R. JHUNJHUNWALA COLLEGE

(Autonomous)

Affiliated to University of Mumbai

SYLLABUS FOR SEM - V & VI

Program: B.Sc. Physics

Course Code : RJSUPHY

(Credit Based Semester System w. e. f. the academic year 2021-22)

Refer to page nos: 03 and 04

highlighting component

of Research Project

EXAMINATION SCHEME OF THEORY, PRACTICALS AND PROJECT

(SEM - V & VI)

Overview of each Semester

Sr No.	Examination	Marks
A.	Continuous Evaluation: Class Test 1 & 2	160
B.	Semester End Evaluation	240
C.	Practicals	160
D.	Project	40
	Total	600

Theory: Total four papers

Marks Distribution per paper			Marks	Grand Total
A.	**Class test per paper** **(Duration : 45 minutes each)**	**I**	20	4 x 40 = **160 marks**
		II	20	
		Total	40	
B.	**Semester End Examination per paper** **(Duration : 2 hours each)** **All questions are compulsory**			
	Q – I : Unit – I		15	4 x 60 = **240 marks**
	Q – II : Unit – II		15	
	Q – III : Unit - III		15	
	Q – IV : Unit - IV		15	
	Total		60	

Practicals : Total Two ; Project : One

Mark Distribution		Marks	Grand Total
C.	**Each Practical Exam**	80	2 x80 = **160 marks**
D.	**Project Evaluation**	40	1 X 40 = **40 marks**

Syllabus

T.Y.B.Sc. Physics

Credit Based Semester System : 2020 - 2021

SEMESTER - V				
Theory				
Course	**UNIT**	**TOPICS**	**Credits**	**Lectures per week**
RJSUPHY501	I	Mathematical Methods in Physics	**2.5**	**4**
	II	Mathematical Methods in Physics		
	III	Thermal and Statistical Physics		
	IV	Thermal and Statistical Physics		
RJSUPHY502	I	Solid State Physics	**2.5**	**4**
	II	Solid State Physics		
	III	Solid State Physics		
	IV	Solid State Physics		
RJSUPHY503	I	Atomic Physics	**2.5**	**4**
	II	Atomic Physics		
	III	Molecular Physics		
	IV	Molecular Physics		
RJSUPHY504	I	Electrodynamics	**2.5**	**4**
	II	Electrodynamics		
	III	Electrodynamics		
	IV	Electrodynamics		
Laboratory				
RJSUPHY5P01		Lab Course 1	**2.5**	**6**
RJSUPHY5P02		Lab Course 2	**2.5**	**6**
RJSUPHY5P03		**Project 1**	**1**	**4**

SEMESTER - VI				
Theory				
Course	**UNIT**	**TOPICS**	**Credits**	**Lectures per week**
RJSUPHY601	I	Classical Mechanics	**2.5**	**4**
	II	Classical Mechanics		
	III	Classical Mechanics		
	IV	Classical Mechanics		
RJSUPHY602	I	Electronics	**2.5**	**4**
	II	Electronics		
	III	Electronics		
	IV	Electronics		
RJSUPHY603	I	Nuclear Physics	**2.5**	**4**
	II	Nuclear Physics		
	III	Nuclear Physics		
	IV	Nuclear Physics		
RJSUPHY604	I	Special Theory of Relativity	**2.5**	**4**
	II	Special Theory of Relativity		
	III	Special Theory of Relativity		
	IV	Special Theory of Relativity		
Laboratory				
RJSUPHY6P04	Lab Course 3		**2.5**	**6**
RJSUPHY6P05	Lab Course 4		**2.5**	**6**
RJSUPHY6P06	**Project-2**		**1**	**4**

Scheme of Examination for Lab Course:

1. Examination for Practical and Project evaluation shall be conducted at the end of each Semester.

2. The candidates shall appear for external examination of **TWO** practical courses each carrying 50 marks (of three hours duration, 40 M pract. + 5 M journal + 5 M Viva) and presentation of project carrying 20 marks.

3. The candidates will be continuously evaluated during their regular sessions for **TWO** practical courses each carrying 30 marks and presentation of project carrying 20 marks.

4. The candidate shall prepare and submit a certified Journal based on the practical course with minimum **6** experiments from each group (total 12) at the time of practical examination.

5. At the time of practical examination, the candidate must also submit the certified Project Report prepared as per the guidelines given in the syllabus.

6. A candidate will be allowed to appear for the practical examination only if the candidate submits a certified journal of T.Y.B.Sc. Physics or a certificate from the Head of the Department to the effect that the candidate has completed the practical course of T.Y.B.Sc. Physics as per the minimum requirements and a project completion report duly certified by the project in-charge and Head of the Department.

SEMESTER V

Theory Course – RJSUPHY501: Mathematical, Thermal and Statistical Physics

Learning outcomes: From this course, the students are expected to learn some mathematical techniques required to understand the physical phenomena at the undergraduate level and get exposure to important ideas of statistical mechanics.

The students are expected to be able to solve simple problems in probability, understand the concept of independent events and work with standard continuous distributions. The students will have idea of the functions of complex variables; solve nonhomogeneous differential equations and partial differential equations using simple methods. The units on statistical mechanics would introduce the students to the concept of microstates, Boltzmann distribution and statistical origins of entropy. It is also expected that the student will understand the difference between different statistics, classical as well as quantum.

