Karmaveer Bhaurao Patil University,

Satara

Syllabus for

B. Sc. I Materials Science

Under

Faculty of Science and Technology

(As per NEP 2020)

With effect from Academic Year 2024-2025

Preamble:

This syllabus is framed to give sound knowledge with understanding of Material Science to undergraduate students at first year of three years of B.Sc. degree course.

The aim of the syllabus is to make the study of Material Science interesting, encouraging and popular to the students for higher studies including research.

The new syllabus is based on a basic and applied approach with vigor and depth. At the same time precaution is taken to make the syllabus comparable to the syllabi of other universities and the needs of industries and research.

The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields.

The units of the syllabus are well defined, taking into consideration the level and capacity of students.

General Objectives of the Program:

1. To nurture academicians with focus and commitment to their subject.
2. To shape good and informed citizens from the students entering into the program.
3. To create a skilled work force to match the requirements of the society.
4. To impart knowledge of science is the basic objective of education.
5. To develop scientific attitude is the major objective to make the students open minded, critical, curious.
6. To develop skill in practical work, experiments and laboratory materials and equipments along with the collection and interpretation of scientific data to contribute the science.

Program Outcomes:

1. The student will graduate with proficiency in the subject.
2. The student will be eligible to continue higher studies in his subject.
3. The student will be eligible to pursue higher studies abroad.
4. The student will be eligible to appear for the examinations for jobs in government organizations.
5. The student will be eligible to appear for jobs with minimum eligibility as science graduate.
6. The student will be eligible to appear for industrial jobs with minimum eligibility as physics/ Material Science graduate.

Program Specific Objectives:

1. The students are expected to understand the fundamentals, principles, concepts and recent developments in the Material Science.
2. The practical course is framed in relevance with the theory courses to improve the understanding of the various concepts in Material Science.
3. It is expected to inspire and boost interest of the students in Material Science.
4. To develop the power of appreciations, the achievements in science and role in nature and society.
5. To enhance student sense of enthusiasm for science and to involve the intellectually stimulating experience of course in a supportive environment.

Program Specific Outcomes:

1. Understand the basics of Material Science.
2. Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.
3. Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Material Science.
4. Identify their area of interest in academic, research and development.
5. Perform job in various fields like science, engineering, education, banking, business and public service, etc. or be an entrepreneur with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach.

1. Title: Material Science

2. Year of Implementation: The syllabus will be implemented from June, 2023.

3. Duration: The course shall be a full time.

4. Pattern: Semester examination.

5. Medium of Instruction: English

6. Structure of Course:

7.

B.Sc.-I Semester-I

Sr. No.	Course Title	Theory			Practical		
		Course Code	Lectures Per week	Credits	Course Title	Lectures Per week	Credits
1	Properties of Materials	BMST 111	5	2	Practical Course – I :BMSP 113	4	2
2	Structure of Materials	BMST 112		2			

B.Sc. – I Semester – II

Sr. No.	Course Title	Theory			Practical		
		Course Code	Lectures Per week	Credits	Course Title	Lectures Per week	Credits
1	Special Materials	BMST 121	5	2	Practical Course – II :BMSP 123	4	2
2	Thermal, Magnetic and Electrical Properties of Material	BMST 122		2			

B: B.Sc. MS: Material Science T: Theory, P: Practical

7. Titles of Courses of B.Sc. I:

B.Sc. I (Semester I)

Theory: 30 lectures, 30 hours (for each Course)

Course – I : BMST 111 : PROPERTIES OF MATERIALS

Course –II : BMST 112: STRUCTURE OF MATERIALS

Practical: 60 lectures: 60 hours (Total)

Practical: BMSP 113: PROPERTIES OF MATERIALS & STRUCTURE OF MATERIALS

B.Sc. I (Semester II)

Theory: 30 lectures, 30 hours (for each Course)

Course – III: BMST 121: SPECIALMATERIALS

Course – IV: BMST 122: THERMAL, MAGNETIC AND ELECTRICAL PROPERTIES OF MATERIAL

Practical: 60 lectures: 60 hours (Total)

Practical: BMSP 123: SPECIAL MATERIALS & THERMAL, MAGNETIC and ELECTRICAL PROPERTIES OF MATERIAL

Material Science

B.Sc. I Semester I

Course – I: BMST 111: Properties of Materials (Credits: 02)

Course Objectives: Students should be able to,

1. understand the of scope of Material Science & importance of materials
2. define the different elastic properties of materials.
3. learn the physical properties of materials.
4. understand concept of band structure based classification of materials.

