



Karmaveer Bhaurao Patil University, Satara

**Syllabus for
B. Sc. III Nanoscience and Technology**

**Under
Faculty of Science and Technology**

(As per NEP 2.0)

With effect from Academic Year 2026-2027

Syllabus for Bachelor of Science (B.Sc.) Part – III Nanoscience and Technology

PREAMBLE:

The B.Sc. Nanoscience and Technology course under the autonomy framework will be introduced in the academic year 2026-2027. It has been designed to meet the specific needs of B.Sc. Nanoscience and Technology students in accordance with the NEP 2020 guidelines. The curriculum has been developed to reflect the expanding scope of industrial applications. The focus is on equipping students with up-to-date knowledge while maintaining a strong foundation in research and development. This approach will enable students to understand and appreciate contemporary interdisciplinary methods in physical science, chemical science, electronics and their contributions to research development. The course also includes new practical exercises, providing students with hands-on experience with the latest techniques currently in use. Additionally, the course is intended to inspire students to pursue higher studies in Nanoscience and Technology, become entrepreneurs, and seek employment in semiconducting industries.

GENERAL OBJECTIVES OF THE COURSE:

1. To investigate and understand the unique physical, chemical and biological properties that emerges at the Nano scale.
2. To design, synthesize, and characterize new Nano materials with tailored properties for various applications.
3. To enable the fabrication of smaller, faster and more efficient electronic, photonic and mechanical devices.
4. To create nanotechnologies that enhances renewable energy production, energy storage and environmental protection.

PROGRAMME OUTCOMES

After completing the B.Sc. program, graduates will:

1. To explain fundamental concepts of Nano scale phenomena and stay updated with recent advancements in the field of nanotechnology.
2. To demonstrate the functioning of advanced instruments used for Nano scale characterization and ability to interpret data to study Nano scale properties.
3. Applying the knowledge of nanomaterial synthesis design various nanostructures with specific properties.
4. To assess the potential applications of nanomaterial based on their unique properties and selecting nanomaterial for specific applications.

PROGRAMME SPECIFIC OUTCOMES

After completing the B.Sc. Nanoscience and Technology program, students will:

1. Learn the fundamental principles, concepts and recent development in Nanoscience and Technology.
2. Understand the properties of materials at Nano scale and working of sophisticated instruments to evaluate Nano scale properties.

3. Apply the knowledge of nanomaterial synthesis methods to design nanostructures and utilize the characterization techniques for analysis of nanostructures.
4. Evaluate the effectiveness of specific nanomaterials for targeted applications. Considering their unique properties.

1. TITLE: **Nanoscience and Technology**

2. YEAR OF IMPLEMENTATION: **2026-2027**

3. DURATION: **01 year**

4. PATTERN: **Semester examination**

5. MEDIUM OF INSTRUCTION: **English**

As per NEP-2020 (2.0)

Level	Sem.	Course				VSC/ SEC	AEC	OJT	CEP	FP	CC	Total
		DSC		DSE*								
		T	P	T	P							
5.5	V	DSC I (2)	DSC P (2)	DSE I (2)	DSE P (2)	VSC P(2)	AEC (2)	OJT (4)	CEP (2)	--	--	22
		DSC II (2)		DSE II (2) (Elective : Any one among two)								
		DSC III (2)										
5.5	VI	DSC I (2)	DSC P (2)	DSE I (2)	DSE P (2)	VSC P(2)	AEC (2)	--	--	FP (2)	CC (2)	22
		DSC II (2)		DSE II (2) (Elective : Any one among two)		SEC P (2)						
		DSC III (2)										

2. COURSE TITLE

1) Fifth Semester

Sr. No.	Subject	Theory				Practical		
		Course No. & Course Code	Title of Course	No. of lectures per week	Credits	Course No. & Course Code	No. of Practical Per week	Credits
1.	DSC XXI	BNTT 351	Science at Nano scale: Properties of Nanomaterial	2	2	BNTTP 356	1	2
2.	DSC XXII	BNTT 352	Nanomaterial based energy conversion and storage	2	2			
3.	DSE XXIII	BNTT 353	Nano Catalysis	2	2			
4.	DSE XXIV (E1)	BNTT 354	Polymer based Nanocomposite	2	2	BNTTP 357	1	2
5.	DSE XXV (E2)	BNTT 355	Chemistry for Nanoscience V					
6.	VSC	--	--	--	--	BNTTPVSC 3	1	2
7.	AEC		English III	2	2			
8.	CEP	--	--	--	--	BNTPCEP	--	2
9.	OJT	--	--	--	--	OJT	4	4

2) Sixth Semester

Sr. No.	Subject	Theory				Practical		
		Course No. & Course Code	Title of Course	No. of lectures per week	Credits	Course No. & Course Code	No. of Practical Per week	Credits
1.	DSC XXVI	BNTT 361	Nanocomposite	2	2	BNTP 366	1	2
2.	DSC XXVII	BNTT 362	Carbon based Nanomaterials	2	2			
3.	DSE XXVIII	BNTT 363	Industrial Application of Nanomaterials	2	2			
4.	DSE XXIX (E1)	BNTT 364	Physics for Nanoscience IV	2	2	BNTP 367	1	2
5.	DSE XXX (E2)	BNTT 365	Nanobiotechnology II					
6.	VSC	--	--	--	--	BNTPVSC 4	1	2
7.	FP	--	--	--	--	BNTPFP I	2	2
8.	SEC	--	--	--	--	BNTPSEC III	2	4
9.	CC	--	--	--	--	CC I	2	2

3. EVALUATION STRUCTURE:

Semester V (5.5)

Course	Course Category	Course Code	Internal Evaluation			ESE	Total Marks	Credits
			CCE-I	CCE- II	CCE- III			
DSC	T	BNTT 351	10	10	10	30	50	02
	T	BNTT 352	10	10	10	30	50	02
	T	BNTT 353	10	10	10	30	50	02
	P	BNTP356	20			30	50	02
DSE (1 Theory Papers Out of Two)	T	BNTT 354	10	10	10	30	50	02
	T	BNTT 355	10	10	10	30	50	
	P	BNTP 357	20			30	50	02
VSC	P	BNTPVSC 3	--	20	--	30	50	02
AEC	T	BNTTAEC	10	10	10	30	50	02
CEP	P	BNTPCEP I	--	20	--	30	50	02
OJT	P	BNTPOJT I	--	--	--	100	100	04
Total							600	22

CCE- out of three CCE marks best of two CCE marks consider

Semester VI

Course	Course Category	Course Code	Internal Evaluation			ESE	Total Marks	Credits
			CCE-I	CCE-II	CCE- III			
DSC	T	BNTT 361	10	10	10	30	50	02
	T	BNTT 362	10	10	10	30	50	02
	T	BNTT 363	10	10	10	30	50	02
	P	BNTP 366	20			30	50	02
DSE (1 Theory Papers Out of Two)	T	BNTT 364	10	10	10	30	50	02
	T	BNTT 365	10	10	10	30	50	
	P	BNTP 367	20			30	50	02
VSC	P	BNTPVSC 4	--	20	--	30	50	02
FP	P	BNTPFP II	--	20	--	30	50	02
SEC	P	BNTPSEC III	--	--	--	100	100	04
CC								02
Total							600	22

CCE- out of three CCE marks best of two CCE marks consider

DSC: Discipline Specific Course; DSE: Discipline Specific Elective; VSC: Vocational Skill Course; SEC: Skill Enhancement Courses; AEC: Ability Enhancement Courses (English); OJT: On Job Training; FP: Field Project; CEP: Community Engagement Program; CC: Co-Curricular courses; T: Theory; P: Practical

4. OTHER FEATURES:

A) LIBRARY:

Reference books, Textbooks, journals, and Periodicals are available in Institute and Departmental Library. (Separate reference lists are attached along with the respective course syllabus)

B) EQUIPMENT:

a) Computer, LCD projector.

b) Laboratory Equipment:

- | | |
|-----------------------------|------------------------------|
| 1. Microscope | 2. Hot Air Oven |
| 3. Digital weighing balance | 4. Incubator |
| 5. pH meter | 6. Refrigerator |
| 7. Centrifuge | 8. Autoclave |
| 9. Magnetic Stirrer | 10. Ultrasonicator |
| 11. Conductometer | 11. UV- Visible Spectroscopy |

