Quantum Optics 046053 - Spring 2024

1. **Course Plan:**

3 Academic Credit.
2 hours of lecture: Tuesday 10:30 - 12:30.
1 hour of Exercise: Tuesday 12:30 - 13:30.

2. **Exams:**

Moed A: 03-09-2024.
Moed B: 08-10-2024.
* The structure of the test/alternative assessment method will be determined subsequently.

3. **Course Grading:**

60% homework (required). Each individual submits his/her own homework.
40% final exam.

4. **Pre-required courses**
   a. **044140** - Electromagnetic Fields or **114246** - Electromagnetism and Electrodynamics

   And

   b. **114073** - Int. to Quantum Physics For Engineering(3H) or **115203** - Quantum Physics 1

5. **Team:**

Lecturer: Prof. Meir Orenstein.
Office: 754, Mayer Building.
Email: meiro@ee.technion.ac.il.
Reception hour: upon request. Every student who wants to meet should send an email and coordinate.

Teaching Assistant: Amit Kam.
Office: 763, Mayer.
Email: amitkam@campus.technion.ac.il.
Reception hour: upon request. Every student who wants to meet should send an email and coordinate.

6. **Books:**
   i. Mandel, L., & Wolf, E. (1995). *Optical coherence and quantum optics*. Cambridge university press.
   ii. Haus, H. A. (2000). Electromagnetic Noise and Quantum Optical Measurements Springer press.
   iii. Gerry, C. C., & Knight, P. L. (2023). *Introductory quantum optics*. Cambridge university press.

7. Weekly Plan:

Weeks 1-2:	Introduction; Quantization of the electromagnetic fields, photon momentum, angular momentum, helicity, the photon wave-function.
Weeks 3-4:	States and more: Density matrix, Fock states, coherent states, thermal states, entangled states, distribution functions of photonic states, pure and mixed states.
Week 5:	Photons multiport: photon transformation by passive optical elements. Semi-silvered mirror, beam splitter, interferometer
Weeks 6-7:	Photon-matter interactions: Jaynes Cummings and the minimal coupling Hamiltonian, derivation of the Fermi Goden rule, the birth and death of a photon.
Week 8:	The photonic quantum vacuum.
Weeks 9-10:	Photons and nonlinear optics, multiphoton processes, parametric processes (SPDC, DFWM), squeezing, photon blockade, photon gates, Photon sources: single photons, photon pairs, discrete, continuous…
Weeks 11-12:	Photon Measurement: detection and statistics, correlations, bunching and antibunching, below standard noise quantum sensing, direct and homodyne/heterodyne detection, and state tomography.