PH-9202 Laser and its Applications

L	T	P	C
4	1	0	5

Course Outcomes:

After successful completion of this course, the students should be able to

CO1: Explain the basic principle and properties of LASERs including laser hazards and safety.

CO2: Explain the reason behind different spectral widths of various lasers

CO3: Explain the reason for different modes of LASER operation and be able to select a particular mode of interest.

CO4: Explain the principle and working of different types of Lasers.

CO5: Use and understand the laser applications in material processing, medical sciences, physical measurements, spectroscopy and holography more effectively

CO/PO Mapping

S-strong, M-medium and W-weak indicate the strength of correlation, N-No correlation

COs	Programme outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	M	W	N	N	N	S	S	W	S
CO2	S	M	M	W	M	N	N	N	S	S	W	S
CO3	S	S	S	W	W	N	N	N	S	S	W	S
CO4	S	W	S	M	S	N	N	N	S	S	W	S
CO5	S	M	S	S	S	S	S	N	S	S	W	S

L	T	P	C
4	1	0	5

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UNIT-I

Basics of Lasers:

Properties of laser beams: Intensity, monochromaticity, coherence, directionality, and brightness.

Interaction of radiation with matter: Absorption & stimulated emission, line broadening mechanism, transition cross section, absorption & gain coefficient, gain saturation (homogenous and inhomogeneous broadened line), spatial hole burning, spectral hole burning, Lamb dip.

Continuous wave and transient laser behavior: Rate equations (Four level and three level laser). CW laser behavior, power in laser oscillator, optimum output coupling, single mode oscillation, reasons for multimode oscillations, and active stabilization of laser frequency, Frequency pulling, relaxation oscillations in single mode lasers. **(19 Hrs)**

Optical Resonators:

Fabry Perot interferometer, photon life time and cavity Q, plane parallel resonator, confocal resonator, generalized spherical resonators, stable and unstable resonators. Gain switching, cavity dumping, Q-switching and mode locking: Active and passive mode locking. **(11 Hrs)**

UNIT-II

Principle and Working of Different Lasers:

Gas Lasers: CO2 laser, Argon ion laser. Excimer lasers, He-Ne Laser, Solid and Liquid Lasers: Neodynium-YAG laser. Neodymium glass laser. Ruby Laser, Dye Lasers. Chemical lasers: HF, DF & Free electron lasers, Semiconductor diode lasers: homostructure and heterostructure, double Hetro Structure p–n junction lasers, Quantum Well Lasers. **(13 Hrs)**

Laser Applications:

Laser in measurements: Measurement of length; homodyne and heterodyne interferometry, Lasers in detection of gravitational waves (qualitative idea only), speckle metrology, laser Doppler velocimetry, measurements of rate and rotation using laser gyroscope, LIDAR.

Holography: The wavefront reconstruction process: Inline hologram, the off axis hologram, Fourier hologram, the lens-less Fourier hologram, image hologram.

The reconstructed image: Image of a point, image magnification, thin hologram, Thick (volume) hologram.

Industrial applications of LASERS: Hole drilling, cutting & welding with Lasers.

Laser in Medical Sciences: LASERs diagnostics, Lasers in Dermatology and cardiology and ophthalmology (qualitative idea).

Laser in spectroscopy: Absorption spectroscopy, Laser induced fluorescence, RAMAN spectroscopy, LASER induced breakdown spectroscopy, Confocal LASER microscopy.

Use of laser at particle accelerators (qualitative idea only).

Laser Hazards and laser safety: Basic knowledge

(17 Hrs)

Total: 60 Hrs

BOOKS:

1. K. Thyagrajan and A.K.Ghatak, Laser: Theory and Applications. (McMillan India. New Delhi, 1984).
2. O.Svelto, Principles of Lasers, (Plenum, New York, 1982).
3. A.K.Ghatak and K.Thyagrajan, Optical Electronics,(Cambridge Univ. Press, 1989).
4. D.C.O.Shea. An Introduction to Lasers and Their Application (Addision -Wesley. Reading, 1978)
5. K. Shimoda, Introduction to Laser Physics (Springer Verlag, Berlin, 1984)
6. Laser Principles and Applications by J.Wilson and Hawkens.
7. B.B. Laud, Laser & Non linear optics, (Wiley Eastern, 1991)

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