Credits (Total Credits 2)	**SEMESTER – I** **BMST 114: Properties of Materials**	**No. of hours per unit/credit**
Unit - I	**Introduction to Material Science**	**(08)**
	What is Material Science?, History of Material origin, Evolution of Materials, Scope of Material Science, Importance of Materials, Classification of Materials, Functional Classification of Materials, Difference between Metals and Non-Metals, Environmental and other effects.	
Unit – II	**Mechanical Properties of Materials**	**(08)**
	Review of Deforming Force, Restoring Force, Elasticity, Plasticity, Rigidity, Stress. Types of Stress, Strain, Types of Strain, Elastic coefficients, factors affecting elastic modulus , Poisson's ratio , yield strength , impact strength, toughness, hardness	
Unit – III	**Physical Properties of Materials**	**(08)**
	Lustre, Colour, Density, Relative Density, Specific Gravity, Melting Point, Surface energy and surface tension, Wetting and contact angle measurements, Surface roughness, Adhesion and cohesion, Surface treatment techniques.	
Unit - IV	**Electronic Properties of materials**	**(06)**
	Concept of energy band diagram for materials: conductors, semiconductors and insulators, Intrinsic Semiconductors, extrinsic semiconductors, direct and indirect band gap semiconductors, Carrier concentration in: intrinsic semiconductors, in extrinsic semiconductors, Carrier concentration in N-type & P type semiconductors.	

Course Outcomes : Students will be able to

1. explain the of scope of Material Science & importance of materials
2. define different elastic properties of materials.
3. classify and understand the physical as well as surface properties of materials.
4. apply the knowledge of band structure to classify different materials based on their electronic properties.

Reference Books:

1. Cahn, R. W. *Physical Metallurgy*. 2nd ed. Amsterdam: North Holland, 1970.
2. Smallman, R.E. *Modern Physical Metallurgy*. London: Butterworths, 1970.
3. Holloway, D.G. *Physical Properties of Glass*. London: Wykeham Publications, 1973.
4. Cottrell, A.H. *An Introduction to Metallurgy*. London: Edward Arnold, 1967.
5. Wahab, M.A. *Solid State Physics*. A.S. International, 2005.
6. Pillai, S.O. *Solid State Physics*. 6th ed. New Age International (P) Ltd Publishers, 2005.

Material Science

B. Sc. I Semester I

Course – II: BMST 112: Structure of Materials (Credits: 02)

Course Objectives: Students should be able to,

1. state the fundamental concepts of atomic structure, chemical bonding, and periodic trends.
2. comprehend the principles and theories of chemical bonding
3. get knowledge on co-ordination chemistry of compounds and theories of co-ordination.
4. explore the principles and theories of electronic structure and its relationship to the electronic & magnetic properties of coordination compounds.

Credits (Total Credits 2)	**SEMESTER – I** **BMST 112: Structure of Materials**	**No. of hours per unit/credit**
Unit - I	**Atomic Structure and Periodic Properties of Elements**	**(08)**
	Introduction to atomic structure, isotope, isobar and isotones, electronic configuration, introduction to periodic table, atomic radius, electonegativity, ionization enthalphy, oxidation states, metal, metalloids and non-metals.	
Unit – II	**Introduction to Bonding**	**(08)**
	Types of bond, covalent bond, concept of hybridization, types of hybridization, valence bond theory (VBT), Valence Shell Electron Pair Repulsion (VSEPR) theory.	
Unit – III	**Co-ordination Compounds**	**(06)**
	Coordinate Bond, double salts and complex salts, ligands and its types, complex formation and chelation, crystal field theory (CFT), Molacular Orbital theory (MOT).	
Unit - IV	**Properties of Co-ordination Compounds**	**(08)**
	Electronic spectra of coordination compounds, d-d transition, charge transfer spectra, diamagnetic, paramagnetic, ferromagnetic properties of coordination complex.	