Unit - I	**Probability**	(15 lect.)
Review of basic concepts, introduction, sample space, events, independent events, conditional probability, probability theorems, methods of counting (derivation of formulae not expected), random variables, continuous distributions (omit joint distributions), binomial distribution, the normal distribution, the Poisson distribution. Ref: MB – 15.1-15.9 Expected to cover solved problems from each section and solve at least the following problems: **section 2:** 1-5, 11-15, **section 3:** 1, 3, 4, 5, **section 4:** 1, 3, 5,13, 21, **section 5:** 1, 10, 13, **section 6:** 1 to 9, **section 8:** 1 and 3, **section 9:** 2, 3, 4, 9.		

Unit -II	Complex functions and differential equations	(15 lect.)
1. Functions of complex variables: The exponential and trigonometric functions, hyperbolic functions, logarithms, complex roots and powers, inverse trigonometric and hyperbolic functions, some applications. Ref.: MB: 2.11 to 2.16 Expected to cover all solved problems. In addition, solve the following problems: **section 2:** 16 – 2, 3, 8, 9, 10.		
2. Second-order nonhomogeneous equations with constant coefficients, partial differential equations, some important partial differential equations in physics, method of separation of variables. Ref : CH :5.2.4, 5.3.1 to 5.3.4 Expected to cover all solved problems. In addition, solve the following problems: 5.17 a to e, 5.23, 5.26, 5.29 to 5.35.		
Unit -III	**Statistical Thermodynamics**	(15 lect.)
Microstates and configurations, derivation of Boltzmann distribution, dominance of Boltzmann distribution, physical meaning of the Boltzmann distribution law, definition of , the canonical ensemble, relating Q to q for an ideal gas, translational partition function, equipartition theorem, energy, entropy ER: 13.1 to 13.5, 14.1, 14.2, 14.4, 14.8, 15.1, 15.4		
Unit -IV	**Classical and Quantum Statistics**	(15 lect.)
The probability of a distribution, The most probable distribution, Maxwell-Boltzmann statistics, Molecular speeds. Bose-Einstein statistics, Black-body radiation, The Rayleigh-Jeans formula, The Planck radiation formula, Fermi-Dirac statistics, Comparison of results. AB : 15.2 to 15.5, 16.1 to 16.6		

References:	
1.	MB: Mathematical Methods in the Physical sciences: Mary L. Boas Wiley India, 3rd ed.
2.	ER: Thermodynamics, Statistical Thermodynamics and Kinetics: T. Engel and P. Reid (Pearson).
3.	AB: Perspectives of Modern Physics: Arthur Beiser, (Mc Graw Hill International).
4.	CH: Introduction to Mathematical Methods: Charlie Harper (PHI Learning).
Additional References:	
1.	Mathematical Physics: A K Ghatak, Chua – 1995 Macmillian India Ltd.
2.	Mathematical Method of Physics: Riley, Hobson and Bence, Cambridge (Indian edition).
3.	Mathematical Physics: H. K. Das, S. Chand & Co.
4.	Mathematical Methods of Physics: Jon Mathews & R. L. Walker, W A Benjamin inc.
5.	A Treatise on heat: Saha and Srivastava (Indian press, Allahabad)
6.	Statistical Physics: F. Reif (Berkeley Physics Course, McGraw Hill)
7.	Introductory Statistical Mechanics: R. Bowley and M. Sanchez (Oxford Science Publications).
8.	An Introduction to Thermal Physics: D. V. Schroeder (Pearson).
9.	PROBABILITY: Schaum's Outlines Series by S. Lipschutz and M. L. Lipson (Mc Graw Hill International).

Theory Course – RJSUPHY502: Solid State Physics

Learning Outcomes: On successful completion of this course students will be able to:

1. Understand the basics of crystallography, Electrical properties of metals, Band Theory of solids, demarcation among the types of materials, Semiconductor Physics and Superconductivity.
2. Understand the basic concepts of Fermi probability distribution function, density of states, conduction in semiconductors and BCS theory of superconductivity.
3. Demonstrate quantitative problem solving skills in all the topics covered.

Unit - I	**Crystal Physics**	(15 lect.)
The crystalline state, Basic definitions of crystal lattice, basis vectors, unit cell, primitive and non-primitive cells, The fourteen Bravais lattices and the seven crystal systems, elements of symmetry, nomenclature of crystal directions and crystal planes, Miller Indices, spacing between the planes of the same Miller indices, examples of simple crystal structures. Ref: Elementary Solid State Physics-Principles and Applications: M. Ali Omar, Pearson Education, 2012 : (1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 2.6)		
Unit -II	**Electrical properties of metals**	(15 lect.)
1. Classical free electron theory of metals, Drawbacks of classical theory, Relaxation time, Collision time and mean free path 2. Quantum theory of free electrons, Fermi Dirac statistics and electronic distribution in solids, Density of energy states and Fermi energy, The Fermi distribution function, Heat capacity of the Electron gas, Mean energy of electron gas at 0 K, Failure of Sommerfeld's free electron Theory		

Ref.: Solid State Physics: S. O. Pillai, New Age International. 6^{th} Ed.

Chapter 6: II, III, IV, V, XIV, XV, XVI, XVII, XVIII, XX, XXXV

Ref: Solid State Physics: A. J. Dekker, Prentice Hall. Chapter 9, Section 6

Unit -III	Band Theory of Solids and Conduction in Semiconductors	(15 lect.)

