bits and quantum logic gates. (B. H. Bransden and C. J. Joachain; Richard Liboff.

Text Book:

1. Quantum Mechanics - E. Merzbacher

Reference Books:

1. Quantum Mechanics - G. Aruldhas
2. Quantum Mechanics - G. S. Chaddha
3. Quantum Mechanics - B. H. Bransden and C. J. Joachain
4. Quantum Mechanics - R. D. Ratna Raju
5. Quantum Mechanics - Richard Liboff
6. Quantum Mechanics - Ghatak and Lokanathan
7. Quantum Mechanics - Gupta Kumar Sharma
8. Quantum Mechanics - Mathews and Venkatesan
9. Quantum Chemistry - Ira N. Levine
10. Quantum Mechanics - Nouredine Zettili

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Model Question Paper
Andhra University
M.Sc. Degree Examination
Physics

First Semester
P 102 – Introductory Quantum Mechanics
(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit
All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

Unit – I

1. a) Derive the Schrodinger wave equation.
   b) Obtain an expression for Probability Current Density.

(OR)

2. a) State and prove Ehrenfest's theorem.
   b) Show that stationary states probability current density is constant in time.

Unit – II

3. a) State the postulates of Quantum Mechanics.
   b) Write the properties of Hermitian Operator.

(OR)

4. a) Define Dirac Delta function and write its properties.
   b) Derive the equation of motion for an operator.

Unit – III

5. a) Derive the equation for a one-dimensional particle in a potential well with infinite walls.
   b) Obtain Eigen values and Eigen functions of rigid rotator.

(OR)

6. a) Show that L^2 and L_z Commute.
   b) Obtain Eigen values and Eigen functions for these operators.

Unit – IV

7. a) Discuss time independent perturbation theory.
   b) Obtain expression for the first order correction to energy.

(OR)

8. a) Discuss the principle of Variation method and its application to helium atom.
   b) What is meant by WKB Approximation?

Unit – V

9. a) What is EPR Paradox?
   b) State and explain the Bell's theorem.

(OR)

10. a) Give an account on Q bits.
    b) Explain in detail the quantum logic gates.

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SYLLABUS

M.Sc. Degree Examination
Physics

First Semester

P 103 – Mathematical Methods of Physics
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. To provide students the ability to hone the mathematical skills necessary to approach problems in advanced physics courses.
2. To expose the students towards the fascinating world of complex analysis.
3. To make the students learn about special functions essential in solving physics problems.
4. To make them understand about Fourier series and Fourier transforms.
5. To expose the students, get acquainted with the various numerical methods.
6. To make them understand about tensor analysis.

Course Outcomes:

1. The students will be able to understand and apply the mathematical skills to solve quantitative problems in the study of Physics.
2. Will enable students to apply integral transform to solve mathematical problems of interest in Physics.
3. The students will be able to use Fourier transforms as an aid for analyzing experimental data.
4. The students should be able to formulate and express a physical law in terms of tensors, and simplify it by use of coordinate transforms.

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Unit I: Complex Variables

Function of complex number- definition-properties, analytic function-Cauchy –Riemann conditions-polar form-problems, Complex differentiation, complex integration –Cauchy's integral theorem- Cauchy's integral formulae-multiply connected region- problems, Infinite series-Taylor's theorem- Laurent's Theorem-Problems, Cauchy's Residue theorem- evaluation of definite integrals-problems.

Unit II: Beta, Gamma Functions &Special Functions

Beta & Gamma functions -definition, relation between them- properties-evaluation of some integrals

Special Functions- Legendre Polynomial, Hermite Polynomial, Laguerre Polynomial, Bessel Function -Generating function-recurrence relations - Rodrigue's formula-orthonormal property-associated Legendre polynomial- simple recurrence relation-orthonormal property-spherical harmonics.

Unit III: Laplace Transforms & Fourier series, Fourier Transforms

Laplace Transforms – definition- properties – Laplace transform of elementary functions-Inverse Laplace transforms-properties- evaluation of Inverse Laplace Transforms-elementary function method-Partial fraction method-Heaviside expansion method-Convolution method-complex inversion formula method-application to differential equations.

Fourier series-evaluation of Fourier coefficients- Fourier integral theorem-problems-square wave-rectangular wave-triangular wave, Fourier Transforms- infinite Fourier Transforms-Finite Fourier Transforms-Properties-problems-application to Boundary value problem.

Unit IV: Numerical Methods

Linear and non- linear curve fitting, least square fitting, Chi – square test, Errors of Coefficients. Solutions of algebraic and transcendental equations-Bisection method-method of successive approximations-method of false position Iteration method-Newton Rapson method Simultaneous linear algebraic equations-Gauss elimination method-Gauss Jordan Method-Matrix inversion method-Jacobi method – Gauss-Seidel method.

Interpolation with equal intervals-Finite differences-Newton Forward & Backward Interpolation formulae, Interpolation with unequal internals-Newton's divided difference formula-Lagrange interpolation formula Numerical Integration-General Quadrature Formula-Trapezoidal rule -Simpson's 1/3 rule & 3/8 rule. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem.

Unit V: Tensor Analysis

Introduction, Transformation of Co-ordinates, Contravariant, Covariant and Mixed tensors, Addition, Subtraction, Contraction, Multiplication, Quotient Law, Symmetric and Anti Symmetric tensors, The

line element, Fundamental Tensors, Covariant differentiation, Christoffel Symbols, Curvature tensor, Riemann curvature, Application of Tensors.

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Text Books:

1. Mathematical Methods of Physics - G. Arfken
2. Mathematical Physics - Satya Prakash
3. Complex Variables - Murray R Spiegel - Schaum's outline series
4. Mathematical Physics - B.S. Rajput
5. Laplace n Fourier Transforms - Goyal & Gupta
6. Introductory methods of Numerical analysis - S. S. Sastry
7. Fundamentals of Mathematical Statistics - S C Gupta & V K Kapoor
8. Tensor Calculus – A Concise Course - Barry Spain

Reference Books:

1. Numerical Methods - V. N. Vedamurthy & N. Ch. S. N. Iyengar
2. Mathematical Methods - B. D. Gupta
3. Special Functions - Gupta & Sharma
4. Integral Transforms - M. D. Raisinghanna
5. Integral Transforms - Goyal & Gupta
6. Fundamentals of Statistics - S C Gupta
7. Probability and Statistics - Murray R Spiegel - Schaum's outline series
8. Tensor Calculus - David C Kay – Schaum 's outline series

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Model Question Paper
Andhra University
M.Sc. Degree Examination
Physics

First Semester
P 103 – Mathematical Methods of Physics
(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit
All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

Unit – I

1. a) State and prove the Taylor's theorem.
   b) Prove that $H_n^1(x) = 2nH_{n-1}(x)$.

(OR)

2. a) State and prove the necessary and sufficient condition for the function to be analytic in a region R.
   b) Show that $\int_{-\infty}^{\infty} \frac{x^2 dx}{(x^2+1)^2(x^2+2x+2)} = 7\pi/50$.

Unit – II

3. a) Starting from the generating function of Laguerre polynomial, Obtain the differential equation satisfied $L_n(x)$.
   b) Define Rodrigue's formula.

(OR)

4. a) Obtain the relation between Beta and Gamma functions
   b) Evaluate the value of Gamma (1/2).

Unit – III

5. a) State and explain Laplace and Inverse Laplace transforms.
   b) Evaluate the Inverse Laplace transform of $\frac{7}{s^2-9} + \frac{5}{s-7} + \frac{1}{2s^{3/2}}$.

(OR)

6. a) Starting form Fourier series obtain the Fourier integral.
   b) Find the Fourier series for function defined by

$f(x) = -\pi$ if $-\pi<x<0$
$f(x) = x$ if $0<x<\pi$.

Unit – IV

7. a) Explain Newton – Raphson method to evaluate the roots of an equation.
   b) Using Bisection method, find the root of the equation $x^3 - x^2 - 1 = 0$

(OR)

8. a) Discuss the Gauss elimination method for solving a system of simultaneous linear equations.
   b) Solve the following equations using Gauss – Seidel method.

$$2x + y + z = 10$$
$$3x + 2y + 3z = 18$$
$$x + 4y + 9z = 16$$

Unit – V

9. a) Explain in detail the Symmetric and Anti-Symmetric tensors?
   b) Write the applications of Tensors.

(OR)

10. a) Give an account on Christoffel Symbols
    b) Define Riemann curvature and write its properties.

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SYLLABUS

M.Sc. Degree Examination
Physics

First Semester

P 104 – Electronic Devices and Circuits
(Effective from the admitted batch of 2021-2022-CBCS)

<u>Course Objectives</u>:

1. To make the students familiar about the concepts of components used in various electronic devices.
2. To make the students learn and understand the basics of analogue electronics.
3. To develop an understanding of fundamentals of electronics in order to deepen the understanding of electronic devices that are part of the technologies that surround us.

<u>Course Outcomes</u>:

1. The students will be able to use techniques for analyzing analogue electronic circuits and formulate the concepts of semiconductor devices, microwave devices, operational amplifier circuits and electronic measurements, instrumentation and experimental methods.
2. At the end of this course, the students will be able to understand the fundamentals behind analog devices.

UNIT-I: Semiconductor Devices
Tunnel diode, Photo Diode, Solar Cell, LED, Silicon Controlled Rectifier (SCR), Uni Junction Transistor (UJT), Field Effect Transistor (JFET & MOSFET), CMOS.

UNIT-II: Microwave Devices
Varactor Diode, Parametric Amplifier, Thyristors, Klystron, Reflex Klystron, Gunn Diode, Magnetron, CFA, TWT, BWO, IMPATT, TRAPATT, APD, PIN Diode, Schottky Barrier Diode.

UNIT-III: Operational Amplifier (OP AMP)
The ideal Op Amp – Practical inverting and Non inverting Op Amp stages, Op Amp Architecture – differential stage, gain stage, DC level shifting, output stage, offset voltages and currents. Virtual ground. Operational Amplifier parameters- input offset voltage, input bias current, Band width, Common Mode Rejection Ratio (CMRR), Slew Rate. Op Amp open loop gain configuration, Differential amplifier, Inverting and Non-inverting amplifiers. Op-amp with negative feedback- effect of feedback on closed loop gain input resistance, output resistance, bandwidth and output offset voltage - voltage follower.

