Resolution No. : AC/II (23-24).2.RPS10

S.P. Mandali's
Ramnarain Ruia Autonomous College
(Affiliated to University of Mumbai)

Syllabus for PG

Program: M.Sc.

Program Code: (RPSPHY)

2024-25

(As per the guidelines of NEP 2020 Academic Year 2024-25)

Graduate Attributes

S. P. Mandali's Ramnarain Ruia Autonomous College has adopted the Outcome Based Education model to make its science graduates globally competent and capable of advancing in their careers. The Master's Program in Science also encourages students to reflect on the broader purpose of their education.

A student completing Master's Degree in Physics (Electronics-I) Program will be able to:	
GA No.	**Description**
GA1	Demonstrate in depth understanding in the relevant science discipline. Recall, explain, extrapolate and organize conceptual scientific knowledge for execution and application and also to evaluate its relevance.
GA2	Critically evaluate, analyse and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary.
GA3	Access, evaluate, understand and compare digital information from various sources and apply it for scientific knowledge acquisition as well as scientific data analysis and presentation.
GA4	Articulate scientific ideas, put forth a hypothesis, design and execute testing tools and draw relevant inferences. Communicate the research. work in appropriate scientific language.
GA5	Demonstrate initiative, competence and tenacity at the workplace. Successfully plan and execute tasks independently as well as with team members. Effectively communicate and present complex information accurately and appropriately to different groups.
GA6	Use an objective, unbiased and non-manipulative approach.in collection and interpretation of scientific data and avoid plagiarism and violation of Intellectual Property Rights. Appreciate and be sensitive to environmental and sustainability issues and understand its scientific significance and global relevance.
GA7	Translate academic research into innovation and creatively design scientific solutions to problems. Exemplify project plans, use management skills and lead a team for planning and execution of a task.
GA8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM OUTCOMES

A student completing Master's Degree in Physics (Electronics-I) Program will be able to:	
PO No.	**Description**
PO1	To demonstrate procedural knowledge related to different areas of study in Physics including Quantum Mechanics, Nuclear Physics, Electronics, Microprocessor and Microcontroller, Embedded Systems and RTOS.
PO2	To demonstrate comprehensive, quantitative and conceptual understanding of the core areas of Physics and keeping update with current developments in the academic field of Physics
PO3	To demonstrate the ability to use analytical skills in Physics and its related areas of technology to solve a wide range of problems including open ended problems associated with Physics.
PO4	Utilize contemporary experimental apparatus and analysis tools to acquire, analyse and interpret scientific data in the extents of Physics with reference to Research.
PO5	Plan and execute Physics-related experiments or investigations, analyse and interpret data collected using appropriate methods, and report accurately the findings relating to relevant theories of Physics.
PO6	Develop skills in areas related to specialization in the subfields of physics- Microprocessor, Microcontroller, VHDL, ARM7 and Python.
PO7	Demonstrate communication skills, to present complex information in a concise manner and develop personal skills such as the ability to work both independently and in a group.

PROGRAM OUTLINE

Year	Semester	Course Code	Course Title	Credits
2024-25	I	RPSPHY.O501 (Discipline Specific Core)	Mathematical Methods	3
		RPSPHYP.O501 (Discipline Specific Core)	Practical based on RPSPHYP.O501	1
		RPSPHY.O502 (Discipline Specific Core)	Classical Mechanics	3
		RPSPHYP.O502 (Discipline Specific Core)	Practical based on RPSPHYP.O502	1
		RPSPHY.O503 (Discipline Specific Core)	Solid State Physics	3
		RPSPHYP.O503 (Discipline Specific Core)	Practical based on RPSPHYP.O503	1
		RPSPHY.O504 (Discipline Specific Core)	Python Programming	2
		RPSRMPHY.O505	Research Methodology	4
		RPSPHY.O506 (Discipline Specific Elective Course)	Microprocessor 8085 and 8086	3
		RPSPHYP.O506 (Discipline Specific Elective Course)	Practical based on RPSPHYP.O506	1
		Total Credits		**22**
Year	**Semester**	**Course Code**	**Course Title**	**Credits**
2024-25	II	RPSPHY.E511 (Discipline Specific Core)	Electrodynamics	3
		RPSPHYP.E511 (Discipline Specific Core)	Practical based on RPSPHYP.E511	1
		RPSPHY.E512 (Discipline Specific Core)	Quantum Mechanics - I	3
		RPSPHYP.E512 (Discipline Specific Core)	Practical based on RPSPHYP.E512	1
		RPSPHY.E513 (Discipline Specific Core)	Solid State Devices	3
		RPSPHYP.E513 (Discipline Specific Core)	Practical based on RPSPHYP.E513	1
		RPSPHY.E514 (Discipline Specific Core)	Advanced Electronics	2
		RPSRMPHY.E515	OJT/FP – Project	4
		RPSPHY.E516 (Discipline Specific Elective Course)	Microcontroller 8051	3
		RPSPHYP.E516 (Discipline Specific Elective Course)	Practical based on RPSPHYP.E516	1
		Total Credits		**22**

Resolution No. : AB/II (20-21).2.RPS10

S.P. Mandali's
Ramnarain Ruia Autonomous College
(Affiliated to University of Mumbai)

Syllabus for
Program: Master of Science (M.Sc.) Physics
Program Code: RPSPHY

(As per the guidelines of NEP 2020 Academic Year 2024-25)

Course Code: RPSPHY.O501

Course Title: Mathematical Methods

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	A Student should gain a deep understanding of foundational mathematical concepts relevant to physics, such as calculus (differentiation, integration, and their applications), linear algebra, complex analysis, and differential equations.
CO2	A Student should develop the ability to apply mathematical methods to solve complex physics problems. This involves selecting appropriate mathematical techniques, performing calculations accurately, and interpreting the results in the context of physical phenomena.
CO3	A Student should be able to work with complex numbers, understand the concept of analytic functions, and use techniques such as contour integration to solve physics problems involving complex variables.
CO4	A Student should be able to solve ordinary and partial differential equations commonly encountered in physics, including equations describing physical processes like diffusion, wave propagation, and quantum mechanics.
CO5	A Student should understand the principles of linear algebra, including vector spaces, matrices, determinants, eigenvalues, and eigenvectors. These concepts are important for describing linear transformations and solving systems of linear equations.
CO6	A Student should be familiar with Fourier series, Fourier transforms, and Laplace transforms, which are essential for analyzing periodic and transient phenomena in physics.

Detailed Syllabus

RPSPHY.O501: Mathematical Methods

Units	Title	Credits - 03
I	Cauchy-Riemann Equations, Analytic functions, Harmonic functions, Elementary functions: Exponential and Trigonometric, Taylor and Laurent series, Residues, Residue theorem, Principal part of the functions, Residues at poles, zeroes and poles of order m, Contour Integrals, Evaluation of improper real integrals, improper integral involving Sines and Cosines, Definite integrals involving sine and cosine functions.	15 Lectures
II	Matrices, Eigenvalues and Eigen vectors, orthogonal, unitary and Hermitian matrices, Diagonalization of Matrices, Applications to Physics problems. General treatment of second order linear differential equations with non-constant coefficients, Power series solutions, Frobenius method, Legendre, Hermite and Laguerre polynomials, Bessel equations, non-homogeneous equation, Green's function, Sturm-Liouville theory.	15 Lectures
III	Integral transforms: three dimensional Fourier transforms and its applications to PDEs (Green function of Poisson's PDE), convolution theorem, Parseval's relation, Laplace transforms, Laplace transform of derivatives, Inverse Laplace transform and Convolution theorem, use of Laplace's transform in solving differential equations.	15 Lectures

Course Code: RPSPHYP.O501	Practical based on RPSPHY.O501	Credits/Hours
1	Numerical Integration: Trapezoidal Method, Simpson's $1/3^{rd}$ Rule	1
2	Solution of Transcendental or Polynomial Equations by Newton Raphson Method	1
3	Solution of Differential Equation by Runge Kutta Method	1
4	Jacobi Method of Matrix Diagonalization	1

Main References:

1. S. D. Joglekar, Mathematical Physics: The Basics, Universities Press 2005.
2. S.D. Joglekar, Mathematical Physics: Advanced Topics, CRC Press 2007.
3. M.L. Boas, Mathematical Methods in the Physical Sciences, Wiley India 2006.
4. G. Arfken and H. J. Weber, Mathematical Methods for Physicists, Academic Press 2005.

Additional References:

1. A.K. Ghatak, I.C. Goyal and S.J. Chua, Mathematical Physics, McMillan.
2. A. C. Bajpai, L. R. Mustoe and D. Walker, Advanced Engineering Mathematics, J Wiley.
3. E. Butkov, Mathematical Methods, Addison-Wesley.
4. J. Mathews and R. L. Walker, Mathematical Methods of Physics.
5. P. Dennery and A. Krzywicki, Mathematics for Physicists.
6. T. Das and S. K. Sharma, Mathematical methods in Classical and Quantum Mechanics.
7. R. V. Churchill and J. W. Brown, Complex variables and applications, 5th Ed. McGraw Hill.
8. A. W. Joshi, Matrices and Tensors in Physics, Wiley India.