1. Band theory of solids, The Kronig- Penney model (Omit eq. 6.184 to 6.188), Brillouin zones, Number of wave functions in a band, Motion of electrons in a one-dimensional periodic potential, Distinction between metals, insulators and intrinsic semiconductors.

   Ref.: Solid State Physics: S. O. Pillai, New Age International, 6^{th} Ed.
   Chapter 6: XXXVI, XXXVII, XXXVIII, XXXIX, XXXX, XXXXI

2. Electrons and Holes in an Intrinsic Semiconductor, Conductivity of a Semiconductor, Carrier concentrations in an intrinsic semiconductor, Donor and Acceptor impurities, Charge densities in a semiconductor, Fermi level in extrinsic semiconductors, Diffusion, Carrier lifetime, Hall Effect.

   Ref.: Electronic Devices and Circuits: Millman, Halkias & Satyabrata Jit.
   (3^{rd} Ed.) Tata McGraw Hill.: 4.1 to 4.10.

Unit -IV	Diode Theory and superconductivity	(15 lect.)

1. Semiconductor-diode Characteristics: Qualitative theory of the p-n junction, The p-n junction as a diode, Band structure of an open-circuit p-n junction, The current components in a p-n junction diode, Quantitative theory of p-n diode currents, The Volt-Ampere characteristics, The temperature dependence of p-n characteristics, Diode resistance.

   Ref.: Electronic Devices and Circuits: Millman, Halkias & Satyabrata Jit. (3^{rd} Ed.)
   Tata McGraw Hill.: 5.1 to 5.8

2. Superconductivity: Experimental Survey, Occurrence of Superconductivity, destruction of superconductivity by magnetic field, The Meissner effect, Type I and Type II Superconductors.

   Ref.: Introduction to Solid State Physics-Charles Kittel, 7^{th} Ed. John Wiley & Sons: Topics from Chapter 12.

Main References:

1.	Elementary Solid State Physics-Principles and Applications: M.Ali Omar, Pearson Education, 2012.
2.	Solid State Physics: S. O. Pillai, New Age International, 6th Ed.
3.	Electronic Devices and Circuits: Millman, Halkias & Satyabrata Jit. (3rd Ed.) Tata McGraw Hill.
4.	Introduction to Solid State Physics - Charles Kittel, 7th Ed. John Wiley & Sons.
5.	Solid State Physics: A. J. Dekker, Prentice Hall.
Additional References:	
1.	Modern Physics and Solid State Physics: Problems and solutions New Age International.
2.	Electronic Properties of Materials: Rolf Hummel, 3rd Ed. Springer.
3.	Semiconductor Devices: Physics and Technology, 2nd Ed. John Wiley & Sons.
4.	Solid State Physics: Ashcroft & Mermin, Harcourt College Publisher.

Theory Course – RJSUPHY503: Atomic and Molecular Physics

Learning Outcome: Upon successful completion of this course, the student will understand

- The application of quantum mechanics in atomic physics
- The importance of electron spin, symmetric and antisymmetric wave functions and vector atom model
- Effect of magnetic field on atoms and its application
- Learn Molecular physics and its applications.
- This course will be useful to get an insight into spectroscopy.

Unit - I		(15 lect.)
1. Hydrogen atom: Schrödinger's equation for Hydrogen atom, Separation of variables, Quantum Numbers: Total quantum number, Orbital quantum number, Magnetic quantum number. Angular momentum, Electron probability density (Radial part). 2. Electron spin: The Stern-Gerlach experiment, Pauli's Exclusion Principle Symmetric and Anti-symmetric wave functions. Ref – Unit – I - B: 9.1 to 9.9, B: 10.1, 10.3. 2		
Unit - II		(15 lect.)
1. Spin orbit coupling, Total angular momentum, Vector atom model, L-S and j-j coupling. Origin of spectral lines, Selection rules. 2. Effect of Magnetic field on atoms, the normal Zeeman effect and its explanation (Classical and Quantum), The Lande g - factor, Anomalous Zeeman effect. Ref – Unit – II - B: 10.2, 10.6, 10.7, 10.8, 10.9. B : 11.1 and 11.2		
Unit - III		(15 lect.)
1. Molecular spectra (Diatomic Molecules): Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibrational-Rotational spectra. Electronic Spectra of Diatomic molecules: The Born-Oppenheimer approximation, Intensity of vibrational-electronic spectra: The Franck-Condon principle. 2. Infrared spectrometer & Microwave spectrometer Ref – Unit – III - B: 14.1, 14.3, 14.5, 14.7		

Unit - IV		(15 lect.)

1. Raman effect: Quantum Theory of Raman effect, Pure Rotational Raman spectra: Linear molecules, symmetric top molecules, Asymmetric top molecules, Vibrational Raman spectra: Raman activity of vibrations,
   Experimental set up of Raman Effect.

2. Electron spin resonance: Introduction, Principle of ESR, ESR spectrometer

3. Nuclear magnetic resonance: Introduction, principle and NMR instrumentation.

Ref – Unit – IV - 1. BM: 6.11, 6.1.3. 2.

