Rayat Shikshan Sanstha's

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA

(AUTONOMOUS)

Department of Material Science

Syllabus for B.Sc. Part – III w.e.f. from June 2023 onwards

Syllabus for B.Sc. III (With Material Science) Implemented from June 2023

1. Structure of Syllabus:

B.Sc.-III Semester-V

Paper Title	Theory			Practical		
	Paper Code	Lectures Per week	Credits	Paper Code	Lectures per week	Credits
Compulsory Papers				BPP508	10	4
Mathematical Physics	BPT 501	3	2			
Quantum Mechanics	BPT 502	3	2			
Classical Mechanics and Electrodynamics	BPT 503	3	2			
Paper-X: Elective Papers (Any one)				BPP514 + Project	10	4
Thin Film Technology	BPT 511	3	2			
Corrosion Science and Technology	BPT 512					
Materials for Electronics	BPT 513					
Numerical Skills in Physics	SECCPT507	2	1	SECCPP510	4	1

B.Sc. III Semester VI

Paper Title	Theory			Practical		
	Paper Code	Lectures Per week	Credits	Paper Title	Lectures per week	Credits
Compulsory Papers				**BPP608**	10	4
Nuclear and Particle Physics	BPT 601	3	2			
Solid State Physics	BPT 602	3	2			
Atomic, Molecular and Astrophysics	BPT 603	3	2	**BPP614 + Project**	10	4
Elective Papers (Any one)						
Material Characterizations	BPT 611	3	2			
Materials for Interdisciplinary Research	BPT 612					
Materials for Energy Conversion, Storage and Gas Sensing Application	BPT 613					
Entrepreneurship Development	SECCPT 607	2	1	SECCPP610	4	1

Titles of Papers

Sr. No.	Semester-V	Semester-VI
1	BPT501: Mathematical Physics	BPT601: Nuclear and Partical Physics
2	BPT 502: Quantum Mechanics	BPT602 : Solid State Physics
3	BPT503:Classical Mechanics and Electrodynamics	BPT603: Atomic, Molecular and Astrophysics
Elective Papers (Any one)		
4	BPT511: Thin Film Technology BPT512: Corrosion Science and Technology BPT513: Materials for Electronics	BPT611: Material Characterizations BPT612: Materials for Interdisciplinary Research BPT613: Materials for Energy Conversion, Storage and Gas Sensing Application
5	SECCPT507 : Numerical Skills in Physics	SECCPT607 :Entrepreneurship Development
6	BPP 508: Practical Paper V	BPP 608: Practical Paper VII
7	BPP 514: Practical Paper VI	BPP 614: Practical Paper VIII
8	SECCPP510: Numerical Skills Practical	SECCPP610: Entrepreneurship Development (Industrial Visit and Project Proposal Writing)

B.Sc. III Semester V
Course - BPT501:- Mathematical Physics

Course Objectives: Students should

1. understand wave method of solving partial differential equations.
2. study applications of partial differential equations.
3. study Cartesian, spherical polar and cylindrical co-ordinate systems.
4. understand Beta and Gamma functions.

Credits (Total Credits 2)	**Semester V** **BPT501** **Mathematical Physics**	No. of hours per unit/credits
Unit I	**Partial Differential Equation**	**(12)**
	Introduction to differential equations, Method of separation of variables for solving second order partial differential equations, Form of two dimensional Laplace Equation in Cartesian coordinates and its solution, Three dimensional partial differential equation in Cartesian coordinates and its solution.	
Unit II	**Applications of Partial Differential Equations**	**(10)**
	The differential equation of progressive wave and its solution, Equation of Vibrating String, One Dimensional Heat Flow, Two Dimensional Heat Flow.	
Unit III	**Orthogonal Curvilinear Coordinates**	**(14)**
	Introduction to cartesian, plane polar, spherical polar, and cylindrical co-ordinate systems, concept of orthogonal curvilinear co-ordinates, unit tangent vectors, arc length, area and volume elements in orthogonal curvilinear co-ordinate system, gradient, divergence, curl, del and Laplacian in orthogonal curvilinear co-ordinate system, extension of gradient, divergence, curl, del and Laplacian in Cartesian, spherical polar and cylindrical coordinate systems.	
Unit IV	**Some Special Integrals**	**(9)**
	Gamma function, Properties of Gamma function, Beta function, Properties of Beta function, Relation between Beta and Gamma functions, Error function (Probability Integral)	

Course outcomes:

After completion of syllabus, Students are able to:

1. solve partial differential equations.
2. apply the methods of solving partial differential equations.
3. differentiate among cartesian, spherical polar and cylindrical co-ordinate systems.
4. understand Beta and Gamma functions.

Reference Books

1. Schaum's Outline of Advanced Calculus, Robert C. Wrede, Murray R. Spiegel, McGraw-Hill Education Publication,3rd edition,2010
2. A First Course in Differential Equations with Modeling Applications, Dennis G.Zill, Cengage Learning Publication, 10th edition ,2012
3. Partial Differential Equations, N. P. Bali, Laxmi Publications, 2011
4. Mathematical Physics, B. S. Rajput, Pragati Prakashan-Meerut ,2016
5. Mathematical Methods for Physicists, Arfken, Weber, Elsevier Publication, 7th edition,2012
6. Mathematical Methods for Scientists and Engineers, McQuarrie, Viva Books Publication ,2008
7. Essential Mathematical methods, K. F. Riley, M. P. Habson, Cambridge University Press,1st edition,2011
8. Mathematics for Physicists, Susan M. Lea, Brooks Cole Publisher, 2003.
9. Mathematical Physics, B. D. Gupta, Vikas publishing house Pvt. Ltd., 4th edition-2010.
10. Mathematical Physics, H. K. Dass, Rama Varma, S. Chand & Company Pvt. Ltd.,7th Edition 2014.

B.Sc. III Semester V
Course - BPT502:- Quantum Mechanics

Course Objectives: Students should

1. study the particle aspect of radiation.
2. study Schrödinger wave equations, Eigen values and Eigen functions.
3. study the applications of Schrödinger wave equation.
4. understand operators, Eigen values and Eigen functions of L^2 and Lz, Commutation relation between x and p, the Hilbert space and wave functions.

