



Karmaveer Bhaurao Patil University, Satara

Syllabus for

B. Sc. IV Physics

Honors with Research

Under

Faculty of Science and Technology

(As per NEP 2020)

With effect from Academic Year 2026-2027

Syllabus for B.Sc. Part – IV**Title: Physics****Year of Implementation: The syllabus will be implemented from Academic Year 2026-2027 onwards.****Duration: One-year full time.****Pattern: Semester examination.****Medium of Instruction: English.****Structure of Course: B.Sc. – IV****Semester – VII**

Level	Semester	Course Code	Course Title	No. of hours Per Week	Credits
6	VII	BPT 471 (R)	Mathematical Methods in Physics	4	4
		BPT 472 (R)	Nanoscience and Nanotechnology	4	4
		BPT 473 (R) BPT 474 (R) DSE (Elective: Any one among two)	E-I: Advanced Quantum Mechanics-I E-II: Atomic, Molecular and Laser Physics	4	4
		BPT 475 (R)	Research Methodology	2	2
		BPP 476 (R)	Practical-I: LAB- I	4	2
		BPP 477 (R)	Research Methodology Lab	4	2
		BPPRP 478 (R)	Research Project	8	4
		Total			22

Structure of Course: B.Sc. – IV**Semester – VIII**

Level	Semester	Course Code	Course Title	No. of hours Per Week	Credits
6	VIII	BPT 481 (R)	Physical Properties of Solid	4	4
		BPT 482 (R)	Energy Conversion and Storage Devices	4	4
		BPT 483 (R) BPT 484 (R) DSE (Elective: Any one among two)	E-I: Advanced Quantum Mechanics-II E-II: Condensed matter Physics	4	4
		BPP 485 (R)	Practical-II: LAB- II	4	2
		BPPRP 486 (R)	Research Project	16	8
		Total			22



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VII

Type: Discipline Specific Courses

Marks: 100

Credits: 4

From: A. Y. 2026-27

Name of the Course: BPT 471 (R): Mathematical Methods in Physics

Course Objectives: student should be able to.....

1. understand the laws of Matrices, eigen values and eigen vectors.
2. study complex algebra.
3. know the singularities, Legendre, Hermite, Laguerre, Bessel's function and their applications.
4. learn the properties of Fourier Series and applications of Fourier Series.

Course Outcomes: After completion of syllabus, student will be able to.....

1. define Inner product, direct product, Diagonal matrices, trace, matrix Inversion
2. perform Complex Algebra, Conjugate Complex Numbers and their sum, Difference, Product and quotient.
3. solve the complex Calculus problems of Residues-Residues Theorem.
4. analyze and apply Fourier transform and inversion theorem.

Module	Title and Contents	Hrs
Module -1:	1.1 Module -1: Matrix Algebra and Eigen value Problems 1.2 Matrix multiplication – inner product, direct product, diagonal matrices, trace, matrix Inversion, Gauss-Jordan Inversion theorem, problems 1.3 Eigenvalues and Eigenvectors 1.4 Properties of Eigenvalues and Eigenvectors, Cayley-Hamilton theorem and applications, similar matrices and diagonalizable 1.5 Matrices, Eigenvalues of some special complex matrices, quadratics forms, problems	15
Module -2:	Module -2: Complex Variables 2.1 Definition of Complex Numbers and variables, equality of complex variables, complex algebra, conjugate complex numbers, geometrical representation of complex number 2.2 Geometrical representations of the sum, difference, product and quotient of Complex Number 2.3 Cauchy- Riemann Conditions, analytic functions, multiply connected regions, Cauchy Theorem, Cauchy Integration formula, problems	15
Module -3:	Module -3: Calculus of Residues & Special function 3.1 Singularities- Poles, Branch Points, Calculus of Residues- Residues Theorem, Taylor Series and Laurent's series 3.2 Special function (only definitions)- Legendre Hermite, Laguerre function, Generating function, Recurrence relations and their differential equations, Orthogonality properties	15

Module -4:	Module-4: Fourier-Series, Integral, and Transform 4.1 Definition, Evaluation of Coefficients of Fourier Series (Cosine and Sine Series), 4.2 Dirichelet's Theorem, Graphical representation of a square wave function, Extension of interval, Complex form of Fourier Series, Properties of Fourier Series (Conversions, Integration, Differentiation, Parseval's Theorem). 4.3 Fourier Integral- exponential form, Applications of Fourier Series analysis in Physics (Square wave, Full wave rectifier, Expansion of Riemann Zeta function) 4.4 Fourier transform, Inversion theorem, exponential transform Example: Full wave train, Uncertainty principle.	15
Reference Books: - 1. Arfken and Weber, <i>Mathematical Methods for Physicists</i> (Publisher: New York: Academic Press, 2005) 2. S R K Iyengar, R K Jain, <i>Mathematical Methods</i> (Publisher: Narosa Publishing House, New Delhi, 2006) 3. B. S. Rajput, <i>Mathematical Physics</i>, (Publisher: Pragati Prakashan, Meerat, 1999) 4. K F Riley, M P Hobson and S J Bence, <i>Mathematical Methods for Physics and Engineering</i> (Publisher: Cambridge University Press, Cambridge, 1997) 5. M. L. Bose, <i>Mathematical Methods of Physical Science</i> (Publisher: Wiley Publications, New Jersey, 1983)		
Evaluation Pattern: 60:40		
Total Marks: 100		
Internal Continuous Evaluation: 40 Marks • Internal Work -1: CCE-I-20 Marks • Internal Work -2: CCE-II-20 Marks • Internal Work -3: CCE-III-20 Marks	End Semester Examination:60 Marks 1. Question No.1 is compulsory. 2. Attempt any four questions from question numbers 2 to 7. • Question -1: 2 Mark x 6 = 12 Marks • Question -2: 6 Marks x 2 = 12 Marks • Question -3: 6 Marks x 2 = 12 Marks • Question -4: 6 Marks x 2 = 12 Marks • Question -5: 4 Marks x 3 = 12 Marks • Question -6: 4 Marks x 3 = 12 Marks • Question -7: 4 Marks x 3 = 12 Marks	



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VII

Type: Discipline Specific Courses

Marks: 100

Credits: 4

From: A. Y. 2026-27

Name of the Course: BPT 472 (R): Nanoscience and Nanotechnology

Course Objectives: student should be able to.....

