Basic knowledge control questions (entrance)

1. Correlate the parameters of the rectangular pulse signal with the definitions

Pulse width per base	The time interval during which the value of the signal exceeds the value 0.1Um
Active pulse width	The time interval during which the signal value exceeds the level of 0.5Um
Active front duration	The rise time of the impulse voltage component from 0.1Um to 0.9Um
Active cutting time	Time to reduce the impulse voltage component from 0.9Um to 0.1Um
Overshoot factor at the front	The ratio of the amplitude of the first ejection of damped oscillations at the front to the pulse amplitude Um

2. Relate the term and its explanation

Metals such as, copper, aluminum and others	have good electrical conductivity
Dielectrics	occupy an intermediate position between conductors and dielectrics in electrical conductivity
	poorly conduct electric current or do not conduct current at all.

3. Relate the term and its explanation

Average value	is the value of such a direct current that carries the same charge of electricity for the same period of time as the alternating current
Effective value	characterizes the energy efficiency of the signal (both current and voltage)
Amplitude value	is the maximum instantaneous value of a current or a voltage for the period of its change

4. Correlate the conductivity type and its explanation

Hole conductivity	Conductivity, which is not observed in metals
Intrinsic conductivity	Observed in a semiconductor without impurities
Electron conductivity	Electrical conductivity due to the presence of free electrons

5. In the linear region of operation, a field effect transistor is used as:
a) amplifier, b) switch.

6. The internal elements of the optocoupler are:
a) LED and photodiod b) photodiod and phototransistor
c) LED and photoresistor d) LED and phototransistor

7. Choose from the proposed two basic functions of the transistor:
a) switch b) filtering c) signal rectification d) signal amplification
e) stabilization

8. Choose the statement corresponding to the field-effect transistor with $U_{gs} = 0$ and $U_{ds} > 0$

- The drain current is the reverse current of the p-n junction between the substrate and the heavily doped flow region
- The drain current is the reverse current of the p-n junction between the substrate and the heavily doped flow region

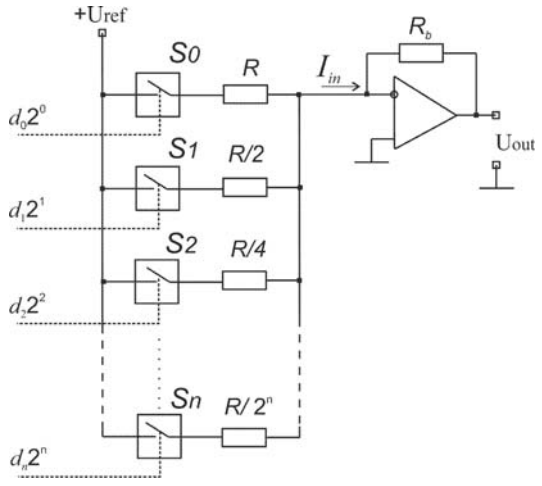
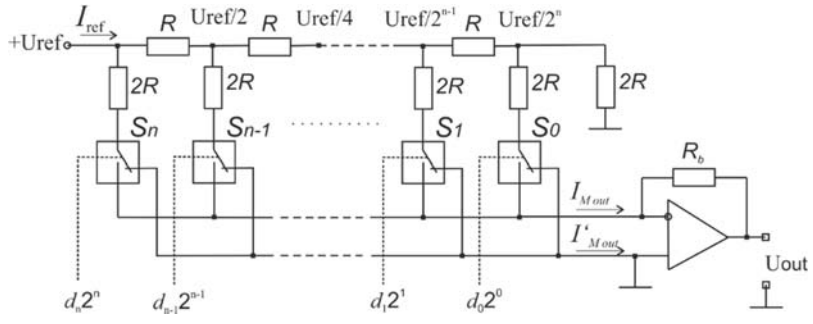
- The thickness of the transitions increases, the channel cross-section and its conductivity decrease, the current Ic decreases.
- The channel narrows so much that the boundaries of the p-n junctions are closed and the channel resistance becomes sufficiently high, the current Ic decreases.

9. Select for each error the appropriate formula for determining this error

Full scale error	$\delta_{FS} = \frac{\Delta U_{FS}}{U_{FS}} \cdot 100\%$
Zero offset error	$\delta_Z = \frac{U_Z}{U_{FS}} \cdot 100\%$
Linearity error	$\delta_{LN} = \frac{\Delta U_{LN}}{U_{LN}} \cdot 100\%$
Differential nonlinearity	$\delta_{DN\%} = \frac{\Delta U_{Q1} - \Delta U_{Q2}}{U_Q} \cdot 100\%$

10. The ideal form of the DAC conversion performance on the graph is
a) Line b) Exponent c) Parabola d) Stepped curve

11. Select the appropriate type of current summation for each DAC circuit

	Parallel summation of currents
	Consecutive summation of currents
	Combined summation of currents