Reference Books:

1. Atkins P. W, Julio De Paula and James Keeler, *Atkin's Physical Chemistry*. 12th ed. New York NY: Oxford University Press, 2023.
2. Bhatt Vasishta, *Essentials of Coordination Chemistry,* Elsevier Science, 2015.
3. Mortimer Robert G. *Physical Chemistry*. 3rd ed. Amsterdam: Academic Press/Elsevier, 2008.
4. Lee, J.D. *Concise Inorganic Chemistry*.5th ed. Oxford University Press, 2008
5. Huheey, J.E., Keiter, E.A., and Keiter, R.L. *Inorganic Chemistry: Principles of Structure and Reactivity*. 4th ed. Harper Collins, 1993.
6. Douglas, B.E., McDaniel, D.H., & Alexander, J.J. *Concepts and Models of Inorganic Chemistry*. 3rd ed. John Wiley, 1993.

Course Outcomes: Student will be able to

1. recall the fundamental concepts of atomic structure, chemical bonding, and periodic trends.
2. comprehend the principles and theories of chemical bonding.
3. gain knowledge on co-ordination chemistry of compounds.
4. explain the principles and theories of electronic structure and its relationship to the electronic & magnetic properties of coordination compounds.

Material Science

B.Sc. I Semester-I

Practical Course I: BMSP 113: Materials Science-I (Credits: 2)

(Based on Theory Course – I: BMST 111: Properties of Materials and Theory Course – II: BMST 112: Structure of Materials)

Course Objectives: Students should be able to,

1. to test elastic properties of materials of materials,
2. compute thermal properties of materials of materials
3. optical properties of materials of materials.
4. determine electronic properties of materials of materials.

• **Experiments:**

Sr. No.	Titles of Experiment
1	Torsional pendulum - Determination of rigidity modulus of Copper wire.
2	Torsional pendulum - Determination of rigidity modulus of Steel wire.
3	Torsional pendulum - Determination of rigidity modulus of Iron wire.
4	Young's modulus (Y) of Copper wire by Searle's method.
5	Young's modulus (Y) of Steel wire by Searle's method.
6	Young's modulus (Y) of Iron wire by Searle's method.
7	Determination of Poisson's ratio of rubber using rubber tube.
8	Determine the contact angle between water and given surface by using travelling microscope.
9	Basic statistical analysis of experimental data – I
10	Study of Multimeter
11	Testing of continuity in an electric circuit.
12	Determination of Band gap of a semiconductor (p-type)
13	Determination of Band gap of a semiconductor (n-type)
14	Determination of Band gap of a commercially available Silicon wafer.
15	Determine the type of semiconductor (p type or n type)

Reference Books:

1. Gupta, S.L., and Kumar, V. *Practical Physics*. 27th ed. Pragati Prakashan 2010.
2. I. Prakash and Ramakrishna, *A Textbook of Practical Physics,* (Kitab Mahal, 11th Edition, 2011.
3. Singh H. Harnam and Hemne P. S., *B.Sc. Practical Physics,* (New Delhi, S. Chand & Co. Ltd., 17th Edition, 2011.
4. Chattopadhyay, D., and Rakshit, P.C. *An Advanced Course in Practical Physics*. 7th ed. New Central Book Agency Pvt. Ltd. 2005.
5. Worsnop B. L and H. T Flint. *Advanced Practical Physics for Students* 9th ed. rev. and enl ed. London: Methuen, 1969.
6. White Marsh W and Kenneth V Manning. *Experimental College Physics; a Laboratory Manual*. 3rd ed. New York: McGraw-Hill.1954.

Course Outcomes : Student will be able to,

1. test elastic properties of materials of materials.
2. compute thermal properties of materials of materials
3. optical properties of materials of materials.
4. determine electronic properties of materials of materials.