Course Code: RPSPHY.O502

Course Title: Classical Mechanics

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Understand formalism of Lagrange equation and D' Alembert's Principle, Hamilton's principle, variation principle. Its application to mechanics of particles.
CO2	Comprehend Conservation theorems, Two-Body Central Force Problem, Scattering in a central force field.
CO3	Application of the differential equation to the problem of the orbit, The Kepler's problem: Inverse square law of force.
CO4	Evaluate Legendre transformations and the Hamilton equations of motion
CO5	Analysis of Small Oscillations using Eigen function and Eigen value
CO6	Analysis of Equations of motion using concepts of Canonical Transformations and Poisson brackets.
CO7	Demonstrate problem solving skills in all above areas

Detailed Syllabus

RPSPHY.O502: Classical Mechanics

Unit/s	Title	Credits - 03
I	Historical context and advantages of the Lagrangian approach. Comparison with Newtonian mechanics and Hamiltonian mechanics. Variational calculus and the principle of least action. Deriving Lagrange's equations and understanding their significance. Coordinate transformations and generalized coordinates. Handling holonomic and non-holonomic constraints. Kinematics and dynamics of rotational motion. Euler's equations of motion for rigid bodies. Hamilton's principle and its connection to Lagrangian mechanics. Noether's theorem and its application to derive conservation laws.	15 Lectures
II	Introduction to central force problems. Non-Inertial frames of reference and pseudoforces: Centrifugal, Coriolis and Euler forces. Gravitational force and the two-body problem. Transformation to relative coordinates. Deriving the effective potential and analyzing equilibrium points. The Virial Theorem. Solutions to the central force equation of motion. Properties of conic sections and Kepler's laws. Analysis of scattering in central force motion. Transformation of the scattering problem to laboratory coordinates. Small oscillations Normal mode analysis. Normal modes of a harmonic chain.	15 Lectures
III	Legendre Transformations, Hamilton's equations of motion and Hamiltonian function. Canonical Transformations, Examples of canonical transformations, The symplectic approach to canonical transformations, 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. Canonical transformations and Poisson brackets. Hamiltonian formulation of continuous systems.	15 Lectures

Course Code RPSPHYP.O502	Practical based on RPSPHY.O502	Credits/Hours
1	Coupled Oscillations	**1**
2	Ultrasonic Interferometry-Velocity measurements in different Fluids	**1**
3	Transient Response of LCR Circuit	**1**
4	M.I of a Flywheel	**1**

Main References:

1. Classical Mechanics, H. Goldstein, Poole and Safko, 3rd Edition, Narosa Publication (2001)
2. Classical Mechanics, N. C. Rana and P. S. Joag. Tata McGraw Hill Publication.

3. Classical Mechanics, G. Aruldhas, Prentice Hall India Learning Private Limited (1 January 2008)

Additional References:

1. Classical Mechanics, S. N. Biswas, Allied Publishers (Calcutta).
2. Classical Mechanics, V. B. Bhatia, Narosa Publishing (1997).
3. Mechanics, Landau and Lifshitz, Butterworth, Heinemann.
4. Classical Mechanics, Vol I and II, E. A. Deslougue, John Wiley (1982).
5. Theory and Problems of Lagrangian Dynamics, Schaum Series, McGraw (1967).
6. Classical Mechanics of Particles and Rigid Bodies, K. C. Gupta, Wiley Eastern (2001)

Course Code: RPSPHY.O503

Course Title: Solid State Physics

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Get a brief idea about crystalline and amorphous substances, about lattice, unit cell, miller indices, reciprocal lattice, and concept of Brillouin zones and diffraction of x-rays by different crystalline materials.
CO2	Gain knowledge of lattice vibrations the basics of the optical and acoustic phonons in crystals.
CO3	Understand about different types of magnetism like diamagnetism and Paramagnetism. Quantum mechanical formulation of magnetism and application of Langevin diamagnetic equation.
CO4	Carry out the experiments based on the theory that they have learned to measure carrier lifetime, magnetic susceptibility, and dielectric constant. They will also employ to four probe methods to determine electrical conductivity and the Hall setup to determine the hall coefficient of semiconductor.
CO5	Demonstrate cautious problem-solving skills in all above areas.

Detailed Syllabus

RPSPHY.O503 - Solid State Physics

Units	Title	Credits - 03
I	Lattice Vibrations and Thermal properties: Vibrations of Monoatomic Lattice, normal mode frequencies, dispersion relation. Lattice with two atoms per unit cell, normal mode frequencies, dispersion relation, Quantization of lattice vibrations, phonon momentum, Inelastic scattering of neutrons by phonons, Surface vibrations, Inelastic Neutron scattering. Anharmonic Crystal Interaction. Thermal conductivity–Lattice Thermal Resistivity, Umklapp Process, Imperfections.	**15 Lectures**
II	Diamagnetism and Paramagnetism: Langevin diamagnetic equation, diamagnetic response, Quantum mechanical formulation, core diamagnetism. Quantum Theory of Paramagnetism, Rare Earth Ions, Hund's Rule, Iron Group ions, Crystal Field Splitting and Quenching of orbital angular momentum; Adiabatic Demagnetisation of a paramagnetic Salt, Paramagnetic susceptibility of conduction electrons.	**15 Lectures**
III	Ferromagnetic order- Exchange Integral, Saturation magnetisation Magnons, neutron magnetic scattering; Ferrimagnetic order, spinels, Yttrium Iron Garnets, Anti Ferromagnetic order. Ferromagnetic Domains – Anisotropy energy, origin of domains, transition region between domains, Blochwall, Coercive force and hysteresis.	**15 Lectures**

Course Code RPSPHYP.O503	Practical based on RPSPHY.O503	Credits/Hours
1	DC Hall Effect	**1**
2	Measurement of dielectric constant, Curie temperature and verification of Curie—Weiss law for ferroelectric material	**1**
3	Hysteresis Loop for a Ferromagnetic Material (B-H Curve)	**1**
4	Four Probe Method: Semiconductor Resistivity and Energy Band Gap	**1**

Main References:

1. Charles Kittel, "Introduction to Solid State Physics", 7th edition John Wiley & sons.
2. J. Richard Christman, "Fundamentals of Solid-State Physics", John Wiley & sons.
3. M.A. Wahab, "Solid State Physics –Structure and properties of Materials", Narosa Publications 1999.
4. M. Ali Omar, "Elementary Solid-State Physics", Addison Wesley (LPE).
5. H. Ibach and H. Luth, 3rd edition "Solid State Physics–An Introduction to Principles of Materials Science", Springer International Edition (2004)

Course Code: RPSPHY.O504

Course Title: Python Programming

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	By the end of the course, students should be proficient in Python's basic syntax, including variables, data types, operators, and basic input/output operations.
CO2	Students should be proficient in using control structures such as loops (for, while) and conditional statements (if, elif, else) to control the flow of a program.
CO3	Students should be able to define and use functions in Python, understanding concepts such as function parameters, return values, and scope.
CO4	Students should develop the ability to break down problems into smaller, solvable components and translate these solutions into Python code, fostering algorithmic thinking and problem-solving skills.

Detailed Syllabus

RPSPHY.O504 - Python Programming

Unit	Title	Credits - 02
I	The Python Programming Language, Program Meaning, Debugging, Formal and Natural Languages, The first program. Values and types, Variables, Variable names and Keywords, Statements, Evaluating Expressions, Operators and Operands, Order of Operations, Operation on Strings, Composition, Comments. Functions Calls, Type Conversion, Type coercion, Math Functions, Composition, Adding New Functions, Definitions and Use, Flow of Execution, Parameters and Arguments, Variables and Parameters are local, Stack Diagrams, Functions with results.	15 Lectures
II	The modulus operator, Boolean expressions, Logical operators, Conditional execution Alternative execution, Chained conditionals, Nested conditionals, the return statement, Recursion, Stack diagrams for recursive functions Infinite recursion Keyboard input, return values Program development, Composition, Boolean functions, more recursion, Leap of faith, Checking types, Multiple assignment, The while statement Tables Two-dimensional tables Encapsulation.	15 Lectures

Main References:

1. Allen Downey, Jeffrey Elkner, Chris Meyers - Learning with PYTHON How to Think Like a Computer Scientist-CreateSpace (2009).

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Course Code: RPSRMPHY.O505

Course Title: Research Methodology

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Describe the fundamental concepts and principles of research, including the research process and various research methodologies.
CO2	Demonstrate the ability to design research studies, including selecting appropriate research methods, variables, and data collection techniques.
CO3	Conduct a comprehensive literature review to identify gaps in existing research and formulate research questions or hypotheses.
CO4	Understand and apply ethical principles in research, including the responsible conduct of research, informed consent, and ethical considerations in data collection and analysis.
CO5	Collect and record data using various research methods, such as surveys, interviews, experiments, observations, or archival research.
CO6	Analyse and interpret research data using appropriate statistical or qualitative analysis techniques, depending on the research design.
CO7	Develop critical thinking skills to evaluate research articles, methodologies, and findings critically.

Detailed Syllabus

RPSRMPHY.O505 - Research Methodology

Units	Title	Credits - 03
I	Introduction to research and its significance, Research process and steps, Types of research (qualitative, quantitative, mixed methods), Ethical considerations in research Introduction to research design, Experimental, quasi-experimental, and non-experimental designs, Survey research design, Case study and ethnographic research design.	**15 Lectures**
II	Importance of literature review in research, Searching and evaluating relevant sources, Organizing and synthesizing literature, Writing a literature review, References, Abstraction of a research paper, Possible ways of getting, oneself abreast of current literature	**15 Lectures**
III	Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography.	**15 Lectures**
IV	Statistical analysis and fitting of data: Introduction to Statistics – Probability, Conditional Probability, Poisson Distribution, Binomial Distribution and Properties of Normal Distributions, Estimates of Means and Proportions; Chi-Square Test, Association of Attributes. t-Test Anova-Standard deviation, Co-efficient of variations. Co-relation and Regression Analysis.	**15 Lectures**

Main References:

1. C.R. Kothari-Research Methodology Methods and Techniques-New Age Publications (Academic) (2009).
2. Data Analysis for Physical Sciences (Featuring Excel®) Les Kirkup, 2nd Edition, Cambridge University Press (2012), Chapters1-6 and 9.
3. Statistical Methods in Practice for scientists and Technologists, Richard Boddy and Gordon Smith, John Wiley & Sons (2009)

Course Code: RPSPHY.O505

Course Title: Microprocessor 8085 and 8086

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Understand the concepts of serial I/O, data communication and the 8085 Interrupt.
CO2	Understand the basic concepts of Programmable Peripheral and Interface Devices like 8255 and 8259A with microprocessor 8085.
CO3	Understand the basic of architecture and of 8086 microprocessor and basic assembly language programming of 8086
CO4	Get exposure to the simulators and software which. mimics the behavior of the microprocessors
CO5	Demonstrate the practical utility of microprocessor through experiments.
CO6	In the laboratory course, student will gain hands-on experience of the working and applications of the microprocessors.

