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Additional Questions to the Lectures

Optical Metrology and Sensing (WS 2015/2016)

1. What is the meaning of a material measure or standard? Give some examples for it!
2. Describe the Abbe comparator principle!
3. What is the meaning of the „confidence interval“ of measured values?
4. Explain the meaning of scanning/sensing a test piece, primary and secondary standards, systematic and random errors, uncertainty of measurement!
5. Describe the difference between “accurate/correct” and “precise”!
6. Explain the measurement terms reproducibility and repeatability!
7. What is the meaning of the sensibility and resolution of an instrument?
8. What has influenced the uncertainty of measurement of the primary standard of length?
9. What is the meaning of spatial and temporal coherence?
10. How can the coherence time and the coherence length be measured?
11. How can the spatial coherence be measured?
12. Which kinds of interference structures are generated if two plane waves, two spherical waves or a plane wave and a spherical wave are superposed?
13. What is the visibility of fringes and how can it be determined?
14. What does the degree of coherence describe and how does it influence the law of interference?
15. What is the meaning of localized interference structures and when do they appear?
16. How can white-light interference patterns be generated with a Michelson interferometer?
17. Give examples for interferometers with division of amplitudes and wavefronts respectively!
18. How interference structures can be generated with Fresnel’s mirror (lecture experiment)?

19. Explain the measurement of the complex degree of coherence with the Young interferometer!

20. Calculate the shift of the positions of interference maxima in a Young interferometer for a given phase of the degree of coherence!

21. Describe the realization of Haidinger fringes and Fizeau fringes with a Michelson interferometer!

22. What is the role of the compensation plate in the Michelson interferometer?

23. Are their compensation plates required for Mach-Zehnder or Sagnac interferometers too?

24. How can wavelengths and path differences be measured with a Michelson interferometer?

25. What is the meaning of a traceability measurement like it was performed out by Michelson with a cadmium lamp and the primary (secondary) standard?

26. Explain the generation of interference fringes for a Fabry-Perot interferometer!

27. What is the meaning of finesse for multiple-beam interferometers?

28. Derive the Airy-formulas of the reflected and transmitted intensities for multiple beam interferences given in the lecture!

29. Explain the instrumental function of a Fabry-Perot interferometer!

30. Which role do surface imperfections of mirrors play in the Fabry-Perot interferometer?

31. What is the meaning of effective finesse?

32. How is the free spectral range of a Fabry-Perot interferometer defined? Is there a difference with regard to the grating interferometer?

33. Which basic principles should be observed in interferometric wavefront analysis to get usable experimental data?

34. Discuss the advantages and disadvantages of Fizeau and Twyman-Green interferometers!

35. Discuss the advantages and disadvantages of Shearing interferometers!

36. What is the difference between null tests and non-null tests?

37. How can be Herschel fringes realized (lecture experiment)?

38. How Newton’s rings can be generated (lecture experiment)?

39. Describe the Fourier transform method for the static evaluation of interference fringes!

40. What are the advantages of carrier-frequency techniques?

41. How do phase shift methods work?

42. What are the advantages and disadvantages of phase step and integrating bucket methods?

43. Which methods of phase shifting can be used?

44. How does a heterodyne interferometer work and what is the reason for its very high accuracy of measurement?

45. Describe the calibration of phase shifters using the ellipse fitting technique!

46. What is the meaning of interferometry with effective or synthetic wavelengths?

47. How does a grazing-incidence interferometer work and for which applications can it be used?

48. What is the meaning of optical phase conjugation?

49. How can phase conjugated waves be generated?

50. Which are the advantages of phase-conjugate mirrors in interferometry?

51. Describe the advantages of a Fizeau interferometer with a PCM!

52. How is it possible to measure reciprocal and non-reciprocal effects with interferometers?

53. What is a novelty filter and how can it be realized?

54. How does a white-light interferometer work and for which applications is it well suited?

55. What is the difference between a Linnik and a Mirau interferometer?

56. How the structure of the retina of the eye can be measured with optical coherence tomography?

57. Why are wavefront aberrations determined in the plane of the exit pupil?

58. How can wavefront aberrations be described by Zernike polynomials?

59. Which aberrations are called Seidel aberrations?

60. Give examples for indirect and direct wavefront sensors?

61. Under which conditions a radial shearing interferometer can be used as a direct wavefront sensor?

62. Which are the advantages of Hartmann-Shack sensors compared with Hartmann sensors?

63. Which are the main fields of application of wavefront sensors?

64. What is the meaning of adaptive optics?

65. What limits the resolution of earth telescopes?

66. How does a telescope with adaptive optics work?

67. How can adaptive mirrors be realized?

68. What is the meaning of guide stars and how can they be generated?

69. How can adaptive optics be used in ophthalmology?

70. Explain the principle of holographic recording and reconstructing of wavefronts!

71. Which physical and technical conditions have to be fulfilled for holography?

72. Under which conditions can a virtual image be reconstructed?

73. What are the differences between the primary image and the conjugate image?

74. Under which conditions a phase conjugate wave can be reconstructed?

75. Which conditions have objects to fulfil for holographic recording?

76. Which are the advantages and disadvantages of holographic interferometry compared with conventional interferometry?

77. Which methods of holographic interferometry do you know and what are they used for?

78. Which effects lead to interference fringes in double exposure techniques?

79. Which advantages and disadvantages of real-time holographic interferometry do you know?

80. Explain the concept of homologous points!

81. Why holography is well-suited for rough objects in contrast to classic interferometry?

82. What is the sensitivity vector?

83. How can holographic interferograms be quantitatively evaluated?

84. How can the shape of objects be measured by holographic means?

85. Which types of contour lines can be generated, if the wavelength or the refractive index is changed?

86. How the 3D-shape of an object can be measured with the two-source method?

87. What means digital holography and what are its advantages and disadvantages compared with conventional holography?

88. Why is the pixel size of the camera the main resolution limiting factor of digital holography?

89. How do shadow Moiré and projection Moiré work?

90. What are the parameters of the apparatus of a two-dimensional fringe projection system?

91. What is a pinhole camera and which advantages and disadvantages has it compared with conventional imaging systems (collecting lens)?

92. Which are the advantages of telecentric projection compared with central projection?

93. Which methods for the generation of fringes in space do you know?

94. Why projector and camera can be described with the same physical model?

95. What means to measure phase values with fringe projection techniques?

96. Explain the principal measurement procedure of a fringe projection system!

97. Why a combination of Gray-code and phase shifting is often used for fringe projection systems?

98. Which methods of (coded) structured light illumination do you know?