BM: 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.2.3, 4.3.1. GA: 8.6.1

2. GA: 11.1,11.2and 11.3

3. GA: 10.1,10.2,10.3

References:

1.	B: Perspectives of Modern Physics : Arthur Beiser Page 8 of 18 McGraw Hill.
2.	BM: Fundamentals of Molecular Spectroscopy : C. N. Banwell & E. M. McCash (TMH).(4th Ed.)
3.	GA: Molecular structure and spectroscopy : G Aruldhas (2nd Ed) PHI learning Pvt Ltd.
4.	Atomic Physics (Modern Physics): S.N.Ghoshal. S.Chand Publication (for problems on atomic Physics).

Theory Course – RJSUPHY504: Electrodynamics

Learning outcomes:

On successful completion of this course students will be able to:

1) Understand the laws of electrodynamics and be able to perform calculations using them.
2) Understand Maxwell's electrodynamics and its relation to relativity
3) Understand how optical laws can be derived from electromagnetic principles.
4) Develop quantitative problem solving skills.

Unit - I	**Electrostatics**	(15 lect.)

1. Review of Coulomb & Gauss law, The divergence of **E**, Applications of Gauss' law, The curl of **E**. Introduction to potential, Comments on potential, The potential of a localized charge distribution. Poisson's equation and Laplace's equation. Solution and properties of 1D Laplace equation. Properties of 2D and 3D Laplace equation (without proof).

2. Boundary conditions and Uniqueness theorems, Conductors and Second Uniqueness theorem, The classic image problem- point charge and grounded infinite conducting plane and conducting sphere.

3. DG: 2.1.1 to 2.1.3, 2.2.2 to 2.2.4, 2.3.1 to 2.3.4
DG: 3.1.1 to 3.1.4, 3.1.5, 3.1.6, 3.2.1 to 3.2.4

Unit - II	Electrostatics in Matter and Magnetostatics	(15 lect.)

1. Dielectrics, Induced Dipoles, Alignment of polar molecules, Polarization,

Bound charges and their physical interpretation, Gauss' law in presence of dielectrics, A deceptive parallel, Susceptibility, Permittivity, Dielectric constant and relation between them, Energy in dielectric systems.

2. Review of Biot-Savart's law and Ampere's law, Straight-line currents, The Divergence and Curl of **B**, Applications of Ampere's Law in the case of a long straight wire and a long solenoid, Comparison of Magnetostatics and Electrostatics, Magnetic Vector Potential.

DG: 4.1.1 to 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.4.1, 4.4.3
DG: 5.2.1, 5.3.1 to 5.3.4, 5.4.1

Unit - III	Magnetostatics in Matter and Electrodynamics	(15 lect.)

1. Magnetization, Bound currents and their physical interpretation, Ampere's law in magnetized materials, A deceptive parallel, Magnetic susceptibility and permeability.

2. Energy in magnetic fields, Electrodynamics before Maxwell, Maxwell's correction to Ampere's law, Maxwell's equations, Magnetic charge, Maxwell's equations in matter, Boundary conditions.

DG: 6.1.1, 6.1.4, 6.2.1, 6.2.2, 6.2.3, 6.3.1, 6.3.2, 6.4.1
DG: 7.2.4, 7.3.1 to 7.3.6

Unit - IV	Electromagnetic Waves	(15 lect.)

1. The continuity equation, Poynting's theorem

The wave equation for **E** and **B**, Monochromatic Plane waves, Energy and momentum in electromagnetic waves, Propagation in linear media, Reflection and transmission of EM waves at normal incidence, Reflection and transmission of EM waves at oblique incidence.

DG : 8.1.1, 8.1.2
DG : 9.2.1 to 9.2.3, 9.3.1 to 9.3.3

References	
1.	DG: Introduction to Electrodynamics, David J. Griffiths (3rd Ed) Prentice Hall of India.
Additional References	
1.	Introduction to Electrodynamics: A. Z. Capria and P. V. Panat, Narosa Publishing House.
2.	Engineering Electrodynamics: William Hayt Jr. & John H. Buck (TMH).
3.	Foundations of Electromagnetic Theory: Reitz, Milford and Christy.
4.	Solutions to Introduction to Electrodynamics: David J. Griffiths (3rd Ed) Prentice Hall of India.

PRACTICALS - SEMESTER V

The T. Y. B.Sc. Syllabus integrates the regular practical work with a series of skill experiments and the project. There will be separate passing head for project work. During the teaching and examination of Physics laboratory work, simple modifications of experimental parameters may be attempted. Attention should be given to basic skills of experimentation which include:

i)	Understanding relevant concepts.
ii)	Planning of the experiments
iii)	Layout and adjustments of the equipments
iv)	Understanding designing of the experiments
v)	Attempts to make the experiments open ended
vi)	Recording of observations and plotting of graphs
vii)	Calculation of results and estimation of possible errors in the observation of results

i) Regular Physics Experiments: A minimum of **06** experiments from each of the course are to be performed and reported in the journal.