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UNIT-IV: OP AMP Applications
Summing amplifier, Integrator, Differentiator Voltage to Current converter, Current to Voltage converter, Logarithmic Amplifier, Instrumentation Amplifier.
Oscillators – Phase shift oscillator, Wien-Bridge Oscillator
Special applications – Monostable and Astable multivibrators using 555, Schmitt Trigger, Voltage Controlled Oscillator (VCO), Phase Locked Loop (PLL), IC 723 Voltage regulator.

UNIT – V: Electronic Measurements, Instrumentation and Experimental Methods
Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors Transducers (temperature, pressure, vibration, optical, and particle detectors) Measurement and control. Signal conditioning and recovery, Impedance matching, Amplification, Filtering and noise reduction, Shielding and grounding.

Text Books:

1. Integrated Electronics - Jacob Millman & C.C. Halkies
2. Op. Amps and Linear Integrated Circuits - Ramakant A.Gayakwad
3. Electronic Communication Systems - George Kennedy
4. Electronic Instrumentation and measurement techniques – W D Cooper & A D Helfric
5. A course in electrical and electronic measurements and instrumentation – A K Sawhney
6. Electronic Instrumentation - H S Kalsi

Reference Books:

1. Microelectronics - Jacob Millman & Arvin Grabel
2. Electronic Devices and Circuits - G.K. Mithal
3. Electronic devices and circuit theory - Robert Boylested & Louis Nashlsky
4. Electronic Principles - AP Malvino & J Bates
5. Micro Electronics - Sedra and Smith
6. Linear Integrated Circuits - D Roy Choudhury & Shail Jain
7. Introduction to electronic devices - Micheal Shur
8. Semi-Conductor Electronics - A.K.Sharma
9. Anlog and Digital Electronics - Nagarath
10. Op-amps and Linear Integrated Circuits - D. Mahesh Kumar
11. Electronic instrumentation and measurements – David A Bell
12. Modern Electronic Instrumentation and Measurement Techniques –A D Helfric & W DCooper
13. Electronic Measurements and Instrumentation - Oliver and Cage

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Model Question Paper

Andhra University

M.Sc. Degree Examination

Physics

First Semester

P 104 – Electronic Devices and Circuits

(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit

All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

Unit – I

1. a) Describe the working principle of FET Amplifier
   b) Explain its characteristics.

(OR)

2. a) Give the construction and characteristics of SCR
   b) Show how an SCR can be used to control power in a circuit.

Unit – II

3. a) Describe the working of Reflex Klystron
   b) Explain its Characteristics.

(OR)

4. a) Describe the working principle of Magnetron
   b) Explain why magnetron is called as CFA.

Unit – III

5. a) Explain in detail the characteristics of an ideal op-amp.
   b) Explain the terms differential gain and DC level shifting.

(OR)

6. a) Discuss in detail the important parameters of an operational amplifier.
   b) Describe the method of their measurement.

Unit – IV

7. a) Draw the circuit diagram of a Voltage Controlled Oscillator (VCO).
   b) Discuss its operation and applications.

(OR)

8. a) Describe the working principle and necessary theory of a Wein Bridge Oscillator using Op – Amp.
   b) What is meant by Phase Locked Loop?

Unit – V

9. a) Explain briefly the error analysis measurement?
   b) Explain the propagation of errors.

(OR)

10. a) Explain What is meant by signal conditioning?
    b) Give an account on recovery and impedance matching in a measurement system.

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M.Sc. Degree Examination
Physics

SYLLABUS

First Semester

P 105 – Modern Physics Laboratory - 1
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. The aim of this laboratory course is to make the students perceive some of the fundamental laws of Physics through experiments.

Course Outcomes:

1. At the end of this laboratory course, the students will be capable of handling sophisticated instruments besides learning the Physics concepts behind these experiments.

LIST OF EXPERIMENTS

1. Atomic Spectrum of Sodium
2. Atomic Spectrum of Zinc
3. Rydberg's Constant using Grating
4. Raman Spectrum of Carbon Tetrachloride
5. Specific Charge of an Electron using Thomson's Method
6. Determination of Planck's Constant

Reference Books:

1. Advanced Practical Physics, B.L. Worsnop & H.T. Flint.
2. A Text Book of Practical Physics, I.Prakash & Ramakrishna.
3. Practical Physics, Geeta Sanon, R. Chand & Co.Publishers.
4. Advanced Practical Physics, S P Singh, Pragati Prakashan.
5. Practical Physics, Gupta & Kumar, Pragati Prakashan.
6. An Advanced Course in Practical Physics, D Chattopadhyay & P C Rakshit. Central Pub.

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SYLLABUS

First Semester

P 106 – Electronics Laboratory - 1
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. To make the students familiar with analog electronic components.
2. To provide hands-on experience to the students to make them familiar with the working and handling of the analog electronic devices and circuits.

Course Outcomes:

1. At the end of this laboratory, the students will be skilled enough to handle and understand the use of analog devices.

LIST OF EXPERIMENTS

1. FET Amplifier (BFW 10/11)
2. Negative Feedback Amplifier (BC 147)
3. Colpitts Oscillator (BF 194)
4. Phase Shift Oscillator (BC 147)
5. Astable Multivibrator (BF 194)
6. Op. Amp. Characteristics (IC 741)

Reference Books:

1. The Art of Electronics, P. Horowitz & W. Hill.
2. Microelectronics, J. Millman & A. Grabel.
3. Electronic Devices and Circuits, Schaum's Outline Series, J.J. Cathey.
4. Basic *Electronics*: *A Text-Lab Manual*, Paul Zbar & Albert P Malvino.
5. Experiments in Electronics, S V Subrahmanyam.
6. Operational Amplifiers & Linear ICs, S V Subrahmanyam.

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Syllabus and Model Papers

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2nd Semester

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Department of Physics
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Andhra University
Visakhapatnam.

M.Sc. Physics
Course Curriculum under CBCS

<u>M.Sc. Physics – II Semester – FIRST YEAR</u>
[Effective from the admitted batch 2021-2022]

THEORY	P 201	Electrodynamics
	P 202	Statistical Mechanics
	P 203	Atomic & Molecular Physics
	P 204	Nuclear and Particle Physics
LABORATORIES	P 205	Modern Physics Lab 2
	P 206	Electronics Lab 2

SCHEME OF INSTRUCTION AND EXAMINATION UNDER CBCS

M.Sc. Physics – II Semester – FIRST YEAR
[Effective from the admitted batch 2021-2022]

Theory Code	Title of the Paper	T	P	Semester End Exam Marks	Mid Exam Marks	Total Marks	Pass Minimum	Credits
P-201	Electrodynamics	4	-	80	20	100	40	4
P-202	Statistical Mechanics	4	-	80	20	100	40	4
P-203	Atomic & Molecular Physics	4	-	80	20	100	40	4
P-204	Nuclear and Particle Physics	4	-	80	20	100	40	4
P-205	Modern Physics Lab 2 (Practical-80 & Record-20)	-	3	100		100	50	4
P-206	Electronics Lab 2 (Practical-80 & Record-20)	-	3	100		100	50	4
	Total					**600**		**24**

(**T**- Theory Hrs /Week, **P**- Practical Hrs/Week)

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M.Sc. Degree Examination
Physics

SYLLABUS

Second Semester

P 201 – Electrodynamics
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. To evaluate fields and forces and potentials in Electrodynamics and Magneto dynamics using basic scientific method.
2. To make the students understand the propagation behavior of electromagnetic waves in different media.
3. To be capable of understanding the physical interpretation of Maxwell's Equations.
4. To provide concepts of relativistic electrodynamics and its applications in branches of Physical Sciences.

Course Outcomes:

1. The students will be able to explain and solve advanced problems based on classical electrodynamics using Maxwell's equation.
2. The students will be able to analyze radiation systems in which the electric dipole, magnetic dipole or electric quadruple dominate.
3. The students will have an understanding of the covariant formulation of electrodynamics and the concept of retarded time for charges undergoing acceleration.
4. This course will lay the foundation for the modern optics, photonics, telecommunications and ionosphere.

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UNIT-I: Gauss's law and its applications, Poisson equation, Laplace equations, Uniqueness theorem, boundary value problems, separation of variables, solution to Laplace's equation in Cartesian, spherical, and cylindrical coordinates, use of Laplace's equation in the solutions of electrostatic problems.

UNIT-II: Biot-Savart law, Ampere's theorem, Faraday's law of electromagnetic induction, magnetic vector potential, displacement current, Maxwell's equations, differential and integral forms, physical significance of Maxwell's equations, Maxwell's equations in free space, Maxwell's equations inside matter, boundary conditions on the fields at interfaces.

UNIT-III: Wave equation, plane electromagnetic waves in free space, in non-conducting isotropic medium, in conducting medium, electromagnetic vector and scalar potentials, uniqueness of electromagnetic potentials and concept of gauge, Lorentz gauge, Coulomb gauge, motion of charged particles in uniform electric field, charged particles in homogenous and non-homogeneous magnetic fields, charged particles in simultaneous electric and magnetic fields.

UNIT-IV: Lienard-Wiechert potentials from a moving charge, electromagnetic fields from Lienard-Wiechert potentials of a moving charge, electromagnetic fields of a uniformly moving charge, radiation from moving charges and dipoles, radiation from an accelerating charge, Bremsstrahlung radiation, Cherenkov radiation and application.

UNIT-V: Lorentz transformations, transformation of electromagnetic potentials, E and B fields from Lorentz transformations, covariance and contra variance, Electromagnetic field tensor and Lorentz invariance of Maxwell's equations.

Text books:

1. Classical Electrodynamics - J. D. Jackson
2. Introduction to Electrodynamics - D.R. Griffiths

Reference Books:

1. Electromagnetic Theory and Electrodynamics - Satyaprakash
2. Electrodynamics - K.L Kakani

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Model Question Paper

Andhra University

M.Sc. Degree Examination

Physics

Second Semester

P 201 – Electrodynamics

(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit

All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

<u>Unit – I</u>

1. a) State and prove Gauss Theorem.
   b) Derive Laplace's and Poisson's equations from the Gauss law.

(OR)

2. a) Explain the method of separation of variables in spherical polar Co-ordinates.
   b) Obtain potentials inside and outside a dielectric sphere in a uniform electric field.