Credits (Total Credits 2)	**Semester V** **BPT 502** **Quantum Mechanics**	No. of hours per unit/credits
Unit I	**Review of Quantum Mechanics**	**(12)**
	Inadequacy of classical mechanics, origin of quantum theory, photoelectric effect, law of photoelectric emission, Compton effect, Ritz combination, principle of Plank's constant	
Unit II	**Schrodinger's Wave Equation**.	**(10)**
	Wave function and its physical interpretation, Condition of physically acceptable wave function, Normalized and orthogonal wave functions, Schrödinger time dependent and time independent (steady state) wave equations in 1D and 3D, Probability current density (continuity equation), Eigen values and Eigen functions, Expectation values of dynamic variables.	
Unit III	**Applications of Schrodinger's Equation**.	**(11)**
	Particle in a rigid box (infinite potential well) in one dimension and three dimension, Step potential- reflection and transmission coefficients, Potential barrier-tunneling effect (qualitative treatment), Schrodinger equation for Hydrogen atom in spherical polar coordinates, Separation of radial and angular parts, Solution of radial part of Schrodinger's equation - Energy Eigen values.	
Unit IV	**Operators and Mathematical Tools in Quantum Mechanics**	**(12)**
	Definition of an operator, Position operator (x), Linear momentum operator (p), Hamiltonian operator (H), Angular momentum operator (L)–components of angular momentum operator in Cartesian coordinate system, Ladder operators, Eigen values of Lz and L2 (use equations for L2 and Lz in spherical	

	polar coordinates), Commutation relation between x and p, The Hilbert space and wave functions: The linear vector space, The Hilbert space, Dimension and basis of a vector space, Square integrable functions (Wave functions)	

Course outcomes:

After completion, Students are able to:

1. understand the photoelectric and Compton effect
2. understand Schrödinger time dependent and time independent wave equations
3. apply Schrodinger equation for the study of microscopic phenomena
4. use operators and commutation relations

Reference Books

1. Quantum Mechanics Concept and Applications-Nouredine Zettili,A John Wiley and Sons Ltd Publisher, 2nd edition, 2009.
2. Quantum Mechanics, Satya Prakash and C. K. Singh, Kedar Nath and Ram Nath Co.Publisher, 2012.
3. Quantum Mechanics,V. Murugan , PEARSON INDIA Publisher, 1st edition ,2014
4. Quantum Mechanics- G.Aruldas , Prentice Hall India Learning Private Limited Publisher, 2nd edition ,2008
5. AText book of Quantum Mechanics, P.M. Mathews and K. Venkatesan, Tata McGraw Hill Publisher,2nd Edn,2010
6. Quantum Mechanics Theory and Applications, A. K. Ghatak and S. Lokanathan, Laxmi Publications Pvt Ltd, 1st edition, 2019.

B.Sc. III Semester V
Course - BPT 503:- Classical Mechanics and Electrodynamics

Course Objectives: Students should

1. understand moving co-ordinate system and pseudo forces.
2. learn langrangian formulation , D'Alembert's principle and applications.
3. study equation of motion with the help of Hamiltonian
4. study concept of motion of charged particles in uniform electric and magnetic fields.

Credits (Total Credits 2)	**Semester V BPT 503 Classical Mechanics and Electrodynamics**	No. of hours per unit/credits
Unit I	**Moving Coordinate System and Coupled Oscillations**	**(12)**
	Moving origin of coordinates, Pseudo force, Rotating coordinate system, Coriolis force, effect of Coriolis force in nature (Flight of missiles and formation of cyclones) Frequencies of coupled oscillatory systems, Normal modes and normal coordinates, Energy of coupled oscillations, Energy transfer in a coupled oscillatory system	
Unit II	**Langrangian Formulation**	**(11)**
	Constraints, degrees of freedom, generalized co-ordinates, principle of virtual work, D'Alembert's principle, Lagrange's equation from D'Alembert's principle, Applications of Langrange's equation: Motion of particle in free space, Atwood's machine and Bead sliding on rotating wire.	
Unit III	**Hamiltonian Formulation**	**(10)**
	Hamilton's principle, deduction of Hamilton's principle from D'Alembert's principle, deduction of Langrange's equation from Hamilton's principle, Applications - Shortest distance between two points in a plane, Brachistochrone problem.	
Unit IV	**Charged particle Dynamics**	**(12)**
	Poisson's and Laplace's equation and their physical significance, Laplace equation in one dimension and it's solutions, non-relativistic motion of charged particles- in uniform electric field E, magnetic field B, crossed uniform electric field E and magnetic field B, Relativistic motion of charged particles- in constant electric field E, magnetic field B.	

Course Outcomes:

After completion of the units, Students are able to:

1. understand the moving coordinate system
2. understand the coupled oscillations
3. define constraints, Degree of freedom and generalized coordinates etc., and understand principle of virtual work and D'Alembert's principle.
4. derive Lagrange's equation from D'Alembert's principle and understand its of Langrange's equation.
5. define Poisons and Laplace equation and their physical significance and describe motion of charged particles in electric and magnetic fields.

Reference books

1. Classical mechanics, Goldstein Herbert, Narosa public/Person education,2018
2. Classical Mechanics, N. C. Rana and P. S. Joag, Tata Mcgraw Hill Publishing Co. Ltd , 2001
3. Classical Mechanics, S.L. Gupta, V. Kumar and H.V. Sharma, Pragati Prakashan, Meerut, 2001
4. Classical mechanics, P. V. Panat **,** Alpha Science International Ltd Publisher,2004
5. Introduction to Classical Mechanics, R.G.Takawale and P.S. Puranik , Tata Mc- Graw Hill Publisher , New Delhi,1980
6. Classical Electrodynamics, Puri S.P.,Tata Mc GrawHill Publishing Company Limited ,1990
7. Classical Electrodynamics, Jackson J.D., Wiley Publisher; Third edition, 2007.

B.Sc. III Semester V
Course - SECCPT507: Numerical Skills in Physics

Course Objectives: Students should

1. understand the basics of algorithms and flowchart.
2. understand python language and operators.