	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.	Semester - V
	Type : Major Paper I	Marks: 50
	Credits : 2	From: 2026-27
Name of the Course: BNTT 351: Science at Nanoscale: Properties of Nanomaterial		
Course Objective: Students will be able to 1) study the physical properties of nanomaterials. 2) understand the mechanical properties of nanomaterials. 3) classify the electrical properties of nanomaterials. 4) explain the optical properties of nanomaterials.		
Course Outcomes: students should be able to..... 1) analyze physical properties of nanomaterials. 2) describe hardness of nanomaterials by using nanoindentation. 3) get knowledge of mechanical properties of nanomaterials. 4) apply thermodynamics of nanomaterials.		
Module	Title and Contents	Hrs
Module -1:	Physical Properties of Nanomaterials 1.1 Mechanical Characterization – Plastic deformation, Toughness, Stiffness 1.2 Ductility modulus and load carrying capability, fatigue – abrasion and wear resistance etc. 1.3 Stress- Strain Curve. Hardness of nanomaterials: Nano indentation. 1.4 Nano machines. Mechanical properties of CNT.	08
Module -2:	Electronic Properties of Nanomaterials 2.1 Density of states of 3D, 2D, 1D and 0D dimensional nanostructures. 2.2 Clusters of metals and semiconductors, nanowires. 2.3 Size-induced metal- insulator-transition (SIMIT). Electronic transport in 1,2 and 3 dimensions. 2.4 Effective mass. Drude conduction of metals - mean free path in 3D-diffusive transport and ballistic conduction.	08
Module -3:	Optical Properties of Nanomaterials 3.1 Interaction of light with matter: Absorption- Emission. Direct and indirect band gap transitions 3.2 Radiative-non radiative process, photoluminescence 3.3 Surface Plasmon: Interaction of light with metal, scattering, extinction. 3.4 Origin of color generation from metal nanoparticles, Size and Shape dependent optical properties.	07
Module -4:	Magnetic Properties of Nanomaterials 4.1 Origin of magnetism in materials, Classification into Dia-, Para- and Ferro- magnetic materials 4.2 Hysteresis in ferromagnetic materials, domains, soft and hard magnetic materials Coercivity vs particle size, Single domain particles, 4.3 Application of nanomaterials based on magnetic properties	07

Reference Books:-

1. Kulkarni, S. K. *Nanotechnology: Principles and Practices*. 3rd ed. New Delhi: Capital Publishing, 2014.
2. *An Introduction to Nanoscience and Nanotechnology*. Hoboken, NJ: John Wiley & Sons, 2008.
3. Callister, William D., Jr., and David G. Rethwisch. *Materials Science and Engineering*. New York: John Wiley & Sons, 2000.
4. Zhang, Jin Zhong. *Optical Properties and Spectroscopy of Nanomaterials*. Singapore: World Scientific Publishing Co., 2009.
5. Kelsall, Robert W., Ian W. Hamley, and Mark Geoghegan. *Nanotubes and Nanomaterials: Synthesis, Properties, and Applications*. Oxford: Oxford University Press, 2023.

Evaluation Pattern: 60:40**Total Marks: 50****Internal Continuous Evaluation: 30 Marks**

- CCE-I: 10 Mark
 - CCE II: 10 Mark
 - CCE-III: 10 Mark
- (Best of Two CCE)**

End Semester Examination: 50 Marks

- Question -1: 2 Mark x 5 = 10 Mark
 - Question -2: 10 Mark x 2 = 20 Mark
 - Question -3: 5 Mark x 4 = 20 Mark
- (50 Marks converted to 30 Marks)**



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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc

Semester - V

Type : Major Paper II

Marks: 50

Credits : 2

From: 2026-27

Name of the Course: BNTT 352: Nanomaterial Based Energy Conversion and Storage

Course Objectives: Students will be able to

- 1) understand the basic concepts of energy systems.
- 2) study the fundamental concepts of energy conversion systems.
- 3) understand the photovoltaic cells.
- 4) classify different semiconducting materials introduced to the students.

Course Outcomes: students should be able to.....

- 1) identify the basic concepts of energy conversion systems.
- 2) appraise the working of electrochemical cells.
- 3) describe the photovoltaic cells.
- 4) summarize the working of energy storage systems.

Module	Title and Contents	Hrs
Module -1:	Fundamental Concepts in Electrochemistry 2.1 Electrochemical Cell, Faraday 's laws, Electrode Potentials 2.2 Thermodynamics of electrochemical cells, Polarization losses in electrochemical cells. 2.3 Electrode process and kinetics, Electrical double layer 2.4 Photo electrochemical cell	07
Module -2:	Photovoltaic Systems 1.1 Principles of photovoltaic energy conversion (PV) 1.2 Types of Photovoltaic Cells 1.3 Performance parameters of solar cells 1.4 Silicon based cells, Dye- Sensitized solar cells, Perovskite solar cells	07
Module -3:	Energy Storage Systems- Batteries 3.1 Issues and Challenges of functional Nanostructured Materials for electrochemical Energy Storage Systems 3.2 Primary and Secondary Batteries (Lithium-ion Batteries) 3.3 Cathode and anode materials, Nanostructured Carbon-based materials, Nano- Oxides 3.4 Novel hybrid electrode materials, Current status and future trends	08
Module -4:	Electrochemical Capacitors 4.1 Capacitor, Electrochemical super capacitors 4.2 electrical double layer model 4.3 Principles and materials design, Nanostructured Carbon-based materials 4.4 Redox capacitor Nano oxides, Conducting polymers-based materials, Current status and future trends	08

Reference Books:-

1. Bard, Allen J., and Larry R. Faulkner. *Electrochemical Methods: Fundamentals and Applications*. 2nd ed. Hoboken, NJ: John Wiley & Sons, 2004.
2. Linden, David, and Thomas B. Reddy. *Handbook of Batteries*. 3rd ed. New York: McGraw-Hill, 2002.
3. Conway, B. E. *Electrochemical Supercapacitors: Scientific Fundamentals and Technological Applications*. New York: Kluwer Academic/Plenum Publishers, 1999.
4. Solanki, Chetan Singh. *Solar Photovoltaics: Fundamentals, Technologies and Applications*. New Delhi: PHI Learning, 2015.
5. O'Hayre, Ryan, Suk-Won Cha, Whitney Colella, and Fritz B. Prinz. *Fuel Cell Fundamentals*. 2nd ed. Hoboken, NJ: Wiley, 2016.

Evaluation Pattern: 60:40**Total Marks: 50****Internal Continuous Evaluation: 30 Marks**

- CCE-I: 10 Mark
 - CCE II: 10 Mark
 - CCE-III: 10 Mark
- (Best of Two CCE)**

End Semester Examination: 50 Marks

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	Board of Studies in Physics	
	Programme: B.Sc	Semester - V
	Type : Major Paper III	Marks: 50
	Credits : 2	From: 2026-27
Name of the Course: BNTT 353: Nano Catalysis		
Course Objectives: Students will be able to 1) explain the reaction on solid surfaces. 2) understand langmuir- hinshelwood mechanism. 3) adopt knowledge about photocatalysts. 4) to develop photocatalyst.		
Course Outcomes: Students should be able to 1) analyze the catalytic efficiency of nanoparticles. 2) evaluating the difference between bulk and nanoscale catalytic activity. 3) remember the types of good photocatalyst. 4) apply knowledge to design photocatalyst.		
Module	Title and Contents	Hrs
Module -1:	Introduction to Catalysis 1.1 Introduction to catalysis, classifications 1.2 Reaction on the solid surfaces, adsorption isotherms 1.3 Physisorption and chemisorptions 1.4 Reaction mechanism and kinetics of the heterogeneous catalytic reactions, activation energy (Arrhenius equation, Eyring equation).	07
Module -2:	Catalytic Activity 2.1 Catalytic activity (bulk and nanoscale), catalytic activity determination for metal/metal oxide nanostructures 2.2 Langmuir-Hinshelwood mechanism for nano catalyst 2.3 Catalytic efficiency and turnover frequency, inhibition 2.4 Application of metal nanoparticles in organic reactions (Heck and Suzuki-Maurya reactions)	08
Module -3:	Photocatalysis 3.1 Introduction of photocatalysis, Basics of electrochemistry and photochemistry 3.2 Electronics structure and photo absorption, Kinetics and photocatalytic activity, Jablonski diagram 3.3 Properties of good photocatalysts, Advantages of photocatalysts 3.4 Types of photocatalysts, Homogeneous, heterogeneous, carbonaceous and plasmonic photocatalysts	08
Module -4:	Application of Photocatalysis 4.1 Photo catalysts design and synthesis 4.2 Application of photo catalysis, Self-cleaning, purification of water and air photo reduction of CO ₂ and fuel production, antimicrobial use 4.3 Characterization and performance of photo catalysts, Fabrication of water purification reactor 4.4 Industrial development of photo catalysts, Environmental remediation	07
Reference Books:- 1. Serpone, N., and E. Pelizzetti. <i>Photocatalysis: Fundamentals and Applications</i> . New York: Wiley, 1989. 2. Astruc, Didier. <i>Nanoparticles and Catalysis</i> . Hoboken, NJ: John Wiley & Sons, 2008. 3. Rohatgi-Mukherjee, K. K. <i>Fundamentals of Photochemistry</i> . 3rd ed. New York: John Wiley & Sons, 2002.		

