EXAMINATION SYNOPSIS IN MEDICAL PHYSICS
Academic Year 2015/2016

1. Medical physics. The role of the experiment. Measurement. SI system
2. Accuracy and significant digits. Scientific notation. The conversion of units
3. The states of matter. The definition of pressure. Pressure in liquids. Distribution of pressure in a static liquid
4. Transmission of pressure: Pascal's principle. Clinical applications of Pascal's principle
5. Buoyant force and Archimedes' principle
6. Pressure in flowing fluids. Pressure gradient. Laminar and turbulent flow. Poiseuille's law. The resistance to flow
7. Evaluation of liquids dynamic viscosity using the Poiseuille's capillary method
8. Types of pumps. The heart as a force pump
9. The circulatory system. The control of volume flow rate. The applicability of Poiseuille's law
10. Changes in blood speed during circulation. Wall tension and Laplace's law
11. Liquids surface tension. Molecular pressure, cohesion pressure, surface tension coefficient. Evaluation of liquids surface tension by the method of blowing away air bubbles
12. The energy supplied by the heart. The variations of the blood pressure. The measurement of blood pressure
13. The kinetic energy of molecules. Diffusion. Fick's law. Osmosis. Semipermeable membrane. Osmotic pressure. Hypertonic and hypotonic solutions. Dialysis
14. Transport across living membranes. Passive and active transport. Molecular transfer in the capillary system
15. Cohesion and adhesion. Surface tension. Surface tension and respiration. The role of surfactant. Capillary action. Viscosity. Adsorption and absorption
16. Internal energy. The distinction between internal energy and temperature. Temperature scales
17. Heat and the first law of thermodynamics. Internal energy. Thermal expansion
18. Methods for temperature measurement. Liquid Expansion Thermometers. Bimetallic Strip Thermometers. Constant Volume Gas Thermometer.
19. Internal energy and specific heat. The calorie as a unit of heat or internal energy. Heat of combustion: the dietary calorie. The mechanical equivalent of heat
20. Changes of phase. Applications of phase changes. Application of the melting transition. Refrigeration cycle.
21. Evaporation and vapor pressure. Saturation vapor pressure and saturation vapor density. Boiling point. Relative humidity
22. Heat transfer. Conduction. Fourier's law. Convection. Radiation. Physiological applications of heat transfer
23. The electrical nature of matter. The behavior of electric charges. Coulomb's law
24. The flow of electric charge. Conductors. Insulators and semiconductors. The electroscope. Electric current
25. Electric fields and voltages. The electric field strength. Point charge. Capacitor. Capacitance

26. Basic terms of RC circuit. Modelling the impedance of the human skin using RC circuits. The relationship between the human skin impedance and the frequency of electric current
27. Cathode ray tube. Oscilloscope. Measuring the amplitude of voltages and currents, and the period and frequency of sine electric signals by an oscilloscope
28. Magnets and magnetic fields. Diamagnetics, paramagnetics and ferromagnetics. Electromagnets
29. The interaction between electricity and magnetism. The magnetic force on a moving charge. The motor principle. Magnetic flux. Faraday's law
30. Sensing elements for physiological measurements. Thermocouples. The electrical resistance thermometer. The thermistor.
31. Graduating thermoelectric and semiconducting thermometer.
32. Pressure transducers. The oximeter. Electrodes for PH, Pco2 and Po2. Amplifiers. Triodes and transistors.
33. Evaluation of V-A characteristic of crystal diode
34. Display devices. The oscilloscope. Meters and chart recorders. Digital displays. The defibrillator. Electrocautery and electrosurgery
35. Measurements with electric instruments. Calculation of the resistance and power of a circuit element
36. The living cell as an electric source. The resting potential. The action potential. Sequence of membrane events during an action potential. Depolarization - repolarization
37. The electrocardiogram. How to read an electrocardiogram. The electrical conduction process controlling the heart's pumping cycle. The triangle of Einthoven. The electroencephalogram. Other bioelectric measurements. The electronic pacemaker
38. Elasticity. Hooke's law. Periodic motion and resonance. Frequency and amplitude of periodic motion.
39. Traveling waves. Transverse waves. Longitudinal waves. Speed of propagation. Wavelength. Frequency. Wave properties of sound and light
40. Energy in waves. The intensity of the radiation. Interference and standing waves. Constructive and destructive interference. Standing wave
41. The Doppler effect. Ultrasonic sound. Doppler ultrasound techniques.
42. The mechanism of the ear. The range and sensitivity of human hearing. The decibel scale
43. The distinction between loudness and intensity. Equal loudness curves. Hearing tests. Audiometry
44. Objective and subjective sound characteristics. Determination of threshold of hearing by plotting an auditory threshold curve – audiogram
45. Refraction and lenses. The index of refraction. Lens power. Ray diagrams. Lens equation. The magnification of a lens.
46. Image formation by the eye. Common vision defects
47. Simple optical instruments. The simple magnifier. The compound microscope. The ophthalmoscope. Fiber optics.
48. Measuring micro-objects by compound microscope. Mean diameter, mean area and diameter distribution of erythrocytes (application of statistical concepts)
49. Color vision

50. The electromagnetic spectrum. Types of electromagnetic waves. The quantum theory of light.
51. Matter waves: the electron microscope. Comparison of electron and optical microscopes. Quantum theory of the atom. Pauli exclusion principle
52. The interaction of electromagnetic waves with matter
53. Clinical applications of electromagnetic waves. Radio frequency and microwave radiation
54. Infrared radiation. Ultraviolet radiation.
55. X-ray radiation. Medical imaging with CT and NMR scans
56. The laser and its applications. Metastable states. Population inversion. Mode of laser action
57. Holography: three-dimensional images
58. A scale model of the atom. The nature of the nucleus. The three basic types of radioactivity – alpha, beta and gamma.
59. Radioactive decay and half-life. Medical radioisotopes. The detection of radiation
60. Effects of ionizing radiation on biologic material. Measurement of radiation exposure. How to minimize your exposure. Radiation therapy.
61. Diagnostic use of radioisotopes. Positron emission tomography. Nuclear energy

REFERENCES

- Alexandrova M, Lecture course, MU-Pleven
- Nave C, Nave B. Physics for the Health Sciences. 3rd edition, ©1985 Saunders Company
- Crowell B. Simple Nature. An Introduction to Physics for Engineering and Physical Science Students. © 2001-2005 Benjamin Crowell.
- Davidovits P. Physics in Biology and Medicine. 3rd Edition, © 2008, Elsevier Inc.
- Halliday, D and Resnick R. Fundamentals of physics. Extended 9th Edition, Copyright © 2011, 2008, 2005, 2003 John Wiley & Sons, Inc
- Hobbie RK, Roth BJ. Intermediate Physics for Medicine and Biology. 4th Edition © 2007 Springer Science+Business Media, LLC

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