The certified journal must contain a minimum of **12** regular experiments (**06** from each group), in semester V. A separate index and certificate in journal is must for each semester course.

ii) Project Includes:

a)	Review articles/ PC Simulation on any concept in Physics/ Comparative study/Improvement in the existing experiment (Design and fabrication concept) /Extension of any regular experiment/Attempt to make experiment open-ended/Thorough survey of existing active components (devices, ICs, methods, means, technologies, applications etc.) / any innovative projects using concepts of physics.
b)	Two students (maximum) per project.
c)	For evaluation of project, the following points shall be considered … Working model (Experimental or Concept based simulation) Understanding of the project Data collection Data Analysis Innovation/Difficulty Report

SEMESTER V	
LAB COURSE 1: RJSUPHY5P01	
Sr. No.	**Name of the Experiment**
1	Determination of ‘g’ by Kater’s pendulum

2	Surface tension of soap solution
3	Elastic constants of a rubber tube
4	Determination of dielectric constant
5	Logarithmic decrement
6	Searle’s Goniometer
7	Determination of Rydberg’s constant
8	Edser’s ‘A’ pattern
9	Determination of wavelength by Step slit
10	Determination of e/m by Thomson’s method
11	R. I. by total internal reflection
12	Velocity of sound in air using CRO

LAB COURSE 2: RJSUPHY5P02

Sr. No.	Name of the Experiment
1	Mutual inductance by BG.
2	Capacitance by parallel bridge
3	Hysteresis loop by CRO
4	L/C by Maxwell’s bridge
5	Band gap energy of Ge diode
6	Design and study of transistorized astable multivibrator (BB)
7	Design and study of Wien bridge oscillator
8	Design and study of first order active low pass filter circuit (BB)
9	Design and study of first order active high pass filter circuit (BB)
10	Application of IC 555 timer as a ramp generator (BB)
11	LM 317 as constant current source

SKILL EXPERIMENTS

Sr. No.	Name of the Experiment
1	Estimation of errors from actual experimental data

2	Soldering and testing of an astable multivibrator (Tr./IC555) circuit on PCB
3	Optical Leveling of Spectrometer
4	Schuster's method
5	Laser beam profile
6	Use of electronic balance: Find the density of a solid cylinder
7	Dual trace CRO: Phase shift measurement
8	C_1/C_2 by B G
9	Internal resistance of voltage and current source
10	Use of DMM to test diode, transistor and factor

References:	
1.	Advanced course in Practical Physics: D. Chattopadhya, PC. Rakshit & B. Saha (8^{th} Edition) Book & Allied Pvt. Ltd.
2.	BSc Practical Physics: Harnam Singh. S. Chand & Co. Ltd. – 2001.
3.	A Text book of Practical Physics: Samir Kumar Ghosh New Central Book Agency (4^{th} edition).
4.	B Sc. Practical Physics: C. L. Arora (1st Edition) – 2001 S. Chand & Co. Ltd.
5.	Practical Physics: C. L. Squires – (3rd Edition) Cambridge University Press.
6.	University Practical Physics: D C Tayal. Himalaya Publication.
7.	Advanced Practical Physics: Worsnop & Flint.

SEMESTER VI

Theory Course – RJSUPHY601: Classical Mechanics

Learning outcomes:

This course will introduce the students to different aspects of classical mechanics. They would understand the kinds of motions that can occur under a central potential and their applications to planetary orbits. The students should also appreciate the effect of moving coordinate system, rectilinear as well as rotating. The students are expected to learn the concepts needed for the important formalism of Lagrange's equations and derive the equations using

D'Alembert's principle. They should also be able to solve simple examples using this formalism. The introduction to simple concepts from fluid mechanics and understanding of the dynamics of rigid bodies is also expected. Finally, they should appreciate the drastic effect of adding nonlinear corrections to usual problems of mechanics and nonlinear mechanics can help understand the irregularity we observe around us in nature.

Unit - I	**Central Force**	(15 lect.)
1. Motion under a central force, the central force inversely proportional to the square of the distance, Elliptic orbits, The Kepler problem. 2. Moving origin of coordinates, Rotating coordinate systems, Laws of motion on the rotating earth, The Foucault pendulum, Larmor's theorem. KRS: 3.13 - 3.15, 7.1 - 7.5.		
Unit - II	**Lagrange's equations**	(15 lect.)
1. D'Alembert's principle, Constraints, Examples of holonomic constraints, examples of nonholonomic constraints, degrees of freedom and generalized coordinates, virtual displacement, virtual work, D'Alembert's principle, illustrative problems. 2. Lagrange's equations (using D'Alembert's principle), properties of Lagrange's equations, illustrative problems, canonical momentum, cyclic or ignorable coordinates. PVP: 4.2 to 4.9, 5.2 to 5.4, 7.2, 7.3.		

Unit - III	Fluid Motion and Rigid body rotation	(15 lect.)
1. Kinematics of moving fluids, Equation of motion for an ideal fluid, Conservation laws for fluid motion, Steady flow. 2. Rigid dynamics: introduction, degrees of freedom, rotation about an axis: orthogonal matrix, Euler's theorem, Eulerian angles, inertia tensor, angular momentum of rigid body, Euler's equation of motion of rigid body, free motion of rigid body, motion of symmetric top (without notation). KRS : 8.6 to 8.9 PVP: 16.1 to 16.10		
Unit - IV	**Non Linear Mechanics**	(15 lect.)
1. Nonlinear mechanics: Qualitative approach to chaos, The anharmonic oscillator, Numerical solution of Duffing's equation. 2. Transition to chaos: Bifurcations and strange attractors, Aspects of chaotic behavior (Logistic map). BO: 11.1, 11.3 to 11.5		

References	
1.	PVP: Classical Mechanics, P. V. Panat (Narosa).
2.	KRS: Mechanics : Keith R. Symon, (Addision Wesely) 3rd Ed.
3.	BO: Classical Mechanics- a Modern Perspective: V. D. Barger and M. G. Olsson. (Mc Graw Hill International 1995 Ed.)
Additional References	
1.	Classical Mechanics: Herbert Goldstein (Narosa 2nd Ed.).
2.	An Introduction to Mechanics: Daniel Kleppner & Robert Kolenkow Tata Mc Graw Hill (Indian Ed. 2007).
3.	Chaotic Dynamics- an introduction: Baker and Gollub (Cambridge Univ. Press).
4.	Classical Mechanics: J. C. Upadhyaya (Himalaya Publishing House).

