Syllabus for B.Sc. II (Material Science)

Introduced from June, 2022

1. Structure of Syllabus:

B.Sc. – II **Semester –III**

Course Title	Theory			Practical		
	Course Code	Lectures Per week	Credits	Course Code	Lectures per week	Credits
Methods of Testing of Material	BMST 301	3	2	BMSP 303	8	4
Advanced Industrial Materials	BMST 302	3	2			

B.Sc. – II **Semester –IV**

Course Title	Theory			Practical		
	Course Code	Lectures Per week	Credits	Course Code	Lectures Per week	Credits
Materials for Semiconductor Technology	BMST 401	3	2	BMSP 403	8	4
Applications in Energy Technology and Biomaterials	BMST 402	3	2			

Note: B: B. Sc. T=Theory and P= Practical

2. Titles of Course

B.Sc. – II Semester – III

Theory: 45 lectures, 36 hours (for each paper)

BMST301: Methods of Testing of Material

BMST302: Advanced Industrial Materials

Practical: 80 lectures, 64 hours

BMSP303:Testing of Material and Advanced Industrial Materials

B.Sc. – II Semester – IV

Theory: 45 lectures, 36 hours (for each paper)

BMST401: Materials for Semiconductor Technology

BMST402: Applications in Energy Technology and Biomaterials

Practical: 80 lectures, 64 hours

BMSP403: Materials for Semiconductor Technology and Applications in Energy Technology and Biomaterials

B. Sc.–II: Semester – III

BMST301: Methods of Testing of Material (Credits:2)

Course Objectives: Students will be able to

1. study elastic and anelastic behavior of materials.
2. understand plastic deformation.
3. study creep in materials.
4. understand different types of fractures in materials.

Unit –I: Elastic and Anelastic Behavior of Materials. (11)

Elastomeric deformation, Thermoelastic effect, Elastic behavior, Atomic model of elastic behavior, Effect of temperature on elastic module. Anelastic deformation, relaxation process, Elasticity of polymers and glasses.

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Unit- II: Plastic Deformation (11)

Mechanism of plastic deformation, Tensile Stress strain curve, plastic deformations by Slip, SCHMID's laws, dislocation movement, Deformation by twinning, Types of twins, Deformation in polycrystalline materials.

Unit-III: Creep in Materials (11)

Mechanism of creep, Creep test, Creep curve, Creep curve equation, Creep at constant temperature, Stress rupture test, Creep resistant materials.

Unit-IV:Fractures in Materials (12)

Ductile fractures, Brittle fractures, Fracture Toughness, The Ductile brittle Transition, Fracture mechanism maps, Method of Protection against fractures, fatigue fractures.

Course Outcomes: Students should be able to:

1. explain elastic and anelastic behavior of materials
2. understand the concept of plastic deformation
3. analyze creep in materials.
4. differentiate different types of fracture in materials

REFERENCES:

1. V. Raghavan, 2013, Material Science and Engineering. Delhi, PHI learning Pvt. Ltd.

2. Singh I.P., Subhash Chander, Prasad K.Rajesh. 2015, Material Science and Engineering.

BMST302: Advanced Industrial Materials (Credits:2)

Course Objectives: Students will be able to

1. study of advanced industrial materials.
2. understand different types of alloys.
3. imbibe the polymeric materials.
4. understand the ceramics and it's properties.

Unit-I: Need of advanced materials (11)

Introduction, Demand of advanced materials, design principles and processing. Structural Materials: Porous matrix ceramics- composites, Metallic foam, Cellular Materials, Nano tubes, Nano wires.

Unit-II: Engineering alloys (11)

Production of iron and steel, aluminum alloys, copper alloys, stainless steel, Titanium alloys, special purpose alloys and their applications.

Unit-III: Polymeric materials (11)

Introduction to polymeric materials, Processing of plastic materials, General-purpose thermoplastic: Polyethylene, polypropylene, Polyacrylonitrile,Polymethyl Methacrylate (PMMA) and their applications.

Unit-IV: Ceramics (12)

Introduction to ceramics, Processing of ceramics, Traditional and Engineering ceramics, Mechanical properties of ceramics, Thermal properties of ceramics, Electrical properties of ceramics

Course Outcomes: Students should be able to

1. explain the basics of advanced industrial materials.
2. analyze the different types of alloys along with its properties.
3. understand the polymeric materials.
4. explain ceramics and it's properties..

