CONTENT OF CLASSES
«MEDICAL AND BIOLOGICAL PHYSICS»
Anglophone Students of the 1 Course
Specialty «GENERAL MEDICINE»
2 term of 2024/2025

MODULE 1
"Medical equipment. Optics"

Class No. 1

Theme: Medical equipment

1. Classification of medical equipment.
2. Electrical safety of medical equipment: general requirements and measures to ensure electrical safety, classes of medical equipment for electrical safety. The threshold of perceptible current, the threshold of non-releasing current.
3. Reliability of medical equipment. Quantitative characteristics of reliability.
4. General scheme of acquisition, transmission and registration of medico-biological information.
5. Transfer and registration devices. Biotelemetry.

Class No. 2

Theme: Sensors, electrodes and amplifiers in medicine

1. Sensors. Types of sensors: generative and parametric. Sensor characteristics: conversion function, sensitivity, sensitivity threshold, sensitivity limit.
2. Electrodes, their types and basic requirements for them.
3. Amplifier. Amplifier characteristics: gain, amplitude response, frequency response, amplifier bandwidth.
4. Sensors, electrodes and amplifiers in medical devices and apparatus.
5. Laboratory works No.9 and No.11 (Task 3: Analysis of an electrocardiograph frequency characteristic).

Class No. 3

Theme: Wave properties of light. Interference and diffraction of light. Application in medicine

1. Interference of light. Conditions for the greatest amplification and attenuation of light.
2. Interferometer and interference microscope in medicine and biology.
3. Light diffraction. Diffraction grating. Diffraction spectrum. X-ray diffraction analysis.
4. Determination of the wavelength of laser radiation and the size of small objects based on the phenomena of interference and diffraction of light. Laboratory work No.16.
5. *Student's independent work on the topic "Wave properties of light" (BRIEF DESCRIPTION):*

- *Coherent light sources: definition, types.*
- *Light interference: definition.*
- *Interference in thin films: ray path, maximum and minimum interference.*
- *Principle of antireflection coating and examples of its application in medicine and/or biology.*

Class No. 4

Theme: Polarization of light. Polarimetry

1. Polarization of light. Natural and polarized light. Polarizing devices.
2. Passage of light through the polarizer-analyzer system. Malus' law.
3. Rotation of the polarization plane by optically active substances.
4. Application of polarized light for solving biomedical problems: polarimetry, polarizing microscopy, photoelasticity.
5. Laboratory work No.14.

Class No. 5

Theme: Geometric optics. Refractometry. Fiber optics and its application in medicine

1. Rectilinear propagation of light. Speed of light. The refractive index of the medium.
2. Laws of refraction and reflection of light. Mirror and diffuse reflection of light.
3. Total internal reflection of light. Fiber optics and its application in medicine. Refractometry. Laboratory work No.12.

Class No. 6

Theme: Lenses. Microscopy in Medicine and Biology. Microscopy types

1. Lenses. Types of lenses. Image construction in thin lenses. Thin lens formula. The optical power of the lens.
2. Lens aberrations.
3. Magnifier. The path of the rays in the magnifying glass and its magnification.
4. Optical microscope, the path of rays in a microscope. Microscope magnification.
5. Limit of resolution and useful magnification of the microscope.
6. Types and special techniques of microscopy. Phase contrast microscopy, ultraviolet microscopy, immersion microscopy, ultramicroscopy, micro-projection and microphotography methods.
7. Electron microscopy.
8. Measuring the size of small objects using an optical microscope. Laboratory work 13.
9. *Student's independent work on the topic "Geometric optics. Specialized Microscopy Techniques" (BRIEF DESCRIPTION):*

- *Magnifier: definition, ray path in it (drawing), magnifier magnification (formula with explanation of symbols).*
- *Confocal Microscopy, Scanning Electron Microscopy and Darkfield Microscopy: definition, areas of application (briefly, no more than 5 sentences for each technique).*

Class No. 7

Theme: COLLOQUIUM 1

Class No. 8

Theme: Absorption and scattering of light. Concentration colorimetry

1. Absorption of light by a matter. Bouguer's Law.
2. Absorption of light by solutions. Absorption cross-section. Bouguer-Lambert-Beer Law.
3. Transmittance coefficient. Optical Density. Absorption spectrum.
4. Concentration colorimetry.
5. Light scattering. Nephelometry.
6. Laboratory work No.15.