<u>Unit – II</u>

3. a) State and prove Biot – Savart law.
   b) What is Faraday's law of electromagnetic induction?

(OR)

4. a) Describe the Maxwell equations in differential and integral forms.
   b) Explain their physical significance.

<u>Unit – III</u>

5. a) Explain how the electromagnetic waves behaves in free space, conducting medium.
   b) Define Lorentz gauge.

(OR)

6. a) Derive the equation of motion of charged particles in uniform electric field.
   b) Derive the equation of motion of charged particles in homogenous magnetic field.

<u>Unit – IV</u>

7. a) What are Lienard – Weichert potentials?
   b) Calculate the electric and magnetic field vectors for a uniformly moving point charge using these potentials.

(OR)

8. a) Give an account on Bremsstrahlung radiation.
   b) What is meant by Cherenkov radiation?

<u>Unit – V</u>

9. a) Explain what is meant by Lorentz Transformations?
   b) Derive the electric and magnetic fields from the Lorentz Transformations.

(OR)

10. a) Give an account on covariance and contra variance of electric and magnetic fields.
    b) Explain briefly about the Electromagnetic field Tensor.

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M.Sc. Degree Examination
Physics

SYLLABUS

Second Semester

P 202 – Statistical Mechanics
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. The course gives an introduction to statistical mechanics and includes the concepts of phase space, ensembles and calculations of thermodynamic parameters using the concepts of ensembles.
2. The course also discusses partition functions and their properties and its applications.
3. It explains quantum statistics such as Maxwell-Boltzmann statistics, Bose-Einstein and Fermi-Dirac statistics, Bose-Einstein condensation, theory of dwarf stars.
4. The course also describes phase transitions and calculation of partition function for non-ideal classical gas.

Course Outcomes:

On completion of course:

1. The student should be able to understand the concepts of phase space, different kinds of ensembles and how to obtain the thermodynamic parameters using these concepts.
2. They are also able to know what Gibb's paradox is and how to resolve it.
3. They are able to differentiate types of quantum statistics and able to know the difference between ideal and non-ideal classical gas.
4. They are able to understand types of orders of phase transitions.

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UNIT-I: Basic Methods and Results of Statistical Mechanics:
Phase space, Isolated systems, Basic postulates, concept of ensembles, different types of ensembles – probability calculations according to micro canonical, canonical and grand canonical ensemble (system with an indefinite number of particles & system in macroscopic motion), simple applications of canonical distribution, system with specified mean energy, calculation of mean values in a canonical ensemble, connection with thermodynamics, Liouvilles theorem, Energy fluctuations in the canonical ensemble. Density and energy fluctuations in the grand canonical ensemble. Thermodynamic equivalence of ensembles.
Reif Chapter: 6.

UNIT-II: Simple Applications of Statistical Mechanics:
Partition functions and their properties. Calculation of thermo dynamic quantities to an ideal mono atomic gas. Gibbs paradox, validity of the classical approximation. Proof of the equipartition theorem. Simple applications – mean K.E. of a molecule in a gas. Brownian motion. Harmonic Oscillator, Partition function for polyatomic molecules, electronic energy, vibrational energy and rotational energy of a diatomic molecule. Effect of Nuclear spin-ortho and para Hydrogen.
Reif Chapter: 7 & 9.12

UNIT-III: Quantum Statistics:
Formulation of the statistical problem. Maxwell–Boltzmann statistics. Photon statistics, Bose-Einstein statistics, Fermi–Dirac statistics, Quantum statistics in the classical limit, calculation of dispersion for MB, BE & FD statistics Equation of state of an Ideal Bose Gas, Bose-Einstein condensation.
Reif Chapter: 9

UNIT-IV: Non Ideal Classical Gas:
Calculation of the partition function for low densities. Equation of state and virial coefficients, Alternative derivation of Van Der Walls equation. Black body radiation, Thermionic emission. The theory of white dwarf stars
Reif Chapter: 10.3, 10.4

UNIT – V: Phase Transitions
Phase transitions, conditions for Phase equilibrium, First order Phase transition – the Clausius–Clayperon equation, Second order phase transition, the critical indices, Van der Waals theory of liquid gas transition. Order parameter, Landau theory.
Sinha Chapter:10

Text Books
1. Fundamentals of Statistical and Thermal Physics - F. Reif

Reference Books:
1. Statistical Mechanics, Theory and Applications - S. K. Sinha
2. Statistical Mechanics - R. K. Pathria
3. Statistical Mechanics - KersonHuang
4. Statistical Mechanics - Gupta Ram

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Model Question Paper

Andhra University

M.Sc. Degree Examination

Physics

Second Semester

P 202 – Statistical Mechanics

(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit

All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

Unit – I

1. a) Explain the concept of ensemble.
   b) Mention the different types of ensembles and their properties.

(OR)

2. a) Derive and explain the Liouville's theorem.
   b) What is the thermodynamic equivalence of ensembles?

Unit – II

3. a) State and prove the equipartition theorem.
   b) Calculate the mean kinetic energy of a molecule in a gas.

(OR)

4. a) Derive the equation for the vibrational and rotational energy of a diatomic molecule.
   b) Define Gibb's Paradox.

Unit – III

5. a) Distinguish between Maxwell, Bose – Einstein and Fermi Dirac Statistics.
   b) Obtain an expression for Fermi – Dirac distribution.

(OR)

6. a) Give an account on Bose – Einstein condensation.
   b) Calculate the Maxwell – Boltzmann statistics equation for an ideal Bose gas.

Unit – IV

7. a) Calculate the partition function for low densities.
   b) Derive the equations for the Virial coefficients.

(OR)

8. a) Derive an alternative derivation for Van Der Walls equation.
   b) What is the theory of white dwarf stars?

Unit – V

9. a) Define Phase transition.
   b) What are the conditions for phase equilibrium?

(OR)

10. a) Derive the first and second order equations for phase transitions.
    b) Describe the Landau theory.

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M.Sc. Degree Examination
Physics

SYLLABUS

Second Semester

P 203 – Atomic and Molecular Physics
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. To provide an understanding of the fundamental aspects of atomic and molecular physics.
2. To make the students understand various couplings effects.
3. To study spectroscopy of the one electron, one valence electron, multi-electron atoms and diatomic molecules.
4. To make the students understand about various absorption/emission spectroscopic transitions.
5. To make the students understand Quantum mechanical phenomenon at the atomic and molecular level.
6. To make the students understand the molecular orbits using Electronic Spectroscopy and Resonance Raman Spectra.

Course Outcomes:

1. The students will be able to understand the normal and anomalous splitting of atomic and molecular energy levels.
2. The students will have an understanding of quantum behavior of atoms in external electric and magnetic fields.
3. The students will be capable to understand infrared spectroscopy.
4. The students will understand the spectroscopy of molecules using Raman Effect.
5. The students will be able to understand the molecular vibrations using the Group Theory.

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UNIT-I: One Electron Atoms

Derivation of Quantum numbers, Term values, Relation between Magnetic dipole moment and angular momentum of an orbiting electron, Spin- orbit interaction, relativistic kinetic energy correction and dependence of energy on J value only, Selection rules. Fine structure of Hydrogen spectra, Fowler series of ionized Helium, Hyperfine structure of Hα line of hydrogen ($I = \frac{1}{2}$).

One Valence Electron Atoms:

Modified term values (quantum defect) due to lifting of orbital degeneracy by core penetration (penetrating orbits), core polarization (non-penetrating orbits) by nl electrons. Term values, Fine structure of chief spectral series of sodium, Intensity rules and application to doublets of sodium. Hyperfine structure of ^2P-^2S transition of sodium ($I = 3/2$).

UNIT-II: Many Electron Atoms

Indistinguishable particles, bosons, fermions, Pauli's principle, Ground states, LS coupling and Hund's rules based on Residual columbic interaction and spin-orbit interaction, Lande's interval rule, Equivalent and non-equivalent electrons, Spectral terms in LS and JJ coupling (ss,s2 ,pp,p2 configurations), Exchange force and Spectral series of Helium.

UNIT - III

Atoms in External Magnetic Field: Normal Zeeman effect, Anomalous Zeeman effect and Paschen-Back effects and application to ^2P-^2S, ^3P-^3S, transitions.

Atoms in External Electric Field: Linear stark pattern of Hα line of hydrogen, Quadratic stark pattern of D1 and D2 lines of Sodium.

UNIT-IV: Diatomic Molecules

Molecular quantum numbers, Bonding and anti-bonding orbitals from LCAO's, Explanation of bond order for N2 and O2 and their ions, Rotational spectra and the effect of isotopic substitution, Effect of nuclear spin functions on Raman rotation spectra of H2 (Fermion) and D2 (Boson), Vibrating rotator and its spectrum, Combination relations and evaluation of rotational constants (infrared and Raman), Intensity of vibrational bands of an electronic band system in absorption.(The Franck-Condon principle), Sequences and progressions, Deslandre's table and vibrational constants.

UNIT- V: Molecular Vibrations

Symmetry elements, operations and identification of point Groups of AH_2, A_2H_2, ABH_2, AB_2H_2, AH_3, and ABH3 type molecules, Properties of irreducible representations and C2v character table. Reducible representation and symmetry in fundamental vibrations of H_2O. Structure determination of AB_2 type molecules from observed and expected fundamental bands of Raman and IR Spectra.

Molecular orbitals:

Walsh diagram, electronic spectroscopy, Herzberg – Teller effect, Resonance Raman Scattering, Fluorescence and Resonance Raman Spectra, Nonlinear effects and Raman Spectra.

Text Books:

1. Introduction to Atomic Spectra - H. E. White
2. Atomic and Molecular Spectra - Rajkumar
3. Fundamentals of Molecular Spectroscopy - C. N. Banwell
4. Group Theory - K. V. Raman

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Model Question Paper
Andhra University
M.Sc. Degree Examination
Physics

Second Semester
P 203 – Atomic and Molecular Physics
(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit
All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

Unit – I

1. a) Describe Spin Orbit interaction.
   b) Derive an expression for the relativistic kinetic energy correction.

(OR)

2. a) What are penetrating and non-penetrating orbitals?
   b) Draw the fine structure of chief spectral series of sodium.

Unit – II

3. a) State and explain Pauli's exclusion principle.
   b) Derive the Hund's rules based on residual coulomb and exchange interactions.