Credits (Total Credits 2)	Semester V SECCPT507 Numerical Skills in Physics	No. of hours per unit/credits
Unit I	**Algorithms and Flowchart**	**(12)**
	Algorithms: Definition, properties and development. Flowchart: Concept of Flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar coordinate, Roots of Quadratic Equation, sum of two matrices, sum and product of a finite series, calculation of sin (x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile at an angle the horizontal	
Unit II	**Overview of Programming and Introduction to Python**	**(12)**
	Structure of a Python Program, Elements of Python, Hello world application, Interpreters, modules, and a more interesting program, Variables, Names and Assignment, Types Input and Output Statements. Python Interpreter, Using Python as calculator, Python shell, Indentation. Atoms, Identifiers and keywords, Literals, Strings, Operators (Arithmetic operator, Relational operator, Logical or Boolean operator, Assignment, Operator, Ternary operator, Bit wise operator, Increment or Decrement operator), Conditional and looping statement.	

Course Outcomes: After completion, students are able to

1. define basics of Algorithms and draw flowcharts.
2. execute programs in python.
3. enlist different operators and their functions.

Reference Books:

1. Introducing Python, Bill Lubanovic**,** Shroff/O'Reilly Publisher, 1st edition, 2014
2. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press, 2nd edition 2018

B.Sc. III Semester V

Course - BPT511:- Thin Film Technology

Course Objective: Student should

1. understand the fundamental principles of Thin film technology.
2. differentiate physical and chemical methods of thin film preparation.
3. know various chemical deposition methods.
4. understand technological applications of thin Films

Credits (Total Credits 2)	**Semester V** **BPT511** **Thin Film Technology**	No. of hours per unit/credits
Unit I	**Introduction to Thin Films**	**(12)**
	Basics of thin films, nucleation and growth, capillarity theory, atomistic and kinetic models of nucleation, stages of film growth , types of thin films, role of thin films in devices, advantage of thin film technology	
Unit II	**Physical Method of Fabrication of Thin Films**	**(11)**
	Vacuum evaporation, Experimental technique for vacuum evaporation, Molecular beam epitaxy, Sputtering deposition	
Unit III	**Chemical Method of Fabrication of Thin Films**	**(11)**
	Chemical vapor deposition, Chemical bath deposition, SILAR, Electro-deposition, Spray Pyrolysis, Sol-gel synthesis.	
Unit IV	**Applications of Thin Films**	**(11)**
	Application of thin films in different areas such as electronics, medical, defense, sports, automobiles, etc.	

Course Outcome: Students will be able to:

1. Explain the fundamental principles of Thin film technology.
2. differentiate physical and chemical methods of thin film preparation.
3. analyze various chemical deposition methods.
4. understand technological applications of thin Films

References:

1. Thin Film Phenomena, K L Chopra, McGraw -Hill Book Company, NY 1969
2. The Materials Science of Thin Films, Milton Ohring, Academic Press, (1992)
3. Properties of Thin Films, Joy George, Marcel and Decker, (1992)
4. Thin Film Technology, O S Heavens, Methuen Young books (1970)

B.Sc. III Semester V
Course - BPT512:- Corrosion Science and Technology

Course Objectives: Students will able to

1. understand and differentiate corrosion and its types.
2. describe the electrochemical kinetics of corrosion mechanics
3. describe forms of corrosion .
4. recognize characterization techniques of corrosion .

Credits (Total Credits 2)	**Semester V** **BPT512** **Corrosion Science and Technology**	No. of hours per unit/credits
Unit I	**Introduction to corrosion**	**(12)**
	Corrosion definition, Electrochemical consideration and thermodynamic principles, electrode potential of metals, EMF and galvanic series, Faraday's laws Pourbaix diagram and its importance to iron, aluminum and magnesium metals.	
Unit II	**Electrochemical Kinetics of corrosion**	**(11)**
	Corrosion rate expressions. Exchange current density, polarization - concentration, activation and resistance, Tafel equation, passivity, electrochemical behavior of active-passive metals, factors governing metals exhibiting passivity, mixed potential theory and its application.	
Unit III	**Forms of Corrosion**	**(11)**
	Atmospheric, galvanic, crevice, stress corrosion cracking, intergranular corrosion, corrosion fatigue, hydrogen damage, cavitation.	
Unit IV	**Corrosion measurement & testing**	**(11)**
	Purpose of testing, laboratory, semi-plant and field tests, susceptibility tests of IGC, stress corrosion cracking and pitting, ASTM standards for corrosion testing; polarization methods to measure corrosion rate, surface characterization techniques.	

Course outcomes: Students should able to

1. differentiate types of corrosion.
2. understand corrosion kinetics with Tafel equation.
3. differentiate and compare forms of corrosion .
4. evaluate corrosion parameters.

References:

1. D. A. Jones, Principles and Prevention of Corrosion, 2nd edition, Prentice Hall, USA, 1996.
2. H. H. Uhlig and R. W. Revie, Corrosion and corrosion control : An introduction to Corrosion science and engineering (4th ed.), John Wiley & Sons,2008.
3. Fontana, M.G., Greene, N.D., Corrosion Engineering, 2nd edition, McGraw-Hill, USA, 1983 4. Philip A. Schweitzer, Fundamentals of corrosion : mechanisms, causes, and preventative methods, CRC Press, 2010
4. Fundamentals of Materials Science and Engineering: An Integrated Approach David G. Rethwisch (Author), William D. Callister Jr.

B.Sc. III Semester V
Course - BPT513:- Materials for Electronics

Course Objectives: Student should

1. understand different types of materials and their atomic structures.
2. know the various characteristics and properties of conducting materials.
3. learn process of manufacturing of semiconductors.
4. understand various insulating materials and their properties

Credits (Total Credits 2)	**Semester V** **BPT513** **Materials for Electronics**	No. of hours per unit/credits
Unit I	**Classification**	**(12)**
	Classification of materials into conducting materials, insulating materials and Semiconducting materials with reference to their atomic structures, magnetic materials.	
Unit II	**Conducting Materials**	**(11)**
	Characteristics of Conducting materials, Classification of conducting material as: low resistivity and high resistivity materials, their applications, Superconductors and their applications.	
Unit III	**Semiconducting Insulating Materials**	**(11)**
	Review of conductors, semiconductors and insulators, manufacturing process of semiconductor components, heat sinks, applications of semiconductor materials.	
Unit IV	**Insulating Materials**	**(11)**
	General properties of insulating materials, insulating materials and their maximum working temperature, classification of insulating materials, inorganic and organic insulating materials, duroplastic materials, synthetic insulating liquids and gasses.	