Class No. 9

Theme: Physics of Vision

1. Light-conducting and light-sensing apparatus of the eye.
2. Accommodation. Distance of the best vision. Near point of the eye.
3. Reduced eye. Resolving power of the eye, visual acuity.
4. Defects of vision and modes of their correction by lenses.
5. Solving of problems.
6. Laboratory work "Optical system of the eye".
7. *Student's independent work on the topic "Physics of Vision" (BRIEF DESCRIPTION):*

- *Structure of the eye.*
- *Structure of the retina.*
- *Light sensitivity and adaptation of the eye to light of different intensities.*

Class No. 10

Theme: Physical fundamentals of Thermography

1. Thermal radiation and its quantitative characteristics.
2. Absorption coefficient. Black, white and grey bodies.
3. Laws of thermal radiation.
4. Features of thermal radiation of the human body. Thermography.
5. Laboratory work No.17

Class No. 11

Theme: Lasers. Laser radiation

1. Spontaneous and stimulated emission.
2. Principles of laser operation.
3. Characteristics of laser radiation.
4. Interaction of laser radiation with biological tissues.
5. Application of lasers in medicine. Safety measures when working with the laser.
6. Solving of problems.
7. *Student's independent work on the topic "Laser radiation" (BRIEF DESCRIPTION):*

Laser classification: *by type of gain (active) medium; by intensity of laser radiation; by hazard class; by field of application in medicine.*

Class No. 12

Theme: Radioactivity. X-ray radiation

1. Radioactivity: natural and artificial. Law of Radioactive decay. Half-life time and its relationship with the Decay Constant. Activity.
2. Types of radioactive decay. Types of ionizing radiation.
3. Application of radioisotopes and ionizing radiation for medical diagnostics and treatment. Nuclear Medicine.
4. X-radiation. X-ray tube device.
5. Braking (Bremsstrahlung) and Characteristic X-ray radiation.
6. Interaction of X-ray radiation with a matter: coherent scattering, incoherent scattering, photoelectric effect.
7. Application of Roentgen radiation in Medicine.
8. Solving of problems.
9. *Student's independent work on the topic "Radioactivity" (BRIEF DESCRIPTION):*

- *Radioactivity (definition).*
- *Natural and artificial radioactivity.*
- *Types of radioactive decay.*

Class No. 13

Theme: Dosimetry of ionizing radiation

1. Interaction of ionizing radiation with a matter. Linear Ionization Density (Specific Ionization), Linear Stopping Power, Path Range.
2. Elements of Dosimetry. Absorbed and Exposure Doses. Dose Rate, relationship between the Exposure Dose Rate and Activity of radioactive substance.
3. Equivalent dose. Relative Biological Effectiveness (RBE). Effective Equivalent Dose. Coefficient of Radiation Hazard.
4. Types of ionizing radiation detectors: trace and integral detectors, counters. Dosimetry devices.
5. Protection against ionizing radiation. Maximum permissible doses. Natural background radiation.
6. Laboratory work "Background radiation measurement".

Class No. 14

Theme: Physical factors of production

1. Physical factors of production and their types.
2. Microclimate. The main components of the microclimate.
3. Humidity. Absolute and Relative humidity and their definition methods.
4. Pressure. Atmospheric pressure.
5. Solving of problems.

Class No. 15

Theme: COLLOQUIUM 2

Class No. 15Class No. 16

Theme: FINAL CONTROL

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