INTRODUCTION TO LASER

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PRE-REQUISITES : Basic undergraduate-level knowledge of Electromagnetics, Optics, and AtomicPhysics/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. The course is 'applied' in nature, and could be taken by B.E/B.Tech IIIrd/ IVth Year, M.Sc IInd/ M.Tech. I Year. Working engineers/scientists/teachers, who did not have exposure to the subject earlier, would also find it very useful, if interested. The course would require a regular and serious study schedule on the part of the students (to understand the subject and do well).

ABOUT INSTRUCTOR :

Prof. M. R. SHENOY received the 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. He has authored/co- authored a number of research papers and book chapters, and has supervised a large number of student projects at the B.Tech, M.Sc. M.Tech and Ph.D. levels. He is a co-editor of the book Fiber Optics Through Experiments (Viva Publications, New Delhi, 1994, 2008). He has delivered a full video course of 46 lectures on Semiconductor Optoelectronics, facilitated by NPTEL, and freely available for download on YouTube. He has been involved in several Sponsored R&D projects on the design and development of guided-wave optical components and devices. His current research interests are in the area of Optoelectronics and Guided Wave Optical Components

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.