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Material Science

B.Sc. I Semester II

Course – III: BMST 121: Special Materials (Credits: 02)

Course Objectives: Students should be able to,

1. identify different composite materials and their properties for different applications.
2. classify the various types of glasses, their optical, electrical properties.
3. state the ceramic materials with their enormous properties.
4. learn the phenomenological understanding of Ferroelectrics & Pyro-electrics and their advanced applications.

Credits (Total Credits 2)	SEMESTER – II BMST 121: Special Materials	No. of hours per unit/credit
Unit - I	**Composite Materials**	**(09)**
	Introduction, Fundamentals of composites, need for composites, enhancement of properties, classification of composites, Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Reinforcing materials for fibrous composites.	
Unit – II	**Glasses**	**(06)**
	Types of glasses, role of oxides in glasses, glass transition temperature, optical properties of glasses, electrical properties of glasses, electronically conducting glasses, special glasses and metallic glasses.	
Unit – III	**Functional Materials**	**(05)**
	Advanced Ceramics : Introduction, Classification of Ceramics, Structure of the Ceramics, Ceramic Processing, Properties of Ceramics, Applications.	
Unit - IV	**Ferroelectrics and Pyroelectrics**	**(10)**
	Ferroelectrics : Ferroelectric phenomena, Representative crystal, types of ferroelectrics: Properties of Rochelle salt, $BaTiO_3$, Applications of ferroelectric materials, ***Pyroelectrics*** : Pyroelectric phenomena, Phenomenological approach to pyroelectric effects, Pyroelectric parameters and their measurements, Applications of pyroelectric materials.	

Course Outcomes: Student will be able to,

1. recognize the different composite materials and their properties for different application.
2. classify the various types of glasses, their optical and electrical properties.
3. explain the ceramic materials with their enormous properties.
4. interpret the phenomenological understanding of Ferroelectrics, and Pyro-electrics

Reference Books:

1. Korablev Vadim V, Thangaprakash Sengodan, Ramadhansyah Putra Jaya, *Functional Materials*, London: Trans Tech Publications Limited, 2023.
2. Garrison John S. *Glass*, London England: Bloomsbury Academic An imprint of Bloomsbury, 2020.
3. Callister, William D., Jr. *Materials Science and Engineering: An Introduction*. 10th ed. John Wiley & Sons. 2017.
4. Gilmore Charles M. *Materials Science & Engineering Properties*, SI ed. Australia: Cengage Learning, 2015.
5. Doremus R. H. *Glass Science*. 2nd ed. New York: Wiley. 1994.
6. Holloway, D.G. *Physical Properties of Glass*. London: Wykeham Publications, 1973.
7. Lawrence J. Broutman and Richard H. Krock . *Modern Composite Materials*. Eds. Addison-Wesley, 1969.

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Material Science

B.Sc. I Semester II

Course – IV: BMST 122: Thermal, Magnetic and Electrical Properties of Materials (Credits:02)

Course Objectives: Students should be able to,

1. define the specific heat and thermal conductivity of material.
2. state the applications of thermal insulation.
3. understand basic properties of magnetic materials.
4. understand phenomenon of superconductivity in materials.

Credits (Total Credits 2)	SEMESTER – II BMST 122: Thermal, Magnetic and Electrical Properties of Materials	No. of hours per unit
Unit - I	**Thermal Properties - I**	**(07)**
	Introduction, Basic concepts of heat transfer, Thermal Resistance of Solids, Thermal Conductivity, Heat Capacity, Thermal expansion of solids and liquids, Expansion joints, Bimetallic strips.	
Unit – II	**Thermal Properties - II**	**(08)**
	Definition and significance of thermal conductivity, Factors influencing thermal conductivity Measurement techniques for thermal conductivity: Lee's disc method: theory and experiment Applications of materials with high and low thermal conductivity: heat exchangers, refrigerators, ovens and solar water heaters.	
Unit – III	**Electrical Properties of Materials**	**(08)**
	Concept of electrical resistor, classification of materials based on electrical resistivity, Measurement of resistivity by Two probe and Four probe method, Hall effect: measurement and determination of charge carrier concentration.	
Unit - IV	**Magnetic Properties of Materials**	**(07)**
	Introduction, Origin of Magnetism in materials, Magnetic Permeability, Magnetization, Electrical Current in Atoms- Bohr Magnetron, Electron Spin and Magnetic Moment, Types of Magnetic Materials and their properties & applications.	

