Optical Measurement and Quality Inspection Laboratory at the Department of Mechanical Engineering is one of the most important laboratories at the School of Engineering and Computer Science of Oakland University. The laboratory deals with Modern Optical Measurement Techniques and their applications to Automobile, Aerospace and other high-tech industries. There are two courses which are being taught regularly to the students both at the graduate and under-graduate level covering the principle and applications of various optical techniques with a laboratory work.

- **ME467/567:Optical Measurements and Quality Inspection**
- **ME665:Optical Methods in Experimental Mechanics**

The research work covers a wide range of areas in the field of optics and their applications in industries as shown below:

- **Digital Optical Measurement Technique for Full-field, Non-contact and 3D measurement of contour, deformation and strain/stress:** This technique is based on the very sensitive Electronic Speckle Pattern Interferometry (ESPI) technique – the electronic version of holographic Interferometry (for measurement of small deformation and strain), the very robust digital 3D-correlation technique (for measurement of large deformation and strain) and very practical white-light digital 3D-profilometry (for contour measurement). They are able to deliver fast, complete three-dimensional information about the component behavior at thousands of measuring points in the field of view. The research has been focusing on whole field determination of strain/stress on 3D object, on a complicated or an indirectly observable surface (e.g. inner surface of a container). The current research in this area involves 3D deformation and contour measurement, Residual Stress measurement, Strain/Stress Analysis and also in certain special applications using optical fibers such as Endoscope Measurement.

- **Nondestructive Testing and Material Evaluation:** In recent years, the use of composite materials in the automobile and aerospace industries has become increasingly widespread. Thus effective techniques for non-destructive testing (NDT), especially for on-line inspection of the composite materials, have become more and more important. Various inspection methods such as Holography, Shearography, Moiré technique, Ultrasonic, Acoustical emissions etc. have been applied for NDT of the composite materials in recent years. Among these methods, digital shearography appears to be more practical. The research in this area is to explore the further applications in industries such as thermal stress measurement, spot weld analysis and so on.

- **Digital Image Processing and New Software Development:** A user-guided software to perform automatic and quantitative measurement is a basic concept to transfer new optical measuring techniques into industries. The research in this area covers developments both in hardware to perform automatic measurement

and in software using C++ language for the quantitative evaluation of the interferograms, e.g. by using phase shift technique.

- **Vibration Analysis:** The demand to reduce the overall noise level on any machine requires detailed knowledge about the vibration behavior of the different components. Using traditional point measuring techniques like vibrometers, the analysis of machine vibrations is especially laborious, because the large areas require many measuring points. Modern optical methods, such as, Holography/ESPI, digital shearography etc. are non-contact measuring techniques and provide full field information. The research in this area has been focusing on non-contact, whole field vibration analysis on any objects with a harmonic or transient exciting, for determination of natural frequencies, vibration amplitude, and vibration phase as well as experimental determination of damping coefficient etc.

- **Measurement of Microstructure and MEMS (MEMS: MicroElectroMechanical Systems):** MEMS are devices fabricated via techniques such as micro photolithography to create miniature actuators and sensors and are being applied increasingly in automobile, aerospace and high-Tech industries. The current research in this lab is to use a novel digital microinterferometer developed by the optical labs to measure 3D-contour and 3D-displacements of MEMS and microelements. This new technique will allow measuring MEMS down to 30 microns in size, which corresponds to the smallest parts of most current MEMS in telecommunication. The results measured will be evaluated quantitatively and automatically by a developed software OMES. The results of this research will have a significant impact on the fast growing industries of miniaturization and on emerging research areas in MEMS and microelements.

- **Determination of Mechanical Properties of Biomedical Materials**: Modern optical technique, such as digital holography/ESPI, digital shearography etc, has so far been well established as a tool for measuring deformation and thus strain/stress on objects in the areas of mechanical engineering. Measurement of mechanical properties on objects in the area of biomedical engineering are highly expected in numerous applications, which poses modern optical technique as one of the best candidate techniques. The research in this areas is to develop novel digital holographic and shearographic technology, such as holographic endoscope and shearographic endoscope, for measurement of deformation and strain/stress on a biomedical material or on a living specimens, such as a human body. This new technology will play a crucial role in terms of the prevention and diagnose of some diseases, like cancer etc. which will impact significantly both on fast growing industry of biomedical engineering and on other merging research areas in biomechanics.