Theory Course – RJSUPHY602: Electronics

Learning Outcome:

On successful completion of this course students will be able to:

1. Understand the basics of semiconductor devices and their applications.
2. Understand the basic concepts of operational amplifier: its prototype and applications as instrumentation amplifier, active filters, comparators and waveform generation.
3. Understand the basic concepts of timing pulse generation and regulated power supplies
4. Understand the basic electronic circuits for universal logic building blocks and basic concepts of digital communication.
5. Develop quantitative problem solving skills in all the topics covered.

Unit - I		(15 lect.)
1. Field effect transistors: JFET: Basic ideas, Drain curve, The transconductance curve, Biasing in the ohmic region and the active region, Transconductance, JFET common source amplifier, JFET analog switch, multiplexer, voltage controlled resistor, Current sourcing. 2. MOSFET: Depletion and enhancement mode, MOSFET operation and characteristics, digital switching. 3. SCR – construction, static characteristics, Analysis of the operation of SCR, Gate Triggering Characteristics, Variable half wave rectifier and Variable full wave rectifier, Current ratings of SCR. 4. UJT: Construction, Operation, characteristics and application as a relaxation oscillator. 1. MB: 13.1 to 13.9 2. MB: 14.1, 14.2, 14.4, 14.6. 3. AM: 28.1, 28.5		
Unit - II		(15 lect.)
1. Differential Amplifier using transistor: The Differential Amplifier, DC and AC analysis of a differential amplifier, Input characteristic-effect of input bias, offset current and input offset voltage on output, common mode gain, CMRR.		

2. Op Amp Applications: Log amplifier, Instrumentation amplifiers, Voltage controlled current sources (grounded load), First order Active filters, Astable using OP AMP, square wave and triangular wave generator using OP AMP, Wein-bridge oscillator using OP AMP, Comparators with Hysteresis, Window Comparator.

1. MB: 17.1 to 17.5
2. MB: 20.5, 20.8, 21.4, 22.2, 22.3, 22.7, 22.8, 23.

Unit - III		(15 lect.)

1. Transistor Multivibrators: Astable, Monostable and Bistable Multivibrators, Schmitt trigger.

2. 555 Timer: Review Block diagram, Monostable and Astable operation Voltage Controlled Oscillator, Pulse Width modulator, Pulse Position Modulator, Triggered linear ramp generator.

3. Regulated DC power supply: Supply characteristics, series voltage regulator, Short circuit protection (current limit and fold back) Monolithic linear IC voltage Regulators. (LM 78XX, LM 79XX, LM 317, LM337).

1. AM: 18.11
2. KVR: 14.5.2.1, 14.5.2.5, 14.5.2.6, 14.5.4.1
3. MB: 23.8, 23.9
4. MB: 24.1, 24.3, 24.4

Unit - IV		(15 lect.)

1. Logic families: Standard TTL NAND, TTL NOR, Open collector gates, Three state TTL devices, MOS inverters, CMOS NAND and NOR gates, CMOS characteristics.

2. Digital Communication Techniques: Digital Transmission of Data, Benefits of Digital Communication, Disadvantages of Digital Communication, Parallel and Serial Transmission, Pulse Modulation, Comparing Pulse-Modulation Methods (PAM, PWM, PPM), Pulse-Code Modulation.

1. ML: 6.2, 6.4, 6.6, 6.7, 7.2 to 7.4.
2. LF: 7.1, 7.2, 7.4

References	
1.	MB: Electronic Principles, Malvino & Bates -7th Ed TMH Publication.
2.	AM: Electronic Devices and Circuits, Allen Mottershead -PHI Publication.
3.	KVR: Functional Electronics, K.V. Ramanan-TMH Publication.
4.	ML: Digital Principles and Applications, Malvino and Leach (4th Ed)(TMH).
5.	LF: Communication Electronics: Principles and applications, Louis E Frenzel 4th edition TMH Publications.

Theory Course – RJSUPHY603: Nuclear Physics

Objectives:

The course is built on exploring the fundamentals of nuclear matter as well as considering some of the important applications of nuclear physics. Topics include decay modes – (alpha, beta & gamma decay), nuclear models (liquid drop model, introduction to shell model), Applications of Nuclear Physics in the field of particle accelerators and energy generation, nuclear forces and elementary particles. The lecture course will be integrated with problem solving.

Learning Outcomes:

Upon successful completion of this course, the student will be able to understand

the fundamental principles and concepts governing classical nuclear and particle physics and have a knowledge of their applications interactions of ionizing radiation with matter the key techniques for particle accelerators the physical processes involved in nuclear power generation.

Knowledge on elementary particles will help students to understand the fundamental constituents of matter and lay foundation for the understanding of unsolved questions about dark matter, antimatter and other research oriented topics.

Unit - I	Alpha & Beta Decay	(15 lect.)

1. Alpha decay: Velocity, energy, and Absorption of alpha particles: Range,

Ionization and stopping power, Nuclear energy levels. Range of alpha particles, alpha particle spectrum, Fine structure, long range alpha particles, Alpha decay paradox: Barrier penetration (Gamow's theory of alpha decay and Geiger-Nuttal law).