4. Zhang, Jinlong, and Min Wei. *Nanocatalysis: Synthesis and Applications*. Amsterdam: Elsevier, 2015.
5. Zhang, Haiyan, and Xianming Li, eds. *Nanocatalysis: Principles and Applications in Chemistry Environmental Science*. 1st ed. Cambridge: Royal Society of Chemistry, 2017.

Evaluation Pattern: 60:40

Total Marks: 50

Internal Continuous Evaluation: 30 Marks

- CCE-I: 10 Mark
 - CCE II: 10 Mark
 - CCE-III: 10 Mark
- (Best of Two CCE)**

End Semester Examination: 50 Marks

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 - Question -3: 5 Mark x 4 = 20 Mark
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	Board of Studies in Physics		
	Programme: B.Sc	Semester - V	
	Type : Elective Paper I	Marks: 50	
	Credits : 2	From: 2026-27	
Name of the Course: BNTT 354: Polymer based Nanocomposites			
Course Objectives: Students will be able to 1) learn various classification and basic concept of polymerization. 2) understand in detail different polymerization techniques. 3) know about structural characteristics of conducting polymers. 4) learn various kinds of nanocomposites and their properties and applications			
Course Outcomes: Students should be able to 1) remember basic concept of polymer and nanocomposites 2) find importance of polymer based nanocomposites techniques 3) evaluate the different types of nanocomposites. 4) analyze about properties and application of nanocomposites.			
Module	Title and Contents	Hrs	
Module -1:	Basic Aspects of Polymer and Nanocomposites 1.1 Classification and some basic definitions of Addition and Condensation polymerization and Copolymerization 1.2 Mechanism of Free radical, cationic and anionic polymerization, Glassy solids, Glass transitions and melting temperature and their determination by DSC 1.3 Factors affecting T _g , Importance of T _g , Crystallinity of polymers	08	
Module -2:	Conducting Polymers 2.1 Discovery, structural characteristics and doping concept, charge carriers and conducting mechanism 2.2 Classification of conducting polymers, intrinsic and extrinsic conducting polymers 2.3 Chemical and electrochemical methods of the synthesis of conducting polymers 2.4 Application of conducting polymers in corrosion protection, sensors, electronic and electrochemical energy devices	07	
Module -3:	Polymer Nanocomposites 3.1 Definition of Nanocomposites, Nanofillers 3.2 Classification of Nanofillers, Synthesis and properties of Nanofillers 3.3 Types of Nanocomposites, synthesis of nanocomposites, Direct mixing, solution mixing 3.4 In-situ polymerization, Polymer/ metal oxide nanocomposites, their properties and applications.	07	
Module -4:	Photosynthesis 4.1 Fractal based Glass, metal nanocomposites 4.2 Core shell structured nanocomposites, super hard nanocomposites 4.3 Self-cleaning nanocomposites, metal matrix nanocomposites, 4.4 Metal with nanoceramic fillers such as SiC, TiO ₂ , CNTs and their mechanical, corrosion resistance properties and functional applications	08	

Reference Books:- 1. Rudin, Alfred. <i>Elements of Polymer Science and Engineering</i>. Amsterdam: Elsevier Science, 1998. 2. Meyer, Bill. <i>A Textbook of Polymer Chemistry</i>. Singapore: John Wiley & Sons, 1994. 3. Eftekhari, Ali, ed. <i>Nanostructured Conductive Polymers</i>. Hoboken, NJ: John Wiley & Sons, 2010. 4. Ajayan, P. M., L. S. Schadler, and P. V. Braun. <i>Nanocomposite Science and Technology</i>. Weinheim: Wiley- VCH, 2004.	
Evaluation Pattern: 60:40	
Total Marks: 50	
Internal Continuous Evaluation: 30 Marks • CCE-I: 10 Mark • CCE II: 10 Mark • CCE-III: 10 Mark (Best of Two CCE)	End Semester Examination: 50 Marks • Question -1: 2 Mark x 5 = 10 Mark • Question -2: 10 Mark x 2 = 20 Mark • Question -3: 5 Mark x 4 = 20 Mark (50 Marks Converted to 30 Marks)

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	Board of Studies in Physics	
	Programme: B.Sc	Semester - V
	Type : Elective Paper II	Marks: 50
	Credits : 2	From: 2026-27
Name of the Course: BNTT 355 : Chemistry for Nanoscience V		

Course Objectives: Students will be able to

- 1) learn different types of electrolytes.
- 2) study formation of coordinate bond.
- 3) understand different types electrolytic methods.
- 4) gain knowledge of theories behind study of f-block elements.

Course Outcomes: Students should be able to

- 1) remember the concept of ionic equilibria.
- 2) evaluate the mechanism of thermodynamics.
- 3) apply the concept of coordination sphere.
- 4) classify the electrolytic methods.

Module	Title and Contents	Hrs
Module -1:	Ionic Equilibria 1.1 Arrhenius theory of electrolytic dissociation, Strong and Weak Electrolytes 1.2 Degree of ionization, factors affecting degree of ionization 1.3 Ionization constant and ionic product of water 1.4 Ionization of weak acid and bases, p^H scale, common ion effect.	07
Module -2:	Coordination Chemistry 2.1 Introduction, Definition and formation of coordinate bond in BF_3-NH_3 2.2 Distinguish between double salt and complex salt 2.3 Werner's theory-postulates, ligand, coordination number 2.4 Coordination sphere, IUPAC Nomenclature of coordination compounds.	07
Module -3:	Conductometric Titration 3.1 Introduction, Definition, General Procedure of Conductometric Titration 3.2 Different types of Conductometric Titration, Strong acid Vs Strong Base 3.3 Strong Acid Vs Weak Base, Weak acid Vs Strong Base 3.4 Weak Acid Vs Weak Base, Cell Constant, Types of Cells.	08
Module -4:	Chemical Thermodynamics 4.1 Introduction and definition of different terms and processes in Thermodynamics 4.2 Zeroth law of Thermodynamics, first law of thermodynamics 4.3 Spontaneous processes and different statement of second law of thermodynamics 4.4 Carnot cycle and its efficiency, carnot theorem.	08

Reference Books:-

1. Atkins, Peter, and Julio de Paula. *Physical Chemistry*. 9th ed. Oxford: Oxford University Press, 2011.
2. Atkins, P. W. *Physical Chemistry*. 8th ed. Oxford: Oxford University Press, 2006.
3. Barrow, G. M. *Physical Chemistry*. New York: McGraw-Hill, 2007.
4. Sony, P. L., O. P. Dharmarha, and U. N. Das. *Textbook of Physical Chemistry*. New Delhi: Sultan Chand & Sons, 2003.
5. Liu, Zhongfan, and Zhiqiang Jiang, eds. *Nanochemistry: A Chemical Approach to Nanomaterials*. 2nd ed. London: Imperial College Press, 2016.

Evaluation Pattern: 60:40

Total Marks: 50

Internal Continuous Evaluation: 30 Marks • CCE-I: 10 Mark • CCE II: 10 Mark • CCE-III: 10 Mark (Best of Two CCE)	End Semester Examination: 50 Marks • Question -1: 2 Mark x 5 = 10 Mark • Question -2: 10 Mark x 2 = 20 Mark • Question -3: 5 Mark x 4 = 20 Mark (50 Marks Converted to 30 Marks)
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	Yashavantrao Chavan Institute of Science, Satara	
	Board of Studies in Physics	
	Programme: B.Sc	Semester - V
	Type : Practical Lab	Marks: 50
	Credits : 2	From: 2026-27
	Name of the Course: BNTP 356 : Practical XI	

Course Objectives: Students will be able to

- 1) learn different characterization techniques.
- 2) understand analysis of the materials by using characterization technique.
- 3) to study frequency distribution curve.
- 4) to determine the energy band gap.

Course Outcomes: Students should be able to

- 1) remember principle and working of various characterization techniques.
- 2) get knowledge about the crystal structure of materials by using xrd.
- 3) evaluating the structural properties by using stm.
- 4) calculate the surface area of colloidal materials by using image of tem.