12. Specify the conversion time for each type of ADC

Sequential counting ADC	$2 \cdot n \cdot t_{генератора}$
Successive approximation ADC	$(2^n) \cdot t_{генератора}$

13. Which laser was the first gas laser implemented

a) CO_2 laser b) He-Ne laser c) Copper vapor laser d) Ruby laser

14. Schematic solutions of elements used in the DAC?

- Sources of alternating voltage and current, key devices
- DC sources and key devices
- Stabilized voltage source and switch devices

15. How many times do we need to increase the input current of the DAC, so that output voltage will increase 4 times?

16. The minimum change in U_{out} when the control code d0, d1, d2 ... dn is changed to the least significant digit, is called

a) quantum b) quantization step c) quantization voltage

17. The conversion of an analog signal occurs at certain points in time, which are called…

18. How many comparators do you need to create a 4-bit parallel ADC?

Questions for current control

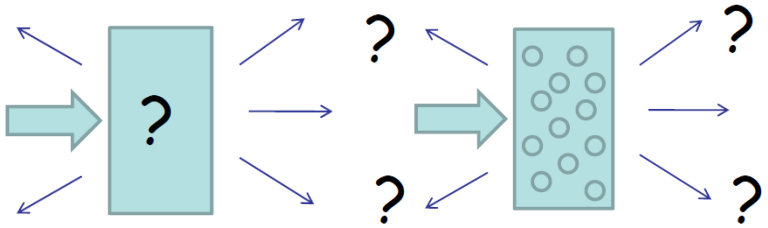
1. Definition of "photonics".
2. When the first optical microscope was invented?
3. Relate the range to the wavelengths

Visible	400-760 nm
UV	10-400 nm
X-rays	0.005-10 nm
γ-rays	<0.005 nm
T-rays	0.1-1 mm

4. Relate the dates of events.

Discovery of DNA structure	1950s
Sanger Method	Late 1900s
Worm Genome	Early 2000s

5. Light with the wavelength 632 nm has the frequency of _____ Hz.
6. Relate the figures with Direct and Inverse problems



7. Fill the gaps with appropriate terms:

[__] allows determine the concentration of the element on the intensity of radiation induced thermal excitation of atoms member.

The value of [__] due the fact that most biochemical compounds do not absorb light in the visible region, ultraviolet is absorbed.

[__] allows identify many biochemical compounds and study their properties. The absorption bands are in the infrared spectrum.

[__] allows distinguishing between structural models molecules. According to the intensity of the bands can be to judge the concentration of substances.

[1] Flame spectroscopy

[2] UV spectroscopy

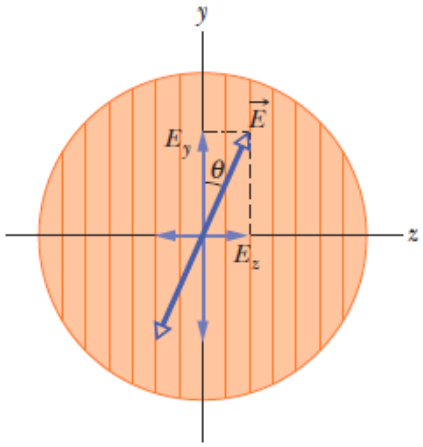
[3] IR (infrared) spectroscopy

[4] Raman Spectroscopy

8. What are the electromagnetic waves?
9. An elementary particle, the quantum of the electromagnetic field including electromagnetic radiation such as light, and the force carrier for the electromagnetic force – is____.
10. What are the heat transfer mechanisms?
11. If the energy of radiation is completely absorbed by the area *S*, the magnitude of the force on the surface is [_]. If the radiation is totally reflected back along its original path, the magnitude of the force on the surface is [_]. Fill the gaps with appropriate terms.

[1] $F = \frac{IS}{c}$ [2] $F = \frac{2IS}{c}$

12. If the original light is initially polarized, the transmitted intensity depends on the angle θ between the polarization direction of the original light and the polarizing direction of the sheet:



1) $cos^2\theta$
2) $cos\theta$
3) $sin\theta$
4) $1- sin^2\theta$

13. It is known, that two laws govern reflection and refraction of light. Relate the formulas and law.

law of reflection	$\theta_1' = \theta_1$
law of refraction	$n_2 \sin\theta_2 = n_1 \sin\theta_1$

14. Choose the right statements:

- If n_2 is equal to n_1, then θ_2 is equal to θ_1 and refraction does not bend the light beam, which continues in the undeflected direction.

- If n_2 is greater than n_1, refraction bends the light beam away from the undeflected direction and toward the normal.

- If n_2 is less than n_1, refraction bends the light beam away from the undeflected direction and away from the normal.