- 1) understand depth knowledge of nanoscience and its technological aspects.
- 2) study dimensions dependent properties of nanoscale materials.
- 3) aware of various types of technologically important nanostructures
- 4) learn recent scientific and technological developments in nanotechnology-based devices.

Course Outcomes: After completion of syllabus, student will be able to....

- 1) identify the different lithography techniques
- 2) describe technological importance of nanomaterials and replacement of bulk materials.
- 3) differentiate different applications of nanomaterials.
- 4) utilize nanoscience in further higher education and research in Nanoscience and Nanotechnology

Module	Title and Contents	Hrs
Module -1:	Module -1: Nanolithography 1.1 Introduction, 1.2 Lithography using UV light and laser beams, 1.3 Use of X-rays in lithography, 1.4 Lithography using particle beams, 1.5 Scanning probe lithography 1.6 Soft lithography	15
Module -2:	Module -2: Properties of nanomaterials: 2.1 Mechanical properties, Structural properties, Electrical conductivity, Optical properties and Melting point of materials, 2.2 Semiconductor materials, 2.3 Luminescence in semiconductor materials. 2.4 Special Nanomaterials: Graphene, Carbon nano tubes and Types (CNT), Fullerenes, Aerogels, Core Shell Nanostructures	15
Module -3:	Module -3: Magnetic Properties of nanomaterials 3.1 Magnetism 3.2 Types of magnetic materials, 3.3 Effect of Nano structuring on magnetic properties,	15

	3.4 Dynamics of Nanomagnets, 3.5 Giant and colossal magnetoresistance, 3.6 Ferrofluids, Nanomagnetic Materials	
Module -4:	Module -4: Transport properties of Nanomaterials 4.1 Excitons in nanomaterials, 4.2 Coulomb Blockade, 4.3 Coulomb Blockade in a tunnel junction, 4.4 Observing the Coulomb Blockade, 4.5 Quantum Transport in Quantum dots, 4.6 Single electron transistor 4.7 Spin polarized transport, 4.8 Spin logic, 4.9 Spin field effect transistor (Spin-FET), Spin Diodes.	15
Reference Books: - 1) Rao, M. S. Ramachandra, and Shubra Singh. <i>Nanoscience and Nanotechnology: Fundamentals to Frontiers</i>. (Publisher: Wiley, 2013) 2) Choudhary, K. K. <i>Nanoscience and Nanotechnology</i>. (Publisher: Narosa Publishing House, 2016) 3) Kulkarni, S. K. <i>Nanotechnology: Principles and Practices</i>. (Publisher: Capital Publishing Company, 2014) 4) Poole, Charles P., Jr., and Frank J. Owens. <i>Introduction to Nanotechnology</i>. (Publisher: Wiley, 2020) 5) Shah, M. A., and K. A. Shah. <i>Nanotechnology: The Science of Small</i>. 2nd ed. (Publisher: Wiley, 2019)		
Evaluation Pattern: 60:40		
Total Marks: 100		
Internal Continuous Evaluation: 40 Marks • Internal Work -1: CCE-I-20 Marks • Internal Work -2: CCE-II-20 Marks • Internal Work -3: CCE-III-20 Marks		End Semester Examination:60 Marks 1. Question No.1 is compulsory. 2. Attempt any four questions from question numbers 2 to 7. • Question -1: 2 Mark x 6 = 12 Marks • Question -2: 6 Marks x 2 = 12 Marks • Question -3: 6 Marks x 2 = 12 Marks • Question -4: 6 Marks x 2 = 12 Marks • Question -5: 4 Marks x 3 = 12 Marks • Question -6: 4 Marks x 3 = 12 Marks • Question -7: 4 Marks x 3 = 12 Marks



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VII

Type: Discipline Specific Elective

Marks: 100

Credits: 4

From: A. Y. 2026-27

Name of the Course: BPT 473 (R): E-I: Advanced Quantum Mechanics- I

Course Objectives: student should be able to.....

1. understand ket and bra spaces, inner products, operators and uncertainty relations.
2. learn Schrödinger wave equation and commutation relations.
3. study Eigen values and Eigen functions of L_2 and L_z operators, Ladder operators, Pauli theory of spins.
4. know perturbation theory, Eigen values and Eigen functions.

Course outcomes: After completion of syllabus, student will be able to.....

1. define ket and bra spaces and inner products and operators
2. solve Schrödinger wave equation - one-dimensional problems, well and barriers.
3. compute Clebsch-Gordon Coefficients in simple cases.
4. find Eigen value of energy and Eigen function in the first order approximation.

