

Contents

1. Introduction	1
2. Some Basic Concepts of Differential Geometry and Continuum Mechanics	3
2.1 Some Elements of Tensor Analysis and Differential Geometry of Surfaces	3
2.1.1 Vectors and Tensors, General Coordinates	3
2.1.2 Derivatives in Three-Dimensional Space, Normal Projections	10
2.1.3 Vectors and Tensors on a Curved Surface	15
2.1.4 Derivatives on a Surface, Curvature of the Surface	18
2.1.5 Connections Between Two Surfaces, Oblique Projections	21
2.2 Elements of Continuum Mechanics: The Kinematics of Deformation	27
2.2.1 Deformation, Strain and Rotation, and Their Relations to the Displacement	27
2.2.2 Strain and Rotation at the Surface of a Body	33
3. Principles of Image Formation in Holography	39
3.1 Image Formation in Standard Holography	39
3.1.1 Recording the Phase and the Amplitude of the Light Wave Emitted by a Point Source	39
3.1.2 Reconstruction of the Image of a Point Source	41
3.1.3 Holography of a Whole Object and Double Exposure	44
3.2 Image Formation in the Case of Modification of the Optical Arrangement at the Reconstruction	47
3.2.1 Large Modification of the Reference Source: Position of an Image Point, Aberrations	47
3.2.2 Small Modification of the Reference Source: Position of an Image Point	56
3.2.3 Modification of the Reference Source: Analysis in Terms of Transverse Ray Aberration	59
3.2.4 Movement of the Hologram: Position of an Image Point	65
3.2.5 Movement of Two Sandwiched Holograms: Difference Between the Lateral Displacements of Two Image Points	69
3.3 Conclusion	74
4. Fringe Interpretation in Holographic Interferometry	75
4.1 Optical-Path Difference in Standard Holographic Interferometry	77
4.1.1 Basic Relation	77

4.1.2	Determination of the Displacement by Means of the Optical-Path Difference	80
4.1.3	Determination of the Displacement with Additional Equipment	85
4.1.4	Determination of Strain with Finite Differences	89
4.2	Derivatives of the Optical-Path Difference in Standard Holographic Interferometry	92
4.2.1	Fringe Spacing and Direction	92
4.2.2	Fringe Contrast or Visibility, Concepts of Localization	97
4.2.3	Fringe Visibility for Different Apertures, Partial Localization	110
4.2.4	Complete Localization, Normality Theorem, Shape of the Line of Complete Localization	115
4.2.5	Determination of Strain and Rotation by Means of the Derivatives of the Optical-Path Difference	127
4.3	Modifications of the Optical Arrangement at the Reconstruction	132
4.3.1	Basic Relations when the Reconstruction Sources are Shifted and when the Wavelength is Changed	132
4.3.2	Principal Relations that Result from the Movement of One Hologram or of Two Sandwiched Holograms	140
4.3.3	Generalization and Application of the Results Concerning the Modification of the Optical Arrangement	145
4.4	Conclusion	151
5.	Second Derivatives of the Displacement and of the Optical-Path Difference	153
5.1	Some Additional Equations of Continuum Mechanics, Particularly Relations Containing the Second Derivative of the Displacement	153
5.1.1	Curvature Change of the Outer Surface of an Arbitrary Body or of the Middle Surface of a Shell	154
5.1.2	Integrability and Compatibility Conditions on a Curved Surface	157
5.1.3	Equations of Motion or of Equilibrium and Kinematic Relations in the Neighborhood of a Free Surface. Constitutive Equations for an Elastic Body	161
5.2	The Second Derivatives of the Optical-Path Difference and Some of Their Possible Applications	164
5.2.1	Derivative of the Fringe Spacing, Curvature of a Fringe, Singularities in the Fringe Pattern	165
5.2.2	Extrapolation of Mechanical Quantities into the Interior of a Nontransparent Body	169
5.3	Conclusion	170
References	171
Author Index	187
Subject Index	191