

“Quantum Optics and Nano-Optics Laboratory”

<http://www.optics.rochester.edu/workgroups/lukishova/QuantumOpticsLab>

Syllabus (08/29/2018)

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Office hours: Prof. Svetlana Lukishova by appointment (Wilmot 303)

1. Schedule : LECTURES: Thursdays (12:00-1:00 p.m., Wilmot 504).

LABS (every week for 2 groups: Tuesday and Friday).

Tuesday group: Tuesdays at 5:30 p.m. – 8:30 p.m. (see appendix to a Syllabus)

Friday group: Fridays at 2:00 p.m.– 5:00 p.m.

2. Needed materials and tools:

- Lab notebook (whatever lab notebook you wish). Each person must have a separate notebook at the time of the laboratory. This record becomes the basis for the formal lab write-up, and should include all data taken, even that which is later discarded.
- USB flash memory stick to save your data after each lab class. This is your responsibility if data are lost.
- I recommend to make pictures of your experimental setups.

3. Experiments on generation and characterization of single and entangled photons:

Lab. 1. Quantum entanglement and Bell’s inequalities. Polarization and angular momentum of light. (Wilmot 405);

Lab. 2. Single-photon interference (Young’s double slit and Mach-Zehnder interferometers), quantum eraser. Low-light level EM-CCD camera and sources of noise (Wilmot 406).

Lab. 3 Single-photon source: Confocal microscope imaging of single-emitter fluorescence, atomic force microscope imaging of nano-emitter topography. Nanoplasmonics, photonic bandgap materials (including chiral liquid crystals) and metamaterials. (Wilmot 323, later 406).

Lab. 4. Single-photon source: Hanbury Brown and Twiss setup. Photon antibunching. Single-photon counting avalanche photodiode modules. Electronics for photon counting instrumentation (Wilmot 323).

4. Preparation for a Lab session

Each lab contains several 3 hour sessions. **Before starting the first session of each new lab your TA will ask each of you questions provided in my lectures. Answering poorly you can lose 5 points.**

5. Laboratory reports:

Each group of three or two students writes reports as a team. At the end of each report should be a special section on each student contribution to this report. Labs 1 and 2 reports should be approximately no longer than 10 pages, Labs 3-4 (joint report) should be no longer than 20 pages.

The reports should follow the following format:

- Style and Format: Scientific publication
- Report Preparation: pdf-format

Outline:

- (a) Abstract: statement of problems and objectives;
- (b) Introduction and theoretical background: briefly review theory necessary to interpret experimental results. Cite references, do not reproduce derivations.
- (c) Procedure, Results and Analysis: Measurement procedure, diagrams of equipment and analysis of data including error analysis.
- (d) Discussion and Conclusion: Comparison of results with theoretical predictions, explanations of any differences.
- (e) Contribution of each student with signed Honor Pledge for each student separately (see section 10).

6. Grading:

OPT 253 (maximum 750 points) you will be graded on:

- four approximately equally weighted lab projects (single Labs 3-4 report is weighted as a two-lab-project) – 400 points maximum;
- three graded quizzes (at home, midterm and final) – 250 points maximum total (50 points for at home and 100 points for midterm and final);
- maintenance of the individual lab notebook during the whole semester – 100 points maximum.

OPT 453 (maximum 950 points) you will be graded on:

- four approximately equally weighted lab projects (single Labs 3-4 report is weighted as a two-lab-project) – 400 points maximum;
- three graded quizzes (at home, midterm and final) – 250 points maximum total (50 points for at home and 100 points for midterm and final);
- maintenance of the individual lab notebook during the whole semester – 100 points maximum;
- ~6-page essay (single-spaced with figures and references) on single photon sources based on searching the literature and internet – 100 points maximum;
- final individual PowerPoint presentation of all lab results (12 min presentation and 3 min for questions) – 100 points maximum.

There will be a penalty of 10% per week for late lab report submission, but you can improve your grade by asking good questions. For very good questions you can receive additional points (5 points for one very good question).

Every lab class I or TA will go through your lab notebooks and will discuss your previous results. Each student should have a separate lab notebook. You can lose points for a bad notebook (-5 points each time).

7. General information

You are expected to attend lab sessions at the scheduled times. Extra lab time will not be offered outside of the scheduled lab days. Lab reports are due a week after the last scheduled lab exercise (the calendar of lectures, labs, lab reports and essay submission, and three graded quiz sessions is provided in Appendix to a Syllabus). **Bring USB-memory for saving your data.**

8. Safety procedures:

The lab is a safe place but if one tries one can easy get in trouble. **Please, read carefully all safety procedures described in the beginning of each manual.** In particular we alert you the following hazards, which could lead to a fatality or serious injury:

- (a) High voltage;

- (b) Laser safety;
- (c) Chemicals.