Module	Title and Contents	Hrs
Module -1:	Module -1: Fundamental Concepts and Formalism 1.1 Why Q.M? Revision; sequential Stern Gerlach experiment, analogy with polarization of light, ket and bra spaces and inner products 1.2 Operators, the associative axiom, base kets and matrix representations, measurements, observables and the uncertainty relations	15
Module -2:	Module -2: Quantum Dynamics 2.1 Time evolution operator and Schrödinger equation 2.2 Schrödinger, Heisenberg, interaction picture and comparison of time evolution in all pictures, simple harmonic oscillator, commutation relations (problems) 2.3 Schrödinger wave equation - one-dimensional problems, well and barriers, General formalism of wave mechanics	15
Module -3:	Module -3: Angular Momentum 3.1 Eigen values and Eigen functions of L_2 and L_z operators, Ladder operators L_+ and L_- 3.2 Pauli Theory of spins (Pauli's Matrices), angular momentum as a generator of infinitesimal rotations, Matrix representation 3.3 Addition of angular momenta, Computation of Clebsch-Gordon Coefficients in simple cases	15
Module -4:	Module -4: Time Independent Perturbation Theory 4.1 Introduction of perturbation theory 4.2 Eigen value of energy and Eigen function in the first order approximation in case of a system with non-degenerate & degenerate energy levels 4.3 First order Stark Effect (Ground state and First Excited state of H atom)	15

Reference Books: -

- 1) J. J. Sakurai, Jim Napolitano, *Modern Quantum Mechanics* (Publisher: Cambridge University Press; 3rd edition, 2020).
- 2) David J. Griffiths, Darrell F. Schroeter, *Introduction to Quantum Mechanics* (Publisher: Cambridge University Press; 3rd edition, 2018).
- 3) N Zettili, *Quantum Mechanics concept and application* (Publisher: Wiley India Pvt. Ltd: 2nd edition, 2016).
- 4) P M Mathews, K Venkatesan, *A Textbook of Quantum Mechanics* (Publisher: McGraw Hill Education; 2nd edition, 2017).

Evaluation Pattern: 60:40**Total Marks: 100****Internal Continuous Evaluation: 40 Marks**

- Internal Work -1: CCE-I-20 Marks
- Internal Work -2: CCE-II-20 Marks
- Internal Work -3: CCE-III-20 Marks

End Semester Examination:60 Marks

- 1. Question No.1 is compulsory.**
- 2. Attempt any four questions from question numbers 2 to 7.**
 - Question -1: 2 Mark x 6 = 12 Marks
 - Question -2: 6 Marks x 2 = 12 Marks
 - Question -3: 6 Marks x 2 = 12 Marks
 - Question -4: 6 Marks x 2 = 12 Marks
 - Question -5: 4 Marks x 3 = 12 Marks
 - Question -6: 4 Marks x 3 = 12 Marks
 - Question -7: 4 Marks x 3 = 12 Marks



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VII

Type: Discipline Specific Elective

Marks: 100

Credits: 4

From: A. Y. 2026-27

Name of the Course: BPT 474 (R) E-II: Atomic, Molecular and Laser Physics

Course Objectives: student should be able to....

1. understand vector atom model and couplings.
2. know Zeeman Effect, Paschen-Back effect and Stark effect.
3. learn classification of molecules, electronic and rotational spectra of diatomic molecules.
4. study the vibrating diatomic molecule and harmonic oscillators.

Course outcomes: After completion of syllabus, student will be able to.....

1. describe and use ll, ss, jj, LS or Russell -Saunders coupling for solving numerical.
2. analyze Zeeman effect for two-electrons, Paschen-Back effect for two-electrons,
3. discuss and draw rotational of diatomic molecules chemical.
4. differentiate between Laser types

Module	Title and Contents	Hrs
Module -1:	Module -1: Vector atom model for two valence electron system 1.1 Introduction, Atomic models, 1.2 Pauli exclusion principle, Types of coupling- ll, ss, LS or Russell -Saunders coupling and coupling schemes for two valence electron system, for two valence electron system, pd configuration of coupling schemes 1.3 Lande interval rule, jj-coupling and factors for jj coupling, Selection rules for LS and jj coupling 1.4 Interaction energies, problems	15
Module -2:	Module -2: Zeeman Effect, Paschen-Back effect and Stark effect 2.1 Introduction, The magnetic moment of the atom, 2.2 Zeeman effect for two- electrons, Intensity rules for Zeeman effect, anomalous Zeeman effect, normal Zeeman effect 2.3 Paschen-Back effect for two-electrons, rules 2.4 Stark effect of hydrogen, weak field stark effect in hydrogen, strong field Stark effect in hydrogen 2.5 Problems	15
Module -3:	Module -3: Rotational Spectroscopy and Vibrational spectroscopy 3.1 Rotational spectra: the rigid diatomic molecule, 3.2 Spectrum and selection rules of a rigid rotator, non-rigid rotator, 3.3 Energy spectrum and selection rules of a non-rigid rotator,	15

	3.4 Techniques and instrumentations of microwave spectroscopy 3.5 The vibrating diatomic molecule: the energy spectrum and selection rules of diatomic molecule 3.6 The simple harmonic oscillator, energy spectrum and selection rules of simple harmonic oscillator, Morse function	
Module -4:	Module -4: Different laser systems 4.1 Gas Lasers: (i) Molecular gas lasers- CO ₂ laser & N ₂ (ii) ionic gas laser – Ar ⁺ laser (iii) gas dynamic laser (iv) high pressure pulsed gas laser 4.2 Solid State Laser: (i) Nd:YAG laser, (ii) Nd:Glass laser, comparison of performances (iii) Tunable solid state laser: Ti:sapphire laser; Alexandrite laser 4.3 Chemical Laser: HF laser, HCl laser, COIL Excimer laser; Color centre laser; Free electron laser; semiconductor diode laser	15
Reference Books: - 1. H. E. White, <i>Introduction to Atomic Spectra</i> (Publisher: McGraw Hill Edu., 2019). 2. Raj Kumar, <i>Atomic and Molecular Physics</i> , (Publisher: Campus Books International 2013). 3. S.N. Ghoshal, <i>Atomic Physics (Modern Physics)</i> (Publisher: S Chand & Company 2010). 4. S P Kuila, <i>Concepts of Atomic Physics</i> (Publisher: New Central Book Agency NCBA), 1 st Edition 2017).		
Evaluation Pattern: 60:40		
Total Marks: 100		
Internal Continuous Evaluation: 40 Marks - Internal Work -1: CCE-I-20 Marks - Internal Work -2: CCE-II-20 Marks - Internal Work -3: CCE-III-20 Marks		End Semester Examination:60 Marks 1. Question No.1 is compulsory. 2. Attempt any four questions from question numbers 2 to 7. - Question -1: 2 Mark x 6 = 12 Marks - Question -2: 6 Marks x 2 = 12 Marks - Question -3: 6 Marks x 2 = 12 Marks - Question -4: 6 Marks x 2 = 12 Marks - Question -5: 4 Marks x 3 = 12 Marks - Question -6: 4 Marks x 3 = 12 Marks - Question -7: 4 Marks x 3 = 12 Marks



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VII

Type: Discipline Specific Courses

Marks: 50

Credits: 2

From: A. Y. 2026-27

Name of the Course: BPTRM 475 (R): Research Methodology

Course Objectives: student should be able to.....

