WORCESTER POLYTECHNIC INSTITUTE
MECHANICAL ENGINEERING DEPARTMENT
ME – 593N

Laser metrology and NDT

http://www.wpi.edu/~cfurlong/me-593n.html

Fall 2000

Days: Monday and Wednesday
Time: 5:00 – 6:20 p.m.
Place: Room 104 Salisbury Labs

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COURSE DESCRIPTION

Demands for increased performance and efficiency of components in the micro, meso, and macro-scale, impose challenges on their engineering study, design, and optimization. These challenges are compounded by multidisciplinary applications to be developed inexpensively in short time while satisfying stringent design objectives. As a consequence, effective quantitative engineering methodologies, such as optical techniques, should be used in the study and optimization of components. State-of-the-art optical techniques are based on the utilization of coherent light sources, or laser sources. Laser sources are characterized by their optical energy and power, wavelength, phase, polarization state, speed of propagation, and direction of propagation. When laser light is reflected or scattered by the surface of an opaque object, or when it is transmitted through a transparent medium, any or all of its characteristics may be altered. By measuring the changes in these characteristics, it is possible to obtain accurate and precise information about the state of an object or medium of interest, such as its size, shape, temperature, velocity, density, or state of stress. Such measurements are of significant importance in many areas of engineering and science, which include solid mechanics, vibrations, tribology, transport phenomena (heat, mass, and momentum transfer), acoustics, and electromagnetism.

In this course, modern laser metrology techniques are covered and their practical applications to solve problems, with emphasis on nondestructive testing (NDT), are illustrated with laboratory demonstrations. Topics covered include wave and Fourier optics, classic and holographic interferometry, speckle techniques, solid state lasers, fiber optics, CCD cameras, computer vision, camera calibration methods, and image processing and data reduction algorithms as required in quantitative fringe analysis. Detail examples of nondestructive testing and coherent optical metrology in solid mechanics, vibrations, heat transfer, electromagnetics, and reverse engineering will be given.

Students will be required to work on projects depending on their background and interests.

Contents

References

E. Hetch, *Optics*, Addison-Wesley, Reading, Massachusetts, 1990.

Y. I. Ostrovsky, V. P. Shchepinov, and V. V. Yakovlev, *Holographic Interferometry in Experimental Mechanics*, Springer-Verlag, Berlin, 1991.

B. E. A. Saleh and M. C. Teich, *Fundamentals of Photonics*, John Wiley, New York, 1991.

D. W. Robinson and G. T. Reid, eds., *Interferogram Analysis: Digital Fringe Pattern Measurement Techniques*, IOP Publishing, London, 1993.

R. N. Bracewell, *Two-dimensional Imaging*, Prentice Hall, Englewood Cliffs, New Jersey, 1995.

R. J. Pryputniewicz, *Holographic Numerical Analysis*, Center for Holographic Studies and Laser micro-mechaTronics, Worcester Polytechnic Institute, Mechanical Engineering Department, Worcester, Massachusetts, 1996.

T. Kreis, *Holographic Interferometry. Principles and Methods*, Akademie Verlag, Berlin, 1996.

P. K. Rastogi, ed., *Optical Measurement Techniques and Applications*, Artech House Inc., Norwood, Massachusetts, 1997.

G. L. Cloud, *Optical Methods of Engineering Analysis*, Cambridge University Press, New York, 1998.

D. C. Ghiglia and M. D. Pritt, *Two-dimensional Phase Unwrapping. Theory, Algorithms, and Software*, John Wiley, New York, 1998.

P. K. Rastogi, ed., *Photomechanics*, Springer-Verlag, Berlin, 1999.

P. K. Rastogi and D. Inaudi, eds., *Trends in Optical Nondestructive Testing and Inspection*, Elsevier Science Ltd., Amsterdam, 2000.

NOTE: The course evaluation will be based 30% on the HOMEWORK, 45% on the PROJECT REPORT, 15% on the PROJECT PRESENTATION, and 10% on the PARTICIPATION in the class.