Course Outcomes: Students will be able to

1. classify various materials into conductors, insulators and semiconductors.
2. explain various properties of conducting materials.
3. explain various applications of semiconductors.
4. understand general properties of insulating materials.

References:

1. Raina, K B, S K Bhattacharya, and Tilak Joneja. 1998. A Text Book of Electrical Engineering Materials & Electronic Components.

B.Sc. III Semester V
BPP 508: Practical Paper V

Course Objectives: Students should understand

1. Understand experimental determination of surface tension by various methods.
2. Understand experimental determination of Yong's modulus (Y) by various methods.
3. Study use of C programming to solve physics experimental calculations.

Credits (Total Credits 2)	BPP 508 Practical Paper V	No. of hours per unit/credits
	1. Resonance pendulum 2. S.T. of soap solution 3. Surface tension of mercury by Fergusson modified method. 4. Surface tension of mercury by ripple method. 5. Y and n using Flat Spiral Spring 6. Y by Koenig's method 7. Y by Cornu's spiral 8. Searle's Viscometer 9. C program to arrange the given set of numbers in ascending/descending order 10. C program to find largest/smallest number from a given set of numbers 11. C program to find area and perimeter of square 12. C program to find area and circumference of circle 13. Scilab Expt. 1 (problem from Quantum Mechanics) 14. Scilab Expt. 2 (problem from Quantum Mechanics)	

Course Outcomes: After completion, students are able to

1. determine surface tension of mercury by various practical methods.
2. determine Yong's modulus (Y) by various practical methods.
3. use a C program to solve physics experimental calculations.
4. determine viscosity of liquid.

B.Sc. III Semester V
BPP 514: Practical Paper VI

Course Objectives: Students will able to

1. understand crystal structure & XRD pattern
2. synthesize the Ferrite material
3. study the crystal structure of Ferrite.
4. deposit thin films by various methods such as CBD, Electrodeposition, Hydrothermal, Dip Coating, SILAR, Spray Pyrolysis etc.

Credits (Total Credits 2)	**BPP 514: Practical Paper VI**	**No. of hours per unit/credits**
	1. Crystal Structure Analysis using X-Ray Diffraction (a) Simple Cubic (b) Face Centered Cubic. 2. Synthesis of Graphene by Hummer's method. 3. Synthesis of TiO2 nanoparticles. 4.Thin film deposition by spray pyrolysis method. 5. Thin film deposition by CBD Method. 6. Thin film deposition by SILAR method. 7. Thin film deposition by electro-deposition method. 8. Thin film deposition by hydrothermal method. 9 Thin film deposition by spray pyrolysis method. 10. Thin film deposition by dip coating method.	

Course Outcome: Students will able to

1. understand crystal structure & XRD pattern
2. synthesize the Ferrites
3. study the crystal structure of Ferrite.
4. deposit thin films by various methods such as CBD, Electrodeposition, Hydrothermal, Dip Coating, SILAR, Spray Pyrolysis etc.

References:

1. Thin Film Phenomena, K L Chopra, McGraw -Hill Book Company, NY 1969
2. The Materials Science of Thin Films, Milton Ohring, Academic Press, (1992)
3. Properties of Thin Films, Joy George, Marcel and Decker, (1992)
4. Thin Film Technology, O S Heavens, Methuen Young books (1970)

B.Sc. III Semester V

SECCPP510:

Practical in Numerical Skill in Physics (Any 10 of following List)

Course Objectives: Student should

1. understand algorithm, flowchart, python program.
2. understand use of WAP.

Credits (Total Credits 2)	SECCPP510 Practical in Numerical Skill in Physics	No. of hours per unit/credits
	1. Write an algorithm to find whether a number is even or odd. 2. Draw a flowchart to calculate the sum of the first 10 natural numbers. 3. Write a Python program to Print "Hello" on the screen 4. Write a Python program to display the current date and time. Sample Output : Current date and time 5. Write a program to convert the given temperature from Fahrenheit to Celsius and vice versa depending upon user's choice. 6. WAP to calculate total marks, percentage and grade of a student. Marks obtained in each of the three subjects are to be input by the user. 7. WAP To find the area of rectangle, square, circle and triangle by accepting suitable input parameters from user. 8. WAP to display the first n terms of Fibonacci series. 9. WAP to find Odd numbers between 1 to n where n is a positive Integer. 10. WAP to Swap Two Numbers using Temporary Variable. 11. WAP to find the largest of three numbers. 12. Write a Python program to find those numbers which are divisible by 7 and multiple of 5, between 1500 and 2700 (both included). 13. Write a Python program to find the median of three values. Go to the editor Expected Output: Input first number : 15	

Course Outcomes : After completion, students are able to

1. write algorithm, flowchart and python program
2. solve the problems by using WAP.

B.Sc. Part-III Semester-VI

Syllabus Structure:

<table>
<tr><th rowspan="2">Paper Title</th><th colspan="3">Theory</th><th colspan="3">Practical</th></tr>
<tr><th>Paper Code</th><th>Lectures Per week</th><th>Credits</th><th>Paper Title</th><th>Lectures per week</th><th>Credits</th></tr>
<tr><td colspan="4">Compulsory Papers</td><td rowspan="3">BPP608</td><td rowspan="3">10</td><td rowspan="3">4</td></tr>
<tr><td>Nuclear and Particle Physics</td><td>BPT 601</td><td>3</td><td>2</td></tr>
<tr><td>Solid State Physics</td><td>BPT 602</td><td>3</td><td>2</td></tr>
<tr><td>Atomic, Molecular and Astrophysics</td><td>BPT 603</td><td>3</td><td>2</td><td rowspan="5">BPP614 + Project</td><td rowspan="5">10</td><td rowspan="5">4</td></tr>
<tr><td colspan="4">Elective Papers (Any one)</td></tr>
<tr><td>Material Characterizations</td><td>BPT 611</td><td rowspan="3">3</td><td rowspan="3">2</td></tr>
<tr><td>Materials for Interdisciplinary Research</td><td>BPT 612</td></tr>
<tr><td>Materials for Energy Conversion, Storage and Gas Sensing Application</td><td>BPT 613</td></tr>
<tr><td>Entrepreneurship Development</td><td>SECCPT 607</td><td>2</td><td>1</td><td>SECCPP610</td><td>4</td><td>1</td></tr>
</table>

B.Sc. Part-III Semester-VI

BPT 601: Nuclear and Particle Physics

Course Objectives: Student should

1. interpret properties of nucleus and nuclear reactions.
2. classify nuclear models.
3. discuss different detectors and accelerators.
4. differentiate elementary particles.

