

# VOLUME 1

## CONTENTS

1. OPTICAL RADIATION AND ITS SOURCES	7
2. OPTICAL MEDIA AND MATERIALS	51
REFERENCES	76
APPENDIXES A	A1 - A5

<b>1. OPTICAL RADIATION</b>	9
1. Radiation	9
2. Electromagnetic radiation	9
3. Classification of Electromagnetic Radiations	9
4. Natural and Artificial Illumination (Irradiation)	11
5. Spectral Dependences of Optical Quantities	11
<b>2. RADIOMETRIC AND PHOTOMETRIC QUANTITIES AND THEIR UNITS</b>	12
1. Radiometry and Photometry	12
2. Spectral and Nonspectral Quantities (Spectral Densities)	13
3. Domains of Spectral Density Functions	14
4. Spectral Luminous Efficacy and Efficiency of Radiation	14
<b>3. CLASSIFICATION OF OPTICAL RADIATION SOURCES</b>	17
<b>4. THERMAL SOURCES OF OPTICAL RADIATION</b>	17
1. Thermal Radiation	17
2. Blackbody	18
a) Blackbody Radiation	18
b) The Planck Radiation Law	18
c) Wien's Displacement Law	20
d) Stefan - Boltzmann's Law	21
<b>5. NON - SELF - RADIATORS OF OPTICAL RADIATION</b>	22
1. Emissivity	22
2. Reflectance (Reflectivity)	23
3. Albedo	23
4. Absorptance	24
5. Transmittance	24
6. Relationship Between Absorptance, Transmittance, and Reflectance	24
<b>6. KIRCHHOFF'S LAW</b>	25
<b>7. GRAYBODY AND SELECTIVITY BODIES</b>	25
<b>8. LUMINESCENT SOURCES OF OPTICAL RADIATIONS</b>	26
1. Luminescence	26
2. Processes That Create Luminescence	26
<b>9. NATURAL THERMAL SOURCES OF OPTICAL RADIATIONS</b>	27
1. Astronomical Measures of Luminosity of Celestial Bodies.	27
a) Stellar Magnitudes	27
b) The Magnitude Scale	28
c) Apparent Magnitude	28
d) Absolute Magnitude	29

e) The Influence of Wavelength	30
f) Standard Celestial Object	30
2. Luminous Intensity of Arbitrary Celestial Object Observed at Sea Level of Earth	30
3. Irradiance (Illumination) of Earth's Surface by an Arbitrary Celestial Body	31
a) Irradiance	31
b) Illumination	32
4. The Sun	32
5. Moon and Planets	34
a) Illumination of the Earth's Surface at Sea Level Due to Reflected Solar Radiation Alone	35
b) Irradiation Above Earth's Atmosphere by Planets Due to Thermal Emission Only	36
6. Stars	36
7. Sky Luminance.	38
8. Terrain Radiation	40
<b>10. LASERS</b>	<b>42</b>
1. Basic Elements	42
2. Spontaneous and Stimulated Emission	43
3. Cavity Resonator	44
4. Laser Beam Propagation	44
5. Types of Lasers	45
a) Pumping Cycle of a Typical Laser	45
b) Gas Lasers	46
c) Solid State Lasers	47
d) Semi - Conductor Injection Lasers	48
6. Laser Safety	48
a) Protection Standards	48
b) Nominal Ocular Hazard Distance	49
A Laser Hazard Classification System	49
<b>11. OPTICAL MEDIA AND MATERIALS</b>	<b>51</b>
1. Earth's atmosphere	51
2. Composition ( structure) of the Earth's atmosphere	51
a) Gases	51
b) Aerosols	52
<b>12. DISTRIBUTION IN ALTITUDE ( ALTITUDE VARIATIONS)</b>	<b>53</b>
a) Temperature	53
b) Density	53
c) Pressure	53
d) Humidity	55
e) Aerosols	55
<b>13. STANDART MODEL ATMOSPHERE</b>	<b>55</b>
a) Meteorological quantities at sea level (Sea level values)	55
b) Meteorological quantities up to altitude $h = 11$ km	55
<b>14. SEASON'S VARIATIONS</b>	<b>56</b>

<b>15. ATMOSPHERIC EFFECTS</b>	56
<b>16. EXTINCTION IN GENERAL</b>	59
a) Bouger-Lambert law	59
b) Beer law	60
<b>17. TRANSMISSION IN GENERAL</b>	60
<b>18. ABSORPTION</b>	61
<b>19. SCATTERING</b>	63
1. Rayleigh scattering	64
a) Introduction	64
b) Incident monochromatic plane wave is linearly polarized	65
c) Incident monochromatic plane wave is unpolarized	69
d) Scattering by molecules of the atmospheric gases	71
e) Scattering by very small atmospheric aerosols	71
f) Total scattered radiation.	72
g) Explanation of the daytime sky color	73
h) Scattering cross-sections	74

## APPENDIXES A

Table A1 Nonspectral Radiometric Quantities ..... A-2

Table A2 Nonspectral Photometric Quantities ..... A-5