(OR)

4. a) Describe Lande's interval rule.
   b) Explain in detail the LS and JJ couplings.

Unit – III

5. a) Explain the Anomalous Zeeman effect.
   b) Apply the quantum theory of Zeeman Effect to the case of 2p-2s transition.

(OR)

6. a) What is meant by Stark effect?
   b) Discuss the quadratic stark pattern of Sodium D1 and D2 lines.

Unit – IV

7. a) What are bonding and anti-bonding orbitals?
   b) Give the theory of Linear combination of atomic orbitals.

(OR)

8. a) State and explain Frank-Condon principle.
   b) Discuss the intensity distribution of vibrational spectra of a diatomic molecule.

Unit – V

9. a) What are the properties of irreducible representations?
   b) Derive its C2v character table.

(OR)

10. a) Draw the Walsh diagram.
    b) Give an account on electronic spectroscopy and Herzberg – Teller effect.

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M.Sc. Degree Examination
Physics

SYLLABUS

Second Semester

P 202 – Statistical Mechanics
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. To familiarize about the essential properties of the nucleus such as its shape, size, radius, density, magnetic moment, electric quadruple moment etc.
2. In order to probe these properties several models have been proposed such as liquid drop model, shell models, collective models.
3. The most useful part of this knowledge is the nuclear energy which has immense applications.
4. The concept behind this energy was first given by Hans Bethe in the form of semi-empirical mass formula which is in the course content.
5. Carbon dating, modern medical applications, radio-physics all require the knowledge of radio-activity.
6. It is a well-known fact that all kind of interactions which we perceive in our life are essentially four in number viz. gravitational, electromagnetic, weak and strong.
7. The ultimate aim of particle physics is to unify these interactions.

Course Outcomes:

1. Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.
2. Discuss nuclear and radiation physics connection with other physics disciplines – solid state, elementary particle physics, radiochemistry.
3. Discuss nuclear and radiation physics applications in medical diagnostics and therapy, energetic, geology, archaeology.
4. Describe experimental techniques used (or developed) for nuclear physics purposes (gamma cameras, semiconductor detectors) and discuss their influence on development of new technologies.
5. Explore an application of nuclear and/or radiation physics and communicate their understanding to a group of their peers in a short presentation.
6. The students will be able to do higher studies in this field.
7. The students may get employment opportunities in radiology and medical field.

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UNIT – I: Introduction: Objective of Studying Nuclear Physics, Nomenclature, nuclear radius, mass & Binding energy, angular momentum, magnetic dipole moment, Electric quadrupole moment, parity and symmetry, domains of instability, mirror nuclei.

Nuclear Forces: Simple theory of the deuteron, scattering cross-sections, qualitative discussion of neutron-proton and proton- proton scattering, exchange forces, Yukawa's Potential, Characteristics of Nuclear Forces.

UNIT – II

Nuclear Models: Liquid drop model: Weissacker's semi-emperical mass formula, Mass – parabolas. Nuclear shell model: Spin orbit interaction, magic numbers, prediction of angular momenta and parities for ground states, Collective model. More-relistic models.

Nuclear Decay: Aplha decay process, Energy release in Beta-decay, Fermi's Theory of β -decay, parity violation in β -decay, detection and properties of neutrino. Energetics of gamma decay, selection rules, angular correlation, Mossbauer Effect.

UNIT – III

Nuclear Reactions: Types of reactions and conservation laws, the Q – equation, Optical model.

Nuclear Energy: Stability limit against spontaneous fission, Characteristics of fission, delayed neutrons, four factor formula for controlled fission, nuclear fusion, prospects of continued fusion energy.

UNIT – IV

Nuclear Radiation Detectors: Interaction of radiation with matter. Gas filled counters, scintillation detectors, semiconductor detectors, energy measurements, coincidence measurements and time resolution, magnetic spectrometers.

Accelerators: Electrostatic accelerators, cyclotron accelerators, synchrotrons, linear accelerators, colliding beam accelerators.

Applications: Trace Element Analysis, Rutherford Back-scattering, Diagnostic Nuclear Medicine, Therapeutic Nuclear Medicine.

UNIT – V

Elementary Particles: Particle interactions and families, conservation laws (energy and momentum, angular momentum, parity, Baryon number, Lepton number, isospin, strangeness quantum number (Gellmann and Nishijima formula) and charm, Elementary ideas of CP aand CPT invariance, Quark model.

Text Books:

1. Introductory Nuclear Physics - Kenneth S. Krane
2. Elementary Particle Physics – M J Longo

Reference Books:

1. Introduction to Nuclear Physics - Harald A.Enge
2. Concepts of Nuclear Physics - Bernard L.Cohen.
3. Introduction to High Energy physics - D.H. Perkins
4. Introduction to Elementary Particles - D. Griffiths

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Model Question Paper

Andhra University

M.Sc. Degree Examination

Physics

Second Semester

P 204 – Nuclear and Particle Physics

(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit

All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

Unit – I

1. a) Explain briefly about the magnetic dipole moment and electric quadrupole moment.
   b) What are the characteristics of nuclear forces?

(OR)

2. a) Describe the simple theory of deuteron and quantitatively.
   b) Discuss the neutron – proton and proton – proton scatterings.

Unit – II

3. a) Discuss the formulation of Semi – empirical mass formula.
   b) Obtain the condition for stable isotope.

(OR)

4. a) Give a brief account of Fermi's theory of β –decay.
   b) Explain in detail the Mossbauer effect.

Unit – III

5. a) What are different types of nuclear reactions?
   b) Derive the Q- equation for the nuclear reaction.

(OR)

6. a) What are the characteristics of nuclear fission?
   b) Derive the four-factor formula for controlled fission.

Unit – IV

7. a) Explain how the radiation interacts with matter.
   b) What are the different types of nuclear radiation detectors?

(OR)

8. a) Give an account on Cyclotron and linear accelerators.
   b) Explain briefly about the Rutherford Back Scattering technique.

Unit – V

9. a) Discuss the conservation laws that explain the behavior of elementary particles.
   b) Define Baryon and Lepton numbers.

(OR)

10. a) Briefly explain the elementary ideas of CP and CPT invariance.
    b) What is Quark Model?

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M.Sc. Degree Examination
Physics

SYLLABUS

Second Semester

P 205 – Modern Physics Laboratory - 2
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. The aim of this laboratory course is to make the students perceive some of the fundamental laws of Physics through experiments.

Course Outcomes:

1. At the end of this laboratory course, the students will be capable of handling sophisticated instruments besides learning the Physics concepts behind these experiments.

LIST OF EXPERIMENTS

1. He-Ne Laser
2. Band Gap of a Semiconductor (Two probe Method)
3. Determination of Curie Temperature
4. Characteristics of LED and Laser Diode
5. Reciprocal Dispersion Curve
6. Vibrational Analysis of ALO Band Spectrum

Reference Books:

1. Advanced Practical Physics, B.L. Worsnop & H.T. Flint.
2. A Text Book of Practical Physics, I.Prakash & Ramakrishna.
3. Practical Physics, Geeta Sanon, R. Chand & Co.Publishers.
4. Advanced Practical Physics, S P Singh, Pragati Prakashan.
5. Practical Physics, Gupta & Kumar, Pragati Prakashan.
6. An Advanced Course in Practical Physics, D Chattopadhyay & P C Rakshit, Central Pub.

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M.Sc. Degree Examination
Physics

SYLLABUS

Second Semester

P 206 – Electronics Laboratory - 2
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. To make the students familiar with analog electronic components.
2. To provide hands-on experience to the students to make them familiar with the working and handling of the analog electronic devices and circuits.

Course Outcomes:

1. At the end of this laboratory, the students will be skilled enough to handle and understand the use of analog devices.

LIST OF EXPERIMENTS

1. Active low, High and Band Pass Filters (IC 741)
2. Twin – T Filter (IC 741)
3. Logarithmic Amplifier (IC 741)
4. Wein Bridge Oscillator (IC 741)
5. Monostable Multivibrator (IC 555)
6. Voltage Regulator (IC 723)

Reference Books:

1. The Art of Electronics, P. Horowitz & W. Hill.
2. Microelectronics, J. Millman & A. Grabel.
3. Electronic Devices and Circuits, Schaum's Outline Series, J.J. Cathey.
4. Basic *Electronics*: *A Text-Lab Manual*, Paul Zbar & Albert P Malvino.
5. Experiments in Electronics, S V Subrahmanyam.
6. Operational Amplifiers & Linear ICs, S V Subrahmanyam.

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Syllabus and Model Papers

M.Sc. Physics
3rd Semester

Under Choice Based Credit System (CBCS)
[Effective from 2021-2022 Admitted Batches]

Department of Physics
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M.Sc. Physics
Course Curriculum under CBCS

M.Sc. Physics – III Semester – SECOND YEAR
[Effective from the admitted batch 2021-2022]

THEORY	P 301	Solid State Physics
	P 302	Lasers & Fiber Optics
	P 303 **Elective-I**	1. Digital Electronics & Microprocessors
		2. Principles of Ultrasonics
	P 304 **Elective-II**	1. Materials Science
		2. Radar Systems and Satellite Communications
LABORATORIES	P 305	Digital Electronics & Microprocessor Lab
	P 306	Solid State Physics Lab
	P 307	MOOCS Paper
	P 308	Value Added Paper (IPR Chair Paper)

SCHEME OF INSTRUCTION AND EXAMINATION UNDER CBCS

M.Sc. Physics – III Semester – SECOND YEAR
[Effective from the admitted batch 2021-2022]

Theory Code	Title of the Paper	T	P	Semester End Exam Marks	Mid Exam Marks	Total Marks	Pass Minimum	Credits
P-301	Solid State Physics	4	-	80	20	100	40	4
P-302	Lasers & Fiber Optics	4	-	80	20	100	40	4
P-303	Elective - I	4	-	80	20	100	40	4
P-304	Elective – II	4	-	80	20	100	40	4
P-305	Digital Electronics & Microprocessor Lab (Practical-80 & Record-20)	-	3	100		100	50	4
P-306	Solid State Physics Lab (Practical-80 & Record-20)	-	3	100		100	50	4
P - 307	**MOOCS Paper**	**ON LINE MODE**						**4**
P - 308	**VALUE Added Paper (IPR Chair Paper)**	**Total 30 hours learning, No Examination**						**2**
	TOTAL					**600**		**30**

(**T**- Theory Hrs /Week, **P**- Practical Hrs/Week)

M.Sc. Degree Examination
Physics

SYLLABUS

Third Semester

P 301 – Solid State Physics
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. To provide extended knowledge of principles and techniques of Solid-State Physics.
2. To make the students familiar with the structures having regular and irregular arrangements of atoms and their bonding etc.
3. To explain the peculiar behavior of materials.
4. To understand various thermal properties of materials under different length scales.
5. To explain the free electron Fermi gas energy levels and density of orbits.
6. To understand the band theory of solids.