Credits (Total Credits 2)	Semester VI BPT 601 Nuclear and Particle Physics	No. of hours per unit/credits
Unit I	**1. General properties of nuclei and nuclear reactions**	**(11)**
	composition of nucleus, nuclear size, nuclear radius, nuclear spin, nuclear magnetic moment, electric quadrupole moment, mass defect, packing fraction, magic numbers, binding energy, binding energy per nucleon and its variation with mass number, nucleus as a liquid drop, liquid drop model of nucleus to obtain semi-empirical mass formula.	
	2. Nuclear Reactions:	**(4)**
	General scheme of nuclear reactions, Q value of reaction and its calculation, Exothermic and **e**ndothermic nuclear reactions, threshold energy, deuteron induced reactions, stripping reaction.	
Unit II	**Particle Accelerators:**	**(11)**
	Need of accelerators, Cyclotron- construction, working, theory- expression for energy of cyclotron and its limitations, Principle of phase stable orbits, Synchrocyclotron- construction, working, advantages and disadvantages, Betatron- Principle, construction, working condition, expression of energy gain.	

Unit III	**Nuclear Detectors:**	**(11)**
	Ionization chamber, Geiger Muller counter- construction, working and theory, dead time and recovery time, quenching mechanism, photoelectric effect, construction of photo-multiplier tube (PMT), Scintillation detector-principle, construction and working, Wilson cloud chamber, Semiconductor detector, cerenkov radiations, cerenkov detector.	
UNIT IV	**Particle Physics**	**(8)**
	Elementary particles and their classification into leptons, mesons and baryons, Symmetries and conservation laws: energy and momentum, angular momentum, parity, Baryon number, Lepton number, isospin, strangeness and charm, quark model.	

Course Outcomes: After completion, students are able to

1. interpret properties of nucleus and nuclear reactions.
2. classify nuclear models.
3. discuss different detectors and accelerators.
4. differentiate elementary particles.

References:

1. Nuclear Physics, D. C. Tayal, Himalaya Publishing House, Mumbai, (5th edi.) 2011.
2. Atomic Physics,Volume II: Electricity, Magnetism, and Atomic Physics, John Yarwood University Tutorial Press, London, UK, (1st edition) 1958.
3. Introduction to Nuclear Physics, H. A. Enge, Addison Wesley Publishing Co., Boston, USA, (1st edition) 1966.
4. Nuclear Physics, J. B. Rajam, S. Chand Publishing Co., New Delhi, (7th edition) 1966.
5. Nuclear Physics, W.E.Burcham, Longman Group Limited, London, UK, (2nd edition) 1973.
6. Concepts of Nuclear Physics, B.L. Cohen, McGraw Hill Company, USA, (1st edition) 1976.
7. Atomic and Nuclear Physics, N. Subramanayam and Brij Lal, S.Chand Publishing Co.New Delhi, (2nd edition) 2013.
8. Basic Nuclear Physics and Cosmic Rays, B. N. Shrivastav, Pragati Prakashan, Meerut, (1st edition) 2019.

BSc III Semester VI
BPT602: Solid State Physics

Course Objectives: Students should

1. classify types of crystal structures.
2. analyze the X-ray diffraction methods for structural analysis of crystals.
3. understand the band formation concept
4. study the superconductivity and types of superconductors.

Credits (Total Credits 2)	**Semester VI BPT 602 Solid State Physics Theory**	**No. of hours per unit/credits**
Unit I	**Crystal Structure**	**(11)**
	Solids : amorphous, polycrystalline and crystalline materials; lattice, basis, unit cell- primitive, non primitive unit cell, symmetry elements of a cube, Bravais lattices in three two dimensions, Miller indices and interplanar spacing, simple crystal structures – SC, BCC, FCC and HCP (coordination number, atoms per unit cell and packing fraction).	
Unit II	**X – Ray Diffraction by Crystals**	**(10)**
	Reciprocal lattice and its properties, Brillouin zone, Diffraction of X-rays by crystals, Ewald construction, Bragg's law in reciprocal lattice, Experimental Methods X-ray diffraction (Laue method, rotating crystal method, powder photograph method), Analysis of crystal by powder crystal method.	
Unit III	**Elementary Band Theory of Solids**	**(13)**
	Origin of energy bands, one electron approximation, Bloch theorem (statement only), Kronig-Penny model, Velocity of electrons according to band theory, Effective mass of an electron, Distinction between metals, semiconductors and insulators, Hall Effect- Hall voltage and Hall Coefficient.	
Unit IV	**Superconductivity**	**(11)**
	Idea of superconductivity, Critical temperature, Critical magnetic field, Meissner effect, Type-I and Type-II superconductors, Introduction of BCS theory, London equation and penetration depth, Isotope effect, Application (magnetic levitation)	

Course Outcomes: After completion, students are able to

1. classify types of solids
2. discuss different methods for structural analysis of crystal
3. explain concept of energy bands in solid
4. explain superconductivity phenomenon and its types

References :

1. Solid state Physics, S. O. Pillai, New Age Internationl, Publishers, (7^{th} Ed.) 2009.
2. Fundamentals of Solid state Physics, Saxena, Gupta, Saxena and Mandal, Pragati Pakashan, Meerut, (28^{th} Ed.) 2016.
3. Solid State Physics, A. J. Dekker, Macmillan Publishers India Ltd., (1^{st} Ed.) 2000.
4. Introduction to Solid state Physics, Charles Kittel, Wiley India Pvt., (8^{th} Ed.) 2004.
5. Elements of X-ray diffraction, B. D. Cullity and S.Stock, Addison-Wesley, Publishers, (2^{nd} Ed.) 1978.
6. Solid state Physics, R. L. Singhal, Kedarnath Ramnath & Co. Meerut, (7^{th} Ed.) 2001.
7. Solid state Physics, C. M. Kachhava, Tata McGraw-Hill Publishers, (1^{st} Ed.) 2002.
8. Solid state Physics, M.A.Wahab, Narosa Publishing House Pvt.Ltd., (3^{rd} Ed.) 2015.