Sr. No.	Name of Experiments	Hrs
1)	To Study Structural properties of Nanomaterials by XRD	60
2)	Use of FT-IR for functional group identification (in CNT, Graphene etc.)	
3)	Determination of crystallite size using Scherer formula	
4)	Structural properties by STM	
5)	Determination of average particle size by frequency distribution curve	
6)	Study of Super paramagnetism in Iron Oxide Nanoparticles.	
7)	Determination of Band Gap Energy in Nanomaterials Using Tauc Plot	
8)	To Study Raman Spectroscopy Analysis of Nanomaterials	
9)	Measurement of IV Characteristics of a Solar Cell	
10)	Study Voltage and Current Measurement of a Lithium-ion Battery.	
11)	Effect of Light Intensity on Solar Cell Performance	
12)	Effect of Nanomaterials on Battery Performance by compare Nano vs bulk materials.	
13)	Verification of Faraday's Laws by study mass deposition vs charge.	
14)	Charging and Discharging of Lithium-ion Battery by plot voltage vs time graph.	
15)	Testing Different Anode and Cathode Materials for Li-ion Batteries.	

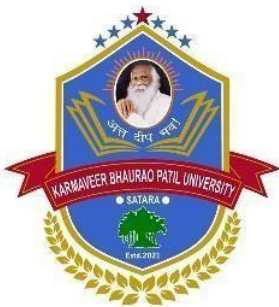
Reference Books:-

1. Poole, Charles P., Jr., and Frank J. Owens. *Introduction to Nanotechnology*. Hoboken, NJ: John Wiley & Sons, 2003.
2. Bhushan, Bharat, ed. *Springer Handbook of Nanotechnology*. Berlin: Springer, 2007.
3. Challa, S. S. R. Kumar, and J. H. Carola. *Nanofabrication Towards Biomedical Application: Techniques, Tools, Application and Impact*. Hoboken, NJ: John Wiley & Sons, 2006.
4. Jayaraman, S. *Laboratory Manual in Biochemistry*. 3rd ed. Chennai: APC Publications, 2018.

Practical Evaluation Pattern 60:40

Total Marks : 50Marks

Internal Continuous Evaluation: (20 M) • Q.1 Internal Work= 20M	End Semester Examination: (30 M) • Q. 1 = 30 M
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	Yashavantrao Chavan Institute of Science, Satara		
	Board of Studies in Physics		
	Programme: B.Sc		Semester - V
	Type : Elective Lab I		Marks: 50
	Credits : 1		From: 2026-27
	Name of the Course: BNTP 357 : Practical XII		
Course Objectives: Students will be able to 1) understand the principles of catalysis and nanotechnology. 2) learn about the synthesis and characterization of nanocatalysts. 3) to evaluate the catalytic activity of nanocatalyst. 4) perform catalytic activity experiments.			
Course Outcomes: Students should be able to 1) operate and maintain equipment used in nanocatalyst synthesis. 2) analyze and interpret data from nanocatalyst. 3) evaluate the advantages of nanocatalyst. 4) describe the limitations of using nanocatalyst in various applications.			
Sr. No.	Name of Experiments	Hrs	
1)	Synthesis of Zinc oxide nanocatalyst for photocatalytic degradation of pollutants.	60	
2)	Synthesis of Graphene oxide nanocatalyst for photocatalytic degradation of pollutants.		
3)	Preparation of GO-ZnO nanocatalyst for degradation of pollutants.		
4)	Synthesis of graphene supported nanocatalysts for enhanced catalytic performance.		
5)	Synthesis of Zinc oxide nanoparticles for UV protection Application.		
6)	Evaluate the effect of particle size on nanocatalyst performance.		
7)	Study test the catalytic activity of graphene supported nanocatalysts.		
8)	To synthesize a metal-polymer nanocomposite and study its properties.		
9)	Synthesis of Silver nanoparticles using Starch and check its Antibacterial activity.		
10)	Preparation of PVA-Chitosan Nanocomposite Film.		
11)	To synthesize a conducting polymer by chemical oxidation.		
12)	Preparation of Polymer Nanocomposites by Solution Mixing.		
13)	Synthesis of polyaniline nanofibers.		
14)	Preparation of Starch based Biodegradable Plastic film.		
15)	To Study Dye adsorption study using polymer nanocomposites.		
Reference Books:- 1. Okada, Akane, and Toshio Kurauchi. <i>Polymer-Based Molecular Composites</i> . Berlin: Springer, 2000. 2. Mai, Yiu-Wing, and Zhong-Zhen Yu. <i>Polymer Nanocomposites</i> . Cambridge: Woodhead Publishing, 2006. 3. Ajayan, Pulickel M., Linda S. Schadler, and P. V. Braun. <i>Nanocomposites: Synthesis, Structure, Properties, and Applications</i> . Weinheim: Wiley-VCH, 2006. Indian Institute of Technology Bombay. <i>Laboratory Manual for Nanocomposites</i> . Mumbai: IIT Bombay, 2020.			

4. Thakur, Mukesh, and Rakesh K. Gupta, eds. *Polymer Nanocomposites: Synthesis, Characterization, and Applications*. Boca Raton, FL: CRC Press, 2015.

Practical Evaluation Pattern :60:40

Total Marks :50Marks

Internal Continuous Evaluation: (20 M)

- Q.1 Internal work= 20M

End Semester Examination: (30 M)

- Q. 1 = 30 M

	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		Semester - V
	Type : VSC		Marks: 50
	Credits : 2		From: 2026-27
	Name of the Course: BNTPVSC 3: Vocational Skill Courses in Applied Nanotechnology I		
Course Objectives: Students will be able to 1) understand the fundamental principles of nanotechnology. 2) learn about the synthesis, characterization and application of nanomaterials. 3) study the principles of nanodevices, nano sensors and nano system. 4) familiarize with the latest advancements and trends in nanotechnology.			
Course Outcomes: Students should be able to 1) understand the principle of nanotechnology. 2) learn to the synthesize and characteristic nanomaterial using various techniques. 3) student will develop entrepreneurial skills through hands on project. 4) prepare students for careers in nanotechnology research.			
Sr. No.	Name of Experiments	Hrs	
1)	To preparation of hydrophobic surface using silica nanoparticles and test its water-repelling ability.	60	
2)	To formulation sunscreen using zinc oxide nanoparticles and evaluate its UV-blocking efficiency.		
3)	To study the role of metal oxide nanoparticles in degrading dyes such as methylene blue.		
4)	Cleaning procedure of ITO/ FTO glass substrate.		
5)	To study the effects of ZnO nanoparticles on seed germination and root growth.		
6)	Study of current behavior with respect to time for oxidation and reduction process.		
7)	Study of Charge behavior with respect to time for oxidation and reduction process.		
8)	To detect the light intensity changes at the nanoscale by using Arduino.		
9)	Testing biosensor using Arduino.		
10)	Develop an energy harvesting system using Arduino nanotechnology-based sensing elements and energy storage devices.		
11)	Directional Control of the DC motor using Arduino.		
12)	Interfacing Servo motor with the Arduino.		
13)	Detection of the light using photo resistor.		
14)	To measure temperature changes at the nanoscale by using Arduino.		
15)	To detect the motion at the nanoscale by using Arduino.		

Reference Books:-

1. Cao, Guozhong. *Nanotechnology: Principles and Applications*. London: Imperial College Press, 2004.
2. Gogotsi, Yury. *Nanomaterials: Synthesis, Properties, and Applications*. Boca Raton, FL: CRC Press, 2006.
3. Koch, Carl C. *Nanostructured Materials: Processing, Properties, and Applications*. 2nd ed. Cambridge: Cambridge University Press, 2007.
4. Drexler, K. Eric. *Nanosystems: Molecular Machinery, Manufacturing, and Computation*. New York: Wiley, 1992.
5. Pradeep, Thalappil. *Nano: The Essentials—Understanding Nanoscience and Nanotechnology*. New Delhi: Tata McGraw-Hill, 2007.

Practical Evaluation Pattern 60:40**Total :50 Marks****Internal Continuous Evaluation: (20 M)**

- Q.1 Internal Work = 20M

End Semester Examination: (30 M)

- Q. 1 = 30 M



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.

Semester - V

Type: OJT

Marks: 100

Credits: 4

From: 2026-27

Name of the Course: BNTPOJT: On Job Training in Nanotechnology

Course Objectives: By the end of the course, Students should be able to....