Detailed Syllabus

RPSPHY.O505 - Microprocessor 8085 and 8086

Units	Title	Credits - 03
I	**Microprocessor 8085** Counters and Time Delays, Stack and Sub-routines. 8085 Interrupts: The 8085 Interrupt, 8085 Vectored Interrupts, Restart as Software Instructions, Additional I/O Concepts and Processes. Programmable Peripheral and Interface Devices: The 8255A Programmable Peripheral Interface.	**15 Lectures**
II	The 8259A Programmable Interrupt Controller, Direct Memory Access (DMA) and 8237 DMA Controller, the 8279 Programmable Keyboard/Display Interface Serial I/O and Data Communication: Basic Concepts in Serial I/O, Software Controlled Asynchronous Serial I/O, The 8085 Serial I/O lines: SOD and SID.	**15 Lectures**
III	**Microprocessor 8086:** Register organization of 8086, Architecture, Signal Descriptions of 8086, Physical Memory Organization, General Bus operation, I/O Addressing Capability, Special Processor Activities, Minimum mode 8086 system and timings, Maximum mode of 8086 system and timings. 8086 Instruction set and assembler directives: Machine Language Instructions Formats, addressing modes of 8086, Instruction set of 8086. Introduction to Stack, Stack structure of 8086, Interrupts and Interrupt Service Routines, Interrupt cycle of 8086, non-maskable interrupt, Maskable interrupt (INTR).	**15 Lectures**

Course Code RPSPHYP.O506	Practical based on RPSPHY.O506	Credits/Hours
1	Study of 8085 microprocessor Kit and execution of simple Programs	**1**
2	Wave form generation using 8085	**1**
3	SID & SOD using 8085	**1**
4	Study of 8085 interrupts (Vector Interrupt7.5)	**1**
5	Study of PPI8255 as Handshake I/O (mode1): interfacing switches, LED's.	**1**
6	8086 assembly language programming: Simple data manipulation programs. (8/16-bit addition, subtraction, multiplication, division, 8/16-bit data transfer, finding greatest/smallest number, finding positive/negative numbers, finding odd/even numbers, ascending/descending of numbers, converting BCD nos. into Binary using INT20, displaying a string of characters using INT20)	**1**

	Please note: Assembly language programming of 8086 may be done by operating PC in real mode by using 'Debug' program. Separate 8086 study kit not needed.	

Main References:

1. Microprocessor Architecture, Programming and Applications with the 8085, R. S. Gaonkar,4thEdition, Penram International.
2. Microprocessor Architecture, Programming and Applications with the 8085 by Ramesh S. Gaonkar, Fifth Edition Penram International Publication (India) Pvt Ltd.
3. Advanced Microprocessors and Peripherals by a K. Rayand K.M. Bhurchandi Second Edition Tata McGraw– Hill Publishing Company Ltd. (AB)
4. 8086 Microprocessor: Programming and Interfacing K. J. Ayala, Penram International
5. Microprocessors and interfacing, programming and hardware, By Douglas V. Hall

Modality of Assessment – DSC / DSE

Theory Examination Pattern:

A) Internal Assessment – 40% - 30 Marks

Sr. No.	Evaluation Type	Marks
1	Internal Class Test	20
2	Class Test/ Project / Assignment / Presentation	10
	Total	**30**

B) External Examination (Semester End) - 60%- 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q1.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - I
Q2.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - II
Q3.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - III
TOTAL		**45**	

Practical Examination Pattern:

A) **External Examination (Semester End)- 25 Marks**
Semester End Theory Examination:
3. Duration – The duration for these examinations shall be of **two hours**.
4. Practical question paper pattern:

Paper Pattern:

Question		Marks
1	Major Experiment	25
	TOTAL	**25**

Modality of Assessment – Research Methodology

Theory Examination Pattern:

A) Internal Assessment – 40% - 40 Marks

Sr. No.	Evaluation Type	Marks
1	Scientific Writing assignment (Abstract /Research Article)	20
2	Research Review/ Research Proposal Writing	20
Total		**40**

B) External Examination (Semester End) - 60%- 60 Marks

Semester End Theory Examination:

5. Duration – The duration for these examinations shall be of **two hours**.
6. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q1.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - I
Q2.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - II
Q3.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - III
Q4.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - IV
TOTAL		**60**	

Overall Examination and Marks Distribution Pattern:

Course	RPSPHY.O501			RPSPHY.O502			RPSPHY.O503			RPSPHY.O504			RPSRMPHY.O505			RPSPHY.O506			Total
	I	E	T	I	E	T	I	E	T	I	E	T	I	E	T	I	E	T	
Theory	30	45	**75**	30	45	**75**	30	45	**75**	-	50	**50**	40	60	**100**	30	45	**75**	**450**

Course	RPSPHYP.O501	RPSPHYP.O502	RPSPHYP.O503	RPSPHYP.O506	Total
Practical	**25**	**25**	**25**	**25**	**100**

[Grand Total Marks: 550]

Course Code: RPSPHY.E511

Course Title: Electrodynamics

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Understand formalism of Maxwell's equations, Pointing vector. Its application to Lorentz Transformations.
CO2	Comprehend concept of Four Vectors and Four Tensors.
CO3	Developing formalism of electromagnetic waves propagation and its application in wave guide and resonant cavity –related to Fiber optics and laser
CO4	Evaluate moving charges in vacuum and application of Leinerd-Wiechert fields to fields-radiation from a charged particle, Antennas
CO5	Analysis of moving charges with application to dipole radiation-electric and magnetic.
CO6	Application of relativity concepts to electrodynamics.
CO 7	Demonstrate problem solving skills in all above areas.

Detailed Syllabus

RPSPHY.E511: Electrodynamics

Units	Title	Credits - 03
I	Maxwell's equations, The Pointing vector, The Maxwellian stress tensor, Lorentz Transformations, Four Vectors and Four Tensors, The field equations and the field tensor, Maxwell equations in covariant notation.	15 Lectures
II	Electromagnetic waves in vacuum, Polarization of plane waves. Electromagnetic waves in matter, frequency dependence of conductivity, frequency dependence of polarizability, frequency dependence of refractive index. Wave guides, boundary conditions, classification of fields in wave guides, phase velocity and group velocity, resonant cavities.	15 Lectures
III	Moving charges in vacuum, gauge transformation, The time dependent Green function, The Lienard-Wiechert potentials, Leinard-Wiechert fields, application to fields-radiation from a charged particle, Antennas, Radiation by multipole moments, Electric dipole radiation, Complete fields of a time dependent electric dipole, Magnetic dipole radiation. Relativistic covariant Lagrangian formalism: Covariant Lagrangian formalism for relativistic point charges, The energy-momentum tensor, Conservation laws.	15 Lectures

Course Code: RPSPHYP.E511	Practical based on RPSPHY.E511	Credits/Hours
1	Study of Antenna Trainer Kit	1
2	Pulse Width Modulation using IC555 Timer	1
3	Visualization of Fields in a Rectangular Waveguide (Simulation) Using MATLAB	1
4	Amplitude Modulation	1
5	Phase Lock Loop using PLL IC565	1

Main Reference:

1. W. Greiner, Classical Electrodynamics (Springer-Verlag,2000) (WG).
2. M. A. Heald and J. B. Marion, Classical Electromagnetic Radiation, 3rd edition (Saunders,1983) (HM)

Additional references:

1. J. D. Jackson, Classical Electrodynamics, 4Th edition, (John Wiley & sons) 2005 (JDJ)
2. W. K. H. Panofsky and M. Phillips, Classical Electricity and Magnetism, 2nd edition, (Addison-Wesley)1962.

3. D. J. Griffiths, Introduction to Electrodynamics, 2nd Ed., Prentice Hall, India,1989.
4. J. R. Reitz, E. J. Milford and R. W. Christy, Foundation of Electromagnetic Theory, 4th ed., Addison-Wesley,1993

Course Code: RPSPHY.E512

Course Title: Quantum Mechanics - I

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Understand the theory of quantum measurements, wave packets and uncertainty principle.
CO2	Understand the concepts of quantum mechanics like wave -function, momentum and energy operators, the Schrodinger equation, time dependent and time independent cases, probability density and the normalization techniques, Commutator algebra, their connection to uncertainty principle, solution to the eigen value problems, etc.
CO3	Develop skills on problem solving for One dimensional rigid box, three-dimensional rigid box and Harmonic oscillator.
CO4	Understand the formalism of modern quantum mechanics, Dirac notation, Hilbert space and matrix mechanisms.
CO5	Learn the Schrodinger equation solutions for Hydrogen atom, determine its eigen value and radial eigen functions, degeneracy, etc.
CO6	Understand the angular momentum operators, its Commutator relations, ladder operators, their eigen functions and eigen values, learn spin eigen functions, Pauli Spin matrices, and understand the addition of angular momentum.
CO7	Understand the Clebsch. -Gordon coefficients