BSc III Semester VI

BPT603: Atomic, Molecular Physics and Astrophysics

Course Objectives: Student should study

1. atomic structure, atomic models and atomic spectra.
2. fine structure and Zeeman effect.
3. Rotational spectra and Vibrational spectra.
4. Raman Effect and Characteristic properties of Raman lines**.**
5. Milky Way galaxy and origin of solar system.

Credits (Total Credits 2)	**Semester VI BPT 603 Atomic, Molecular Physics & Astrophysics**	**No. of hours per unit/credits**
Unit I	**Atomic Structure**	**(09)**
	Revision of atomic models- Rutherford and Bohr model. Electron orbits,Atomic spectra, Bohr atom, Energy level and spectra, Atomic excitation, Vector atom model- quantum numbers, Pauli's exclusion principle.	
Unit II	**Atomic Spectra**	**(09)**
	Observed hydrogen fine structure, Spectral notations and optical spectral series for doublet structure, Spectrum of sodium and its doublet fine structure, Selection and intensity rules for fine structure doublets, Normal order offine structure doublets, Electronspin-orbit interaction, Normal and anomalous Zeeman effect and their explanation from vector atom model, Lande's g factor (qualitative).	
Unit III	**1. Molecular Spectra**	**(09)**
	Molecular bond, Electron sharing, H^+ molecular ion, The hydrogen molecule, Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibrational spectra, Vibration – rotation spectra, Electronic spectra of diatomic molecules.	

	2. Raman Spectra	**(09)**
	Raman Effect, Classical and quantum theory of Raman Effect, Characteristic properties of Raman lines, Difference between Raman spectra and infrared spectra.	
UNIT IV	**Structure of Universe**	**(09)**
	Formation and types of Galaxies, Milky Way galaxy, Origin of solar system - Condensation theory; arguments for and against the theory.Hubble law, Big-Bang theory, Steady state theory, Oscillating theory, Cosmological tests.	

Course Outcomes: **After completion, students are able to**

1. discuss atomic structure, atomic models and atomic spectra.
2. understand fine structure and Zeeman effect.
3. analyze Rotational and Vibrational spectra, Raman Effect and identify Characteristic properties of Raman lines**.**
4. explain Milky Way galaxy, origin of solar system and universe

Reference books

1. Modern Physics, J.B. Rajam, S. Chand Publishers, (1st Ed.) 1966.
2. Introduction to Atomic Spectra, H. E. White, McGraw Hill Publishers, 1934.
3. Concepts of Modern Physics, Arthur Beiser, McGraw-Hill Higher Education Publishers, (6th Ed.) 1994.
4. Elements of Atomic and Molecular and LASER Physics, Gupta, Kumar, Sharma, Pragati Prakashan, Meerut, (1st Ed.) 2016.
5. Astronomy: Fundamentals and Frontiers, Robert Jastrow and M. H.Thompson, Wiley NewYork, (2nd Ed.) 1974.
6. Molecular Spectra and Molecular Structure: Spectra of Diatomic Molecules, G. Herzberg, Krieger Pub. Co., (2nd Ed.) 1989.
7. Fundamentals of molecular spectroscopy, Colin N. Banwell and Elaine M. McCash, McGraw-Hill College Publishers, (4th Ed.), 1994.

B.Sc. Part-III Semester-VI
SECCPT607: Entrepreneurship Development (EDP)
Theory: 24 lectures, 48 minutes (18 Hours)

Course Objectives:

1. Identification of opportunities for development
2. To learn the mechanism of finance and fund raising
3. To understand the importance of marketing for better business opportunities
4. To understand procedure of energy audit.

Credits (Total Credits 01)	**Semester VI BPT 607 Entrepreneurship Development (EDP)**	**No. of hours per unit/credits**
Unit I	**Entrepreneurship Development**	**(06)**
	Introduction to entrepreneurship, Identification of opportunities for entrepreneurship, Concept of different occupations: - business, employment and profession. Functions of an entrepreneur. Business idea and plan, Types of businesses / ownerships – Sole Proprietorship, Partnership, Private limited company, Public limited company, Joint stock Company, Co- operative society.	
Unit II	**Sources of Finance**	**(05)**
	Preparation of project report for business, Sources of finance – government and nongovernment agencies, Working capital, Cash flow, Fund flow, Preparation of basics of financial statements, costing and pricing, Policies and incentives.	
Unit III	**Marketing Management**	**(06)**
	Small business management and entrepreneurship, Woman entrepreneurship, Features of small business firms, Process of management in small business, Concept of data and information, Information as acommodity, Study of marketing strategy and marketing mix, Decision-making models, Types of decisions, Decision Support Systems, Introduction to e-commerce, types – B2B, B2C, C2B, C2C. Case study on Small scale industries in India.	

UNIT-IV	**Energy Audit**	**(07)**
	Need of Energy audit - Types of energy audit - Energy management (audit) approach - understanding energy costs - Bench marking - Energy performance - Matching energy use to requirements - Maximizing system efficiencies - Optimizing the input energy requirements - Duties and responsibilities of energy auditors - Energy audit instruments - Procedures and Techniques.	

Course Objectives: After completion, students are able to

1.understand about Entrepreneurship, Creativity & Opportunities.
2.avail the financial and marketing skill
3.to prepare the proposal for small scale industry.
4.to study the procedure of energy audit.