1. provide practical exposure to industrial, research or laboratory environments related to nanotechnology.
2. develop technical skills in handling instruments, experimental techniques, and data analysis methods.
3. enhance problem solving ability and application of theoretical nanoscience concepts in real world situations.
4. build professional skills such as communication, teamwork , work ethics and report writing.

Course Outcomes: After completion of course, students will be able to....

1. apply fundamental nanotechnology concepts in practical industrial or research based environments.
2. operate scientific instruments and perform experiments with accuracy and safety.
3. analyse and interpret experimental/field data using appropriate tools and techniques.
4. demonstrate professional behaviour, teamwork and effective communication in workplace.

Evaluation Pattern: 60:40

Total Marks : 100

Internal Continuous evaluation: 40 M

- **Q.1 Internal Work = 40 M**

End Semester Examination: (60 M)

- **Q. 1 = 60 M**

On Job Training provides practical exposure to real world applications of nanotechnology in industries, laboratories and research organizations. Students gain hand on experience with instruments, experimental techniques, data analysis and workplace practicals. It helps students connect theoretical concepts learning in the classroom with practical application. OJT develops technical skills, problem solving abilities, professional ethics and confidence for higher education and employment.



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.

Semester - V

Type: CEP

Marks: 50

Credits: 2

From: 2026-27

Name of the Course: BNTPCP: Community Engagement Programme in Nanotechnology

Course Objectives: By the end of the course, Students should be able to....

1. create awareness among students about societal issues and the role of science in community development.
2. encourage application of nanotechnology concepts in solving real life problems at the community level.
3. develop social responsibility, leadership and ethical values among students.
4. promote active participation in outreach activities such as science awareness programs , environmental campaigns and energy conservation initiatives.

Course Outcomes: After completion of course, students will be able to....

1. apply basic nanotechnology principles to address community related problems such as energy conservation and environmental protection.
2. communicate scientific knowledge effectively to the public through demonstrations and awareness activities.
3. demonstrate leadership, teamwork and social responsibility while working in community based projects.
4. analyse and evaluate the impacts of scientific interventions on society and environment.

Evaluation Pattern: 60:40

Total Marks : 50

Internal Continuous Evaluation: 20 M

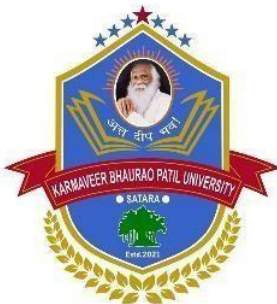
- Q.1 Internal Work = 20 M

End Semester Examination: (30 M)

- Q. 1 = 30 M

	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	Semester - VI
	Type : Major Paper I	Marks: 50
	Credits : 2	From: 2026-27
Name of the Course: BNTT 361 : Nanocomposites		
Course Objectives: Students will be able to 1) understand the fundamentals of nanocomposites. 2) explain the types and synthesis of nanocomposites. 3) study the role of nanofillers in enhancing material performance. 4) learn the properties and applications of ceramic and carbon-based nanocomposites.		
Course Outcomes: Students should be able to 1) discuss various properties of nanocomposites and study mechanical properties of super hard nanocomposites. 2) gain experimental knowledge on various syntheses of nanocomposites 3) evaluate the role of nanocomposites in society 4) apply knowledge of nanocomposites towards commercialization.		
Module	Title and Contents	Hrs
Module -1:	Introduction to Nanocomposites 1.1 Definition of composite material, Classification based on matrix and topology, Constituents of composites 1.2. Interfaces and Interphases, Distribution of constituents, Advantage of composite materials 1.3 Nanofillers, classification of Nano fillers 1.4 Carbon and noncarbon based nanofillers- synthesis and properties of fillers	08
Module -2:	Types of Nanocomposites 2.1 Metal-Metal nanocomposites, Natural nanocomposite systems 2.2 Polymer-Metal nanocomposites 2.3 Ceramic nanocomposites 2.4. Dielectric and CMR based nanocomposites. (One example for each type).	07
Module -3:	Ceramic Metal Nanocomposites 3.1 Ceramic based nonporous composites, metal matrix nanocomposites 3.2 Natural nano-bio composites, nanocomposites for hard coatings 3.3 DLC coatings, thin film nanocomposites 3.4 Various nanocomposites materials	07
Module -4:	Carbon based Nanocomposites 4.1 Carbon nanomaterials, Carbon dot 4.2 SWCNT, MWCNT, Graphene 4.3 Graphene oxide, Reduced Graphene Oxide, Metal/carbon nanomaterials 4.4 Polymer/carbon nanomaterials, Silica/carbon nanomaterials, TMD-MXene/carbon nanomaterials	08
Reference Books:- 1. Ajayan, P. M., L. S. Schadler, and P. V. Braun. <i>Nanocomposite Science and Technology: Processing and Properties of Structural Nanomaterials</i> . Weinheim: Wiley-VCH, 2003. 2. Royal Society of Chemistry. <i>Nanochemistry: A Chemical Approach to Nanomaterials</i> . Cambridge: Royal Society of Chemistry, 2005. 3. Mai, Yiu-Wing, and Zhong-Zhen Yu, eds. <i>Polymer Nanocomposites</i> . Cambridge: Woodhead Publishing, 2006. 4. Joseph, K. S., and P. A. S. Shukla, eds. <i>Nanocomposites: Synthesis, Characterization, and Applications</i> . Boca Raton, FL: CRC Press, 2015. 5. Nguyen, Tai K. T., and Mohamed A. S. Z. Mohammed, eds. <i>Polymer Nanocomposites: From Synthesis to Applications</i> . Berlin: Springer, 2017.		

Evaluation Pattern: 60:40	
Total Marks: 50	
Internal Continuous Evaluation: 30 Marks • CCE-I: 10 Mark • CCE II: 10 Mark • CCE-III: 10 Mark (Best of Two CCE)	End Semester Examination: 50 Marks • Question -1: 2 Mark x 5 = 10 Mark • Question -2: 10 Mark x 2 = 20 Mark • Question -3: 5 Mark x 4 = 20 Mark (50 Marks converted to 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	Semester - VI	
	Type : Major Paper II	Marks: 50	
	Credits : 2	From:2026-27	
Name of the Course: BNTT 362: Carbon based Nanomaterials			
Course Objectives: Students will be able to 1) study the physical properties of nanomaterials. 2) understand the mechanical properties of nanomaterials. 3) explain the electrical properties of nanomaterials. 4) describe the optical properties of nanomaterials			
Course Outcomes: Students should be able to 1) to classify of physical properties of nanomaterials. 2) describe concept of density of states. 3) evaluate the concept of quantum dots. 4) apply exchange coupling in magnetic multilayers.			
Module	Title and Contents	Hrs	
Module -1:	Graphene 1.1 Introduction of graphene, Graphite, Definition and structure of graphene 1.2 Types of graphene: stacking AA, BB, AB dispersion relation, Single layer, Bi- layer, Few layer 1.3 Properties of graphene; Optical: thickness dependency, optical conductivity 1.4 Electric filed tunable transparency, Plasmon's and Polari tons, carrier multiplication.	08	
Module -2:	Preparation and Characterization of Graphene 2.1 Epitaxial growth of graphene on Silicon carbide, Chemical deposition (CVD) growth of graphene films 2.2 Chemically derived graphene, Synthesis of graphene oxide: Hummer's method, Modified Hummer's method 2.3Reduction of graphene oxide: Chemical methods, Physical methods 2.4. Electrochemical exfoliation, Nanotube slicing, from solid state carbon sources	08	
Module -3:	Carbon Nanotubes 3.1 Introduction of Carbon Nanotube (CNT): Introduction and definition of CNT 3.2 Bonding of carbon atoms, SP ³ , SP ² , Deformed SP ² 3.3 Structure of Carbon Nanotubes, Chiral Vector 3.4 Armchair, Zig-Zag and Chiral tubes, Properties of Carbon Nanotubes.	07	
Module -4:	Carbon Nanotubes: Synthesis Method and Growth Mechanism 4.1 High temperature method, Arc discharge 4.2 General technical features of the production process, Growth Mechanism 4.3 Laser Ablation of Graphite, Low temperature method 4.4Chemical Vapor deposition (CVD) process, Vapor liquid solid model, Catalytic Role.	07	

Reference Books:-

1. Harris, Peter J. F. *Carbon Nanotubes and Related Structures: New Materials for the Twenty-First Century*. Cambridge: Cambridge University Press, 2009.
2. Jorio, Ado, G. Dresselhaus, and M. S. Dresselhaus. *Carbon Nanotubes: Advanced Topics in the Synthesis*. Berlin: Springer, 2008.
3. Reich, S., C. Thomsen, and J. Maultzsch. *Carbon Nanotubes: Basic Concepts and Physical Properties*. Weinheim: Wiley-VCH, 2004.
4. Gogotsi, Yury, and Volker Presser. *Carbon Nanomaterials*. 2nd ed. Boca Raton, FL: CRC Press, 2017.
5. □ Fiori, Gianluca, and L. S. M. Su, eds. *Carbon Nanomaterials for Advanced Energy Systems*. New York: Springer, 2019.

