



IIT Kanpur

Center for Lasers and Photonics (CELP)

**PSE604A: Photonics Systems and Applications**

**WTF 11:00-11:50 AM (TB-108)**

**Dr. Saurabh Mani Tripathi**

**Office hour: Wednesday 4-5 PM**

**smt@iitk.ac.in, 0512-333-6871**

**CL-103/C (Old core labs)**

**Course objectives:** Number of industrial and scientific applications related to photonics is growing rapidly across various disciplines. The present course focuses on design issues for various applications/devices of photonics. Design of lasers, its tuning system and design of beam transmission components are discussed specific to different practical applications.

**Course Topics:**

[1.] **Principles and Applications of Solid State Laser Systems:** Laser diode Structures, Mechanism of photon emission in semiconductor laser, Tunable semiconductor diode laser, Rare earth doped lasers, Nd-Glass/Nd-Yag/Er-doped/Vd-Yag Lasers, Transition metal lasers, Ruby/ Ti-Sapphire lasers, High Power Diode lasers, DPSS Lasers, Quantum cascade Laser.

[2.] **Principles and Applications of Liquid and Gas Laser Systems:** Dye laser, Tunable Lasers, Frequency stabilization, Tuning Techniques, Ar<sup>+</sup> lasers, He-Ne laser, CO<sub>2</sub> lasers.

[3.] **Nonlinear optics:** Parametric processes, Phase matching, Nonlinear optical processes, SHG, Chirped pulse amplifier, parametric amplifier.

[4.] **Photonics Applications in Medicine and Surgery:** Laser Tissue Interaction, Turbid media, Depth of penetration, Thermal and optical properties of tissue, Heat dissipation by blood flow, Diagnostic application of lasers, Dosimetry Photon Transport theory, Measurement of tissue properties, Double integrating sphere.

[5.] **Laser Applications in Material Processing:** Laser matter interaction, Non-Fourier thermal transport, Ablation, Laser induced plasma, Laser micromachining, Microfabrication, Direct-write patterning, Laser CVD, Texturing, Joining, Annealing, Scribing.

[6.] **Optical measurements:** Thin film measurements, Temperature and concentration measurements, Stresses, Flow imaging, Biomedical diagnostics, Optical Tomography.

[7.] **Entertainment:** CD Rom, Video Projection, Laser shows.

[8.] **Special Topics:** Plasmonics, Photonic crystals, Optical antennas, Photonic metamaterials, nanophotonics.

**Reference books:**

1. Kjell J. Gasvik, Optical Metrology, 3rd Edition, John Wiley and Sons, 2002.
2. O. Svelto and D C Hanna, Principles of lasers, 5th Edition, Springer, 2010.
3. R W Boyd, Nonlinear optics, Academic Press, 3rd Edition, Elsevier, 2003.
4. M. H. Niemz, Laser Tissue Interaction Fundamentals and Applications, 3rd Edition, Springer, 2007.
5. K. Sugioka, M. Meunier, A. Piqué, Laser Precision Microfabrication, Springer, 2017.
6. W. T. Silfvast, Laser Fundamentals, 2nd Edition, Cambridge University Press, 2012.

### Course policies:

- a) Assessment of performance: the marks breakup for this course will be:- till mid-sem: 5 (assignments) + 10 (quizzes) + 30 (exam); after mid-sem: 5 (assignments) + 10 (quizzes) + 40 (exam).
- b) Passing mark for this course is 35 marks (**F** grade will be awarded for 34 or lower marks). Rest of the grading will be relative.
- c) There will be two fixed quizzes (02 February and 30 March) and a number of random quizzes during lectures. All the quizzes added together will carry 20 marks in total.
- d) No partial marks will be awarded for quizzes.
- e) Some questions from the assignments and quizzes will be repeated in exams. If you fail to answer those questions correctly you will be awarded zero mark for corresponding assignment and quiz, even if you had submitted the correct solutions.
- f) No request for makeup quizzes will be entertained. We'll adhere to the institute policy for makeup exam.
- g) Cheating or any use of unfair means at any stage of the course will not be tolerated. An **F** grade will awarded and the case will be reported to authorities for further strict actions.
- h) A minimum of 75% attendance is necessary. Your final marks will be normalized as per your attendance, for example weighting factor for 45% attendatnce will be  $45/75 \times$  your total marks, and weighting factor will be 1 for attendance  $\geq 75\%$ .