Detailed Syllabus

RPSPHY.E512: Quantum Mechanics – I

Unit/s	Title	Credits - 03
I	Postulates of quantum mechanics, observables and operators, measurements, state function and expectation values, the time-dependent Schrodinger equation, time development of state functions, The Superposition principle, Commutator relations, complete set of commuting observables, conservation theorems and parity. Linear Vector Spaces and operators, Dirac notation, Hilbert space, Hermitian operators and their properties, Matrix mechanics: Basis and representations, unitary transformations, the energy representation.	**15 Lectures**
II	Gaussian wave packet, Schrodinger equation solutions: one dimensional problem: General properties of one-dimensional Schrodinger equation, Particle in a box, Harmonic oscillator by raising and lowering operators, one dimensional barrier problems, finite potential well. Orbital angular momentum operators in Cartesian and spherical polar coordinates. Commutation and uncertainty relations, spherical harmonics, two particle problem-coordinates relative to centre of mass,	**15 Lectures**
III	Hydrogen atom, eigen-values and radial eigen-functions, degeneracy, probability distribution. Ladder operators, eigen-values and eigen-functions of L2 and Lz using spherical harmonics, angular momentum and rotations. Total angular momentum J; L-S coupling; eigen-values of J2 and Jz. Addition of angular momentum, Clebsch-Gordan coefficient for j1=j2=½ and j1=1 and j2=½. Angular momentum matrices, Pauli spin matrices, free particle wave function including spin, addition of two spins.	**15 Lectures**

Course Code: RPSPHYP.E512	Practical based on RPSPHY.E512	Credits/Hours
1	Double Slit Fraunhoffer Diffraction (Missing Order)	1
2	Stefan's Law of Radiation	1
3	Diameter of Lycopodium Powder Particles using Diffraction.	1
4	Simulation Based Practical	1

Main references:

1. Richard Liboff, Introductory Quantum Mechanics, 4th edition, Pearson.
2. D J Griffiths, Introduction to Quantum Mechanics 4th edition.
3. A. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 5th edition.
4. N. Zettili, Quantum Mechanics: Concepts and Applications, 2nd edition, Wiley.

Additional References

1. W. Greiner, Quantum Mechanics: An introduction, Springer, 2004.
2. R. Shankar, Principles of Quantum Mechanics, Springer, 1994.
3. P. M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill (1977).
4. J. J. Sakurai Modern Quantum Mechanics, Addison-Wesley (1994).

Course Code: RPSPHY.E513

Course Title: Solid State Devices

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Study about P-N junction diodes its fabrication by different processes. Characteristics like I-V and C-V characteristics and evaluate the dependence of reverse saturation current on minority carrier concentration and forward diffusion current on potential barrier.
CO2	Learn about Metal- Semiconductor contacts like Schottky and Ohmic Contacts and its I-V and C-V characteristics
CO3	Describe the principle and analyse the operation of Bipolar Junction Transistors, MOSFETs, MODFETs, MESFETs and study its I-V and C-V characteristics.
CO4	Demonstrate cautious problem-solving skills in all above areas.
CO5	Carry out the experiments based on the theory that they have learnt to measure I-V, C-V characteristics on semiconductor specimen, carrier mobility by conductivity, barrier capacitance of a junction diode and Energy band gap.

Detailed Syllabus

RPSPHY.E513 - Solid State Devices

Units	Title	Credits - 03
I	p-n junction: Fabrication of p-n junction by diffusion and ion-implantation; Abrupt and linearly graded junctions; Thermal equilibrium conditions; Depletion regions; Depletion capacitance, Capacitance – voltage (C-V) characteristics, Evaluation of impurity distribution, Varactor; Ideal and Practical Current-voltage(I-V) characteristics; Tunnelling and avalanche reverse junction breakdown mechanisms; Minority carrier storage, diffusion capacitance, transient behaviour; Ideality factor and carrier concentration measurements; Carrier life time measurement by reverse recovery of junction diode; p- i-n diode; Tunnel diode, Introduction to p-n junction solar cell and semiconductor laser diode.	**15 Lectures**
II	Metal–Semiconductor Contacts: Schottky barrier–Energy band relation, Capacitance- voltage (C-V) characteristics, Current-voltage(I-V) characteristics; Ideality factor, Barrier height and carrier concentration measurements; Ohmic contacts. Bipolar Junction Transistor (BJT): Static Characteristics; Frequency Response and Switching. Semiconductor hetero-junctions, Hetero-junction bipolar transistors, Quantum well structures.	**15 Lectures**
III	Metal-semiconductor field effect transistor (MESFET)- Device structure, Principles of operation, Current voltage (I-V) characteristics, High frequency performance. Modulation doped field effect transistor (MODFET); Introduction to ideal MOS device; MOSFET fundamentals, Measurement of mobility, channel conductance etc. from Ids vs Vds and Ids vs Vg characteristics. Introduction to Integrated circuits.	**15 Lectures**

Course Code: RPSPHYP.E513	**Practical based on RPSPHY.E513**	**Credits/Hours**
1	Carrier Lifetime by Pulse Reverse Method	**1**
2	Barrier capacitance of a junction Diode	**1**
3	Input Output Characteristics of a BJT	**1**
4	N-Channel MOSFET Output and Transfer Characteristics	**1**
5	Delayed linear sweep using IC 555	**1**
6	Active filter circuits (second order)	**1**
7	Instrumentation amplifier and its applications	**1**
8	Shift registers	**1**

Additional References:

1. Jasprit Singh; Semiconductor Devices: Basic Principles, John Wiley, New York, 2001.
2. Donald A. Neamen; Semiconductor Physics and Devices: Basic Principles, 3rd edition, Tata McGraw-Hill, NewDelhi,2002.
3. M. Shur; Physics of Semiconductor Devices, Prentice Hall of India, New Delhi, 1995.
4. Pallab Bhattacharya; Semiconductor Optoelectronic Devices, Prentice Hall of India, New Delhi,1995.

Course Code: RPSPHY.E514

Course Title: Advanced Electronics

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Analyse, explain the operation of ideal and non-ideal Op-Amps and identify the key characteristics of Op-Amps, such as gain, input impedance, and output impedance.
CO2	Gain knowledge regarding inverting and non-inverting amplifiers, active filter circuits, instrumentation amplifiers for signal conditioning applications.
CO3	Understand different types of Oscillators such as Wein Bridge Oscillator, RC Oscillator, Colpitts Oscillators, LC oscillators.
CO4	Learn about IC555 timers in astable, monostable, and bistable modes. Design and understand circuits that generate precise timing signals and oscillations.
CO5	Develop an understanding regarding the logic gates, combinational logic circuits Data Processing Circuit: Multiplexers, demultiplexers, decoder, encoder, parity generators.
CO6	Study about flip-flops, RS, JK, D, edge triggering, registers, SISO, SIPO, PISO, PIPO, application of shift registers, counters, asynchronous counters, synchronous counter, modulus of a counter, counter design, design of synchronous and asynchronous sequential circuits.

RPSPHY.E514 - Advanced Electronics

Unit	Title	Credits - 02
I	Differential Amplifier, Instrumentation and operational amplifiers; Op-Amp Circuits: Characteristics of ideal and practical op-amp; inverting, noninverting and differential amplifier, Basic characteristics with detailed internal circuit of IC Op-Amp; Active filters; Nonlinear amplifiers using Op-Amps-log amplifier, anti-log amplifier, regenerative comparators; ADC and DAC circuits; Op-amp based self-oscillator circuits- RC phase shift, Wien bridge, non-sinusoidal oscillators.	**15 Lectures**
II	Oscillators: sinusoidal oscillation, Wein Bridge Oscillator, RC Oscillator, Colpitts Oscillators, LC oscillators, Quartz crystals, the 555 timer, astable operation of the 555 timers, 555 circuit applications, the phase locked loop. Digital Principle and Digital Logic: logic gates, combinational logic circuits Data Processing Circuit: Multiplexers, demultiplexers, decoder, encoder, parity generator and checker, arithmetic circuits, adder, subtractors, clocks and timing circuits, 555 timer-astable, monostable, flip-flops, RS, JK, D, edge triggering, registers, SISO, SIPO, PISO, PIPO, application of shift registers, counters, asynchronous counters, synchronous counter, modulus of a counter, counter design, design of synchronous and asynchronous sequential circuits.	**15 Lectures**

Main References:

1. Malvino, A., Bates, D., Electronic Principles, McGraw-Hill, 2016.
2. Leach, D. P., Malvino, A. P. and Saha, G., Digital Principles and Applications, TMH, 2014.
3. Horowitz, P. and Hill, W., The Art of Electronics, CUP, 2016.
4. Op-Amps and Linear Integrated Circuits R. A. Gayakwad, 3rd Edition Prentice Hall India.
5. Operational Amplifiers and Linear Integrated Circuits, Robert F. Coughlin and Frederic F. Driscoll, 6th Edition, Pearson Education Asia.

Course Code: RPSPHY.E516

Course Title: Microcontroller 8051

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Understand the basic architecture and the assembly language programming of 8051controller & PIC microcontrollers
CO2	Understand the basics of 8051 serial communication and serial port programming in assembly language
CO3	Understand the basic programming of the microcontroller with and without the interrupt service request.
CO4	Acquire knowledge of microcontrollers and their role in I/0 port programming and their interface with peripherals.
CO5	Get exposure to the simulators and software which. mimics the behaviour of a mainframe microcontrollers
CO6	Demonstrate the practical utility of microcontrollers through experiments
CO7	In the laboratory course, student will gain hands-on experience of the working and applications of the microcontrollers.

