INTRODUCTION TO LASER

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TYPE OF COURSE : New | Elective | UG/PG
COURSE DURATION : 12 weeks (18 Jan'21 - 9 Apr'21)
EXAM DATE : 24 Apr 2021

PRE-REQUISITES : Basic undergraduate-level knowledge of Electromagnetics, Optics, and Atomic Physics/Modern Physics would be required.

INTENDED AUDIENCE : IIIrd, IVth year B.Tech / M.Sc (Physics/ Electronics/ Electronic Sciences) students, and also M.Tech Ist Sem students, who had no previous exposure to Lasers in any course. PLUS Engineers working/ dealing with Lasers

INDUSTRIES APPLICABLE TO : Companies and R&D Laboratories working on Laser Applications, Optoelectronic and Optical Communication are expected to value this course.

COURSE OUTLINE :
This course introduces LASER to senior undergraduate students, as well as first year postgraduate students. The objective is to provide a detailed account of the basic physics, including resonator physics, and the principle of operation of Lasers. Issues relevant to the design and output characteristics of the Lasers, and some specific laser systems would also be discussed.

ABOUT INSTRUCTOR :
M. R. SHENOY received his M. Sc. in Physics in 1979 from Mysore University and the PhD in the field of Fiber and Integrated Optics from IIT Delhi in 1987. He joined the faculty of IIT Delhi in 1988, where he is currently Professor in the Department of Physics. Dr. Shenoy was a Visiting Scientist with the Department of Electrical and Electronic Engineering, University of Glasgow, Glasgow, U.K., in 1990 for 10 months, and on short- duration visits at the University of Nice-Sophia Antipolis, Nice, France, in 1992, 1997, 2006 and 2008 for collaborative research on Integrated Optical Devices.

COURSE PLAN :

Week 1: PART-I: Interaction of Radiation with Matter: General Introduction, Spontaneous and stimulated emissions, the Einstein coefficients

Week 2: Line shape function, Line-broadening mechanisms: Homogeneous and inhomogeneous broadening, natural-, Doppler- and collision broadening.

Week 3: PART-II: Scheme of Light Amplification: Rates of stimulated emission and absorption, condition for amplification by stimulated emission, the meta-stable state and laser action.

Week 4: 3-level and 4-level pumping schemes. Laser Rate Equations: Two-, three- and four-level laser systems, condition for population inversion, gain saturation;

Week 5: Laser amplifiers, gain and bandwidth; Rare earth doped fiber amplifiers.

Week 6: PART-III: Optical Resonators: Plane mirror resonator: resonance frequencies, cavity loss, cavity lifetime and Q-factor;

Week 7: Spherical mirror resonators: Ray paths in the resonator, stable and unstable resonators, resonator stability condition

Week 8: Transverse modes of laser resonators. Hermite-Gauss modes of a spherical mirror resonator. Gaussian beams in laser resonators.

Week 9: PART-IV: The Laser: Laser Oscillations, Optical feedback, threshold condition, variation of laser power near threshold, optimum output coupling,

Week 10: Characteristics of the laser output, oscillation frequency, Mode selection, single-frequency lasers; Methods of pulsing lasers, Q-switching and mode-locking.

Week 11: PART-V: Some Laser Systems: Ruby, He-Ne, Nd:YAG, Fiber lasers

Week 12: Tunable lasers: The Ti Sapphire laser, Semiconductor lasers; Laser safety.