15. A magnifying glass produces the enlarged _____ virtual image.

a) Inverted

b) Noninverted

16. A compound microscope produces enlarged _____ virtual image.

a) Inverted

b) Noninverted

17. The main components of binocular optical microscope (mark the right):

- Eyepiece
- Objective lenses
- Light source
- Objective lenses
- Diaphragm and condenser
- Camera
- Laser

18. In _____ microscopy, by image processing, many slices can be superimposed giving an extended focus image.

19. Types of microscopy which use laser radiation

- confocal microscopy
- standard microscopy
- fluorescence microscopy
- scaning electron microscopy

20. This technique creates super-resolution images by the selective deactivation of fluorophores, minimising the area of illumination at the focal point, and thus enhancing the achievable resolution for a given system.

- Stimulated emission depletion
- Programmable array microscopy
- Fluorescence lifetime imaging
- Saturated structured illumination microscopy

21. Methods of microscopy, which use scanning principle?

- 4Pi Microscopy
- STED Microscopy

- Fluorescence microscopy
- Laser projection microscopy
- Standard optical microscopy

22. Resolution of optical coherence tomography:

- 1-15 μm
- 100-1000 μm
- 10-100 nm
- 1-15 nm

23. Arrange research methods on the depth of penetration of radiation (from min to max)

- Optical coherent tomography
- Ultrasonic tomography
- MRI

24. Applications of Optical Coherence Tomography?

25. Applications of diffuse optical tomography?

26. The wavelengths of Cu vapor laser lay in _____ spectral range.

27. Who did create the first human-made laser?

28. CW lasers:

- Argon ion
- He-Ne
- Cu vapor
- Nd:YAG
- CO_2

29. Pulsed Lasers:

- Argon ion
- He-Ne
- Cu vapor
- $MnBr_2$ vapor
- Nd:YAG
- CO_2

30. In a human eye, the ____ focuses the light on the _____.

31. It forms the eyes color.

- retina
- iris
- lens
- sclera
- cornea

32. Laser effects on tissue depend on

- power density of the incident beam
- direction of the incident beam
- absorption of tissues at the incident wavelength
- time beam is held on tissue
- blood circulation in the affected area
- heat conduction of the affected area

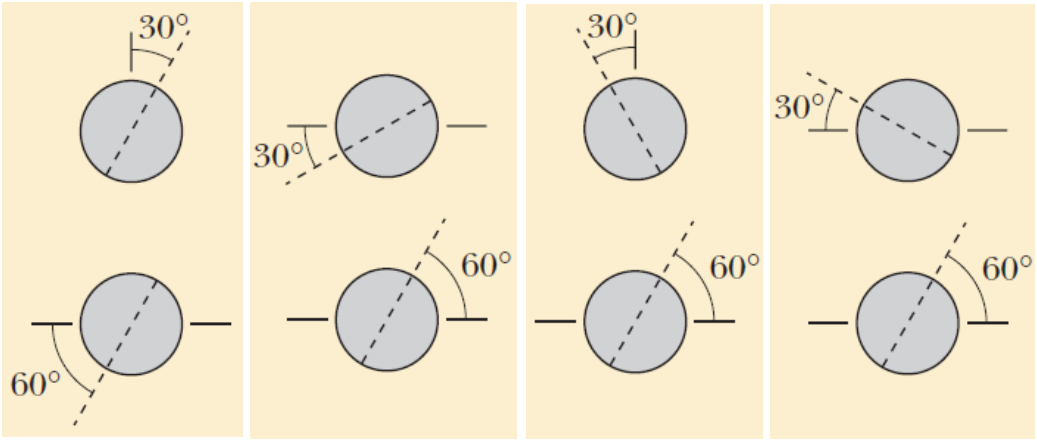
33. Classification of lasers with respect to medical applications

- Class 1
- Class 2
- Class 3a
- Class 3b
- Class 3c
- Class 4
- Class 5

34. Non-contact types of radiation delivery.

Special questions

1. Light travels from water (n_1=1.33) to glass (n_2=1.52). Please calculate the angle of *Total internal reflection.*
2. Please calculate the diffraction limit for λ = 632 nm, n=1.52, angle of incidence = 10°.
3. The figure shows four pairs of polarizing sheets, seen face-on. Each pair is mounted in the path of initially unpolarized light. The polarizing direction of each sheet (indicated by the dashed line) is referenced to either a horizontal x-axis or a vertical y-axis. Rank the pairs according to the fraction of the initial intensity that they pass, greatest first.



4. Light absorption by the components of human eye:

- Near UV
- Far UV
- Visible

- Near IR
- Far IR

5. What are the necessary components of the gas laser and their purpose?

- gas
- resonator
- polarizer
- gas discharge tube
- flash lamp
- electrical circuit.

6. Specify the temperatures for the mentioned photothermal effects:

- Hyperthermia leading to protein structural changes
- Coagulation, protein denaturation
- Collagen denaturation
- Dehydration
- Vaporization, tissue ablation
- Carbonization