Detailed Syllabus

RPSPHY.E516 – Microcontroller 8051

Units	Title	Credits - 03
I	Introduction, Microcontrollers and Microprocessors, History of Microcontrollers and Microprocessors, Embedded versus External Memory Devices, 8–bit and16–bit Microcontrollers, CISC and RISC Processors, Harvard and Von-Neumann Architectures, Commercial Microcontroller Devices. 8051 Microcontrollers: Introduction, MCS–51 Architecture, Registers in MCS-51, 8051 Pin Description, Connections,8051 Parallel I/O Ports and Memory Organization.	**15 Lectures**
II	8051 Instruction set and Programming: MCS-51 Addressing Modes and Instruction set. 8051 Instructions and Simple programs using Stack Pointer.	**15 Lectures**
III	Counters, Interrupts, Serial communication. Programming 8051 Timers, Counter Programming, Basics of Serial Communication, 8051 Connection to RS232, 8051 Serial Port Programming in assembly. 8051 Interrupts, Programming. Timer, interrupts Programming External hardware Interrupts, Programming the Serial Communication Interrupt, Interrupt Priority in 8051/52	**15 Lectures**

Course Code: RPSPHYP.E516	**Practical based on RPSPHY.E516**	**Credits/Hours**
	Microcontroller 8051 Programming	
1	8031/51 assembly language programming: Simple data manipulation programs. (8/16-bit addition, subtraction, multiplication, division,8/16-bit data transfer, cubes of nos., to rotate a 32- bit number, finding greatest/smallest number from a block of data, decimal/ hexadecimal counter)	
2	Study of IN and OUT port of 8031/51 by Interfacing switches, LEDs and Relays: to display bit pattern on LED's, to count the number of "ON" switches and display on LED's, to trip a relay depending on the logic condition of switches, event counter (using LDR and light source).	
3	Study of external interrupts (INT0/INT1) of 8031/51.	
4	Study of internal timer and counter in 8031/51.	
	Microcontroller 8051 Interfacing	
1	Interfacing 8-bit DAC with 8031/51 to generate waveforms: square, saw-tooth, triangular.	
2	Interfacing stepper motor with 8031/51: to control direction, speed and number of steps.	

3	Interface 8-bit ADC (0804) with 8031/51: to convert an analog signal into its binary equivalent.	

Main References:

1. The 8051 Microcontroller and Embedded Systems, Dr. Rajiv Kapadia, Jaico Publishing House.
2. The 8051 Microcontroller & Embedded Systems by M. A. Mazidi, J. G. Mazidi and R.D. McKinlay
3. The 8051 Microcontroller: K. J. Ayala: Penram International
4. Programming & customizing the 8051 Microcontroller: Myke Predko, TMH
5. The 8051 Microcontroller & Embedded Systems by M.A. Mazidi, J.G. Mazidi and R.D. McKinlay, Second Edition, Pearson (MMM)
6. Microcontrollers by Ajay V. Deshmukh, Tata-McGraw Hill Publication (AVD)

Modality of Assessment – DSC / DSE

Theory Examination Pattern:

C) Internal Assessment – 40% - 30 Marks

Sr. No.	Evaluation Type	Marks
1	Internal Class Test	20
2	Class Test/ Project / Assignment / Presentation	10
Total		**30**

D) External Examination (Semester End) - 60%- 45 Marks

Semester End Theory Examination:

7. Duration – The duration for these examinations shall be of **two hours**.
8. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q1.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - I
Q2.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - II
Q3.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - III
TOTAL		**45**	

Practical Examination Pattern:

A) **External Examination (Semester End)- 25 Marks**
Semester End Theory Examination:
9. Duration – The duration for these examinations shall be of **two hours**.
10. Practical question paper pattern:

Paper Pattern:

Question		Marks
1	Major Experiment	25
	TOTAL	**25**

Overall Examination and Marks Distribution Pattern:

Course	RPSPHY.E511			RPSPHY.E512			RPSPHY.E513			RPSPHY.E514			RPSPHY.E515			RPSPHY.E516			Total
	I	E	T	I	E	T	I	E	T	I	E	T	I	E	T	I	E	T	
Theory	30	45	75	30	45	75	30	45	75	-	50	50	-	100	100	30	45	75	450

Course	RPSPHYP. E511	RPSPHYP. E512	RPSPHYP. E513	RPSPHYP. E514	Total
Practical	25	25	25	25	100

[Grand Total: 550 Marks]

Resolution No. : AB/II (20-21).2.RPS10

S.P. Mandali's
Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for
Program: Master of Science (M.Sc.) Physics
Program Code: RPSPHY

(As per the guidelines of NEP 2020 Academic Year 2024-25)

Graduate Attributes

S. P. Mandali's Ramnarain Ruia Autonomous College has adopted the Outcome Based Education model to make its science graduates globally competent and capable of advancing in their careers. The Master's Program in Science also encourages students to reflect on the broader purpose of their education.

A student completing Master's Degree in Physics (Electronics-I) Program will be able to:	
GA No.	**Description**
GA1	Demonstrate in depth understanding in the relevant science discipline. Recall, explain, extrapolate and organize conceptual scientific knowledge for execution and application and also to evaluate its relevance.
GA2	Critically evaluate, analyse and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary.
GA3	Access, evaluate, understand and compare digital information from various sources and apply it for scientific knowledge acquisition as well as scientific data analysis and presentation.
GA4	Articulate scientific ideas, put forth a hypothesis, design and execute testing tools and draw relevant inferences. Communicate the research. work in appropriate scientific language.
GA5	Demonstrate initiative, competence and tenacity at the workplace. Successfully plan and execute tasks independently as well as with team members. Effectively communicate and present complex information accurately and appropriately to different groups.
GA6	Use an objective, unbiased and non-manipulative approach.in collection and interpretation of scientific data and avoid plagiarism and violation of Intellectual Property Rights. Appreciate and be sensitive to environmental and sustainability issues and understand its scientific significance and global relevance.
GA7	Translate academic research into innovation and creatively design scientific solutions to problems. Exemplify project plans, use management skills and lead a team for planning and execution of a task.
GA8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM OUTCOMES

A student completing Master's Degree in Physics (Electronics-I) Program will be able to:	
PO No.	**Description**
PO1	To demonstrate procedural knowledge related to different areas of study in Physics including Quantum Mechanics, Nuclear Physics, Electronics, Microprocessor and Microcontroller, Embedded Systems and RTOS.
PO2	To demonstrate comprehensive, quantitative and conceptual understanding of the core areas of Physics and keeping update with current developments in the academic field of Physics
PO3	To demonstrate the ability to use analytical skills in Physics and its related areas of technology to solve a wide range of problems including open ended problems associated with Physics.
PO4	Utilize contemporary experimental apparatus and analysis tools to acquire, analyse and interpret scientific data in the extents of Physics with reference to Research.
PO5	Plan and execute Physics-related experiments or investigations, analyse and interpret data collected using appropriate methods, and report accurately the findings relating to relevant theories of Physics.
PO6	Develop skills in areas related to specialization in the subfields of physics-Microprocessor, Microcontroller, VHDL, ARM7 and Python.
PO7	Demonstrate communication skills, to present complex information in a concise manner and develop personal skills such as the ability to work both independently and in a group.

PROGRAM OUTLINE

Year	Semester	Course Code	Course Title	Credits
2024-25	III	RPSPHYO601 (Discipline Specific Core)	Statistical Mechanics	3
		RPSPHYPO601	Practical Based on RPSPHYO601	1
		RPSPHYO602 (Discipline Specific Core)	Quantum Mechanics II	3
		RPSPHYPO602	Practical Based on RPSPHYO602	1
		RPSPHYO603 (Discipline Specific Core)	Physics of Nanomaterials	3
		RPSPHYPO603	Practical Based on RPSPHYO603	1
		RP	Research Project	6
		RPSEPHYO604 (Discipline Specific Elective Course)	PIC Microcontroller and ARM I	3
		RPSEPHYPO604	Practical Based on RPSEPHYO604	1
			Total Credits	**22**
Year	**Semester**	**Course Code**	**Course Title**	**Credits**
2024-25	IV	RPSPHYE611 (Discipline Specific Core)	Nuclear Physics	3
		RPSPHYPE611	Practical Based on RPSPHYE611	1
		RPSPHYE612 (Discipline Specific Core)	Atomic and Molecular Physics	3
		RPSPHYP E612	Practical Based on RPSPHYE612	1
		RP	Research Project	10
		RPSEPHYE614 (Discipline Specific Elective Course)	VHDL and ARM II	3
		RPSEPHYPE614	Practical Based on RPSPHYE614	1
			Total Credits	**22**

Resolution No. : AB/II (20-21).2.RPS10

S.P. Mandali's
Ramnarain Ruia Autonomous College
(Affiliated to University of Mumbai)

Syllabus for
Program: Master of Science (M.Sc.) Physics
Program Code: RPSPHY

(As per the guidelines of NEP 2020 Academic Year 2024-25)

Course Code: RPSPHYO6O1

Course Title: Statistical Mechanics

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Recall and identify the concepts of macroscopic and microscopic states in thermodynamics, and understand the connection between statistics and thermodynamics.
CO2	Explain the statistical basis of thermodynamics, including the classical ideal gas, entropy of mixing, Gibbs paradox, and the enumeration of microstates.
CO3	Apply the principles of ensemble theory to analyze the phase space of classical systems, understand Liouville's theorem, and its consequences.
CO4	Analyze the microcanonical ensemble, canonical ensemble, and grand canonical ensemble, including equilibrium conditions, statistical quantities, partition functions, and energy fluctuations.
CO5	Evaluate the physical significance of statistical quantities in different ensembles, such as the microcanonical, canonical, and grand canonical ensembles, and compare their correspondence with thermodynamic principles.
CO6	Solve problems involving the statistical mechanics of classical and quantum systems in different ensembles, including systems of harmonic oscillators and para-magnetism.
CO7	Integrate knowledge of statistical mechanics and thermodynamics to analyze and interpret density and energy fluctuations in the grand canonical ensemble, and demonstrate their correspondence with other statistical ensembles.

