ED - PRACTICAL EXAM TOPIC LIST - 2024/2025 SEMIFINAL

1. Refractometry
    1/1. Definition of refractive index. Law of light refraction. Critical angle. Total internal reflection. Dispersion.
    1/2. Formation of Snell's window. Abbe’s refractometer. Concentration determination by refractometry.

2. Microscopy
    2/1. Image formation in microscope, magnification, calibration for size determination. Characterization of red blood cells size distribution.
    2/2. Resolution of microscope, Abbe’s principle and formula. Image formation by special microscopes.

3. Optics of the eye
    3/1. Focal accomodation of the eye. Refractive media and image formation of the eye. Refractive disorders of the eye and their corrections.
    3/2. The reduced eye. Limiting angle of vision. Characterisation and measurement of visual acuity. Estimation of receptor density.

4. Light emission
    4/1. Thermal emission and luminescence. Characterization of light emission spectra. Examples of light sources.
    4/2. Parts of a spectrometer, monochromator types. Flame photometer and its diagnostic applications.

5. Light absorption
    5/1. Definition of absorbance and transmission. Beer-Lambert law. Concentration determination by light absorption.
    5/2. Absorption spectra, types, characteristics. Parts and function of absorption spectrometer.

6. Resonance
    6/1. Harmonic oscillation, damped and undamped free oscillation, critical damping. Driven oscillation, resonance.
    6/2. Elastic deformation, Hooke's law. The concept of resonance and the interpretation of the resonance curve.

7. Polarimetry
    7/1. Definition of polarized light. Relations between linearly and circularly polarized light. Optical activity. Parts of a polarimeter.
    7/2. Biot’s law. Definition of specific rotation. Factors influencing specific rotation. Concentration determination by polarimetry.

8. Nuclear medicine
    8/1. Parts and function of the scintillation counter. Processes in the scintillation crystal.
    8/2. Parts and function of the scintillation counter. Processes in the PM tube. Signal selection. Sources of noise. Signal-to-noise ratio.

9. Gamma absorption
    9/1. Attenuation of gamma radiation. Attenuation coefficient and half-value thickness. Mass attenuation coefficient, surface density, half-value mass.
    9/2. Atomic-level interactions determining the mass attenuation coefficient, their dependence on photon energy. Scintillation counter.

10. Dosimetry
    10/1. Ionizing radiations, direct and indirect chemical effects, stochastic and deterministic effects. Scintillation counter, thermoluminescence dosimeter.
    10/2. Definition of dose concepts (absorbed dose, exposure, equivalent and effective dose). Dose rate. Parts and function of ionization chambers.

11. Amplifier

11/1. Electric gain, linear transfer function, distortion. Power gain, voltage gain, gain level, transfer band.

11/2. Frequency response curve of the amplifier. Negative feedback. Advantage and disadvantage of negative feedback.

ED - THEORETICAL EXAM TOPIC LIST - 2024/2025 SEMIFINAL

1. Radiation: definition, types, descriptive physical parameters of radiation, examples of radiation.

2. Law of attenuation of radiation: differential and integral forms, applications in medical and laboratory practice.

3. Basic principles of optics I: geometric optics, Fermat's principle, refraction of light, Snell's law. Applications: prism, optical fiber.

4. Basic principles of optics II : reflection, spectral reflectance. Rayleigh, Mie, Raman scattering.

5. Optics of the human eye: image formation and its disorders, accomodation, reduced eye model, visual acuity, resolution of the eye.

6. Image formation by optical devices and their medical application: lenses, microscope, resolution, Abbe’s principle.

7. Light as electromagnetic wave: parameters of waves, electromagnetic spectrum.

8. Wave nature of light: Huygens' principle, diffraction, superposition principle, interference, optical grating for decomposition of white light.

9. Particle nature of light: photoelectric effect, the photon concept, example for the application of photoelectric effect.

10. Mechanism of light absorption, absorption spectra, Beer-Lambert law and its applications. Parts of a spectrophotometer.

11. Origin and characteristics of thermal radiation. Kirchhoff's law, spectrum of blackbody radiation, Wien's displacement law.

12. Principles of thermography: Stefan-Boltzmann law, Wien's displacement law, thermal radiation of human body, applications.

13. Luminescence: Mechanisms of luminescence, Kasha's rule, emission spectra, Stokes shift, lifetimes and quantum yield.

14. Definition of luminescence. Light sources based on luminescence, medical applications.

15. Concept of light amplification: Optical pumping and population inversion, induced emission, optical resonator.

16. Properties of LASER light, LASER types, medical applications of LASER light.

17. Light absorption in human tissues: skin, eye. Biological effects of light, photodynamic therapy.

18. Generation of X-ray: X-ray tube, Duane-Hunt law, spectrum of Bremsstrahlung and characteristic radiation, efficiency of X-ray tube.

19. Absorption of X-ray: Linear and mass attenuation coefficients, absorption mechanisms, effective atomic number.

20. X-ray diagnostics 1: principles of X-ray imaging, factors influencing image quality, application of contrast materials, DSA.

21. X-ray diagnostics 2: Summation image, concept of CT, CT generations, Hounsfield units, windowing, X-ray image amplifier.

22. Nuclear radiation: Composition and stability of nuclei, nuclear force, mass defect, radioactive decay, activity.

23. α, β, and γ radiations: mechanisms of decay, energy spectra, penetration depths.

24. Isotope diagnostics I: Selection of radioisotopes, radiopharmacons, isotope accumulation curve, effective and biological half-life, static and dynamic investigations.

25. Isotope diagnostics II: gamma camera, SPECT, PET.

26. Modern microscopy techniques: fluorescent microscopy, confocal laser scanning microscopy; two-photon excitation.

27. Concept of electron microscopy, resolution, TEM, SEM.

28. Structure of matter: Development of atomic models, Bohr's model of hydrogen atom, energy levels of atoms, molecules, and solid-state materials.