1. understand fundamentals of research methods
2. learn design and measurement concepts of research
3. know data collection and analysis tools
4. get knowledge of scientific report writing

Learning outcomes: After completion of syllabus, student will be able to.....

1. explain fundamental methods of research
2. evaluate, design and measure the concepts of research
3. differentiate different research matrices
4. write scientific report

Module	Title and Contents	Hrs
Module -1:	Module -1: Fundamentals of Research Methods 1.1 Definition of research 1.2 Research ethics and morality, Role and objectives of research, 1.3 Applications and types of research, 1.4 Research process and steps in it, Collecting and reviewing the literature, hypothesis	07
Module -2:	Module -2: Research Design and Measurement Concepts 2.1 Selecting and defining a research problem, 2.2 Need for research design, Different research designs, Different research designs, Scales of measurements, Nominal, Ordinal, Interval and ratio scales, Errors in measurements, 2.3 Validity and Reliability in measurement, Scale Construction Techniques.	08
Module -3:	Module -3: Literature Searching 3.2 Search engines, Scifinder, Scopus, Web of science, INFLIBNET, database, use of AI tools for literature search (Open knowledge map, research rabbit, publish or perish etc.) 3.2 Research Matrices: Citation index, H index, Impact factor, i10 index, etc. 3.3 Plagiarism: introduction, types and awareness, detection tools	08
Module -4:	Module -4: Review Writing 4.1 Discussions, Conclusion, referencing and various formats for reference writing, Review writing	07

	4.2 Use of Mendeley/Zotero software, Bibliography, Formats of publications in research journals, Use of AI tools for review writing (Scispace and Notebooklm)	
Reference Books: - 1. Kothari C.R., <i>Research Methodology, Methods and Techniques</i> (Second revised edition, Publisher: New Age International Publication, 2004). 2. Saravanavel P., <i>Research Methodology</i> (Publisher: Kitab Mahal, Sixteenth edition, 2007). 3. Ranjit Kumar, <i>Research Methodology, a step-by-step guide for beginners</i> (Publisher: Pearson education Australia, Second edition 2005). 4. Mark Saunders, Philip Lewis, Adrain Thornhiu, <i>Research Methods for Business Students</i> (Publisher: Pearson Education ltd, Seventh edition, 2016)		
Evaluation Pattern: 60:40		
Total Marks: 50		
Internal Continuous Evaluation: 20 Marks • Internal Work -1: CCE-I-10 Marks • Internal Work -2: CCE-II-10 Marks • Internal Work -3: CCE-III-10 Marks	End Semester Examination:30 Marks 1. Question No.1 is compulsory. 2. Attempt any two questions from question numbers 2 to 4. • Question -1: 2 Mark x 5 = 10 Marks • Question -2: 5 Marks x 2 = 10 Marks • Question -3: 5 Marks x 2 = 10 Marks • Question -4: 5 Marks x 2 = 10 Marks	



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VII

Type : Discipline Specific Courses

Marks: 50

Credits : 2

From: A. Y. 2026-27

Name of the Course: BPPRM 477 (R): Research Methodology LAB

Course Objectives: student should be able to.....

1. understand Origin Software
2. learn Mendeley Software
3. draw XPS plot using XPSPeak41 Software
4. know how to search literature

Course outcomes: After completion of syllabus, student will be able to.....

1. calculate particle size of material through SEM image using ImageJ software
2. demonstrate the given data using Origin software
3. determine reference style using Mendeley Software
4. illustrate the literature review process.

Credits=2	BPPRM 477 (R): Research Methodology LAB	No. of hours
	1. Use of Origin Software for base line fitting 2. Use of Origin Software for XPS fitting plotting 3. Use of Mendeley/Zotero Software (8 hr) 4. Use of XPSPeak41 Software 5. Calculate particle size via ImageJ Software 6. Synthesis of gold nanoparticles 7. Synthesis of silver nanoparticles 8. Synthesis of silicon nanoparticles 9. Synthesis of graphene oxide 10. Research Project Problem: literature searching, Review, Report, Presentation (equivalent to 5 practicals)	60

Reference Books:

1. <https://www.originlab.com/index.aspx?go=Downloads/BrochuresAndInfoSheets>
2. <https://www.mendeley.com/>
3. <https://usercontent.one/wp/www.harwellxps.guru/wp-content/uploads/2020/05/XPSPEAKusersguide.pdf>
4. <https://imagej.net/learn/user-guides>.
5. Kothari C.R., *Research Methodology, Methods and Techniques* (Second revised edition, Publisher: New Age International Publication, 2004).

Evaluation Pattern: 60:40	
Total Marks: 50	
Internal Continuous Evaluation: 20 Marks Internal Work-1: 20 Marks	End Semester Examination: 30 Marks Question -1: 30 Marks



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VII

Type: Discipline Specific Courses

Marks: 50

Credits: 2

From: A. Y. 2026-27

Name of the Course: BPP 476 (R): Practical I: LAB I

Course Objectives: student should be able to.....