Detailed Syllabus

RPSPHYO6O1: Statistical Mechanics

Units	Title	Credits - 03
I	The Statistical Basis of Thermodynamics-The macroscopic and the microscopic states, contact between statistics and thermodynamics, the classical ideal gas, The entropy of mixing and the Gibbs paradox, the enumeration of the microstates. Elements of Ensemble Theory-Phase space of a classical system, Liouville's theorem and its consequences. The micro-canonical ensemble – Examples Quantum states and the phase space.	15 Lectures
II	The Canonical Ensemble-Equilibrium between a system and a heat reservoir, a system in the canonical ensemble, physical significance of the various statistical quantities in the canonical ensemble, expressions of the partition function, the classical systems, energy fluctuations in the canonical ensemble, correspondence with the microcanonical ensemble, the equipartition theorem and the virial theorem, system of harmonic oscillators, statistics of para-magnetism, thermodynamics of magnetic systems.	15 Lectures
III	The Grand Canonical Ensemble-Equilibrium between a system and a particle-energy reservoir, a system in the grand canonical ensemble, physical significance of the various statistical quantities, Examples, Density and energy fluctuations in the grand canonical ensemble, correspondence with other ensembles.	15 Lectures

Main References:

1. Statistical Mechanics- R.K. Pathria & Paul D. Beale (Third Edition), Elsevier 2011 Chapter 1 to 5

Additional References:

1. Thermodynamics and Statistical Mechanics, Greiner, Neise and Stocker, Springer 1995.
2. Introduction to Statistical Physics, Kerson Huang,Taylor and Francis 2001.
3. Thermal and Statistical Physics, F Reif.
4. Statistical Physics, D Amit and Walecka.
5. Statistical Mechanics, Kerson Huang.
6. Statistical Mechanics, J.K.Bhattacharjee.
7. Non-equilibrium Statistical Mechanics, J.K.Bhattacharjee.
8. Statistical Mechanics, Richard Feynman.

9. Statistical Mechanics, Landau and Lifshitz.
10. Thermodynamics, H.B.Callen.

RPSPHYP.O601: PRACTICAL BASED ON RPSPHYO601

Sr. No.	Experiment Name	Credits
1	Plot the probability of macrostates in tossing a coin (SCILAB)	1
2	Plot Maxwell Speed distribution function for different gases (SCILAB)	1
3	Plot Maxwell-Boltzmann, Bose-Einstein & Fermi-Dirac distribution functions (SCILAB)	1
4	Plot Partition function & other thermodynamic variables (SCILAB)	1
5	Thermal diffusivity of Brass	1

Course Code: RPSPHYO602

Course Title: Quantum Mechanics II

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Recall the principles and methods of time-independent perturbation theory, including first and second-order corrections to energy eigenvalues and eigenfunctions.
CO2	Explain the concepts of degenerate perturbation theory and its application in calculating first-order corrections to energy levels.
CO3	Apply time-dependent perturbation theory to analyze harmonic perturbations, Fermi's Golden Rule, sudden and adiabatic approximations, and their applications in quantum mechanics.
CO4	Analyze the variation method and its application in solving simple potential problems, such as the hydrogen atom, to determine energy eigenvalues.
CO5	Evaluate the WKB approximation, including turning points, connection formulas, and quantization conditions, and its applications in solving quantum mechanical problems.
CO6	Integrate knowledge of partial wave analysis, Born approximation, and S-wave scattering to understand scattering from finite spherical potential wells and apply the optical theorem in scattering phenomena.

Detailed Syllabus

RPSPHYO602: Quantum Mechanics II

Unit/s	Title	Credits - 03
I	**Perturbation Theory:** Time independent perturbation theory: First order and second order corrections to the energy eigen-values and eigen-functions. Degenerate perturbation Theory: first order correction to energy. Time dependent perturbation theory: Harmonic perturbation, Fermi's Golden Rule, sudden and adiabatic approximations, applications.	15 Lectures
II	**Approximation Methods:** Variation Method: Basic principle, applications to simple potential problems, He- atom. WKB Approximation: WKB approximation, turning points, connection formulas, Quantization conditions, applications.	15 Lectures
III	**Scattering Theory:** Laboratory and center of mass frames, differential and total scattering cross-sections, scattering amplitude, Partial wave analysis and phase shifts, optical theorem, S- wave scattering from finite spherical attractive and repulsive potential wells, Born approximation.	15 Lectures

Main References:

1. Richard Liboff, Introductory Quantum Mechanics,4th edition, Pearson.
2. D J Griffiths, Introduction to Quantum Mechanics4thedition
3. A Ghatak and S Lokanathan, Quantum Mechanics: Theory and Applications, 5thedition.
4. N Zettili, Quantum Mechanics: Concepts and Applications,2nd edition, Wiley.
5. J. Bjorken and S. Drell, Relativistic Quantum Mechanics, McGraw-Hill (1965).

Additional References:

1. W. Greiner, Quantum Mechanics: An introduction, Springer,2004
2. R. Shankar, Principles of Quantum Mechanics, Springer,1994
3. P. M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill (1977).
4. J. J. Sakurai Modern Quantum Mechanics, Addison-Wessley (1994).

RPSPHYPO602: PRACTICAL BASED ON RPSPHYO602

Sr. No.	Experiment Name	Credits
1	Simulations based experiments	1
2	Frank-Hertz experiment	1
3	e/m by Thopson method	1
4	Verification of Richardson's law	1

Course Code: RPSPHYO603

Course Title: Physics of Nanomaterials

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Recall and describe the particle properties of waves, including phenomena such as black body radiation, the photoelectric effect, and the Compton effect.
CO2	Understand the wave properties of particles, including De Broglie waves, wave-particle duality, particle diffraction, and the uncertainty principle, along with its applications.
CO3	Apply knowledge of atomic structure, including electron orbits and the Bohr atom model, and quantum structures like quantum wells, wires, and dots, to analyze and interpret experimental observations.
CO4	Analyze quantum mechanical systems using the Schrödinger equation in its steady-state form, including the particle in a box and finite potential well problems.
CO5	Evaluate the phenomenon of barrier penetration, including step potential and rectangular barrier penetration, and understand its applications in quantum mechanics.
CO6	Integrate the Schrödinger approach to describe the hydrogen atom, including quantum numbers, electron probability density, radiative transitions, and selection rules, with the understanding of phenomena like the normal Zeeman effect and spin-orbit coupling.

Detailed Syllabus

RPSPHYO603- Physics of Nanomaterials

Units	Title	Credits - 03
I	Particle properties of waves: Black body radiation, Photoelectric effect, Compton Effect; Wave properties of particles: De Broglie waves, Wave description, Particle diffraction, Uncertainty principle and application of uncertainty principle.	**15 Lectures**
II	Atomic structure: Electron orbits, The Bohr atom; Quantum Structure: 2D (Quantum well), 1D (Quantum Wires), 0D (Quantum Dots); Quantum mechanics: Schrodinger equation (steady state form), Particle in a box, Finite potential well; Barrier Penetration: Step Potential, Rectangular Barrier Penetration, Applications of Barrier Penetration; Tunnelling: Scanning Tunnelling Microscope; Harmonic Oscillator.	**15 Lectures**
III	Schrodinger approach for the hydrogen atom; Quantum numbers: principal, orbital and magnetic; Electron probability density; Radiative transitions; Selection rules; Normal Zeeman effect; Degeneracy of Hydrogen atom energy levels; Spin Orbit coupling.	**15 Lectures**

Main References:

6. Charles Kittel, "Introduction to Physics of Nanomaterials", 7th edition John Wiley & sons.
7. J. Richard Christman, "Fundamentals of Solid-State Physics", John Wiley & sons.
8. M.A. Wahab, "Physics of Nanomaterials –Structure and properties of Materials", Narosa Publications 1999.
9. M. Ali Omar, "Elementary Solid-State Physics", Addison Wesley (LPE).
10. H. Ibach and H. Luth, 3rd edition "Physics of Nanomaterials–An Introduction to Principles of Materials Science", Springer International Edition (2004).

RPSPHYPO603: PRACTICAL BASED ON RPSPHYO603

Sr. No.	Experiment Name	Credits
1	Characterization study of nanomaterial (powder) using XRD techniques	**1**
2	Characterization study of lattice strain of nanomaterial (powder) using W-H plot.	**1**
3	Characterization study of surface morphology of nanomaterial (powder) using SEM technique.	**1**
4	Characterization study of nanomaterial band gap (powder) using Tauc plot.	**1**

Course Code: RPSEPHYO604

Course Title: PIC Microcontroller and ARM I

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Recall and identify the fundamental features and components of PIC microcontrollers, including their pin diagram, STATUS register, and Power Control Register (PCON).
CO2	Explain the architecture and organization of PIC microcontrollers, including memory organization, I/O ports, and the functionality of Capture/Compare/PWM (CCP) modules.
CO3	Apply knowledge of PIC microcontroller instructions, addressing modes, and I/O port configurations to develop simple embedded systems solutions.
CO4	Analyze the operation of PIC microcontrollers, including reset actions, oscillator connections, and interrupt handling mechanisms, to troubleshoot and debug system issues.
CO5	Assess the effectiveness of different PIC microcontroller configurations and programming techniques in achieving specific system requirements and performance objectives.
CO6	Design and implement advanced embedded systems solutions using PIC microcontrollers, incorporating features such as timers, interrupts, and analog-to-digital conversion.
CO7	Integrate knowledge of ARM architecture, including the Acorn RISC Machine (ARM), ARM Programmer's model, and ARM organization and implementation, to compare and contrast with PIC microcontroller architectures for embedded systems development.