2. Beta decay: Introduction, Velocity and energy of beta particles, Energy levels and decay schemes, Continuous beta ray spectrum-Difficulties encountered to understand it, Pauli's neutrino hypothesis, Detection of neutrino, Energetics of beta decay.

1. IK: 13. 1, 13.2, 13.5, SBP: 4. II. 1, 4. II. 2, 4. II. 3, 1.II.3
2. IK: 14.1, 14.7, SBP: 4. III. 1, 4. III. 2, 4. III. 3, 4. III. 5, SNG : 5.5.

Unit - II	Gamma Decay & Nuclear Models	(15 lect.)

1. Gamma decay: Introduction, selection rules, Internal conversion, nuclear isomerism, Mossbauer effect.

2. Nuclear Models: Liquid drop model, Weizsacker's semi-empirical mass formula, Mass parabolas - Prediction of stability against beta decay for members of an isobaric family, Stability limits against spontaneous fission. Shell model (Qualitative), Magic numbers in the nucleus.

1. SBP: 4. IV. 1, 4. IV.2, 4. IV. 3, 4. IV. 4, 9.4
2. SBP: 5.1, 5.3, 5.4, 5.5. AB: 11.6-pages (460,461).

Unit - III	Nuclear Energy & Particle Accelerators	(15 lect.)

1. Nuclear energy: Introduction, Asymmetric fission - Mass yield, Emission of delayed neutrons, Nuclear release in fission, Nature of fission fragments,

Energy released in the fission of U235, Fission of lighter nuclei, Fission chain reaction, Neutron cycle in a thermal nuclear reactor (Four Factor Formula), Nuclear power and breeder reactors, Natural fusion Possibility of controlled fusion.

2. Particle Accelerators: Van de Graaff Generator, Cyclotron, Synchrotron, Betatron and Idea of Large Hadron Collider.

1. SBP: 6.1, 6.3 to 6.9, 9.6, 9.7, 8.1,8.2,8.3
2. SBP: 1.I.4 (i), 1.I.4 (ii), 1.I.4 (iii), 1.I.4 (iv), 6.9, AB: 13.3

Unit - IV	Nuclear force & Elementary particles	(15 lect.)

1. Nuclear force: Introduction, Deuteron problem, Meson theory of Nuclear Force- A qualitative discussion.

2. Elementary particles: Introduction, Classification of elementary particles, Particle interactions, Conservation laws (linear &angular momentum, energy, charge, baryon number & lepton number), particles and antiparticles (Electrons and positrons, Protons and anti-protons, Neutrons and anti-neutrons, Neutrinos and anti-neutrinos), Photons, Mesons, Quark model
(Qualitative).

1. SBP: 8.6
2. DCT: 18.1, 18.2,18.3, 18.4 , 18.5 to 18.9 AB: 13.5

References	
1.	AB: Concepts of Modern Physics: Arthur Beiser, Shobhit Mahajan, S Rai Choudhury (6th Ed.) (TMH).
2.	SBP: Nuclear Physics, S.B. Patel (Wiley Eastern Ltd.).
3.	IK: Nuclear Physics, Irving Kaplan (2nd Ed.) (Addison Wesley).
4.	SNG: Nuclear Physics, S. N. Ghoshal (S. Chand & Co.)
5.	DCT: Nuclear Physics, D. C. Tayal (Himalayan Publishing House) 5th ed.
Additional References	
1.	Modern Physics: Kenneth Krane (2nd Ed.), John Wiley & Sons.
2.	Atomic & Nuclear Physics: N Subrahmanyam, Brij Lal. (Revised by Jivan Seshan.) S. Chand.
3.	Atomic & Nuclear Physics: A B Gupta & Dipak Ghosh Books & Allied (P) Ltd.
4	Introduction to Elementary Particles: David Griffith, Second Revised Edition, Wiley-VCH.

Theory Course – RJSUPHY604: Special Theory of Relativity

Learning outcomes:

This course introduces students to the essence of special relativity which revolutionized the concept of physics in the last century by unifying space and time, mass and energy, electricity and magnetism. This course also gives a very brief introduction of general relativity. After the completion of the course the student should be able to

1. Understand the significance of Michelson Morley experiment and failure of the existing theories to explain the null result
2. Understand the importance of postulates of special relativity, Lorentz transformation equations and how it changed the way we look at space and time, Absolutism and relativity, Common sense versus Einstein concept of Space and time.
3. Understand the transformation equations for: Space and time, velocity, frequency, mass, momentum, force, Energy, Charge and current density, electric and magnetic fields.
4. Solve problems based on length contraction, time dilation, velocity addition, Doppler effect, mass energy relation and resolve paradoxes in relativity like twin paradox etc.

Unit - I		(15 lect.)
Introduction to Special theory of relativity: Inertial and Non-inertial frames of reference, Galilean transformations, Newtonian relativity, Electromagnetism and Newtonian relativity. Attempts to locate absolute frame: Michelson-Morley experiment (omit derivation part), Review of (Attempts to preserve the concept of a preferred ether frame: Lorentz Fitzgerald contraction and Ether drag hypothesis (conceptual), Stellar aberration, Attempts to modify electrodynamics). **Relativistic Kinematics - I**: Postulates of the special theory of relativity, Simultaneity, Derivation of Lorentz transformation equations. Some consequences of the Lorentz transformation equations: length contraction, time dilation and meson experiment, The observer in relativity. RR: 1.1 to 1.9, 2.1 to 2.5		

Unit - II		(15 lect.)