Course Outcomes:

1. The students will be able to formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials.
2. The students will be able to understand the relation between band structure and the thermal properties of a material.
3. At the end of this course, the students will be able to understand various physical phenomena and the reasons behind them.

UNIT-I: Crystal Structure

Periodic array of atoms—Lattice translation vectors, fundamental types of lattices-two- and three-dimensional lattice types, the Basis and the Crystal Structure, Primitive and compound unit cells, determination of number of atoms in a cell and position of atoms, simple crystal structures-- sodium chloride, cesium chloride and diamond structures, Review of Symmetries in solid, Miller Indices, indexing pattern of cubic crystals and non-cubic crystals (analytical methods).

UNIT-II: X-Ray Diffraction and Reciprocal Lattice

Diffraction of x-rays by crystals, scattered wave amplitude-Fourier analysis, Bragg's law, Laue's equations, Reciprocal lattice vectors, diffraction conditions, reciprocal lattice to bcc and fcc Lattices, concept of Brillouin Zone, Ewald construction, Structure factor and atomic form factors.

UNIT-III: Lattice Vibrations

Vibrations of lattice with monoatomic and diatomic basis, dispersion relation, optical and acoustical branches, quantization of elastic waves and phonons, classical theory of specific heat, phonon density of states, Einstein and Debye models of specific heat.

UNIT-IV: Free Electron Fermi Gas

Free electron theory and electronic specific heat, energy levels and density of orbits in one-dimension, free electron gas in three-dimension, thermal properties of an electron gas, Hall effect, thermal conductivity, Wiedemann-Franz law.

UNIT-V: Band Theory of Solids

Nearly free electron model and origin of energy gap, Block function, Kronig-Penny Model, wave equation of electron in a periodic potential, Bloch theorem and crystal momentum, classification of metals, insulators and semiconductors.

Text Books:

1. Introduction to Solid State Physics - C. Kittel
2. Solid State Physics - A. J .Dekker

Model Question Paper

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M.Sc. Degree Examination

Physics

Third Semester

P 301 – Solid State Physics

(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit

All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

Unit – I

1. a) Explain the concept of translation vectors in lattice.
   b) Describe the fundamental types of two- and three-dimensional lattice types.

(OR)

2. a) Draw the simple crystal structures of sodium chloride, cesium chloride and diamond.
   b) Explain the indexing pattern of cubic crystals and non – cubic crystals.

Unit – II

3. a) What is meant by diffraction? Explain the diffraction of X – rays by crystals.
   b) State and prove the Bragg's law.

(OR)

4. a) What are the reciprocal lattice vectors?
   b) Construct the reciprocal lattice to the body centered and face centered cubic crystals.

Unit - III

5. a) Explain the vibrations of lattice with monoatomic and diatomic basis.
   b) Define dispersion relation.

(OR)

6. a) What is the classical theory of specific heat?
   b) Explain in detail the Einstein and Debye models of specific heat.

Unit – IV

7. a) Give an account on free electron theory and electronic specific heat.
   b) Explain the energy levels and density of orbits in one dimension.

(OR)

8. a) What are the thermal properties of an electron gas?
   b) Discuss the Wiedemann – Franz law.

Unit – V

9. a) What is the origin of energy band gap of solids?
   b) Explain the Kronig – Penny model for an electron in one dimensional potential.

(OR)

10. a) Derive the wave equation for an electron in periodic potential.
    b) State and prove Bloch theorem.

M.Sc. Degree Examination **SYLLABUS**

Physics

Third Semester

P 302 – Lasers and Fiber Optics
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. To explain the basics of LASER.
2. Describing the construction and working of various types of lasers and the applications of lasers.
3. Explaining the propagation mechanism of light through optical fiber.
4. Deriving the relation between Numerical Aperture and Refractive indices.
5. Classification of the types of optical fibers.
6. Explaining about the attenuation mechanisms.
7. Demonstrate an understanding of light propagating through an optical fiber
8. Characterize different types of optical fibers and optical connectors

Course Outcomes:

1. Absorption and spontaneous and stimulated emission in two level system, the effects of homogeneous and inhomogeneous line broadening, and the conditions for laser amplification.
2. Operations of the cavity including mode separation and line-widths, laser gain conditions, gain clamping in both homogeneous and inhomogeneous line broadened media.
3. Operations and basic properties of the most common laser types such as Ruby, He-Ne, Nd:YAG and knowledge of other main laser types.
4. The various laser systems, the simple homogeneous laser and its output behavior and optimal operating conditions.
5. Spectral properties of longitudinal and transverse modes, mode locked laser operation, schemes for active and passive mode locking in real laser system.
6. Matrix optics of the laser cavity and stability conditions.
7. Basics of Gaussian beam in laser cavity and optical properties of laser output, design of stable laser cavities using Gaussian beam optics, the ABCD law for Gaussian beams.
8. Better understanding of the Ray and Modal Analysis in Optical Fibers.
9. Basic understanding about the various Fiber Signal Characteristics such as pulse broadening and dispersion.
10. Exhaustive understanding about the Nonlinear optics.

UNIT-I
Laser systems: Introduction, Characteristics of Laser Light, coherence, directionality, spontaneous and stimulated emission, absorption and emission processes, Einstein coefficients, Optical pumping mechanism, Population inversion, Rate equations for three level and four level systems, Types of Lasers - Ruby laser, He-Ne laser, Nd:YAG laser, CO_2 Laser, Dye laser, Excimer laser, Semiconductor laser, Hetero junction laser, Optical resonator, laser power and threshold condition confinement of beam within the resonator, coherence length, stability condition, stability diagram.

UNIT – II:
Laser cavity modes: Line shape function and Full Width at half maximum (FWHM) for Natural broadening, Collision broadening, Doppler broadening, Saturation behavior of broadened transitions, Longitudinal and Transverse modes. ABCD matrices and cavity Stability criteria for confocal resonators. Quality factor, Q-Switching, Mode Locking in lasers. Expression for Intensity for modes oscillating at random and modes locked in phase. Methods of Q-Switching and Mode locking.

UNIT-III
Optical fiber waveguides: Basic optical laws and self-focusing. Optical fiber modes and configurations Fiber types, Rays and Modes, Step-index fiber structure. Ray optics representation, wave representation. Mode theory of circular step-index wave guides. Wave equation for step-index fibers, modes in step-index fibers and power flow in step-index fibers. Graded – index fiber structure, Graded-index numerical aperture, modes in Graded-index fibers.

UNIT-IV
Fiber characteristics: Signal Degradation In Fibers - Attenuation, Absorption, Scattering and Bending losses in fibers, radiative losses, Core and Cladding losses. Signal distortion in optical wave guides: Group delay, material dispersion, waveguide dispersion and intermodal dispersion. Pulse broadening in optical fibers. Power launching in Optical fibers, Source-output pattern, Lensing schemes. Fiber-to-fiber joints: Mechanical misalignment, fiber related losses, Fiber and face preparation. Fiber splicing techniques, fiber connectors.

UNIT – V
Nonlinear Optics: Second harmonic generation, parametric amplification, Phase matching, parametric oscillation, Frequency up conversion, Electro optic modulation of laser beams, electro optic effect, electro optic retardation, electro optic amplitude modulation, phase modulation of light, electro optic beam deflection.

Text Books:
1. Lasers -Theory and Applications – K. Thyagarajan and A.K. Ghatak
2. Optical Fiber Communications – Gerd Keiser
3. Optical Electronics – Amnon Yariv

Reference Books:
1. Laser Fundamentals – William T. Silfvast
2. Introduction to Fiber Optics – Ajoy Ghatak and K. Thyagarajan
3. Optical Electronics – Ajoy Ghatak and K.Thyagarajan
4. Optical Electronics – J. Wilson and J.F.B. Hawkes

Model Question Paper

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M.Sc. Degree Examination

Physics

Third Semester

P 302 – Lasers and Fiber Optics

(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit

All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

Unit – I

1. a) Explain in detail the characteristics of Lasers.
   b) What are Einstein's Coefficients in laser?

(OR)

2. a) Describe the working and construction of He – Ne laser.
   b) Explain briefly about the optical resonators in lasers.

Unit – II

3. a) Give an account on Collision and Doppler broadening in lasers.
   b) Describe the Longitudinal and Transverse modes in lasers.

(OR)

4. a) What is meant by Q -Switching?
   b) Explain the methods of Q – Switching and mode locking.

Unit – III

5. a) What are the basic optical laws and optical fiber modes?
   b) Describe the mode theory of circular step - index wave guides.

(OR)

6. a) Derive the wave equation for the step – index fibers.
   b) Explain the power flow in step – index fibers.

Unit – IV

7. a) Explain the different types of losses in fiber optics.
   b) Give an account on Group delay and material dispersion in optical fibers.

(OR)

8. a) Describe the power launching in optical fibers.
   b) Explain in detail the different types of optical fiber connectors.

Unit – V

9. a) Write a brief note on parametric amplification and parametric oscillation.
   b) What is the frequency up conversion in nonlinear optics?

(OR)

10. a) Define the electro optic retardation.
    b) Describe the electro optic beam deflection in nonlinear optics.

M.Sc. Degree Examination
Physics

SYLLABUS

Third Semester

P 303 – ELECTIVE PAPER
1. Digital Electronics and Microprocessors

(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. To make the students learn the basics of digital electronics.
2. To Introduce the concept of digital and binary systems
3. To be able to design and analyze combinational logic circuits.
4. To be able to design and analyze sequential logic circuits.
5. To understand the basic design and implementation of digital circuits and systems.
6. To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.
7. To prepare students to perform the analysis and design of various digital electronic circuits.
8. Reinforce theory and techniques taught in the classroom through experiments in the laboratory.
9. To introduce students with the architecture and operation of typical microprocessors and microcontrollers.
10. To familiarize the students with the programming and interfacing of microprocessors and microcontrollers.
11. To provide strong foundation for designing real world applications using microprocessors and microcontrollers.