Reference Books

1. Energy Management, W.R.Murphy, G.Mckay, Butterworth-Heinemann Ltd., 1981.
2. Energy Management Principles, Craig Smith Kelly Parmenter, Elsevier Publishers., 2015.
3. Efficient Use of Energy, I.G.C.Dryden, Elsevier Publishers, (2nd Ed.) 1982.
4. Energy Economics, A.V.Desai, New Age Publishers, 1996.
5. Entrepreneurship, Alpana Trehan, Wiley India Publishers, (1st Ed.) 2011.
6. Complete guide to successful Entrepreneurship, G.N.Pande, S.Chand (G/L) & Company Ltd ., 1994.

B.Sc. Part-III Semester-VI

BPP 608: Practical Paper VII

Course Objectives: Student should understand

1. experimental determination of wavelength of sodium by various optical methods.
2. absorption spectrum of a liquid $KMnO_4$ solution.
3. practical use of optical fiber.
4.

Credits (Total Credits 2)	BPP 608: Practical Paper VII	No. of hours per unit/credits
	1. Cardinal points by turn table method 2. Measurement of temperature of Na flame 3. Diffraction at a Single Slit 4. Diffraction at cylindrical obstacle 5. Lloyd's single mirror 6. Double refracting prism 7. Diameter of Lycopodium powder 8. Absorption spectrum of a liquid ($KMnO_4$ solution) 9. Study of divergence of LASER beam 10. Determination of Thickness of air film by interference. 11. Measurement of Numerical Aperture 12. Design of fiber optic Transmitter/ Receiver.	

Course Outcomes: After completion, students are able to

1. Determinate wavelength of sodium by various optical methods.
2. understand the absorption spectrum of a liquid $KMnO_4$ solution.
3. know practical use of optical fiber.

B.Sc. Part-III Semester-VI

SECCPT610: Project Work

Project Proposal Writing/Preparation of entrepreneurship Proposal and Presentation/ Industrial Visits.

Revised Scheme of Practical Examination for B. Sc. Part-III

1. Practical examination are conducted semester wise.
2. There are two practical groups for each semester.
3. Every candidate should perform one experiment from each Practical Paper.
4. Practical examination are conducted for 1.5 days per batch (No. of Students = 12)
5. The examination are conducted in two sessions per day and each session are of three hours duration.
6. Study tour is compulsory.
7. At least 80% practical's must be completed by the student.
8. **Scheme of marking for practical examination B. Sc.III Semester V/VI :**

B.Sc. III Semester VI
Course – BPT611:- Material Characterizations

Course Objectives: Student should

1. understand the fundamentals of spectroscopic methods.
2. understand and describe the principles behind UV-visible, IR and Raman spectroscopy.
3. import knowledge on different electron microscopy techniques used for characterization
4. To characterize materials using thermal methods.

Credits (Total Credits 2)	**Semester VI** **BPT611** **Material Characterizations**	No. of hours per unit/credits
Unit I	**Introduction to spectroscopy**	**(12)**
	Atomic and Molecular spectroscopy, interaction of EMR with matter, Energy levels in atoms and molecules, Absorption and Emission techniques, Fluorescence, Phosphorescence and Chemi-luminescence, Beer Lambert's law, Qualitative and Quantitative analyses, limitations, Visible absorption spectroscopy.	
Unit II	**Spectroscopic Techniques**	**(11)**
	Principle, Instrumentation (Block Diagram) and working: UV- visible spectroscopy: IR spectroscopy, Raman Spectroscopy, Differences between IR and Raman.	
Unit III	**Electron Microscopy**	**(11)**
	Principle, Instrumentation (Block Diagram) and working: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Specimen preparation techniques for SEM and TEM. synthesis.	

Unit IV	**Thermal Analysis**	**(11)**
	General discussion, Thermo-gravimetric analysis (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Basic theory, Instrumentation and applications.	

Course Outcomes: Students will be able to

1. understand the fundamentals of spectroscopic methods.
2. apply the principles of UV-visible, IR, and Raman techniques for material characterization
3. understand the techniques of SEM, TEM, XRD and AFM
4. to evaluate the thermal of materials using analytical techniques

References:

1.Skoog D.A., James Leary F., and. Nieman T. A., "Principles of instrumental analysis, Fifth Edn., Saunders Publications, 1998.

2.Willard, H. H., Merritt, I. I., Dean J. A. and Settle, F. A., "Instrumental methods of analysis", Sixth Edn., CBS publishers, 1986.

3. Sharma B.K., "Instrumental methods of analysis", Goel Publishing House, 1995

4. Yang Leng, "Material Characterization: Introduction to microscopic and spectroscopic methods", Wiley and Sons, 1st edn., 2008.

5. Skoog D. A., Holler F. J. and Crouch S. R., "Principles of instrumental analysis, Sixth Edn., Thomas Brookes Cole, 2007.

B.Sc. III Semester VI
Course – BPT612:- Materials for Interdisciplinary Research

Course Objectives: Students will able to

1. understand the need of photocatalysis, its advantages, limitations, etc.
2. understand the basics of antimicrobial activity.
3. describe fundamentals MEMS.
4. recognize components and types of biosensor.

Credits (Total Credits 2)	**Semester VI** **BPT612** **Materials for Interdisciplinary Research**	No. of hours per unit/credits
Unit I	**Materials for Photocatalysis Application**	**(12)**
	Need of photocatalysis, principles, Photocatalytic mechanism: oxidation and reduction mechanism, Factor affecting photocatalysis, Advantages of photocatalysis, Limitations of photocatalysis, Methods of Improving Photocatalytic Activity.	
Unit II	**Materials for Antimicrobial Application**	**(11)**
	Introduction, antimicrobial agent, broad and narrow spectrum, Therapeutic ratio, Antimicrobial susceptibility testing: Diffusion methods- (a) Kirby Bauer method, (b) Gradient plate technique, (c) E test, (d) Stokes method, Factor affecting Antimicrobial susceptibility testing.	
Unit III	**Overview of Micro Electronic Mechanical Systems (MEMS)**	**(11)**
	Introduction, microsystems and microelectronics, construction and working of acoustic wave sensor, pressure sensor and optical sensor.	
Unit IV	**Materials for Bio-sensing Application**	**(11)**
	Introduction to Overview of Biosensors, components of a biosensor, Types of biosensors: Electrochemical Biosensors, Calorimetric Biosensors, Newer biosensing Technologies	

Course Objectives: Students should able to

1. understand the need of photocatalysis, its advantages, limitations, etc.
2. understand the basics of antimicrobial activity.
3. describe fundamentals MEMS.
4. recognize components and types of biosensor.

