LIST OF ENTRANCE EXAM QUESTIONS

FOR THE INTERNATIONAL MASTER'S DEGREE PROGRAM

ITMO

APPLIED OPTICS

1. Main laws of geometrical optics.
2. Main invariants of geometrical optics.
3. Optical phenomena at two media boundary. Reflection, refraction, total internal reflection (TIR).
4. Optical phenomena at two media boundary. Fresnel relations for normal and oblique light incidence.
5. Light and energy photometric quantities and their connection.
6. Main relations of ideal optical systems.
7. Linear, angular and longitudinal magnification. Cardinal points and distances.
8. Laws of signs in optics. Parameters of optical systems.
9. Matrix optics. Examples of application.
10. Ray beam constraints. Aperture and field diaphragms. Vignetting.
11. Abbe's relation. Real ray tracing through an optical surface. Conditions of ray tracing through a surface.
12. Aberration descriptions (wave, transverse, longitudinal).
13. Types of aberrations.
14. Image structure characteristics. Diffraction image structure. Non-aberration Optical transfer function (OTF), Point spread function (PSF).
15. Optical image formation scheme. Pupil function.
16. Aberration influence on the OTF and PSF. Strehl ratio. Marechal criterion.
17. Diffraction-limited and geometrical limited optical systems.
18. Modular transfer function (MTF). Optical image performance criteria. Rayleigh resolution. Foucault resolution.
19. Main characteristics of optical systems. Diopter calculus basics.
20. Main types of optical systems from the point of view of image and object position and their characteristics.
21. Projection systems. Mains characteristics. Examples of applications.
22. Telescopic systems. Lens and mirror-lens telescopes. Main characteristics. Examples of applications.
23. Camera lens. Mains characteristics. Examples of applications.
24. Optical microscopes. Mains characteristics. Examples of applications.
25. Illumination optical systems. Methods of illumination.
26. Plane-parallel plate. Image shift with a plane-parallel plate.
27. Optical mirrors.
28. Prisms. Reflecting prisms and their using in optical instruments.
29. Thin lens. Thick lens. Main properties.
30. Optical wedge. Refracting angle of an optical wedge.
31. Spherical surfaces and aspherics. Features and their application in optical systems.
32. Gradient and diffraction optic components. Special features and examples of application.
33. Fiber optic components. Special features and examples of application.
34. Optical fibers. Numerical aperture. Single-mode and multimode fibers.
35. Optical system of human eye. Light adaptation and accommodation.
36. Optical system of human eye. Defects of vision and their compensation.
37. Light absorption.
38. Light polarization. Polarization conditions. Linear, circular, elliptic polarization. Examples of light polarization.
39. Linear polarizers (general principles: dichroism, birefringence, reflection, scattering). Methods of polarized light analysis.
40. Light interference. Interference conditions. The interference pattern equation. Types of interferometers.
41. Light diffraction. Diffraction conditions. Fresnel diffraction. Fraunhofer diffraction.

42. Holography basics. Gabor's equations. Types of holograms. Denisyuk hologram.
43. Electromagnetic spectrum. Optical range. Examples of optical devices working in various spectral ranges.
44. Light dispersion. Dispersion formula.
45. Optical medium parameters: refractive index (n), absorption (α), reflection (ρ), transmittance (τ), scattering (σ). Bouguer–Lambert–Beer law.
46. Modern optical materials. Features and application.
47. Optical glass and its characteristics.
48. Anisotropic materials. Birefringence.
49. Optical coatings. Theory. Classification.
50. AR coatings.
51. Characteristics of performance of optical materials and their control.
52. Control of accuracy of optical surfaces – spherical and plane.
53. Photoemissive effect.
54. Photovoltaic effect.
55. Thermal radiation laws.
56. Temperature equivalents: total radiation temperature, brightness temperature and color temperature.
57. Lasers. Laser operation principle. Main elements of lasers.
58. Lasers. Classification of lasers. Laser beam structure.
59. LED operation principle.
60. Operation principle of a CCD.
61. Operation principle of a CMOS.
62. Principle of analog-to-digital conversion.
63. Digital representation of the image.
64. Two-dimensional discrete cosine transformation.
65. Basic principles of digital video compression.
66. Convolution.
67. Fourier transform.
68. Fourier series.
69. Random variable distribution laws and their properties.
70. Array operations, linear algebra relations.

RECOMMENDED LITERATURE

1. Handbook of Optics : [in 5 vol.] / Ed.-in-Chief M. Bass .— 3rd ed. — New York [etc.] : McGraw-Hill, [2010].
2. Ch. Roychoudhuri (ed.), "Fundamentals of Photonics". 23 May 2008 – Pages: 418, ISBN: 9780819471284, Volume: TT79. URL: http://spie.org/publications/fundamentals-of-photonics-modules (free open access)
3. Steven Schwartz, Geometrical and Visual Optics, Third Edition Hardcover, Mc Graw Hill, 2019
4. Steven W. Smith, "The Scientist and Engineer's Guide to Digital Signal Processing" (available online: http://www.dspguide.com)
5. Eugene Hecht. Optics. Pearson Education, Incorporated, 2017