1. determine conductivity
2. understand concept of stair case ramp generator
3. study frequency response of negative feedback amplifier
4. learn concept of Astable multivibrator

Course outcomes: After completion of syllabus, student will be able to.....

1. calculate the heat capacity value of given material
2. demonstrate the concept of stair case ramp generator using CRO
3. determine frequency response of negative feedback amplifier using CRO
4. illustrate the Astable multivibrator using IC 555

Credits 2	BPP 476 (R): LAB I	No. of hours
	1 Deposition of thin films by CBD method (8 hr) 2 Electrodeposition/ anodization of thin films 3 Synthesis of thin films by Hydrothermal/Solvothermal method (8hr) 4 Preparation of thin films by Reflux method (8 hr) 5 Synthesis of material by Sol-gel method 6 Preparation of thin films by SILAR method 7 Synthesis of nanoparticles by Co-precipitation method (8 hr) 8 Preparation of thin films by Spray Pyrolysis method (8 hr) 9 Microwave synthesis of thin films 10 Preparation of film by Doctor Blade method	60

Reference Books:

1. Rao, M. S. Ramachandra, and Shubra Singh. Nanoscience and Nanotechnology: Fundamentals to Frontiers. Wiley, 2013.
2. A.K. Sawhney, "Electrical and Electronic Measurements and Instrumentation" (Dhanpat Rai & Co., Eleventh edition 2015).
3. Kulkarni, S. K. Nanotechnology: Principles and Practices. Capital Publishing Company, 2014.
4. Charles Kittel, "Introduction to Solid State Physics" (Wiley, Eighth edition 2005).
5. A.K. Sawhney, "Electrical and Electronic Measurements and Instrumentation" 2006.

Evaluation Pattern: 60:40**Total Marks: 50****Internal Continuous Evaluation: 20 Marks**

- Internal Work -1: **20 Marks**

End Semester Examination: 30 Marks

- Question -1: **30 Marks**



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VII

Type: Discipline Specific Courses

Marks: 100

Credits: 4

From: A. Y. 2026-27

Name of the Course: BPPRP478 (R): Research Project

Course Objectives: student should be able to.....

1. understand the importance of research.
2. study the literature review on recent advanced materials.
3. write the review article on selected area of research.
4. learn concepts of research metrics.

Course outcomes: After completion of syllabus, student will be able to.....

1. calculate the interplanar spacing and crystallite size of the material.
2. demonstrate the practical on CBD, SILAR, electrodeposition, etc. methods.
3. determine the particle size using ImageJ software.
4. analyze the properties of materials.

Credits 4	BPPRP478 (R): Research Project	No. of hours
	Students will undertake research in specific area of his Major/Core with an advisory supported by a teacher/Faculty member. Students are required to take 4 credit Research Project for semester VII under the guidance of faculty members. There is separate guideline for research projects as per NEP.	120
Evaluation Pattern: 60:40		
Total Marks: 100		
Internal Continuous Evaluation: 40 Marks Internal Work-1: 40 Marks		End Semester Examination: 60 Marks Project presentation, Project report, Viva: 60 Marks



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VIII

Type: Discipline Specific Courses

Marks: 100

Credits: 4

From: A. Y. 2026-27

Name of the Course: BPT 481 (R)- Physical Properties of Solid

Course Objectives: student should be able to.....

1. understand the Drude model and DC electrical conductivity.
2. study Transport Properties of Metals like Sommerfeld theory of electrical conductivity, The mean free path in metals, Thermal scattering and thermal conductivity of metals.
3. know Phonons, Plasmons, Polaritons, and Polarons
4. learn magnetic properties of materials

Course Outcomes: After completion of syllabus, student will be able to....

1. describe Drude Theory of metals and Basic assumptions of Model, Collision or relaxation times, DC electrical conductivity
2. discuss steady state, Drift velocity and relaxation time
3. analyze Quantization of lattice vibrations, Phonon momentum
4. explain the structure of ferrite, the saturation magnetization and elements of Neels theory

Module	Title and Contents	Hrs
Module -1:	Module -1: Theory of metals 1.1 Basic assumptions of Drude Model, Collision or relaxation times, 1.2 DC electrical conductivity, Ground state properties of electron gas, 1.3 Sommerfeld theory of metals, Failures of the free electron model. 1.4 Band theory of solid, 1.5 Brillouin zones Electron Levels in a Periodic Potential : Introduction, 1.6 The tight-binding method, Linear combinations of atomic orbitals 1.7 Application to bands from s-Levels, 1.8 Wannier functions, Other methods for calculating band structure, Independent electron approximation, general features of valence band wave functions, Cellular method, 1.9 Muffin-Tin potentials, Augmented plane wave (APW) method, Pseudopotentials	15
Module -2:	Module-2 Transport Properties of Metals 2.1 Some features of the electrical conductivity of metals, A simple model leading to a steady state,	15