Detailed Syllabus

RPSEPHYO604 - PIC Microcontroller and ARM I

Units	Title	Credits - 03
I	**16C61/71 PIC Microcontrollers:** Overview and Features, PIC 16C6X/7X, PIC Reset Actions, PIC Oscillator Connections, PIC Memory Organization, PIC 16C6X/7X Instructions, Addressing Modes, I/O Ports, Interrupts in PIC 16C61/71, PIC 16C61/71 Timers, PIC 16C71 Analog-to-Digital Converter.	**15 Lectures**
II	**PIC 16F8XX Flash Microcontrollers:** Introduction, Pin Diagram, STATUS Register, Power Control Register (PCON), OPTION Register, Program memory, Data memory, I/O Ports. AVD – Ch. 10: 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7, 10.10 Capture/Compare/PWM (CCP) Modules in PIC 16F877, Analog-to- Digital Converter.	**15 Lectures**
III	**The ARM Architecture:** The Acorn RISC Machine, Architectural inheritance, The ARM Programmer's model, ARM development tools. SF - Ch 2: 2.1, 2.2, 2.3, 2.4 ARM Organization and Implementation: 3–stage Pipeline ARM organization, ARM instruction execution, ARM implementation. SF - Ch 4: 4.1, 4.3, 4.4 ARM Processor Cores: ARM7TDMI SF – Ch 9: 9.1 only.	**15 Lectures**

Main References:

1. Microcontrollers by Ajay V. Deshmukh, Tata-Mcgraw Hill Publication (AVD).
2. ARM System-on-Chip Architecture, by Steve Furber, Second Edition, Pearson (SF)
3. Microprocessors and interfacing, programming and hardware, By Douglas V. Hall (TMH)

RPSEPHYPO604: PRACTICAL BASED ON RPSEPHYO604

Sr. No.	Experiment Name	Credits
	PIC MICROCONTROLLER BASED PRACTICAL	
1	Interfacing LED's: flashing LED's, to display bit pattern, 8-bit counter.	**1**
2	Interfacing Push Buttons: to increment and decrement the count value at the output by recognizing of pushbuttons, etc.	**1**
3	Interfacing Relay: to drive an AC bulb through a relay; the relay should be tripped on recognizing of a pushbutton.	**1**
4	Interfacing buzzer: the buzzer should be activated for two different frequencies, depending on recognizing of corresponding pushbuttons.	**1**
	ARM 7 BASED PRACTICAL	
1	Simple data manipulation programs (addition, subtraction, multiplication, division etc.)	**1**

2	Study of IN and OUT port of ARM7 by Interfacing switches, LEDs etc.	**1**
3	Study of Timer.	**1**
4	Interfacing DAC/ADC using I2C Protocols.	**1**

Modality of Assessment – DSC / DSE

Theory Examination Pattern:

E) Internal Assessment – 40% - 30 Marks

Sr. No.	Evaluation Type	Marks
1	Internal Class Test	20
2	Class Test/ Project / Assignment / Presentation	10
Total		**30**

F) External Examination (Semester End) - 60%- 45 Marks

Semester End Theory Examination:

11. Duration – The duration for these examinations shall be of **two hours**.
12. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q1.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - I
Q2.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - II
Q3.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - III
TOTAL		**45**	

Practical Examination Pattern:

B) External Examination (Semester End)- 25 Marks
Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Practical question paper pattern:

Paper Pattern:

Question		Marks
1	Major Experiment	25
	TOTAL	**25**

Overall Examination and Marks Distribution Pattern:

Course	RPSPHY.O601			RPSPHY.O602			RPSPHY.O603			RPSEPHY.O604			RPSRPPHY.O605			Total
	I	E	T	I	E	T	I	E	T	I	E	T	I	E	T	
Theory	30	45	75	30	45	75	30	45	75	-	50	50	-	150	150	450

Course	RPSPHYP.O601	RPSPHYP.O602	RPSPHYP.O603	RPSEPHYP.O604	Total
Practical	25	25	25	25	100

[Grand Total: 550 Marks]

Course Code: RPSPHYE611

Course Title: Nuclear Physics

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Recall and identify the static properties of nuclei, including charge, mass, binding energy, size, shape, angular momentum, and magnetic and electric moments.
CO2	Explain the principles and methods used in measuring nuclear size, estimating R, and calculating Q-values for fusion and fission reactions.
CO3	Apply knowledge of the Deuteron Problem, square well potential, tensor force, and nucleon-nucleon scattering to analyze the ground state properties of nuclei and their interactions.
CO4	Analyze alpha decay, beta decay, and gamma decay processes, including Fermi theory, selection rules, and gamma ray interactions with matter.
CO5	Evaluate the strengths and limitations of the shell model and collective model in describing nuclear structure, including spin-orbit interactions and predictions of Schmidt lines.
CO6	Integrate knowledge of various nuclear decay processes, including alpha, beta, and gamma decay, to understand their role in determining the stability and dynamics of atomic nuclei.

Detailed Syllabus

RPSPHYE611: Nuclear Physics

Units	Title	Credits - 03
I	All static properties of nuclei (charge, mass, binding energy, size, shape, angular momentum, magnetic dipole momentum, electric quadrupole momentum, statistics, parity, isospin), Measurement of Nuclear size and estimation of R (mirror nuclei and mesonic atom method) Q- value equation, energy release in fusion and fission reaction. Deuteron Problem and its ground state properties, Estimate the depth and size of (assume)square well potential, Tensor for ceasan example of non-central force, nucleon- nucleon scattering-qualitative discussion on results, Spin-orbit strong interaction between nucleon, double scattering experiment. *Tutorials should include 3 problem solving session based on above mentioned topics	**15 Lectures**
II	Review of alpha decay, Introduction to Beta decay and its energetic, Fermi theory: derivation of Fermi's Golden rule, Information from Fermi– curie plots, Comparative half- lives, selection rules for Fermi and G-T transitions. Gamma decay: Multipole radiation, Selection rules for gamma ray transitions, Gamma ray interaction with matter, and Charge-particle interaction with matter. *Tutorials should include 4 problem solving session based on above mentioned topics	**15 Lectures**
III	**Nuclear Models:** Shell Model (extreme single particle): Introduction, Assumptions, Evidences, Spin-orbit interactions, Predictions including Schmidt lines, limitations, Collective model-Introduction to Nilsson Model. **Nuclear Reactions:** Kinematics, scattering and reaction cross sections, Compound nuclear reaction, direct nuclear reaction. *Tutorials should include 4 problem solving session based on above mentioned topics	**15 Lectures**

Main References:

1. Introductory Nuclear Physics, Kenneth Krane, Wiley India Pvt. Ltd.
2. Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, Robert Eisberg and Robert Resnick, Wiley (2006).

3. Introduction to Elementary Particles, David Griffith, John Wiley and sons.

Additional References:

1. Introduction to Nuclear Physics, H. A. Enge, Eddison Wesley.
2. Nuclei and Particles, E. Segre, W. A. Benjamin.
3. Concepts of Nuclear Physics, B. L. Cohen.
4. Subatomic Particles, H. Fraunfelder and E. Henley, Prentice Hall.
1. Nuclear Physics: Experimental and Theoretical, H. S. Hans, New Age International.
2. Introduction to Nuclear and Particle Physics, A. Das & T. Ferbel, World Scientific.
3. Introduction to high energy physics, D. H. Perkins, Addis on Wesley.
4. Nuclear and Particle Physics, W. E. Burcham and M. Jones, Addison Wesley.
5. Introductory Nuclear Physics, S. M. Wong, Prentice Hall.
6. Nuclear Physics: An Introduction, S. B. Patel, New Age International.
7. Nuclear Physics: S. N. Ghoshal.

RPSPHYPE611: PRACTICAL BASED ON RPSPHYE611

Sr. No.	Experiment Name	Credits
1	Characteristics of a Geiger Muller counter and measurement of dead time.	1
2	Verification of Inverse Square Law for Gamma Rays.	1
3	Linear and Mass attenuation coefficient using Gamma Source.	1
4	To study Beta Particle Range and Maximum Energy.	1
5	Measurement of Short Half Life.	1
6	Rydberg constant experiment	1
7	Simulation based Experiments	1

Course Code: RPSPHYE612

Course Title: Atomic and Molecular Physics

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Recall the fundamental principles of one-electron eigenfunctions, energy levels of bound states, and the probability density in quantum mechanics.
CO2	Explain the concepts of the virial theorem, fine structure, Lamb shift, hyperfine structure, and isotope shift in the hydrogen atom.
CO3	Apply knowledge of linear and quadratic Stark effects, Zeeman effect, and Paschen-Back effect in describing the behavior of atoms in external electric and magnetic fields.
CO4	Analyze the Schrödinger equation for two-electron atoms, considering identical particles, the exclusion principle, exchange forces, and the independent particle model.
CO5	Evaluate the central field, Thomas-Fermi potential, and gross structure of alkalis within the framework of the Hartree theory and its implications for multi-electron atoms and the periodic table.
CO6	Design and interpret energy level diagrams and term symbols using the L-S coupling approximation, identifying allowed terms, fine structure, and relative intensities.
CO7	Integrate knowledge of the interaction of one-electron atoms with electromagnetic radiation, including absorption and emission transition rates, Einstein coefficients, selection rules, and line intensities, to analyze X-ray spectra and line shapes.