Course Outcomes:

1. At the end of the course, a student will be able to:
2. Convert different type of codes and number systems which are used in digital communication and computer systems.
3. Employ the codes and number systems converting circuits and compare different types of logic families which are the basic unit of different types of logic gates in the domain of economy, performance and efficiency.
4. Analyze different types of digital electronic circuit using various mapping and logical tools and know the techniques to prepare the most simplified circuit using various mapping and mathematical methods.
5. Design different types of with and without memory element digital electronic circuits for particular operation, within the realm of economic, performance, efficiency, user friendly and environmental constraints.
6. Apply the fundamental knowledge of analog and digital electronics to get different types analog to digitalized signal and vice-versa converters in real world with different changing circumstances.

7. Assess the nomenclature and technology in the area of memory devices and apply the memory devices in different types of digital circuits for real world application.
8. Learn microprocessor with the help of basic knowledge of digital electronics.
9. Understand the fundamentals of digital electronics and microprocessor and microcontroller, which will be useful to them in understanding the concept behind Digital India.
10. Assess and solve basic binary math operations using the microprocessor and explain the Microprocessor's and Microcontroller's internal architecture and its operation within the area of manufacturing and performance.
11. Apply knowledge and demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor and microcontroller.
12. Compare accepted standards and guidelines to select appropriate Microprocessor (8085) and Microcontroller (8051) to meet specified performance requirements.
13. Analyze assembly language programs, select appropriate assemble into machine a cross assembler utility of a microprocessor and microcontroller.
14. Design electrical circuitry to the Microprocessor I/O ports in order to interface the processor to external devices.
15. Evaluate assembly language programs and download the machine code that will provide solutions to real-time control problems.

UNIT- I: Combinational Logic Circuits: **(i)** Simplification of Boolean Expressions: Algebraic method, Karnaugh Map method, **(ii)** Encoder, decoder, Multiplexer, Demultiplexer, Design of Adders and Subtractors, IC parallel adder. **(iii)** Applications of Boolean algebra: Magnitude Comparator, Parity generator, Checker, Code converter, Seven-segment decoder/ Driver display.

UNIT – II: Sequential Logic Circuits: (i) Flip-Flops: NAND latch, NOR latch, , Clocked S-C flip-flop, J-K flip-flop, D flip-flop, Asynchronous inputs **(ii)** Counters: Asynchronous counters (Ripple), Counters with MOD number < 2^N, Asynchronous down counter, Synchronous counters, Up-down counter **(iii)** Registers: Shift Register, Integrated Circuit registers, Parallel In Parallel Out (PIPO), SISO, SIPO, PISO. **(iv)** Applications of Counters: Frequency Counter.
(v) A/D and D/A Converter Circuits**:** D/A Converter, Linear weighted and ladder type, an integrated circuit DAC; Analog-to-Digital Conversion, Digital Ramp ADC, Successive Approximation Method, Sample and Hold Circuit, Digital Voltmeter.

UNIT – III: Intel 8085 Microprocessor (i) Architecture, Functional diagram, Pin description, Timing Diagram of Read Cycle, Timing diagram of write Cycle **(ii)** Programming the 8085 Microprocessor**:** Addressing Methods, Instruction set, Assembly language programming **(iii)** Examples of Assembly Language Programming: Addition/Subtraction of two 8-bit/16-bit numbers, Addition of two decimal numbers, Sum of series of 8-bit numbers, Largest element in the array, Multiple byte addition, Delay sub-routine.

UNIT – IV: Data Transfer Techniques: (i) Serial transfer, Parallel transfer, Synchronous, Asynchronous, DMA transfer, Interrupt driven Data transfer **(ii)** 8085 Interfacing**:** I/O Interfacing: Programmable Peripheral Interfacing, 8255, Programmable Peripheral Interval Timer 8253.

UNIT – V: 8051 Microcontroller: (i) 8051 Internal Architecture, Register Structure, I/O pins, Memory Organization, 8051 Addressing modes**,** 8051 Assembly Language Programming Tools**,** 8051 Instruction set**, (ii)** Data Transfer Instructions, Arithmetic instructions, Logical instructions **(iii)** Boolean Variable Manipulation Instructions-Bit Addressability, Single-Bit instructions, Program Branching instructions-Jump, Loop, and Call instructions, Rotate Instructions, Stack Pointer.

Text Books:

1. Digital Systems – Principles and applications –Ronald J. Tocci
2. Fundamentals of Microprocessors & Microcomputers - B. RAM
3. Digital principles and applications - A. P. Malvino & Donald P. Leech
4. Micro Controllers: Theory and Applications - Ajay V. Deshmukh
5. Micro Controllers – Rajkamal
6. Micro Controllers – Kenneth J Ayala

Reference Books:

1. Digital Electronics – William H Gothmann
2. Digital Fundamentals – Thomas L. Floyd
3. Fundamentals of Digital Circuits - A. Ananda Kumar
4. Introduction to Microprocessors for Engineers and Scientist - P.K.Ghosh and P.R.Sridhar
5. Microprocessor Architecture, Programming and Applications with the 8085 /8080A - Ramesh. S. Gaonkar
6. 8051 Microcontroller and Embedded systems - Mahammad Ali Mazidi & Janice GillispieMazidi
7. 8051 Microcontroller – Mike Predko

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Third Semester
P 303 – ELECTIVE PAPER
1. Digital Electronics and Microprocessors
(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit
All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

Unit – I

1. a) Draw the circuit symbol and truth tables of 3 line-8-line decoder.
   b) Write a detailed note on half adder and full adder.

(OR)

2. a) Write a note on K – Map method of simplification of Boolean function with a variable map.
   b) Write a note on parity generator and checker circuits.

Unit – II

3. a) With a neat block diagram explain the working of JK flip-flop.
   b) Write a note on shift registers.

(OR)

4. a) With a neat block diagram explain the working of 3 bit Up/Down counter.
   b) Distinguish between ripple counters and parallel counters.

Unit – III

5. a) Draw the functional diagram of 8085 and explain the register section of 8085.
   b) Write a note on addressing methods of 8085 with examples.

(OR)

6. a) Write an Assembly Language Programming to find the sum of series of 8-bit numbers.
   b) Write a brief note on Delay sub routine.

Unit – IV

7. a) What are the different data transfer techniques?
   b) Write a note on DMA transfer and Interrupt driven data transfer techniques.

(OR)

8. a) Draw the functional diagram of programmable peripheral interface 8255 and explain the different pin names and functions.
   b) Write a brief note on DAC 0800 and ADC 0800 interfacing.

Unit – V

9. a) Define the internal architecture of 8051 microcontroller and explain the memory organization of 8051.
   b) Write a note on assembly language programming tools of 8051.

(OR)

10. a) Explain in detail the data transfer and arithmetic instructions of 8051 Microcontroller?
    b) Give a brief account on stack pointer.

M.Sc. Degree Examination
Physics

SYLLABUS

Third Semester

P 303 – ELECTIVE PAPER
2. Principles of Ultrasonics

(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. The course gives introduction of ultrasonics and its properties and production of ultrasonics by various methods.
2. The course also describes the propagation of ultrasonics in different media and describes the measurement of ultrasonic velocities using various techniques.
3. The course discusses different methods in non-destructive testing and its applications.
4. The course discusses the applications of both low and high intensity ultrasonics in various fields.

Course Outcomes:

1. Students will be able to know the concept of different ranges of frequencies and ultrasonic waves and its production and properties by various methods.
2. They also able to learn the concept of propagation of ultrasonic waves in different liquid media with binary and ternary mixtures. They will be able to know the concept viscoelasticity.
3. They able to measure ultrasonic velocities and absorption coefficients in liquids by using various instruments.
4. They able to understand non-destructive testing methods and applications and learn applications of low and high intensities ultrasonic in the medical field, imaging, process control.

UNIT I:

Introduction of ultrasonics, basic principles of ultrasonic waves, properties, production of ultrasonics i. Magnetostriction method. ii. Piezoelectric method. Detection of ultrasonic waves, basic design of ultrasonic transducer.

UNIT II:

Propagation of ultrasonics velocity of plane wave in a medium, absorption of plane longitudinal waves in gases and low viscosity liquids where relaxation effects are absent.
Viscoelasticity**:** Viscoelasticity of a medium, molecular picture of viscoelastic relaxation, propagation of shear wave in a visco elastic medium, The Maxwell model.

UNIT III:

Measurements of ultrasonic velocities and absorption coefficients in liquids.
i. DSA 5000 M (Density and Sound Velocity Meter) ii. The ultrasonic Interferometer iii. Pulse-echo technique iv. Optical diffraction method, Cavitation process, cleaning technique.

UNIT 1V:

Non-destructive testing, different methods in non-destructive testing and applications of ultrasonic waves using non-destructive testing, flaw detection, applications of ultrasonics in medical field.

UNIT V:

Application of ultrasonics (low and high intensities) in mechanical, chemical and metallurgical area. Ultrasonic imaging, process control and applications.

Reference Books:

1. Fundamental of ultrasonics - Jock Blitz
2. Ultrasonics- the low and high intensity applications - Dale Ensminger
3. Engineering Physics -1 - Dr. D. Tirupati Naidu & M. Veeranjaneyulu
4. Molecular Acoustics - A. J. Matheson

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Third Semester

P 303 – ELECTIVE PAPER

2. Principles of Ultrasonics

(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit

All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

Unit – I

1. a) What is ultrasonics. Explain the production of ultrasonics by Piezoelectric method.
   b) What are ultrasonic transducers. Explain basic design of ultrasonic transducers.

(OR)

2. a) What is meant by Magnetostriction effect and explain how ultrasonic waves are produced using this effect.
   b) Mention Properties of ultrasonic waves and explain how ultrasonic waves are detected.

Unit – II

3. a) Explain the propagation of ultrasonic waves in different media at various temperatures in liquids.
   b) Explain the absorption of plane longitudinal waves in gases at low viscosity where the relaxation effects are absent in the liquids.