	2.2 Drift velocity and relaxation time, 2.3 The Boltzmann transport relation, The Sommerfeld theory of electrical conductivity, The mean free path in metals, Thermal scattering, The electrical conductivity at low temperature, The thermal conductivity of metals, Dielectric Properties of insulators. 2.4 Macroscopic electrostatic Maxwell equations, Theory of Local Field, 2.5 Theory of polarizability, Clausius- Mossotti relation, Long- wavelength optical modes in Ionic crystals	
Module -3:	Module -3 Phonons, Plasmons, Polaritons, and Polarons 3.1 Vibrations of monatomic lattices: first Brillouin zone, group velocity, Long wavelength limit, Lattice with two atoms per primitive cell. 3.2 Quantization of lattice vibrations, Phonon momentum, Dielectric function of the electron gas, Plasma optics, Dispersion relation for Electromagnetic waves, 3.3 Transverse optical modes in a plasma, Longitudinal Plasma oscillations, Plasmons, Polaritons, LST relations, Electron- electron interaction, Electron-phonon interaction: Polarons	15
Module -4:	Module -4: Optical Properties of Solids 4.1 Introduction 4.2 Classical Model–Drude Model 4.3 Ionic Conduction 4.4 Optical Refractive Index and Relative Dielectric Constant 4.5 Optical Absorption in Metals, Insulators and Semiconductors 4.6 Color Centers, Excitons, Luminescence, Maser and Laser, Application of Lasers 4.7 Physics of Optical Fibers	15
Reference Books:- 1. Ashcroft, Neil W., and N. David Mermin. 2003. <i>Solid state physics</i>.(Units 1pp. 1 to 304,II pp.534-643) 2. Kittel, Charles, and Paul McEuen. 2019. <i>Introduction to solid state physics</i>. Hoboken, NJ: John Wiley & Sons. (Units 3pp. 89-640) 3. Dekker, Adrianus J. 1981. <i>Solid State Physics</i>.(Units 1pp. 3-299, II pp. 395-397) 4. Pillai, S. O. 2018. <i>Solid state physics</i>.(Units 1pp.293-700, II pp. 427-485, Unit VI-pp 694-pp 740) 5. Saxena, B. S., R. C. Gupta, and P. N. Saxena. 1993. <i>Fundamentals of solid state physics</i>. Meerut:Pragati Prakashan.(Units IV pp.351-397)		
Evaluation Pattern:60:40		
Total Marks: 100		
Internal Continuous Evaluation: 40 Marks • Internal Work -1: CCE-I-20 Marks • Internal Work -2: CCE-II-20 Marks • Internal Work -3: CCE-III-20 Marks		End Semester Examination:60 Marks 1. Question No.1 is compulsory. 2. Attempt any four questions from question numbers 2 to 7. • Question -1: 2 Mark x 6 = 12 Marks • Question -2: 6 Marks x 2 = 12 Marks • Question -3: 6 Marks x 2 = 12 Marks • Question -4: 6 Marks x 2 = 12 Marks • Question -5: 4 Marks x 3 = 12 Marks • Question -6: 4 Marks x 3 = 12 Marks • Question -7: 4 Marks x 3 = 12 Marks



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VIII

Type: Discipline Specific Courses

Marks: 100

Credits: 4

From: A. Y. 2026-27

Name of the Course: BPT 482 (R): Energy Conversion and Storage Devices

Course Objectives: student should be able to.....

- 1) understand solar cell and its characteristics.
- 2) learn generations of Solar cell and types of solar cells.
- 3) know battery parameters, Ni/Cd batteries, Lithium batteries and Supercapacitors.
- 4) study importance of Hydrogen as a future fuel..

Course Outcomes: After completion of syllabus, student will be able to....

- 1) explain solar cell, its characteristics and analytical techniques.
- 2) differentiate between generations and types of Solar cell.
- 3) describe Ni/Cd batteries and Lithium batteries and supercapacitors.
- 4) analyze methods of Hydrogen production and principle of Fuel cell.

Module	Title and Contents	Hrs
Module -1:	Module -1: Photovoltaics 1.1 P-N junction under illumination 1.2 Light generated current and I-V equation 1.3 Characteristics of solar cells 1.4 Upper limits of cell parameters 1.5 Losses in solar cells and equivalent circuit 1.6 Effects of various parameters on efficiency 1.7 Solar cell design for high Isc and high Voc 1.8 Antireflective coating (ARC) and fill factor 1.9 Analytical techniques: Solar simulator, quantum efficiency	15
Module -2:	Module-2 Types of solar cells 2.1 Generations of solar cells and trends in efficiency (η) 2.2 Dye-sensitized solar cells: advantages and disadvantages 2.3 Quantum dot sensitized solar cells 2.4 Perovskite solar cells 2.5 Photoelectrochemical (PEC) solar cells 2.6 Tandem solar cells 2.7 Polymer solar cells	15
Module -3:	Module -3 Batteries and Supercapacitors 3.1 Basics of electrochemical cells 3.2 Primary and rechargeable batteries	15

	3.3 Battery parameters: capacity, voltage, life cycle, discharge/charge rate 3.4 Ni/Cd battery charging methods and characteristic curves 3.5 Lithium batteries: chemistry, physics, anode, and cathode materials 3.6 Applications of lithium batteries 3.7 Supercapacitors: Similarities and differences between supercapacitors and batteries, 3.8 Energetics, Double layer electrostatic capacitor 3.9 Pseudocapacitance, Origin, Kinetic theory, Regon plot, Electrolyte factor, 3.10 Energy density and Power density, Impedance of a pseudocapacitance, Technology development, 3.11 Various oxides as pseudocapacitors	
Module -4:	Module -4: Hydrogen Energy 4.1 Hydrogen fuel: importance, sources, and vehicle applications 4.2 Hydrogen production methods: solar water splitting, direct electrolysis, direct thermal decomposition 4.3 Hydrogen storage: gaseous, cryogenic, and metal hydride 4.4 Hydrogen utilization: fuel cell principle, construction, and applications	15
Reference Books: - 1) Solanki Chetan Singh, Solar photovoltaics, Fundamentals, Technologies and Applications, PHI Learning Private Limited, Delhi, 2015. 2) Ohta T., Solar Hydrogen Energy Systems, Pergamon Press, 1979. 3) Kiehne H. A., Battery Technology Handbook, Marcel Dekker Inc Publisher, 1989. 4) Jarzabek B., Polymer Films for Photovoltaic Applications, Mdpi AG Publisher, 2022. 5) Yu A., Chabot V., Zhang J., Electrochemical Supercapacitors for Energy Storage and Delivery		
Evaluation Pattern:60:40		
Total Marks: 100		
Internal Continuous Evaluation: 40 Marks - Internal Work -1: CCE-I-20 Marks - Internal Work -2: CCE-II-20 Marks - Internal Work -3: CCE-III-20 Marks		End Semester Examination:60 Marks 1. Question No.1 is compulsory. 2. Attempt any four questions from question numbers 2 to 7. - Question -1: 2 Mark x 6 = 12 Marks - Question -2: 6 Marks x 2 = 12 Marks - Question -3: 6 Marks x 2 = 12 Marks - Question -4: 6 Marks x 2 = 12 Marks - Question -5: 4 Marks x 3 = 12 Marks - Question -6: 4 Marks x 3 = 12 Marks - Question -7: 4 Marks x 3 = 12 Marks