Relativistic Kinematics - II: The relativistic addition of velocities, acceleration transformation equations, Aberration and Doppler effect in relativity, The common sense of special relativity.

The Geometric Representation of Space-Time: Space-Time Diagrams, Simultaneity, Length contraction and Time dilation, The time order and space separation of events, The twin paradox.

RR: 2.6 to 2.8, Supplementary topics A1, A2, A3, B1, B2, B3.

Unit - III		(15 lect.)

Relativistic Dynamics: Mechanics and Relativity, The need to redefine momentum, Relativistic momentum, Alternative views of mass in relativity,

The relativistic force law and the dynamics of a single particle, The equivalence of mass and energy, The transformation properties of momentum, energy and mass.
RR: 3.1 to 3.7

Unit - IV		(15 lect.)

Relativity and Electromagnetism: Introduction, The interdependence of

Electric and Magnetic fields, The Transformation for E and B, The field of a uniformly moving point charge, Force and fields near a current-carrying wire,
Force between moving charges, The invariance of Maxwell's equations.

The principle of equivalence and general relativity, Gravitational red shift.

RR: 4.1 to 4.7. Supplementary topics C1, C2, C3, C4.

Note: A good number of problems to be solved.

References	
1.	RR: Introduction to Special Relativity: Robert Resnick (Wiley Student Edition).
2.	Special theory of Relativity: A. P. French.
3.	Very Special Relativity – An illustrated guide: by Sander Bais - Amsterdam University Press.
4.	Concepts of Modern Physics by Arthur Beiser.
5.	Modern Physics by Kenneth Krane.

PRACTICALS - SEMESTER VI

The T. Y. B.Sc. Syllabus integrates the regular practical work with a series of skill experiments and the project. There will be separate passing head for project work. During the teaching and examination of Physics laboratory work, simple modifications of experimental parameters may be attempted. Attention should be given to basic skills of experimentation which include:

i)	Understanding relevant concepts.
ii)	Planning of the experiments
iii)	Layout and adjustments of the equipments
iv)	Understanding designing of the experiments
v)	Attempts to make the experiments open ended
vi)	Recording of observations and plotting of graphs
vii)	Calculation of results and estimation of possible errors in the observation of results

i) **Regular Physics Experiments:** A minimum of **06** experiments from each of the course are to be performed and reported in the journal.

The certified journal must contain a minimum of **12** regular experiments (**06** from each group), in semester V. A separate index and certificate in journal is must for each semester course.

ii) Project Includes:

a)	Review articles/ PC Simulation on any concept in Physics/ Comparative study/Improvement in the existing experiment (Design and fabrication concept) /Extension of any regular experiment/Attempt to make experiment open-ended/Thorough survey of existing active components (devices, ICs, methods, means, technologies, applications etc.) / any innovative projects using concepts of physics.
b)	Two students (maximum) per project.
c)	For evaluation of project, the following points shall be considered … Working model (Experimental or Concept based simulation) Understanding of the project Data collection Data Analysis Innovation/Difficulty Report

SEMESTER VI	
Sr. No.	**LAB COURSE 4: RJSUPHY6P04**
1.	Surface tension of mercury by Quincke's method
2.	Thermal conductivity by Lee's method
3.	Diameter of Lycopodium powder
4.	Wavelength of LASER using diffraction grating
5.	Study of JFET characteristics
6.	UJT characteristics and relaxation oscillator
7.	Study of Pulse width modulation (BB)
8.	Study of Pulse position modulation (BB)
9.	Determination of h/e by photocell
10.	R. P. of Prism
11.	Double refraction
12.	Lloyd's single mirror: determination of wavelength

SEMESTER VI	
Sr. No.	**LAB COURSE 5: RJSUPHY6P05**
1.	Determination of M/C by using BG
2.	Self-inductance by Anderson's bridge
3.	Hall effect
4.	Solar cell characteristics and determination of V_{oc}, I_{sc} and P_{max}
5.	Design and study of transistorized monostable multivibrator (BB)
6.	Design and study of transistorized bistable multivibrator (BB)
7.	Application of Op-Amp as a window comparator
8.	Application of Op-Amp as a Log amplifier
9.	Application of IC 555 as a voltage to frequency converter (BB)
10.	Application of IC 555 as a voltage to time converter (BB)
11.	LM-317 as variable voltage source
12.	Shift register
13.	JFET as a common source amplifier
14.	JFET as switch (series and shunt)

References:	
1.	Advanced course in Practical Physics: D. Chattopadhya, PC. Rakshit & B. Saha (8th Edition) Book & Allied (P) Ltd.
2.	BSc Practical Physics: Harnam Singh. S. Chand & Co. Ltd. – 2001.
3.	A Text book of Practical Physics: Samir Kumar Ghosh New Central Book Agency (4th edition).
4.	B Sc. Practical Physics: C. L. Arora (1st Edition) – 2001 S. Chand & Co.
5.	Practical Physics: C. L. Squires – (3rd Edition) Cambridge Univ. Press
6.	University Practical Physics: D C Tayal, Himalaya Publication.
7.	Advanced Practical Physics: Worsnop & Flint.

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