Evaluation Pattern:60:40**Total Marks: 50****Internal Continuous Evaluation: 30 Marks**

- CCE-I: 10 Mark
 - CCE II: 10 Mark
 - CCE-III: 10 Mark
- (Best of Two CCE)**

End Semester Examination: 50 Marks

- Question -1: 2 Mark x 5 = 10 Mark
 - Question -2: 10 Mark x 2 = 20 Mark
 - Question -3: 5 Mark x 4 = 20 Mark
- (50 Marks Converted to 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.	Semester – VI
	Type : Major Paper III	Marks: 50
	Credits : 2	From: 2026-27
Name of the Course: BNTT 363: Industrial Application of Nanomaterials		
Course Objectives: Students will be able to 1) learn various application of nanomaterials in different sectors. 2) understand in detail different applications in electrical and electronic industry. 3) know about nanotechnology in textile and cosmetic industries. 4) describe the nanotechnology in agriculture and defense industry.		
Course Outcomes: Students should be able to 1) understand nanotechnology in different electronic circuits and nano sensors. 2) describe importance of nanotechnology in textile and cosmetic field. 3) evaluate the military application of nanotechnology. 4) able to learn about mutation and different application of nanotechnology in agriculture and food industry.		
Module	Title and Contents	Hrs
Module -1:	Nanotechnology in Electrical and Electronic Industry 1.1 Advantages of nano electrical and electronic devices 1.2 Electronic circuit chips, Nano sensors and actuators 1.3 Optical switches, Diodes and Nanowire transistors, Memory storage	08
Module -2:	Nanotechnology in Textile and cosmetics 2.1 Textiles: Nanofiber production, Electrospinning, controlling morphologies of nanofibers, nano fillers embedded polypropylene fibers 2.2 Bionics- swim suits with shark skin effect, soil repellence 2.3 Cosmetics: Formulation of gels, Shampoos, Hair conditioners, sunscreen dispersion for UV protection using titanium oxide Color cosmetics	08
Module -3:	Nanotechnology in Défense 3.1 Military application of Nanotechnology 3.2 Artificial intelligence materials, propulsion, vehicles, Propellants and Explosives 3.3 Armour protection, Soldier system 3.4 Mini/Micro robots, Nuclear weapons.	07
Module -4:	Nanotechnology in Agriculture and Food Technology 4.1 Nanotechnology in Agriculture, Precision Farming, Smart Delivery system 4.2 Nano fertilizers, Nano urea and mixed Fertilizers, nanoferigation, Nano pesticides, Nano seed science 4.3 Nanotechnology in Food Industry: Nano packaging of enhanced shelf life, smart/ intelligent packaging 4.4, Food processing and Food safety and Bio security, Electrochemical sensors for food analysis and contaminant detection.	07
Reference Books:- 1) Brown, P. J., and K. Stevens. <i>Nanofibers and Nanotechnology in Textiles</i>. London: Woodhead Publishing, 2006. 2) Mai, Yiu-Wing. <i>Polymer Nanocomposites</i>. Cambridge: Woodhead Publishing, 2006. 3) Frewer, Lynn J., Wilhelm Norde, R. H. Fischer, and W. H. Kampers. <i>Nanotechnology in the Agri-Food Sector</i>. Chichester: Wiley-Blackwell, 2011. 4) Brown, P. J., and K. Stevens. <i>Nanofibers and Nanotechnology in Textiles</i>. Cambridge: Woodhead Publishing, 2007.		

Brinker, Udo H., and Jean-Luc Mieusset. *Molecular Encapsulation: Organic Reactions in Constrained Systems*. Hoboken, NJ: John Wiley & Sons, 2010.

Evaluation Pattern: 60:40

Total Marks: 50

Internal Continuous Evaluation: 30 Marks

- CCE-I: 10 Mark
 - CCE II: 10 Mark
 - CCE-III: 10 Mark
- (Best of Two CCE)**

End Semester Examination: 50 Marks

- Question -1: 2 Mark x 5 = 10 Mark
 - Question -2: 10 Mark x 2 = 20 Mark
 - Question -3: 5 Mark x 4 = 20 Mark
- (50 Marks converted to 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.	Semester - VI	
	Type : Elective Paper I	Marks: 50	
	Credits : 2	From: 2026-27	
Name of the Course: BNTT 364: Physics for Nanoscience IV			
Course Objectives: Students will be able to 1) learn the fundamental physical principles underlying the nanoscale materials. 2) understand the central concept and principles in quantum mechanics for small systems. 3) classify between macroscopic thermodynamics. 4) explain the fundamental principles, structure, processing, properties and performance of materials.			
Course Outcomes: Students should be able to 1) analyze the physics behind the small systems. 2) apply the quantum mechanical concepts to the multidimensional nanosystems. 3) describe the concepts of statistical mechanics, chemical kinetics and thermodynamics. 4) evaluate crystal structure of material and changes at nanoscale.			
Module	Title and Contents	Hrs	
Module -1:	Quantum Mechanics I 1.1 History, Feynman scorecard, Schrödinger's quantum mechanics in small system 1.2 Overview of quantum effects and fluctuations in nanostructures, Uncertainty principle 1.3 probability amplitude and the rules of quantum mechanics, Wave function , Dirac notation 1.4 Many Particle wave functions and identical particles, The Pauli Exclusion principle	07	
Module -2:	Quantum Mechanics II 2.1 Solution of the one-electron time independent Schrodinger equation for a constant potential (Quantum confinement) 2.2 Electron tunneling through a potential barrier Important results with 1D models 2.3 Hydrogen atom, Multielectron atoms 2.4 Approximate methods for solving the Schrodinger equation	07	
Module -3:	Solid State Physics I 3.1 Crystal structure, Periodic array of atoms, Lattice translation vectors, Basis and the crystal structure 3.2 Packing fraction Fundamental types of lattices, Two and three dimensions, Index of crystal planes 3.3 Diffraction of waves by crystals, Bragg law, Reciprocal lattice vector, Diffraction conditions, Laue equations, Brillouin zones 3.4 Reciprocal lattice to <i>sc</i> , <i>bcc</i> and <i>fcc</i> lattices ,Structure factor for <i>bcc</i> and <i>fcc</i> lattices, Atomic form factor.	08	
Module -4:	Solid State Physics II 4.1 Nearly free electron model, Origin of the energy gap, Magnitude of the energy gap, Bloch Functions 4.2 Kronig-Penney model, Wave equation of electron in a periodic potential 4.3 Restatement of the Bloch theorem, Crystal momentum of an electron 4.4 Kronig-Penney model in reciprocal space, Density of states for 1, 2 and 3 dimensional electron gas	08	

Reference Books:-

1. Cross, Matthew E., and Emma V. E. Plunkett. *The Physics of Solids*. Oxford: Oxford University Press, 2014.
2. Andrew, Lealand N. *A Textbook of Physics*. 1st ed. New Delhi: [Publisher not specified], 2003.
3. Kittel, Charles. *Introduction to Solid State Physics*. 8th ed. Hoboken, NJ: John Wiley & Sons, 2005.
4. Griffiths, David J. *Introduction to Quantum Mechanics*. 2nd ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.
5. hankar, R. *Principles of Quantum Mechanics*. 2nd ed. New York: Plenum Press, 1994.

Evaluation Pattern: 60:40**Total Marks: 50****Internal Continuous Evaluation: 30 Marks**

- CCE-I: 10 Mark
 - CCE- II: 10 Mark
 - CCE-III: 10 Mark
- (Best of Two CCE)**

End Semester Examination: 50 Marks

- Question -1: 2 Mark x 5 = 10 Mark
 - Question -2: 10 Mark x 2 = 20 Mark
 - Question -3: 5 Mark x 4 = 20 Mark
- (50 Marks converted to 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

Semester – VI

Type : Elective Paper II

Marks: 50

Credits : 2

From: 2026-27

Name of the Course: BNTT 365: Nanobiotechnology II

Course Objectives: Students will be able to

- 1) learn variations in gram positive and gram-negative bacterial cell wall.
- 2) understand in detail different structures and functions of cell organelles and cytoplasmic inclusions.
- 3) know about bacterial systematic and taxonomy.
- 4) adopt basic concepts of genetics w.r.t. various definitions.