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VIII

Type : Discipline Specific Elective

Marks: 100

Credits : 4

From: A. Y. 2026-27

Name of the Course::BPT 483 (R) E-I: Advanced Quantum Mechanics-II

Course Objectives: student should be able to.....

1. understand Time-dependent perturbation theory and degeneracy.
2. study basic principle of variation method, application to their ground state of Hydrogen atom, first excited state of harmonic oscillator, WKB method and its applications
3. learn scattering theory.
4. know Semi classical theory of radiation and Selection rules.

Course Outcomes: After completion of syllabus, student will be able to....

1. discuss Stark effect and Fermi's Golden rule.
2. solve the problems of hydrogen atom.
3. analyze Low energy scattering and bound state, Resonance scattering, Scattering by hard sphere, Coulomb scattering.
4. describe the electric dipole and forbidden transitions and selection rules.

Module	Title and Contents	Hrs
Module -1:	Module -1: Time dependent Perturbation 1.1 Time-dependent Perturbation Theory, 1.2 Two State Problem, Transition probability for constant and harmonic perturbations, Fermi's Golden rule	15
Module -2:	Module -2: Approximation methods 2.1 Variational method: Basic principle, Application to their ground state of Hydrogen atom and first excited state of harmonic oscillator, 2.2 WKB method and its applications	15
Module -3:	Module -3: Scattering Theory 3.1 Laboratory and center of mass frames, scattering amplitude, 3.2 differential scattering cross section and total scattering cross section: scattering by spherically symmetric potentials; Method of partial waves; Phase shift; Ramsauer-Townsend effect; 3.3 scattering by a perfectly rigid sphere and by square well potential. 3.4 The Born approximation, applications and validity of the Born approximation	15
Module -4:	Module -4: Theory of Radiation 4.1 Semi classical theory of radiation;	15

	4.2 Transition probability for absorption and induced emission; 4.3 Electric dipole and forbidden transitions, Selection rules	
Reference Books:- 1. J. J. Sakurai, Jim Napolitano, Modern Quantum Mechanics, (Publisher: Cambridge University Press; 3rd edition, 2020). 2. David J. Griffiths, Darrell F. Schroeter, Introduction to Quantum Mechanics, (Publisher: Cambridge University Press; 3rd edition, 2018). 3. N Zettili, Quantum Mechanics concept and application, (Publisher 2nd edition, 2016).;Wiley India Pvt. Ltd: 4. P M Mathews, K Venkatesan, A Textbook of Quantum Mechanics, (Publisher: McGraw Hill Education; 2nd edition, 2017).		
Evaluation Pattern:60:40		
Total Marks: 100		
Internal Continuous Evaluation: 40 Marks • Internal Work -1: CCE-I-20 Marks • Internal Work -2: CCE-II-20 Marks • Internal Work -3: CCE-III-20 Marks	End Semester Examination:60 Marks 1. Question No.1 is compulsory. 2. Attempt any four questions from question numbers 2 to 7. • Question -1: 2 Mark x 6 = 12 Marks • Question -2: 6 Marks x 2 = 12 Marks • Question -3: 6 Marks x 2 = 12 Marks • Question -4: 6 Marks x 2 = 12 Marks • Question -5: 4 Marks x 3 = 12 Marks • Question -6: 4 Marks x 3 = 12 Marks • Question -7: 4 Marks x 3 = 12 Marks	



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VIII

Type : Discipline Specific Elective

Marks: 100

Credits : 4

From: A. Y. 2026-27

Name of the Course: BPT 484 (R) E-II: Condensed Matter Physics

Course Objectives: student should be able to.....

1. study crystal growth and imperfections in crystals.
2. understand dielectricity, ferroelectricity and its consequences.
3. learn ferromagnetism and Antiferromagnetism its applications.
4. know semiconducting and Superconducting Properties of materials.

Course Outcomes: After completion of syllabus, student will be able to....

1. discuss concept of crystal growth.
2. analyze Langevin's theory and measurement of dielectric constant.
3. describe two sub lattice model of anti- ferromagnetism.
4. explain BCS theory of superconductivity

Module	Title and Contents	Hrs
Module -1:	Module -1: Crystal growth and Imperfections in crystals 1.1 Crystal growth:- Nucleation and growth- Homogeneous and heterogeneous nucleation- classification of crystal growth techniques - melt growth, Bridgman, Czochralski techniques. 1.2 Imperfections : Classification of imperfections- point defects – schottky and freckle defects-Expressions for equilibrium defect concentrations Colour centers- Production of colour centres- line defects- Dislocations- Edge and Screw dislocations-Burger Vector- Estimation of dislocation densities- Mechanism of creep	15
Module -2:	Module-2 Dielectrics 2.1 Dielectrics: Introduction, 2.2 Dipole moment, various types of polarization, electronic, ionic and orientation polarization, 2.4 Langevin's theory, Lorentz field, Local electric effect and its expression Clausius- Mosotti equation and Lorentz-Lorentz relation (Related to C-M relation), measurement of dielectric constant, 2.4 Applications of dielectrics.	15
Module -3:	Module -3 Ferromagnetism 3.1 Ferromagnetism: Introduction, 3.2 Weiss molecular field theory- Temperature dependence of spontaneous	15

	magnetization, Heisenberg model, 3.3 Hysteresis curve (property of Ferromagnetic materials), 3.4 Exchange interaction, ferromagnetic domains- Magnetic bubbles, Bloch wall, Thickness and energy, ferromagnetic spin waves, 3.5 Magnons- Dispersion relations.	
Module -4:	Module -4 Semiconducting Properties 4.1 Semiconductors: Kronig Penny Model (revision and significance), 4.2 Nearly free electron approximation, tight binding approximation, 4.3 Derivation of width of band in SC, BCC & FCC structure, intrinsic semiconductor: band model, calculation of electron & hole concentration, electrical conductivity, 4.4 extrinsic semiconductor: impurity states and band model, calculation of electron & hole concentration, electrical conductivity.	15

