Major - Examination

M. Tech. (Instrument Technology)

IDL-734 (Laser Based Instrumentation and Holography)

Max. Marks = 40; **Time: 2.0 Hour Date:04-05-2007**

Attempt All Questions

Q. No. 1- Answer to the point.

(a) Explain in brief the meaning of coherence and brightness. 2

(b) How phase is coded in holographic process? 2

(c) In two-beam interference under what conditions the maximum depth of modulation can be achieved? 2

(d) How volume or thick phase hologram can work as laser goggles or selective filters- explain with ray diagram. 2

(e) What is Talbot effect? Give the meaning of positive and negative images. 2

Q. No. 2 (a) - Explain how Digital Speckle Pattern Interferometry (DSPI) / TV holography can be used for the measurement of dynamic deformations (study of vibrations). Why DSPI/TV holography is preferred for Non-destructive Testing over conventional holography. 4 + 2 = 6

(b) - Give a brief survey of different optical techniques which can be used for alignment of machines / machine components. How much order of uncertainty in the alignment can be achieved by using (i) Quadrant Detector (ii) Talbot Effect. 3 + 2 = 5

Q. No. 3 - Explain why laser heterodyne interferometry is preferred over the laser homodyne interferometry for measuring the displacement and length. Give ray diagram and derive formula for displacement measurement using laser heterodyne interferometric technique. 5

Q. No. 4 - In a tightly focused Laser beam (Gaussian, TEM_{00}) of power P, wavelength λ, describe the types of forces acting on a micro-particle of size 10 μm immersed in water, near the vicinity of the focus. Explain which force is dominant at the focus and why? Describe one method to measure the force acting on the particle. 5

Q. No. 5 - A fluid in a transparent pipe is flowing with velocity V and seeded with a suitable scattering particle. Derive expression for the measurement of fluid velocity using differential Doppler technique. What are the advantages of differential Doppler technique over other optical techniques. 5

Q. No. 6 - The complex amplitude of a Gaussian beam in free space is given by the following expression

$$U(\vec{r}) = A_0 \frac{W_0}{W(z)} \exp\left[-\frac{\rho^2}{W^2(z)}\right] \times \exp\left\{-j\left[kz - \tan^{-1}\left(\frac{z}{z_0}\right)\right]\right\} \times \exp\left[-j\frac{k\rho^2}{2R(z)}\right]$$

Explain each term in the above expression. When this beam passes through a conversing lens derive expression for depth of focus, beam waist and beam divergence. 4