Current subject area:
Physics

Status	**Course code / number in the book:** ***PHYSICAL MATERIALS SCIENCE*** Taught by**: Yuriy Plevachuk**			
Acad. cycle	**ECTS credits**	**Duration**	**Semester**	**Contact hours**
Barchelor	4	1 semester	Autumn	24
Year of study	**Weekly lectures/seminars**		**Prerequisites**	
4th	1 / 1		**Common course of physics, solid-state physics**	
Languages	**Examination**		**Assessment**	
English	Written exam		100 point scale	

Aims and objectives: provide with knowledge concerning structure and physico-chemical properties of different types of materials.

Intended capabilities: to know the basic regularities of the structure of metals and alloys, their relationship to the physico-chemical properties; classification of materials; the physical basis of metallurgical technology and other modern ways of material production; the scope of the practical application of materials. To be able to apply fundamental knowledge of materials science to analyze the properties of metal, polymer and other materials under different thermodynamic conditions.

Description: Classification of materials. Atomic and electronic structure of metals. Polymorphism. Binary phase diagrams. Systems with unlimited solubility in solid and liquid state. Eutectic and peritectic systems. Systems with limited solubility in the liquid state. Immiscible systems. Phase diagrams with chemical compounds. Steels and cast iron. Transformations in steel. Iron-carbon alloys. Perlite, ferrite, austenite, martensite and ledeburite. Phase diagram of Fe-C and its general characteristics. Transitions perlite-austenite, austenite-perlite, martensite and austenite-martensite pearlite. Thermodynamic and kinetic conditions for phase transformations in steel. Cyaniding, carburizing and nitriding of steel. Stainless and tool steels. Special steels. Non-ferrous alloys. Aluminium and Al-based alloys. Structure and physical properties of duralumin. Al-based alloys (Al-Si, Al-Mg, Al-Ni, Al-Ti). Cu-based alloys. New lead-free solders. Amorphous metal alloys, their properties and production. Non-metallic materials. Composites. Glasses. Physicochemical basis of metallurgical processes. Non-metallic materials and their main characteristics. Composites with a polymer matrix. Styrofoam and foam. Composite materials with a metal matrix. Glass-ceramics and graphite. Practical application of glass. Methods for ceramic production and their practical application.

Reading list:

1. **G. Gottstein. Physical Foundations of Materials Science. Springer-verlag, 2005.**
2. **W. A. Monteiro. Light Metal Alloys Applications. InTech, 2014.**

Physical Material Science

Education program

(Prof. Dr. Yuriy Plevachuk)

Lecture 1. General characteristics of metals.

- Introduction.
- The subject of physical material scinece.
- Materials. Classification of materials.
- Metals. Classification of metals.

Lecture 2. Atomic and electronic structure of metals

- The crystal structure of metals.
- Polymorphism.
- The electronic structure of metals.

Lecture 3. Alloys. Phase diagrams.

- Classification of metal alloys.
- Binary phase diagrams.
- Systems with unlimited solubility in solid and liquid state.
- Eutectic systems.
- Systems with limited solubility in the liquid state.
- Immiscible systems.
- Phase diagrams with chemical compounds.
- Peritectic systems.

Lecture 4. Steels and cast iron. Transformations in steel. Heat treatment. Mechanical properties of metals

- Iron-carbon alloys.
- Perlite, ferrite, austenite, martensite and ledeburite.
- Phase diagram of Fe-C and its general characteristics.
- Steel and iron.
- Four major transformations in steel.
- Transitions perlite-austenite, austenite-perlite, martensite and austenite-martensite pearlite.
- Thermodynamic and kinetic conditions for phase transformations in steel.
- Heat treatment of steel.
- Types of heat treatment.
- The practice of heat treatment.
- Chemical heat treatment of steel.
- Cyaniding, carburizing and nitriding of steel.
- Thermomechanical processing.
- The influence of impurities on the properties of steel.
- Stainless and tool steels.
- Special steels.
- Mechanical properties of metals.
- Strength, hardness, ductility and tensile strength.
- Methods of metal strengthening.
- Defects in metal alloys.

Lecture 5. Non-ferrous alloys

- Non-ferrous metals.
- Aluminium and Al-based alloys.
- Phase diagram of Al-Cu. Al-Cu alloys.
- Heat treatment of Al-Cu alloys. Guigny-Prenston zones.
- Duralumin. Structure and physical properties.
- Other aluminum alloys (Al-Si, Al-Mg, Al-Ni, Al-Ti).
- Copper-based alloys. Bronze and brass.
- Fusible alloys and their applications. Solders. New lead-free solders.
- Amorphous metal alloys and their properties.
- Methods for amorphous metal production.

Lecture 6. Non-metallic materials. Composites. Glasses. The physical transformation in ceramic materials. Physicochemical basis of metallurgical processes.

- Non-metallic materials and their main characteristics.
- Polymers, structure and properties.
- Thermoplastics. Composite materials.
- Composites with a polymer matrix.
- Styrofoam and foam.
- Composite materials with a metal matrix.
- Gas-eutectic reaction. General characteristics of glass.
- The structure and physical properties of glass.
- Glass-ceramics and graphite. Practical application of glass.
- Ceramics. Classification of ceramics, their structure and physical properties.
- Methods for ceramic production and their practical application.