Reference Books:-

1. Saxena and Gupta, Fundamentals of Solid State Physics (Meerut, Pragati Publications, 2016) 355-437.
2. M.A.Wahab, Solid State Physics (Narosa Publisher, 2009) 150-558.
3. C. Kittel, Introduction to Solid State Physics (Wiley Publisher, 1979) 257-482.
4. R. K.Puri and V. K. Babbar, Solid State Physics (S. Chand Publication, 2010) 88-122.
5. A. J. Dekker, Solid State Physics (Laxmi Publisher, 2008) 132-430.

Evaluation Pattern:60:40

Total Marks: 100

Internal Continuous Evaluation: 40 Marks • Internal Work -1: CCE-I-20 Marks • Internal Work -2: CCE-II-20 Marks • Internal Work -3: CCE-III-20 Marks	End Semester Examination:60 Marks 1. Question No.1 is compulsory. 2. Attempt any four questions from question numbers 2 to 7. • Question -1: 2 Mark x 6 = 12 Marks • Question -2: 6 Marks x 2 = 12 Marks • Question -3: 6 Marks x 2 = 12 Marks • Question -4: 6 Marks x 2 = 12 Marks • Question -5: 4 Marks x 3 = 12 Marks • Question -6: 4 Marks x 3 = 12 Marks • Question -7: 4 Marks x 3 = 12 Marks
---	---



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VIII

Type : Discipline Specific Course

Marks: 50

Credits : 2

From: A. Y. 2026-27

Name of the Course: BPP 485 (R): Practical II: LAB II

Course Objectives: student should be able to.....

1. study PVD deposition technique
2. analyze the Photoluminescence, Raman, IR, TGA-DTA spectra.
3. calculate the electrochromic properties using Cyclic –Voltammetry.
4. measure the gas sensitivity of given sample.

Course Outcomes: After completion of syllabus, student will be able to....

- 1) understand deposition parameters of PVD.
- 2) analyze the Photoluminescence, Raman, IR, TGA-DTA spectra.
- 3) calculate the electrochromic properties using Cyclic –Voltammetry.
- 4) differentiate the gas sensitivity of different samples.

Credits=2	BPP 485 (R): LAB II	Hrs
	1) Deposition of Thin film using PVD (8 hr) 2) I-V characteristics of Silicon solar cell 3) Spectral response studies of solar cell 4) Measurement of different parameters of supercapacitor (2 days) 5) To study characteristics of photodiode 6) Analysis of given Photoluminescence spectrum 7) Analysis of given Raman spectrum 8) Analysis of given FTIR spectrum 9) Analysis of given TGA-DTA spectrum 10) To study effect of operating temperature on gas sensing performance of given sample (8 hr) 11) To study effect of gas concentration (ppm) on gas sensing performance of given sample. (8 hr)	60

Reference Books:-

1. Kulkarni, S. K. Nanotechnology: Principles and Practices. (Capital Publishing Company, 2014).
2. S.M. Sze, "Physics of Semiconductor Devices" (Publisher: Wiley; 3rd edition, 2006).
3. H.S. Kalsi, "Electronic Instrumentation" (Publisher: Tata McGraw Hill; 3rd edition, 2010)
4. Arthur Beiser, "Concepts of Modern Physics" (Publisher: McGraw Hill Education; 6th edition, 2009).

Evaluation Pattern: 60:40	
Total Marks: 50	
Internal Continuous Evaluation: 20 Marks	End Semester Examination: 30 Marks
Internal work-1: 20 Marks	Question -1: 30 Marks

BPPRP486 (R): Research Project (8 Credits) (240 hr)

Students will undertake research in specific area of his Major/Core with an advisory supported by a teacher/Faculty member. Students are required to take 8 credit Research Project for semester VIII under the guidance of faculty members. There is special guidelines for Research projects as per NEP.



Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc. IV

Semester - VII

Type: Discipline Specific Courses

Marks: 200

Credits: 8

From: A. Y. 2026-27

Name of the Course: BPPRP486 (R): Research Project

Course Objectives: student should be able to.....

1. understand the real-life applications of various nanomaterials.
2. study how to write research paper.
3. write research project on nanomaterials.
4. learn the importance of research in daily life.

Course outcomes: After completion of syllabus, student will be able to.....

1. calculate the energy density, power density of given materials.
2. demonstrate the device on solar cell, supercapacitor, gas sensor, photodiode, etc.
3. determine specific capacitance, Tafel slope, HER, OER of given material.
4. analyze the materials using various characterization techniques.

Credits 8

BPPRP486 (R): Research Project

**No. of
hours**

Students will undertake research in specific area of his Major/Core with an advisory supported by a teacher/Faculty member. Students are required to take 8 credit Research Project for semester VII under the guidance of faculty members. There is separate guideline for research projects as per NEP.

240

Evaluation Pattern: 60:40

Total Marks: 200

Internal Continuous Evaluation: 80 Marks

Internal Work-1: 80 Marks

End Semester Examination: 120 Marks

Project presentation, Project report, Viva:
120 Marks