REFERENCES:

1.Gandhi, Mukesh V., and Brian S. Thompson. 1992. *Smart materials and structures*. London: Chapman & Hall.

2. Smith, William F., Javad Hashemi and Ravi Prakash. 2014. *Materials science and engineering*. New Delhi: McGraw-Hill.

3. Rama Rao, P. 1993. Advances in materials and their applications. New Delhi: Wiley Eastern

BMSP303: Testing of Material and Advanced Industrial Materials

Practical: 80 lectures, 64 hours **(Credits: 02)**

Course Objectives: Students will be able to

1. understand how to conduct Hardness tests, sulphur tests and evaluate material properties.
2. to study and draw microstructures of different materials.

Experiments:

Group - A

1. To study the Brinell Hardness test.
2. To study the Rockwell Hardness test.
3. To verify Erichson Cupping test.
4. To study the magnafluxtest.
5. To study the dye penetrant test.
6. To study the specimen preparation for microscopy.
7. To verify sulphur print test.

Group - B

1. Perform spark test for classification of ferrous materials.
2. Study and drawing of microstructures of plain carbon steels of varying carbon percentage.
3. Study and drawing of microstructures of heat treated steels
4. Measure the hardenability of a steel using the Jominy end quench test.
5. Study and drawing of microstructures of cast irons.
6. Study and drawing of microstructures of non-ferrous alloys.
7. Hardening of steels of varying carbon percentage.

Course Outcomes: Students should be able to

1. conduct different hardness tests and evaluate material properties.
2. anlyze microstructures of different materials.

REFERENCES:

1. Dieter, George E, 2013, Mechanical Metallurgy.

2. Dowling, Norman E. 1993. Mechanical behavior of materials: engineering methods for deformation, fracture, and fatigue. Englewood Cliffs (New Jersey): Prentice-Hall.

3. Newby, J R. 1985. "Metals handbook, 9th edition. Volume 8: Mechanical testing". United States.

Semester-IV

BMST401:Materials for Semiconductor Technology (Credits: 2)

Course Objectives: Students will be able to

1. study semiconductors and their electrical properties
2. imbibe the various combinations of contacts between semiconductor and metal
3. understand p-n junction and its application
4. understand the optical material

Unit-I: Electrical Properties of Semiconductor **(14)**

Semiconductor, energy band diagram, Intrinsic Semiconductors: The Mechanism of Electrical Conduction, Electrical Charge Transport in the Crystal Lattice of Pure Silicon, Energy-Band Diagram, Extrinsic Semiconductors: n-Type (Negative-Type) and p-Type (Positive-Type)

Unit-II: Semiconductor Devices **(10)**

The pn Junction: The pn Junction Diode at Equilibrium, forward bias, reverse-biased

Applications for pn Junction: Rectifier Diodes, Breakdown Diodes, Tunnel diode, Photodiode

Unit-III: Semiconductor interface structure **(14)**

Metal-n type semiconductor junction and its rectifying action, Metal-p type semiconductor junction and its rectifying action, Schottky contact and ohmic contact, metal-metal contact and its rectifying action, semiconductor -insulator interface

Unit-IV: Selection of Materials **(07)**

Introduction, material properties- design parameters, electronic materials- Light Emitting Diode.
Optical Materials- introduction, optical properties, optical system and devices, Glass for smartphones and tablets.

Course Outcomes: Students should able to

1. differentiate the difference between the intrinsic semiconductor and extrinsic semiconductor
2. differentiate the difference between ohmic and Schottky contact
3. understand p-n junction and its application for devices
4. explain how to obtain design parameters and select the electronic material from metals

REFERENCES:

1. Smith, William F., Javad Hashemi, and Francisco Presuel-Moreno. 2019. Foundations of materials science and engineering.

2. Singhal, R. L., 2007. Solid State Physics, KedarNath Ram Nath & Co., Meerut,

3 Shackelford, James F., and Michael P. Clode. 1998. Introduction to materials science for engineers. Upper Saddle River, N.J.: Prentice Hall International.

4. Neamen, Donald A. 2012. Semiconductor physics and devices: basic principles. New York: McGraw-Hill Higher Education.

BMST402:Applications in Energy Technology and Biomaterials (Credits: 2)

Course Objectives: Students will be able to

1. understand which type of metals and alloys are used to make a turbine blades.
2. imbibe the properties of materials while making a cars.
3. undertand the different metals, alloys and polymers for medicinal purpose.
4. study the uses of biomaterials in medical field.