9. Equipment safety:

In this lab you will use very expensive and fragile equipment with the cost \$50,000-\$60,000 (lasers); \$42,000 (EM-CCD-camera); \$14,000 (a TimeHarp 200 computer card); \$5,300 (each of APDs), etc. Interference filters cost ~ \$350 each, glass filters - \$70. So, please, read carefully all instructions in the beginning of each manual.

10. Honor Pledge

(1) The following Honor Pledge should be copied and signed by all students on all examinations: “I affirm that I will not give or receive any unauthorized help on this exam, and that all work will be my own.”

(2) The following wording as a sign-off for other graded assignments should be added:

“I affirm that I have not given or received any unauthorized help on this assignment, and that this work is my own.”

(3) Suggested for group projects, to be signed by each group member:

“I accept responsibility for my role in ensuring the integrity of the work submitted by the group in which I participated.”

Note: Students are responsible for upholding the AS&E Academic Honesty Policy whether or not they are instructed to write and sign a pledge. I uploaded a UR file about Academic Honesty to the B.B.

11. Students groups:

Lab Group 1: Tuesday 5:30pm-8:30pm
Yu Hui, Kyle, Andrew, Matthew, Liam

Lab Group 2: Friday 2:00pm-5:00pm
Xiaoduo, Ciara, Jack, Nikita, Nora, Kristoffer

OPT 253/453 Schedule – Fall 2018 (Appendix to a Syllabus)

LECTURES (every week): R - 12:00-1:00 p.m. (Wil 504),

Two lab GROUPS: T, F (see the list of the groups that was sent earlier).

LABS (3 hours every week): T – 5:30-8:30 p.m. ; F – 2:00–5:00 p.m. (Wil, 405, 406, 323).

Lab 1. Entanglement/Bells inequalities (1)

Lab 2. Single Photon Interference (2)

Lab 3. Confocal fluorescence microscopy of nanoemitters (3).

Lab 4. Antibunching correlation measurements (4).

Lab report submission:

One week after the lab at the beginning of lab time (e.g. T group should submit a report before 5:30 p.m. next T).

Graded quizzes:

At home: M9/17-M 9/24 (submission before 9:00 a.m.)

MidTerm: R 10/25 at 12:00-1:00 p.m. (1 hour);

Final: R 11/29 p.m. at 12:00-1:00 p.m (1 hour).

For a graduate level (only)

(1) Essay submission (writing almost the whole semester) – R 11/15 before 10 a.m.

(2) 12 min PowerPoint presentation (+ 3 mins for questions) of all lab experiments – R 12/6 at 12:00-1:00 p.m.

Group Week	R	T	F
1	L		
2	L	1	1
3	L	1	1
4	Quiz at home M9/17-M9/24	Quiz at home M9/17-M9/24	Quiz at home M9/17-M9/24
5	L	1	1
6	L	2 Lab 1 report	2 Lab 1 report
7	L	2	2
8	L (MidTerm quiz discussion)	No lab Fall Break	No Lab IA
9	MidTerm quiz in class on Labs 1-2	3-4	3-4
10	L,	3-4 Lab 2 report	3-4 Lab 2 report
11	L Graduate students essays	3-4	3-4
12	L Final Quiz discussion	3-4	3-4
13	Thanksgiving	Thanksgiving	Thanksgiving
14	Final quiz (Labs 3-4)	3-4	3-4
15	Graduate students presentations	Lab 3-4 report	Lab 3-4 report

WEEK	DATES (Fall 2018)
1	8/29(W) - 8/31 (F)
2	9/4 (T) – 9/7 (F)
3	9/10 (M) – 9/14(F)
4	9/17 (M) – 9/21 (F) OSA Meeting Quiz at home M9/17-M9/24
5	9/24 (M) – 9/28 (F)
6	10/1 (M) – 10/5 (F)
7	10/8 (M) – 10/12 (F)
8	10/15 (M) – 10/19 (F) Fall break 10/15 (M) -10/16 (T) no T lab IA – no F lab (10/19)
9	10/22 (M) – 10/26 (F) Mid-Term Quiz 10/25
10	10/29(M) – 11/2(F)
11	11/5 (M) – 11/9 (F)
12	11/12 (M) - 11/16 (F)
13	11/19 (M) – 11/23 (F) Thanksgiving holiday
14	11/26 (M) – 11/30 (F) Final Quiz on Thursday 11/29
15	12/3 (M) – 12/7 (F)

No classes:

9/17(M)-9/21(F)
OSA Meeting

Fall Break
10/15(M)-10/16(T)

Industrial
Associates
10/19(F)

Thanksgiving
week: 11/20
(M) -11/24(F)