Course Outcomes: Students should be able to

- 1) describe structure and functions of different organelles and cytoplasmic inclusions of bacteria.
- 2) discuss ecological significance and economic importance of different groups of bacteria and learn about nomenclature of bacteria.
- 3) evaluate the concept of gene, genetic code and operon.
- 4) classify about mutation and different types of mutations and dna repair mechanisms.

Module	Title and Contents	Hrs
Module -1:	Bacterial cell structure 1.1 Structure of components of gram positive and gram negative bacterial cell wall with their variations 1.2 Bacterial cell membrane structure chemical composition and function 1.3 Bacterial Endospore ultrastructure, sporulation and Germination 1.4 Flagella structure mechanism of movement, tactic behavior.	08
Module -2:	Bacterial systematics 2.1 Classification of bacterial systematic 2.2 Systematics and taxonomy, concept of species, taxa strain 2.3 Molecular recent approaches to bacterial taxonomy 2.4. rRNA ligonucleotide sequencing	08
Module -3:	Basic concept of Genetics 3.1 Gene, Genome, genotype, phenotype 3.2 Mutagen, recon, muton, cistron, split genes 3.3 Forms of DNA, definition and properties of genetic code 3.4 Lac operon concept	07
Module -4:	Mutations 4.1 Missense, nonsense, neutral, silent 4.2 Suppressor mutations 4.3 Types of Mutations 4.4 DNA repair mechanism, photoreactivation	07

Reference Books:-

1. Sitharaman, Balaji. *Nanobiomaterials: Development and Applications*. 2013.
2. Zhang, Mingjun. *Nanobiotechnology: Bioinspired Devices and Materials of the Future*. 2006.
3. Kim, Dong-Woo. *Nanobiotechnology and Biomaterials*. 2015.
4. Gao, Xiaohu. *Nanotechnology in Biology and Medicines: Methods, Devices and Applications*. 2013.
5. Kunkel, Thomas A., and Michael A. Bebenek. *DNA Mutation: Methods and Applications*. New York: Springer, 2011.

Evaluation Pattern: 60:40	
Total Marks: 50	
Internal Continuous Evaluation: 30 Marks • CCE-I: 10 Mark • CCE II: 10 Mark • CCE-III: 10 Mark (Best of Two CCE)	End Semester Examination: 50 Marks • Question -1: 2 Mark x 5 = 10 Mark • Question -2: 10 Mark x 2 = 20 Mark • Question -3: 5 Mark x 4 = 20 Mark (50 Marks converted to 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

Semester - VI

Type : Practical Lab

Marks: 50

Credits : 2

From: 2026-27

Name of the Course: BNTP 366 : Practical XIII

Course Objectives: Students will be able to

- 1) understand the fundamental concepts of nanocomposites, their classification, and their advantages over conventional materials.
- 2) synthesize and characterize different types of nanocomposites, including polymer, metal, ceramic, and carbon- based composites.
- 3) to study of various synthesis and fabrication methods.
- 4) classify of carbanions nanomaterials in fields such as energy storage.

Course Outcomes: Students should be able to

- 1) apply knowledge of nanocomposite materials, their structures, and key characteristics.
- 2) to synthesize and analyze nanocomposites using simple, cost-effective lab-scale methods.
- 3) to evaluate the structure and functionality of carbon nanomaterials.
- 4) to evaluate the suitability of carbonaceous nanomaterials for applications in energy, electronics, environmental, and biomedical fields, considering performance and sustainability factors.

Sr. No.	Name of Experiments	Hrs
1)	Synthesis of a Polymer based Thin Film via Spin coating method	60
2)	Preparation and Characterization of a Nano filler-Reinforced Polymer Composite	
3)	Study of Interface and Interphase in a Composite Using Microscopy	
4)	Synthesis of Metal-Metal Nanocomposite by Sol-gel Method	
5)	Dispersion Analysis of Nanofillers in a Polymer Matrix	
6)	Synthesis of Metal-Metal Nanocomposites by Chemical Co- Reduction	
7)	Fabrication and Study of a Polymer-Metal Nanocomposite	
8)	Synthesis of Metal-Polymer Nanocomposite by Co-precipitation method	
9)	Functionalized Graphene and identification of groups	
10)	Synthesis of Graphene Oxide by modified Hummer's method	
11)	Effect of Series resistance and temperature on solar cell- (Simulation)	
12)	Comparison of surface area of activated carbon and CNTs	
13)	Synthesis of Mesoporous Nanocomposite Materials via Sol-gel method	
14)	Raman Spectroscopy Analysis of Graphene and Carbon Nanotubes	
15)	Synthesis of Polymer-Metal nanocomposite Biofilm by Co-reduction method	

Reference Books:-

- 1) Sign, Ishwar. *Polymer-Based Nanomaterials for Sensing Applications*. 2020.
- 2) Mishra, Aklesh. *Polymer-Based Nanomaterials for Catalytic Applications*. 2020.
- 3) Kalia, Susheel, and Henna Hundal. *Polymer-Based Nanomaterials for Water Treatment Applications*. 2020.
- 4) Rentería, Juan D., and Gabriela M. Pérez. *Carbon Nanomaterials: Synthesis, Properties and Applications*. New York: Springer, 2017.
- 5) Zhang, Lin, and Hai-Wen Zhang. *Carbon Nanotubes and Graphene: Synthesis, Properties, and Applications*. Hoboken, NJ: John Wiley & Sons, 2019.

Evaluation Pattern: 60:40

Total Marks : 50

Internal Continuous Evaluation:

- Q.1 Internal work= 20M

End Semester Examination:

- Q.1= 30M

	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		Semester - VI
	Type : Elective Lab I		Marks: 50
	Credits : 2		From:2026-27
	Name of the Course: BNTP 367: Practical XIV		
Course Objectives: Students will be able to 1) understand double slit experiment. 2) learn about schrodinger equation using matlab. 3) create simulation lab. 4) calculate electron density of material			
Course Outcomes: Students should be able to 1) enable students to effectively use laboratory instruments. 2) to perform standard physics experiments with accuracy and precision. 3) describe the students to record, interpret, and analyze experimental data using appropriate scientific methods. 4) determine theoretical physics concepts by correlating them with practical observations.			
Sr. No.	Name of Experiments		Hrs
1)	Double slit experiment: Demonstrate wave particle duality.		
2)	Polarization of Light: Demonstrate light polarization.		
3)	Measure the interference pattern of photons passing through a double slit		
4)	Demonstrate the entanglement of photons using a beam splitter and a polarizer.		

5)	To solve time – independent Schrodinger equation using MATLAB.	60
6)	Implement a simple quantum mechanics experiment using MATLAB.	
7)	Measure the current- voltage characteristics of a tunnel diode to demonstrate electron tunneling.	
8)	Develop a simulation lab to demonstrate electron tunneling.	
9)	To synthesize and test the electrical properties of carbon nanotube- based electronic components.	
10)	To demonstrate the use of silver nanoparticles in antibacterial fabric.	
11)	Preparation of TiO ₂ nanoparticles for self cleaning glass.	
12)	Synthesis of Cu nanoparticles for antifouling paint.	
13)	Synthesis of ZnO nanoparticles in Sunscreen.	
14)	Synthesis NiO nanofibers by Electrospinning method	
15)	Synthesis Cobalt oxide nanofibers by Electrospinning method	
Reference Books:- 1. Taylor, John R. <i>An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements</i>. 2nd ed. Sausalito, CA: University Science Books, 1997. 2. Bevington, Philip R., and D. Keith Robinson. <i>Data Reduction and Error Analysis for the Physical Sciences</i>. 3rd ed. Boston: McGraw-Hill, 2003. 3. Giancoli, Douglas C. <i>Physics: Principles with Applications</i>. 7th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2013.		
Serway, Raymond A., and John W. Jewett. <i>Physics for Scientists and Engineers with Modern Physics</i> . 10th ed. Boston: Cengage Learning, 2014.		