Course Outcomes: Student will be able to,

1. define the specific heat and thermal conductivity of material.
2. explain the applications of thermal insulation.
3. interpret the basic properties of magnetic materials.
4. describe the phenomenon of superconductivity in materials.

Reference Books:

1. Kittel Charles and Paul Mc Euen. *Introduction to Solid State Physics* Global ed. Hoboken NJ: Wiley. 2022.
2. Jain V. K., *Solid State Physics*, 3rd ed. Cham India : Springer : ANE Books India, 2022.
3. Pillai S. O. *Solid State Physics* 8th ed. London UK: New Academic Science an imprint of New Age International (UK). 2018.
4. Wahab M. A. *Solid State Physics : Structure and Properties of Materials* 3rd ed. Oxford: Alpha Science International.2017.
5. Kumar Arun. *Introduction to Solid State Physics* 2nd ed. Delhi: PHI Learning Private Ltd., 2015.
6. Dekker A. J. *Solid State Physics*. London: Macmillan Education Ltd., 1969.

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B.Sc. I Semester-II

Practical Course II: BMSP123: Special Materials and Thermal, Magnetic & Electrical Properties of Materials (Credits: 2)

(Based on Theory Course – III: BMST124: Special Materials and

Theory Course – IV: BMST123: Thermal, Magnetic & Electrical Properties of Materials)

Course Objectives: Students should be able to,

1. to determine the specific heat of Graphite material.
2. to determine the Brinel Hardness number of given material
3. to determine the Rockwell Hardness number of given material
4. to determine resistivity of various thin films by Two Probe and Four Probe method.

Experiments

Sr No.	Titles of Experiment
1	Basic statistical analysis of experimental data – II
2	Determination of specific heat of Graphite material.
3	Determination of specific heat of Steel material.
4	Lee's disc- Determination of thermal conductivity of a bad conductor (Asbestos).
5	Lee's disc- Determination of thermal conductivity of a bad conductor (PUF).
6	Determine the Impact toughness (strain energy) through Charpy test
7	Determine the Impact toughness (strain energy) through Izod impact test.
8	Hardness test on Cast Iron. (Rockwell Hardness Test).
9	Hardness test on mild Steel. (Rockwell Hardness Test).
10	Hardness test on Cast Iron. (Brinell Hardness Test).
11	Hardness test on mild Steel. (Brinell Hardness Test).
12	Measurement of Resistivity of ZnO thin film by Two Probe method.
13	Measurement of Resistivity of CdS thin film by Two Probe method.
14	Study the temperature dependence of resistivity of a semiconductor (Four probe method)
15	Determine the band gap of experimental material (Ge) using Four probe method.

Course Outcomes: Student will be able to,

1. to determine the specific heat of Graphite material.
2. to determine the Brinel Hardness number of given material
3. to determine the Rockwell Hardness number of given material
4. to determine resistivity of ZnO thin film by Two Probe method.

Reference Books:

1. Gupta, S.L., and Kumar, V. *Practical Physics*. 27th ed. Pragati Prakashan 2010.
2. I. Prakash and Ramakrishna, *A Textbook of Practical Physics*, (Kitab Mahal, 11th Edition, 2011.
3. Singh H. Harnam and Hemne P. S., *B.Sc. Practical Physics*, (New Delhi, S. Chand & Co. Ltd., 17th Edition, 2011.
4. Chattopadhyay, D., and Rakshit, P.C. *An Advanced Course in Practical Physics*. 7th ed. New Central Book Agency Pvt. Ltd. 2005.
5. Worsnop B. L and H. T Flint. *Advanced Practical Physics for Students* 9th ed. rev. and enl ed. London: Methuen, 1969.
6. White Marsh W and Kenneth V Manning. *Experimental College Physics; a Laboratory Manual*. 3rd ed. New York: McGraw-Hill.1954.

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