Unit-I: The turbine blade (12)

Introduction, Properties required of a turbine blade, Nickel-based super-alloys, Engineering developments—blade cooling, Future developments: metals and metal–matrix composites, Future developments: high-temperature ceramics, Cost effectiveness, Examples

Unit-II: Materials and energy in car design (10)

Introduction, Energy and cars, Ways of achieving energy economy, Alternative materials: Primary mechanical properties, Secondary properties, Production methods

Unit-III: Materials used in Medicine (12)

Introduction, Materials for use in the body, Metals: Steps in the fabrication of implants, Stainless Steels, Cobalt-based alloys, ASTM F799, ASTM F90, ASTM FS62,Titanium-based alloys, ASTM F136, Polymers

Unit IV: Properties and Applications of Biomaterials (11)

Physical Properties of Biomaterials, Chemical Properties, Uses of Biomaterials, Biomaterials in Organs, Joint Replacements, Drug Delivery Systems, Dental Implants, Breast Implants, Cardiovascular Biomaterials

Course Outcomes: Students should be able to

1. understand the future developments of materials while making a turbine blade.
2. differentiate the different ways of achieving energy economy in cars.
3. understand the metals and polymers used in biomaterials.
4. understand the applications of biomaterials in the human body.

REFERENCES:

1. Ashby, M. F., and David Rayner Hunkin Jones. 2019. Engineering materials 1: an introduction to properties, applications and design. Oxford, UK; Cambridge, MA, US: Butterworth-Heinemann.

2. Bronzino, Joseph D., and Joon Bu Park. 2003. Biomaterials: principles and applications. Boca Raton: CRC Press.

3. Wagner, William R., Shelly E. Sakiyama-Elbert, Guigen Zhang, Michael J. Yaszemski, Buddy D. Ratner, and Allan S. Hoffman. 2020. Biomaterials science an introduction to materials in medicine.

4. Park, Joon Bu, and Roderic S. Lakes. 2007. Biomaterials an introduction. New York, NY: Springer

5. Bandarenka, Aliaksandr. 2022. Energy materials: a short introduction to functional materials for energy conversion and storage.

BMSP403:Materials for Semiconductor Technology and Applications in Energy Technology and Biomaterials (Credits: 02)

Practical: 80 lectures, 64 hours

Course Objectives: Students will be able to

1. determine the crystal structure of a given specimen.
2. determine the band gap of the semiconductor.
3. determine resistivity by four probe methods.
4. determine resolving power of prism.
5. determine the refractive index of various liquids using hollow prisms.

Experiments:

Group - A

1. To determine the Energy Band Gap of a Semiconductor by using PN Junction Diode.
2. Resistivity measurement of Silicon by four probe method.
3. Resistivity measurement of metal oxide thin film two probe method.
4. Resistivity measurement of ITO substrate by four probe method.
5. Resistivity measurement of polyaniline thin film by four probe method.
6. To study the variation of magnetic field with distance along the axis of a circular coil carrying current.
7. To find the resolving power of the prism.
8. To find the temperature coefficient of resistance of a given coil.
9. To determine the Hall voltage developed across the sample material.
10. To calculate the Hall coefficient and the carrier concentration of the sample material.

Group - B

1. To find the refractive index of paraffin oil using hollow prism.
2. To find the refractive index of ethyl alcohol using hollow prism.
3. Preparation of Polyaniline thin film by electrodeposition.
4. Thermoelectric power measurement of given palet sample.
5. Thermoelectric Power measurement of thin film.
6. Magnetic susceptibility of $FeCl_3$ Solution.
7. Determination of wavelengths of given laser sources by diffraction method.
8. To study heat treatment processes (hardening and tempering) of steel specimens.
9. To draw the static current-voltage (I-V) characteristics of a junction diode.

Course Outcomes: Students should be able to

1. determine the crystal structure of a given specimen.
2. determine the band gap of the semiconductor.
3. measure resistivity by four probe methods.
4. determine resolving power of prism.
5. find the refractive index of ethyl alcohol using hollow prism.
6. find the refractive index of HCL using hollow prism.

REFERENCES:

1. Streetman, Ben G., and Sanjay Banerjee. 2016. Solid state electronic devices.
2. Sanon Geeta, 2021, B.Sc. Practical Physics.
3. Singh Harnam, Hemne P.S., 2000, B. Sc. Practical Physics.
4. Newby, J R. 1985. "Metals handbook, 9th edition. Volume 8: Mechanical testing". United States.

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