References:

1. Basic Principles, Mechanism, and Challenges of Photocatalysis R. Saravanan, Francisco Gracia and A. Stephen
2. The molecular basis of antibiotics action by john wiley and sons
3. MEMS & Microsystems Design and Manufacture Tai-Ran Hsu
4. Biosensors and nanomaterials Songjun Li , Jagdish Singh, He Li , Ipsita A. Banerjee
5. K. Park (2009), Park's Textbook of Preventive and Social Medicine (20th Edition).
6. Challa S., S. R. Kumar, J. H. Carola (2006) Nanofabrication towards biomedical application: Techniques, tools, Application and impact. John Wiley and sons.

B.Sc. III Semester VI
BPT613:- Materials for Energy Conversion, Storage & Gas Sensing Application

Course Objectives: Students will able to

1. understand the need of solar cells, batteries and gas sensor.
2. explain the working principle of solar cell, and solar cell parameters.
3. distinguish the generations and types of solar cell.
4. describe battery fundamentals and parameters.
5. explain gas sensor, types of gas sensors, and parameters.

Credits (Total Credits 2)	**Semester VI BPT613 Materials for Energy Conversion, Storage & Gas Sensing Application**	No. of hours per unit/credits
Unit I	**Basics of Solar Cell**	**(12)**
	World energy demand, Solar spectrum, Need of Solar Cell, Construction and Working of Solar Cell, Parameters of Solar Cell (Fill Factor, Efficiency, Short Circuit Current, Open Circuit Resistance, Parasitic Resistances, Quantum Efficiency), Module Structure, Mismatch Effects.	
Unit II	**Materials for Solar Cell Application**	**(11)**
	Generations of Solar Cells, CIGS Solar Cells, CdTe Solar Cells, Amorphous Silicon Solar Cell, Polymer Solar Cell.	
Unit III	**Materials for Battery Application**	**(11)**
	Reversible and irreversible cell reactions, Parameters for characterizing batteries (electrodes, electrolytes, separator and binders) of different types of batteries: Leclanche/Dry/Alkaline cell, Silver cell, Mercury cell, Lead-acid battery, Charge-Discharge characteristics, Energy/power density, overcharging, Mechanics of battery cells and materials. Current status and future trends.	

Unit IV	Materials for Gas Sensing Application	(11)
	Introduction to sensor, Need of Gas Sensor, Types of Gas Sensors, Gas Sensing Mechanism for p-type and n-type semiconductor, Gas Sensor Parameters (Gas Response, Response and Recovery Time, Operating Temperature, Detection Limit, Selectivity, etc), Factors affecting gas sensor. Metal oxide semiconductors (MOS) and chalcogenides for gas sensor. Challenges and opportunities in the gas sensing field.	

Course outcomes: Students should able to

1. understand the need of solar cells, batteries and gas sensor.
2. explain the working principle of solar cell, and solar cell parameters.
3. distinguish the generations and types of solar cell.
4. describe battery fundamentals and parameters.
5. explain gas sensor, types of gas sensors, and parameters.

Reference Books:

1. Chetan Singh Solanki, Solar Photovoltaics, Fundamentals, Technologies and Applications(Delhi, PHI Learning Private Limited, 3rd Edition, 2015) 5-302 (Unit I)
2. A. R. Jha, Solar Cell Technology and Applications, Auerbach Publications, 2010 (Unit II)
3. Sabrie Soloman, Sensors handbook, McGraw Hill, 2nd edition, 2010 (Unit IV)
4. A.J. Bard, L.R. Faulkner, Electrochemical Methods, Fundamentals and Application. Wiley, 2001.

5. C. Daniel and Jurgen O. Besenhard, Handbook of Battery Materials, Wiley-VCH Verlag, 2011
6. K.E. Aifantis, S.A. Hackney, and R. V. Kumar (Ed.) High Energy Density Lithium Batteries Materials, Engineering, Applications, WILEY-VCH Verlag GmbH & Co. KGaA, 2010.
7. A.Yu, V. Chabot, and J. Zhang, Electrochemical Supercapacitors for Energy Storage and 5. Delivery Fundamentals And Applications, Taylor & Francis Group, 2013.

B.Sc. Part-III Semester-VI

BPP 614: Practical Paper VIII

Course objectives: Students should acquire experimental skills

1. to prepare TiO_2, ZnO, Cu_2O, NiO etc.
2. to measure CV of different MOS.
3. to measure gas sensing performance of MOS.
4. to fabricate TiO_2 based solar cells.
5. to measure photocatalytic activity of TiO_2.
6. to measure glucose sensing performance of Cu_2O.

Credits (Total Credits 2)	**BPP 614: Practical Paper VIII**	**No. of hours per unit/credits**
	1. Preparation of TiO_2 for dye sensitized solar cell application. 2. Preparation of TiO_2-Cu_2O by chemical method. 3. Preparation of ZnO-Cu_2O by chemical method. 4. Preparation of NiO electrode for battery application. 5. Measurement of cyclic voltammetry of NiO electrode. 6. Preparation of ZnO electrodes by chemical method. 7. Preparation of ZnO-polyaniline electrode by chemical method. 8. Measurement of gas sensing properties of ZnO electrode. 9. Measurement of gas sensing properties of ZnO-polyaniline electrode. 10. Study photocatalysis application for TiO_2 material. 11. Measurement of glucose sensing properties of Cu_2O.	

Course Outcomes: After completion, students are able to:

1. to prepare different MOS.
2. to measure gas sensing performance.
3. to measure CV's of different MOS.
4. to study photocatalytic activity of TiO_2.
5. to measure glucose sensing of Cu_2O.

References:

1. Thin Film Phenomena, K L Chopra, McGraw -Hill Book Company, NY 1969
2. The Materials Science of Thin Films, Milton Ohring, Academic Press, (1992)
3. Properties of Thin Films, Joy George, Marcel and Decker, (1992)
4. Thin Film Technology, O S Heavens, Methuen Young books (1970)