(OR)

4. a) What is Viscoelasticity and explain the molecular picture of Visco elastic relaxation.
   b) Explain the propagation of shear wave in a Visco elastic medium using Maxwell model.

Unit – III

5. a) Mention different methods for measuring the ultrasonic velocity. Discuss advantages and disadvantages of these methods.
   b) Using DSA 5000M Density and Sound velocity Meter explain the measurement of refractive index and viscosity with variation of the angles.

(OR)

6. a) Explain in detail the Cavitation process.
   b) Discuss various cleaning techniques using ultrasonic waves.

Unit – IV

7. a) What is the basic principle of ultrasonic testing. How ultrasonics are used in non-destructive testing.
   b) Mention different methods in non-destructive testing. Give brief note on each method.

(OR)

8. a) Explain two or three applications of ultrasonic waves using non-destructive testing.
   b) Discuss applications of ultrasonics in medical field.

Unit – V

9. a) Explain applications of ultrasonics at low and high intensities in mechanical area.
   b) Give a note on ultrasonic imaging and process control.

(OR)

10. a) Give applications of ultrasonics at low and high intensities in chemical and metallurgical area.
    b) Discuss the applications of both low and high intensity ultrasonic waves in various fields.

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SYLLABUS

Third Semester

P 304 – ELECTIVE PAPER
1. Material Science
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. Give basic knowledge of science behind materials & physical metallurgy.
2. Introduce the concept of structure property relations.
3. To have fundamental understanding of materials behavior, or conceived, designed, and realized useful products and technology platforms within realistic engineering constraints, as demonstrated by, for example, development of new materials, improvement of existing materials, development of new materials processing, or development of new analytical tools and core competence in materials.
4. Lay the groundwork for studies in mechanical behavior of materials & applications of recent materials.
5. Are valued not only for understanding the structure and composition of materials, but equally for analytical and creative abilities fostered by a broad engineering,
6. To work effectively in multidisciplinary areas of materials science to solve complex problems.
7. Ability to deal with business and non-technical aspects of materials science & engineering.
8. Develop intuitive understanding of the subject to present a wealth of real-world engineering examples to give students a feel of how material science is useful in engineering practices.
9. Analyze the Structure of materials at different levels, basic concepts of crystalline materials etc. understanding.
10. Concept of mechanical behavior of materials and calculations of same using appropriate equations understanding.
11. Explain the concept of phase & phase diagram & understand the basic terminologies associated with metallurgy understanding.
12. Construction and identification of phase diagrams and reactions Understanding,
13. Understand and suggest the heat treatment process & types.
14. Significance of properties.
15. Explain features, classification, applications of newer class materials like smart materials, piezoelectric materials, biomaterials, composite materials, etc.

Course Outcomes:

1. An ability to apply knowledge of mathematics, science and engineering to materials issues.
2. An ability to design and conduct experiments and critically analyze and interpret data.
3. An ability to design a process and/or material system to achieve specific requirements within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. An ability to work effectively in multidisciplinary teams, be conversant in languages of other fields, and provide leadership to such teams.
5. An ability to identify, formulates, and solves science & engineering problems.
6. An understanding of professional and ethical responsibility.
7. An ability to communicate effectively.
8. The broad education necessary to understand the impact of science & engineering solutions in a global, economic, environmental, and societal context.
9. A recognition of the need for, and an ability to engage in, lifelong learning.
10. A knowledge of contemporary issues in science, engineering and society.
11. An ability to use modern techniques, skills, and science & engineering tools appropriate to materials research.
12. An integrated understanding of structure, properties, processing and performance of materials systems.

UNIT-I: Structure of Materials:

Concept of amorphous, single crystal and polycrystalline materials, defects in crystalline materials, point, line and surface imperfections, vacancies, interstitials, dislocations; grain boundaries, twins, stacking faults.

UNIT-II: Classification of Materials:

Metals and Alloys: alloying nature, concept of formation of alloys, types of alloys, solid solutions, Nd-Fe-B alloy, AlNiCo alloys

Ceramics: introduction, classification, oxides, carbides, nitrides, or silicates of metals, glass, porcelain, ferrites

Polymers: structure of polymers, strengthening of polymers, crystallization and glass formation, types of polymers, nylon, polyethylene, polyvinyl chloride, rubber

Composites: definition, classification, types of matrices and reinforcements, metal-matrix composites, polymer-matrix composites, and ceramic-matrix composites, composite strengths, particles, whiskers and fibers as reinforcements

Semiconductors: concept of doping, simple and compound semiconductors, silicon, germanium, gallium arsenide, amorphous silicon, oxide semiconductors.

UNIT-III: Processing of Materials:

Heat treatment of alloys; annealing, re-crystallization and grain growth, preparation of ceramic powders, solid-state reaction, sintering; thin film deposition, evaporation and sputtering techniques, and chemical vapor deposition.

UNIT-IV: Properties of Materials:

Mechanical Properties: stress, strain, elastic properties, deformation- elasticity, hardness, stress-strain response (elastic, inelastic and plastic deformation)

Electrical Properties: dielectric polarization, mechanism of polarization, dielectric constant, dielectric losses and breakdown, piezoelectric and ferroelectric behavior, electrical conduction in semiconductors, temperature dependence of electrical conductivity

Magnetic Properties: classification of magnetic materials, ferromagnetism, ferrimagnetism, antiferromagnetism and superparamagnetism, domain theory and hysteresis, magnetization processes in terms of domain theory, Domain wall, properties of domain walls and domain wall motion, magnetic anisotropy.

UNIT-V: Applications of Materials:

Metals and Alloys: Nd-Fe-B, AlNiCo alloys,

Ceramics: soft and hard ferrites, ferroelectric and piezoelectric materials

Polymers: plastic fibers, coating adhesives, biomedical applications,

Composites: aircraft engineering-space hardware, wind turbine, marine craft-space structure, applications in surgery.

Text & Reference Books:

Composite Materials	Krishnan K. Chawla
Materials Science and Engineering	V Raghavan
Electronic Processes in Materials	L.W. Azaroff and J.J.Brophy
Introduction to Solid State Physics	C.Kittel
Science of Engineering Materials	C.M.Srivastava and C. Srinivasan
Solid State Physics	A.J.Dekkar
Solid State Physics	S.O.Pillai
Solid State Devices and Materials	Ben.G Streetman

Model Question Paper

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Physics

Third Semester

P 304 – ELECTIVE PAPER

1. Material Science

(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit

All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

Unit – I

1. a) Explain about the single crystal and polycrystalline materials.
   b) Describe the defects in crystalline materials.

(OR)

2. a) Write a note on line and surface imperfections.
   b) Give an account on grain boundaries and stacking faults.

Unit – II

3. a) Explain the nature and formation of alloys.
   b) What are the different types of ceramics?

(OR)

4. a) Describe the crystallization and glass formation of polymers.
   b) Discuss about the different types of matrices and reinforcements of composites.

Unit – III

5. a) What is meant by annealing?
   b) Explain the re – crystallization and grain growth of alloys.

(OR)

6. a) Describe the preparation of ceramic powders.
   b) Write a detailed note on thin film deposition and evaporation techniques.

Unit – IV

7. a) Write the mechanical properties of materials.
   b) Define the dielectric polarization.

(OR)

8. a) Give an account on piezoelectric and ferroelectric behaviour of materials.
   b) Distinguish between dia, para and ferro magnetic materials.

Unit – V

9. a) What are the applications of metal and alloy materials?
   b) Describe the ferroelectric and piezoelectric materials.

(OR)

10. a) What are the biomedical applications of polymers?
    b) Write the applications of composite materials.

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SYLLABUS

Third Semester

P 304 – ELECTIVE PAPER
2. Radar Systems and Satellite Communications
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. To learn about Radar systems, Design and Tracking of Radars.
2. To study about MTI and Pulsed Radar Systems.
3. To study Satellite basics and Satellite communication systems.
4. To learn about satellite link design and multiple access techniques.

Course Outcomes:

On completion of the course, students will be able to

1. Describe the working principle of different RADAR systems and their applications.
2. Identify the various RADAR systems in existence, specify their applications and limitations, and explain the principles of how they work.
3. Describe the most commonly used techniques in processing RADAR signals.
4. Recognize and describe the various technologies used in the design of RADAR systems: antennas, transmitters, duplexers, data display screens, etc.
5. Design simple radar systems and the associated signal processing, at block diagram level.
6. Understand the Satellite fundamentals and types of satellite.
7. Explain the working of a Satellite communication system and its other subsystems.
8. Know the applications of Satellites in different areas.
9. Describe the principles of radio navigation systems (including secondary radar and GPS).
10. Identify the fundamentals of orbital mechanics, the characteristics of common orbits used by communications and other satellites, and be able to discuss launch methods and technologies.
11. Describe the systems required by a communications satellite to function and the trade-offs and limitations encountered in the design of a communications satellite system.
12. Describe the radio propagation channel for Earth station to satellite and satellite to satellite communications links, and the basics of designing antenna systems to accommodate the needs of a particular satellite system.
13. Analyze an accurate link budget for a satellite or other wireless communications link.

Unit – I:

Radar Systems: Fundamental – A simple RADAR – overview of frequencies – Antenna gain Radar Equation – Accuracy and Resolution – Integration time and the Doppler shift

Designing a surveillance radar – Radar and surveillance – Antenna beam – width consideration – pulse repetition frequency – unambiguous range and velocity – pulse length and sampling – radar cross section – clutter noise

Tracking Radar – Sequential lobbing – conical scanning – Mono pulse Radar – Tracking accuracy and Process – Frequency Agility – Radar guidance, Signal and data processing.

UNIT – II:

MTI and Pulse doppler Radar: Introduction to Doppler and MTI radar, MTI and pulse radar, Doppler frequency shift, simple CW Doppler Radar, sweep to sweep subtraction and delay line cancellers, MTI radar block diagram Radar Antenna – Antenna parameters – Antenna Radiation Pattern and aperture distribution – Parabolic reflector – cosecant squared antenna pattern.