Practical Evaluation Pattern 60:40	
Total : 50 Marks	
Internal Continuous Evaluation: (20M) • Q.1 Internal Work= 20M	End Semester Examination: (30M) • Q. 1 = 30 M

	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	Semester - VI
	Type : VSC	Marks: 50
	Credits : 2	From:. 2026-27
Name of the Course: BNTPVSC 4 : Computational Skills for Nanotechnology		
Course Objectives: Students will be able to 1) understand the principles of computational method and nanotechnology. 2) create the computational tools. 3) study the problem -solving skills using computational methods. 4) discuss properties and behavior of nanomaterials, such as nanoparticles, nanowire and nanotubes.		
Course Outcomes: Students should be able to 1) apply computational methods to solve problems in nanotechnology. 2) analyze and understand nanoscale phenomena, such as quantum mechanics and thermodynamics. 3) design and optimize nanomaterials using computational methods. 4) describe various computational tools, such as matlab, python.		
Sr. No.	Name of Experiments	Hrs
1)	Plotting of X ray Photoelectron Spectroscopy (XPS) data using XPS peak fit software.	60
2)	Calculation of porosity by color gradient analysis using Image software.	
3)	Analysis and Plotting survey spectrum of XPS data.	
4)	Plotting XRD graph using origin software.	
5)	Study of band structure of TiO2 by using density functional theory.	
6)	Measuring average particle size from SEM image by image J software and origin software by plotting histogram.	
7)	Study the behavior of nanoparticles, nanocrystals, nanostructure materials.	
8)	Simulate the size distribution of nanoparticles by use MATLAB histogram Function.	
9)	Simulate the aggregation of nanoparticles by use MATLAB random Function.	
10)	Simulate the diffusion of nanoparticles byuse MATLAB diffusion Function.	
11)	Simulate to structure of nanotube byuse MATLAB plot 3 Function.	
12)	Simulate to structure of nanowires byuse MATLAB plot Function.	
13)	Identification and classification of crystalline and amorphous materials.	
14)	Simulate to mechanics materials byuse of nanoparticles MATLAB ode45 Function	
15)	Simulation of nano structured material electronics use MATLAB.	
Reference Books:- 1) Rogers, Ben, Jesse Adams, and Sumita Pennathur. <i>Nanotechnology: Understanding Small Systems</i> . Cham: Springer, 2018. 2) Poole, Charles P., and Frank J. Owens. <i>Introduction to Nanotechnology</i> . 2nd ed. Hoboken, NJ: John Wiley & Sons, 2017. 3) Lee, June Gunn. <i>Computational Materials Science: An Introduction</i> . Cham: Springer, 2018. 4) Musa, Sarhan M. <i>Computational Nanotechnology: Modeling and Applications with MATLAB</i> . Cham: Springer, 2017. 5) Biegler, Lorenz T., James J. Damiano, and Alexander M. Layn. <i>ComputationalMethods in Chemical</i>		

Engineering. Cham: Springer, 2019.

Practical Evaluation Pattern 60:40

Total :50 Marks

Internal Continuous Evaluation: (20 M)

- **Q.1 internal Work= 20 M**

End Semester Examination: (30 M)

- **Q. 1 = 30 M**



Karmaveer Bhaurao Patil University, Satara
(A State Public University Est. u/s 3(6) of MPUA 2016)
Faculty of Science and Technology

Yashavantaro Chavan Institute of Science, Satara

Board of Studies in Physics

Programme: B.Sc.

Semester - VI

Type: SEC

Marks: 50

Credits: 2

From: 2026-27

Name of the Course: BNTPSEC III: Thin Film Coating Techniques III

Course Objectives: By the end of the course, Students should be able to....

1. understand crystal structure analysis of materials such as TiO_2 , ZnO , CuO , NiO_2 , and SiO_2 using def (density of energy function / computational tools).
2. study the electronic properties of materials through density of states (dos) analysis.
3. explain the band gap energy of different semiconductor and oxide materials.
4. learn practical skills in computational/material analysis tools for interpreting structural and electronic behaviour of materials.

Course Outcomes: After completion of course, students will be able to....

1. analyze crystal structures and identify lattice parameters and symmetry of TiO_2 , ZnO , CuO , NiO_2 , and SiO_2 .
2. interpret density of states (dos) plots to understand electronic distribution and energy levels in materials.
3. determine and compare band gap values of different materials and classify them as conductors, semiconductors, or insulators.
4. apply def/computational techniques to study material properties and relate them to real-world applications like semiconductors, sensors, and energy devices.

Sr. No	List of Experiments	Hrs
1	Fabrication of Antibacterial Nanocomposite Film Ag-based	60
2	Study of UV–Visible Absorption of Nanocomposite Materials	
3	Preparation of Reduced Graphene Oxide–Polymer Nanocomposite Film	
4	Synthesis of Carbon-Based Nanocomposite via Hydrothermal Method	
5	Synthesis of Carbon Dots from Citrus Peel Waste	
6	Fabrication of Antibacterial Nanocomposite Film Zn- based	
7	Fabrication of Antibacterial Nanocomposite Film Cu -based	
8	To study the optical absorption characteristics of nanocomposite materials using UV–Visible spectroscopy.	
9	To prepare ZnO nanoparticle-based antibacterial polymer nanocomposite film.	
10	To analyze optical absorption properties of TiO_2 nanocomposite material.	
11	To synthesize graphene–metal oxide nanocomposite using hydrothermal technique.	
12	To prepare conductive polyaniline-based nanocomposite film.	
13	To study optical absorption of silver nanoparticles using UV–Vis spectroscopy.	
14	To synthesize copper oxide nanoparticle-based nanocomposite film.	
15	To synthesize nickel oxide–carbon nanocomposite by hydrothermal method	

Reference Books:-

1. Rao, C. N. R., Achim Müller, and A. K. Cheetham, eds. *The Chemistry of Nanomaterials: Synthesis*,

Properties and Applications. Weinheim: Wiley-VCH, 2004.

2. UV–Visible Spectroscopy Skoog, Douglas A., F. James Holler, and Stanley R. Crouch. *Principles of Instrumental Analysis*. 7th ed. Boston: Cengage Learning, 2018.
3. Silver Nanoparticles Rai, Mahendra, Alka Yadav, and Aniket Gade. “Silver Nanoparticles as a New Generation of Antimicrobials.” *Biotechnology Advances* 27, no. 1 (2009): 76–83.
4. Zinc Oxide Nanoparticles Sirelkhatim, Ali, et al. “Review on Zinc Oxide Nanoparticles: Antibacterial Activity and Toxicity Mechanism.” *Nano-Micro Letters* 7, no. 3 (2015): 219–242.
5. Byrappa, Kullappa, and Masahiro Yoshimura. *Handbook of Hydrothermal Technology*. 2nd ed. Oxford: William Andrew Publishing, 2013.

Evaluation Pattern:60:40

Total Marks: 50 M

Internal Continuous Evaluation: (20 M)

- Q.1 Internal work= 20 M

End Semester Examination: (30 M)

- Q. 1 = 30 M

	Karmaveer Bhaurao Patil University, Satara (A State Public University Est. u/s 3(6) of MPUA 2016)	
	Faculty of Science and Technology	
	Yashavantaro Chavan Institute of Science, Satara	
	Board of Studies in Physics	
	Programme: B.Sc.	Semester - VI
	Type: FP	Marks: 50
	Credits: 2	From: 2026-27
Name of the Course: BNTFPF: Field Project in Nanotechnology		
Course Objectives: By the end of the course, Students should be able to.... 1. develop the ability to apply theoretical nanoscience concepts to real world field situations. 2. enhance observational. analytical and data collection skills through field-based investigations. 3. provide exposure to scientific instruments, measurement techniques and environmental conditions. 4. promote teamwork, scientific communication, and report writing skills through project work.		
Course Outcomes: After completion of course, students will be able to.... 1. apply fundamental nanotechnology principles to analyse real life problems encountered in the field. 2. collect, record and interpret experimental/field data using appropriate scientific methods. 3. use basic instruments and techniques effectively for field measurements and observations. 4. present findings in a structured report and demonstrate improved communication and teamwork skills.		
Evaluation Pattern: 60:40		
Total Marks : 50		
Internal Continuous evaluation: 20 M • Q.1 Internal Work = 20 M	End Semester Examination: (30 M) • Q. 1 = 30 M	

A field project for students is a practical learning activity where students study real-world Nanoscience application outside the classroom. The project can be done individually or in group under faculty guidance with report writing and presentations included. Its help students connect theory with observations, improve research skills and understanding the use of Nanotechnology in daily life.

Bachelor of Science (B.Sc.) Part- III Nanoscience and Technology

Semester VI

C. C. (Co-Curricular) (Credit 2)

Evaluation Pattern: 60:40	
Total Marks : 50	
Internal Continuous Evaluation: 20 M • Q.1 Internal Work = 20 M	End Semester Examination: (30 M) • Q. 1 = 30 M