Detailed Syllabus

RPSPHYE612: Atomic and Molecular Physics

Unit/s	Title	Credits - 03
I	Review*of one-electron eigen functions and energy levels of bound states, Probability density, Virial theorem. Fine structure of hydrogen atoms, Lamb shift. Hyper fine structure and isotope shift. (ER8-6) Linear and quadratic Stark effect in spherical polar coordinates. Zeeman effect in strong and weak fields, Paschen-Back effect. (BJ,GW) Schrodinger equation for two electron atoms: Identical particles, The Exclusion Principle. Exchange forces and the helium atom (ER), independent particle model, ground and excited states of two electron atoms. (BJ)	15 Lectures
II	The central field, Thomas-Fermi potential, the gross structure of alkalis (GW). The Hartree theory, ground state of multi-electron atoms and the periodic table (ER), The L-S coupling approximation, allowed terms in L-S coupling, fine structure in L-S coupling, relative intensities in LS coupling, j-j coupling approximation and other types of coupling (GW).	15 Lectures
III	Interaction of one electron atoms with electromagnetic radiation: Electromagnetic radiation and its interaction with charged particles, absorption and emission transition rates, dipole approximation. Einstein coefficients, selection rules. Line intensities and lifetimes of excited state, line shapes and line widths. X-ray spectra. (BJ)	15 Lectures

Main References:

1. Robert Eisberg and Robert Resnick, Quantum physics of Atoms, Molecules, Solids, Nuclei and Particles, John Wiley & Sons, 2nded, (ER).
2. B.H. Bransden and G. J. Joachain, Physics of atoms and molecules, Pearson Education 2nd ed, 2004 (BJ).
3. G. K. Woodgate, Elementary Atomic Structure, Oxford university press, 2nded, (GW).
4. G. Aruldhas, Molecular structure and spectroscopy, Prentice Hall of India 2nded, 2002 (GA).
5. Ira N. Levine, Quantum Chemistry, Pearson Education, 5th edition, 2003 (IL).

Additional References:

1. Leighton, Principals of Modern Physics, McGraw hill.
2. Igor I. Sobelman, Theory of Atomic Spectra, Alpha Science International Ltd. 2006.
3. C. N. Banwell, Fundamentals of molecular spectroscopy, Tata McGraw-Hill, 3rded.
4. Wolfgang Demtröder, Atoms, molecules & photons, Springer-Verlag 2006.
5. Sune Svanberg, Atomic and Molecular Spectroscopy Springer, 3rded 2004.

6. C.J. Foot, Atomic Physics, Oxford University Press, 2005 (CF).

RPSPHYPE612: PRACTICAL BASED ON RPSPHYE612

Sr. No.	Experiment Name	Credits
1	Zeeman Effect	1
2	e/m by Thopson method	1
3	FTIR Analysis	1
4	Spectral Analysis	1
5	Analysis of Sodium Spectra	1

Course Code: RPSEPHYE614

Course Title: VHDL and ARM II

Academic Year: 2024-25

Course Outcomes:

Course Outcome	Description
CO1	Recall and define VHDL terms, including entities, architectures, and concurrent signal assignment, as well as ARM assembly language instructions and their syntax.
CO2	Explain the concepts of event scheduling, statement concurrency, and behavioural modelling in VHDL, as well as the ARM instruction set architecture and its execution model.
CO3	Apply VHDL concepts to describe hardware designs, including structural designs and sequential behavior, and write simple programs to perform data processing and control flow operations.
CO4	Analyze the differences between inertial delay and transport delay models in VHDL behavioural modelling, as well as the impact of sensitivity lists versus WAIT statements in sequential processing.
CO5	Evaluate the effectiveness of using subprograms, packages, and predefined attributes in VHDL for code organization and reuse, as well as the advantages and limitations of different configurations in hardware design.
CO6	Design and implement VHDL code using appropriate data types, subprograms, and packages to model complex hardware systems
CO7	Develop ARM assembly language programs to accomplish specific tasks utilizing the ARM instruction set.

Detailed Syllabus

RPSEPHYE614 – VHDL and ARM II

Units	Title	Credits - 03
I	**VHDL-I:** Introduction to VHDL: VHDL Terms, Describing Hardware in VHDL, Entity, Architectures, Concurrent Signal Assignment, Event Scheduling, Statement concurrency, Structural Designs, Sequential Behavior, Process Statements, Process Declarative Region, Process Statement Part, Process Execution, Sequential Statements, Architecture Selection, Configuration Statements, Power of Configurations. Behavioral Modeling: Introduction to Behavioral Modeling, Transport Versus Inertial Delay, Inertial Delay, Transport Delay, Inertial Delay Model, Transport Delay Model, Simulation Deltas, Drivers, Driver Creation, Bad Multiple Driver Model, Generics, Block Statements, Guarded Blocks. Sequential Processing: Process Statement, Sensitivity List, Process Example, Signal Assignment Versus Variable Assignment, Incorrect Mux Example, Correct Mux Example, Sequential Statements, IF Statements, CASE Statements, LOOP statements, NEXT Statement, EXIT Statement, ASSERT Statement, Assertion BNF, WAIT Statements, WAIT ON Signal, WAIT UNTIL Expression, WAIT FOR time expression, Multiple WAIT Conditions, WAIT Time-Out, Sensitivity List Versus WAIT Statement, Concurrent Assignment Problem, Passive Processes.	**15 Lectures**
II	**VHDL-II:** Data Types: Object Types, Signal, Variables, Constants, Data Types, Scalar Types, Composite Types, Incomplete Types, File Types, File Type Caveats, Subtypes. Subprograms and Packages: Subprograms Function, Conversion Functions, Resolution Functions, Procedures, Packages, Package Declaration, Deferred Constants, Subprogram, Declaration, Package Body. DLP -Ch 5 Predefined Attributes: Value Kind Attributes, Value Type Attributes, Value Array Attributes, Value Block Attributes, Function Kind Attributes, Function Type Attributes, Function Array, Attributes, Function Signal Attributes, Attributes 'EVENT and, LAST-VALUE Attribute 'LAST- EVEN Attribute, 'ACTIVE and 'LAST-ACTIVE Signal Kind Attributes, Attribute 'DELAYED, Attribute 'STABLE, Attribute 'QUIET, Attribute TRANSACTION, Type Kind Attributes, Range Kind Attributes. Configurations: Default Configurations, Component Configurations, Lower-Level Configurations, Entity-Architecture Pair Configuration, Port Maps, Mapping Library Entities,	**15 Lectures**

	Generics in Configurations, Generic Value Specification in Architecture, Generic Specifications in Configurations, Board-Socket-Chip Analogy, Block Configurations, Architecture configurations.	
III	ARM Assembly language Programming: Data processing instructions, Data transfer instructions, Control flow instructions, Writing simple assembly language programs. SF – Ch 3: 3.1, 3.2, 3.3, 3.4 The ARM Instruction Set: Introduction, Exceptions, Condition execution, Branch and Branch with Link (B, BL), Branch, Branch with Link and exchange (BX, BLX), Software Interrupt (SWI), Data processing instructions, multiply instructions, count leading zeros (CLZ), Single word and unsigned byte data transfer instructions, Half-word and signed byte data transfer instructions, Multiple register transfer instructions, Swap memory and register instructions. (SWP), Status register to general register transfer instructions, General register to Status register transfer instructions SF–Ch 5:5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,5.10,5.11,5.12,5.13,5.14,5.15 The Thumb Instruction Set: The Thumb bit in the CPSR, The Thumb programmer's model, Thumb branch instructions, Thumb software interrupt instruction, Thumb data processing instructions, Thumb single register data transfer instructions, Thumb multiple register data transfer instructions, Thumb breakpoint instruction, Thumb implementation, Thumb applications, Example and exercises. SF – Ch 7: 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 7.10, 7.11	**15 Lectures**

Main References:

1. VHDL programming by example by Douglas L. Perry, Fourth edition, Tata McGraw- Hill (DLP).
2. ARM System-on-Chip Architecture, by Steve Furber, Second Edition, Pearson (SF)
3. Microprocessors and interfacing, programming and hardware, By Douglas V. Hall (TMH)

RPSEPHYPE614: PRACTICAL BASED ON RPSEPHYE614

Sr. No.	Experiment Name	Credits
	VHDL Programming Based Experiments	
1	Write VHDL programs to realize: logic gates, half adder and full adder	1
2	Write VHDL programs to realize the following combinational designs:2 to 4 decoder, 8 to 3 encoder without priority, 4 to 1 multiplexer, 1 to 4 de-multiplexer	1
3	Write VHDL programs to realize the following: SR–Flip Flop, JK–Flip Flop, T – Flip Flop	1
4	Write a VHDL program to realize a 2/3/4-bit ALU (2-arithmetic,2-logical operations)	1
	VHDL Interfacing Based Experiments	
1	Interfacing stepper motor: write VHDL code to control direction, speed and number of steps.	1

2	Interfacing dc motor: write VHDL code to control direction and speed using PWM.	**1**
3	Interfacing relays: write VHDL code to control AC bulbs (at least two) using relays.	**1**

Modality of Assessment – DSC / DSE

Theory Examination Pattern:

G) Internal Assessment – 40% - 30 Marks

Sr. No.	Evaluation Type	Marks
1	Internal Class Test	20
2	Class Test/ Project / Assignment / Presentation	10
Total		**30**

H) External Examination (Semester End) - 60%- 45 Marks

Semester End Theory Examination:

13. Duration – The duration for these examinations shall be of **two hours**.
14. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q1.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - I
Q2.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - II
Q3.	3 questions of 5 M each from 4 Questions OR 7/8 marks questions with option to any one	15	Unit - III
TOTAL		**45**	

Practical Examination Pattern:

A) External Examination (Semester End)- 25 Marks
Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Practical question paper pattern:

Paper Pattern:

Question		Marks
1	Major Experiment	25
	TOTAL	**25**

Overall Examination and Marks Distribution Pattern:

Course	RPSPHYE611			RPSPHYE612			RPSEPHYE614			RPSRPPHYE615			Total
	I	E	T	I	E	T	I	E	T	I	E	T	
Theory	30	45	75	30	45	75	30	45	75	-	200	200	450

Course	RPSPHYPE611	RPSPHYPE612	RPSEPHYPE614	Total
Practical	25	25	25	125

[Grand Total: 550 Marks]