UNIT – III:

Satellite Communication: Satellite System – Historical development of satellites – communication satellite systems – communication satellites – orbiting satellites – satellite frequency bands – satellite multiple access formats, Satellite orbits and inclination – Look angles, orbital perturbations, space craft and its subsystems – attitude and orbit control system – Telemetry, Tracking and Command – Power system – Transponder – Reliability and space qualification – launch vehicles

UNIT – IV:

Satellite Link Design: Introduction, General Link Design Equation, System Noise Temperature, C/N and G/T Ratios, Uplink Design, Downlink Design, Downlink Rain Fade Margin, Complete Link Design, Satellite Link Design with Specified (C/N), Dependence of (C/N) Ratio on Earth Station Parameters.

UNIT V:

Multiple Access Techniques – Time division multiple access – Frequency division multiple access – Code division multiple access – Space domain multiple access, Earth Station technology – Subsystem of an earth station – Transmitter – Receiver, Tracking and pointing – Small earth station – different types of earth stations – Frequency coordination – Basic principles of special communication satellites – INMARSAT, VSAT, GPS, RADARSAT, INTELSAT.

Text Books:

1. Understanding Radar Systems – Simon Kingsley and Shaun Quegan.
2. Satellite Communication – Robert M. Gagliardi
3. Satellite Communication – Monojit Mitra

Reference Books

1. Introduction to Radar Systems – MI Skolnik
2. Satellite communications – Timothy Pratt,Carles Bostian and Jeremy Allnutt

Model Question Paper

Andhra University
M.Sc. Degree Examination
Physics

Third Semester
P 304 – ELECTIVE PAPER
2. Radar Systems and Satellite Communications
(Effective from the admitted batch of 2021-2022-CBCS)

Answer one question from each unit
All questions carry equal marks

Time: 3 Hrs. **Max.Marks:80 (16 X 5 = 80)**

Unit – I

1. a) Explain the design of surveillance Radar.
   b) Write a note on Radar cross section of targets.

(OR)

2. a) Explain the unambiguous range and velocity of a Radar.
   b) With a neat block diagram explain the signal and data processing in Radars.

Unit – II

3. a) With a neat block diagram explain the working of MTI Doppler Radar.
   b) Explain in detail about the Doppler frequency shift.

(OR)

4. a) What are the antenna parameters?
   b) Describe the radiation pattern and aperture distribution of antenna.

Unit – III

5. a) Explain the historical development of satellites.
   b) State Kepler's second law of planetary motion, with reference to Geo-stationery Satellites, with necessary illustrations.

(OR)

6. a) Give an account on Look angles and orbital perturbations.
   b) Explain the Reliability and space qualification of satellite systems.

Unit – IV

7. a) Derive the general link equations of satellites.
   b) Explain C/N and G/T ratios.

(OR)

8. a) Write a note on Uplink and Downlink designs.
   b) Explain how the C/N ratio depends on the Earth Station Parameters.

Unit – V

9. a) Discuss about the time and frequency division multiple access techniques.
   b) Explain the working of transmitter and receiver of a system.

(OR)

10. a) What are the basic principles of special communication satellites?
    b) Write a brief note on GPS.

M.Sc. Degree Examination
Physics

SYLLABUS

Third Semester

P 305 – Digital Electronics and Microprocessor Laboratory
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. This course will enable the students to learn the basic concepts and techniques and application of knowledge in digital electronic circuits and systems.
2. To acquire the basic knowledge of digital logic levels.
3. The learning objective of this course is to understand the concepts of digital circuits and systems with adequate introduction to both combinatorial and sequential logic circuits, such as, adders, comparator, decode counter, etc.
4. This course introduces the assembly language programming of 8085.
5. The course objective is to introduce the basic concepts of microprocessor and to develop in students the assembly language programming skills and real time applications of Microprocessor as well as microcontroller. It gives a practical training of interfacing the peripheral devices with microprocessor.
6. The objective of this laboratory is to understand various Modulation techniques in time domain and frequency domain to impart hands on experience and train the students to analyze various modulation techniques and understand their performance to comprehend various coding techniques on transmission medium in Digital communications.

Course Outcomes:
After studying this course, the students would gain enough knowledge

1. Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.
2. Identify the various digital ICs and understand their operation.
3. Learn about comparator and decade counter.
4. The ability to identify and prevent various hazards and timing problems in a digital design.
5. Ability to identify basic requirements for a design application and propose a cost-effective solution.
6. The student will be able to design AM, FM, Mixer and analyze the modulation techniques.
7. Design interfacing circuits with 8085.
8. Practice different types of programming keeping in mind technical issues and evaluate possible causes of discrepancy in practical experimental observations in comparison.

LIST OF EXPERIMENTS

1. Adders: Half Adder, Full Adder and Parallel Adder
2. Digital Comparator (IC 7485)
3. Decade Counter (IC 7490)
4. Addition/ Subtraction of 8-bit numbers using 8085.
5. Largest number in an Array, Sum of Series of 8 – bit and Sum of two 16 – bit numbers
6. Interfacing of 8255 PPI: Generation of Square Wave and Rectangular Wave
7. Amplitude Modulation
8. Butterworth First Order Low Pass and High Pass Filters
9. Mixer

Reference Books:

1. Digital Principles and Applications - Malvino and Leach
2. Digital Fundamentals - Thomas L Floyd
3. Digital Logic and Computer Design - M. Morris Mano
4. Digital Design - M. Morris Mano
5. Advanced Microprocessors & Peripherals - A K Ray and K M Bhurchandi
6. 8051 microcontroller and embedded systems - M A Mazidi and J G Mazidi
7. An introduction to analog and digital communications – Simon Haykin
8. Modern Analog and Digital Communication Systems – B P Lathi
9. Basic *Electronics: A Text-Lab Manual* - Paul Zbar & Albert P Malvino
10. Experiments in Electronics - S V Subrahmanyam

M.Sc. Degree Examination **SYLLABUS**
Physics

Third Semester

P 306 – Solid State Physics Laboratory
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. This course will concentrate on experiments in solid state physics covering a broad range of topics representative of the field.
2. This course is an upper division lab with some focus on solid state physics.
3. This course integrates theory of Solid-State Physics with experimental demonstrations in the Research Physics Lab.
4. This course will provide a valuable theoretical introduction and an overview of the fundamental applications of the physics of solids.
5. This course includes theoretical description of crystal and electronic structure, lattice dynamics, and properties of different materials (metals, semiconductors, dielectrics, magnetic material), based on the classical and quantum physics principles.
6. However, the student is expected to master the topic of the experiment in depth and produce an experiment procedure before attempting data collection.
7. After the experiment is completed, each student will write a record that includes experimental results, and analysis and discussion of these results.
8. Several advanced experiments like X-ray diffraction, Raman Scattering, etc., will be carried out in the Research Physics Lab followed by their theoretical discussion.

Course Outcomes:

1. Student will be able to observe and analyze physical data relevant to some of the experiments in solid state physics.
2. Provide students with a thorough understanding of the basic concepts of physics and the methods scientists use to explore natural phenomena, including observation, hypothesis development, measurement and data collection, experimentation, evaluation of evidence, and employment of mathematical analysis.
3. Interpreting results through analyzing data and analysis, writing record.
4. Learning more advanced physics topics, not encountered at the introductory level.
5. Students are expected to develop a clear concept of the crystal classes and symmetries.
6. Students will be able to calculate the Braggs conditions for X-ray diffraction in crystals and will calculate the conditions for allowed and forbidden reflections in crystals.
7. Students will learn the basics of the phonons in crystals.
8. Students will become familiar with the free-electron model for metals and use the concept of Fermi energy and Fermi temperature.
9. Basic concepts of the band theory of solids will be given to Students, who will be able to predict the properties of materials and compounds.
10. Students will master their skills for oral presentations on the selected topics of the modern Solid-State Theory.

LIST OF EXPERIMENTS

1. Hall Effect: Determination of Hall coefficient and estimation of carrier concentration and its mobility
2. Coupled Oscillations**:** Study of the frequencies of normal modes of two coupled pendulums, strength of the coupling constant
3. X-ray Diffraction: Study of the X-ray diffraction and determination of lattice parameter and the number of atoms per unit cell in NaCl and KCL
4. Four –probe**:** Determination of energy gap of a semiconductor using four-probe method
5. Magneto resistance**:** Observe the magneto resistance of a semiconductor using four –probe arrangement
6. Thermo electric power**:** Calculation of Thermoelectric power and carrier concentration of a Ferrite material
7. Lattice Dynamics**:** Study of the Phonon dispersion characteristics for mono atomic lattice
8. Measurement of ultrasonic velocity in binary liquid mixtures at different temperatures using ultrasonic interferometer at a fixed frequency.

Reference Books:

1) Solid State Electronic Devices - Ben G. Streetman and Sanjay Kumar Banerjee
2) Semiconductor Physics and Devices - Donald A. Neamen and Dhrubes Biswas
3) Physics for Scientists and Engineers - Raymond A. Serway and John W. Jewett
4) Introduction to Modern Solid-State Physics - Yuri M. Galperin
5) Solid State Physics – Laboratory Manual – Lucian ION
6) Advanced Practical Physics - B.L. Worsnop & H.T. Flint

M.Sc. Physics Programme

Matrix Mapping of PO's vs CO's

(THIRD SEMSTER)

P 301: SOLID STATE PHYSICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1			✓		
PO-2	✓				
PO-3		✓			
PO-4					
PO-5					

P 302: LASERS & FIBER OPTICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1					
PO-2	✓				
PO-3			✓		
PO-4					
PO-5					✓

P 303: ELECTIVE PAPER: 1. DIGITAL ELECTRONICS AND MICROPROCESSORS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1					
PO-2		✓			
PO-3			✓		
PO-4				✓	
PO-5					✓

P 303: ELECTIVE PAPER: 2. PRINCIPLES OF ULTRASONICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2		✓			
PO-3					
PO-4				✓	
PO-5					

P 304: ELECTIVE PAPER: 1. MATERIAL SCIENCE

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2		✓			
PO-3			✓		
PO-4					
PO-5				✓	

P 304: ELECTIVE PAPER:

2. RADAR SYSTEMS AND SATELLITE COMMUNICATIONS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2					
PO-3		✓	✓		
PO-4				✓	
PO-5					

P 305: DIGITAL ELECTRONICS & MICROPROCESSOR LAB

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1		✓			
PO-2			✓		
PO-3					
PO-4	✓				
PO-5				✓	

P 306: SOLID STATE PHYSICS LAB

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1			✓		
PO-2	✓				
PO-3					
PO-4		✓			
PO-5					