COMPUTATIONAL IMAGING

L0. Introduction to the course

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Associate Professor

Skoltech

Crash course

- Large volumes of material with practical focus
- Learn while doing something by hands

30-Sept-2024	07-Oct-2024	14-Oct-2024	21-Oct-2024
1	2	3	4
TERM 1B			
C	C	C	E
Intro, Lecture 1, Lecture 2 Lab 1	Q&A session, Lab 2	Lecture 3 Lab 3	Final exam

Schedule overview

Academic calendar:

https://new.skoltech.ru/academic-calendar/2024-2025

Week-by-week calendar:

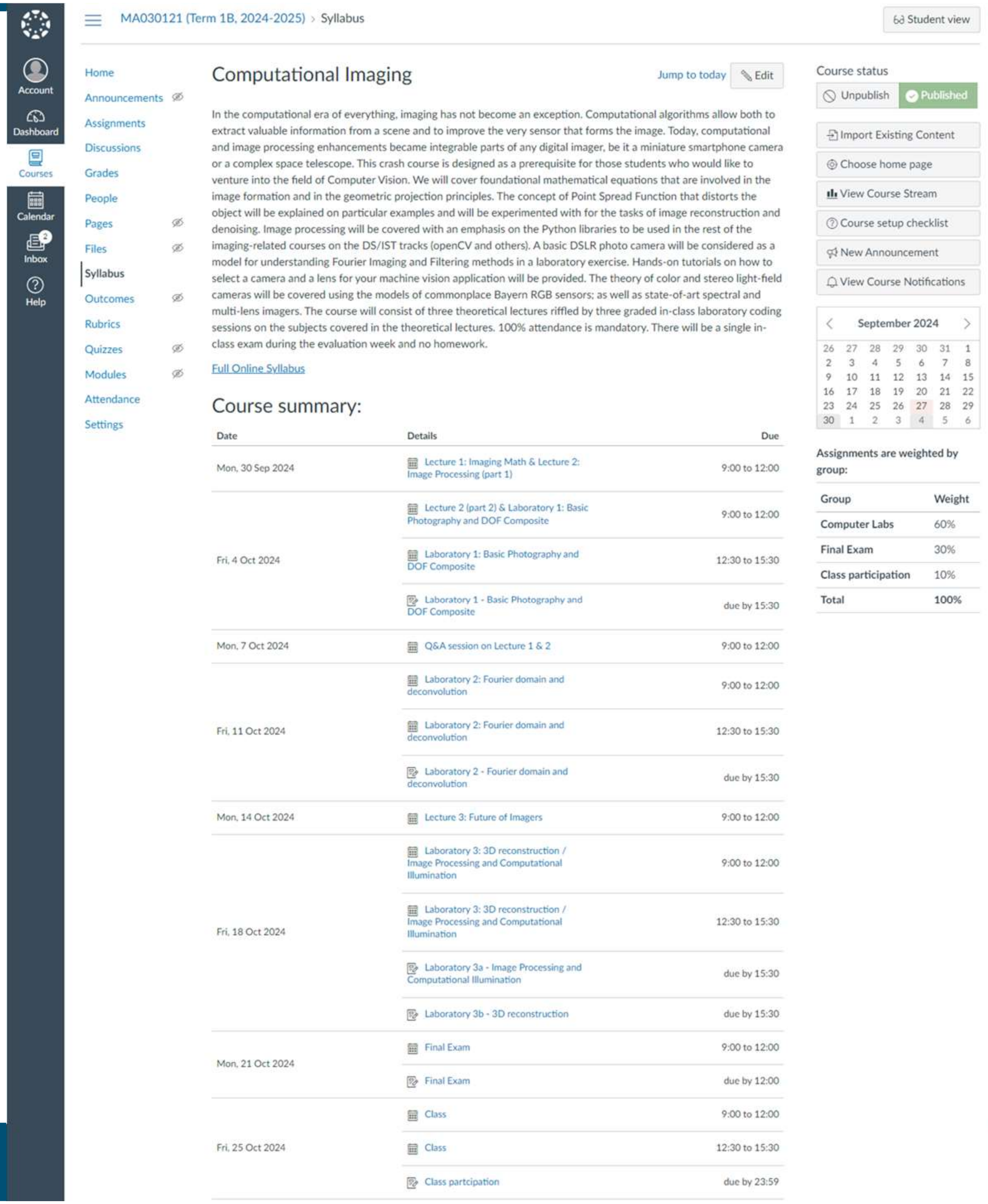
https://schedule.skoltech.ru/?term=2024-2025-term1b&date=2024-09-30&view=course&filter=2024-2025-term1b_MA030121

Course in 2024: Monday & Friday

Venue: New Campus: B4-3005, In-person

(please check **canvas or the week-by-week link regularly**)

Canvas!



MA030121 (Term 1B, 2024-2025) › Syllabus

Computational Imaging

In the computational era of everything, imaging has not become an exception. Computational algorithms allow both to extract valuable information from a scene and to improve the very sensor that forms the image. Today, computational and image processing enhancements became integrable parts of any digital imager, be it a miniature smartphone camera or a complex space telescope. This crash course is designed as a prerequisite for those students who would like to venture into the field of Computer Vision. We will cover foundational mathematical equations that are involved in the image formation and in the geometric projection principles. The concept of Point Spread Function that distorts the object will be explained on particular examples and will be experimented with for the tasks of image reconstruction and denoising. Image processing will be covered with an emphasis on the Python libraries to be used in the rest of the imaging-related courses on the DS/IST tracks (openCV and others). A basic DSLR photo camera will be considered as a model for understanding Fourier Imaging and Filtering methods in a laboratory exercise. Hands-on tutorials on how to select a camera and a lens for your machine vision application will be provided. The theory of color and stereo light-field cameras will be covered using the models of commonplace Bayern RGB sensors; as well as state-of-art spectral and multi-lens imagers. The course will consist of three theoretical lectures riffled by three graded in-class laboratory coding sessions on the subjects covered in the theoretical lectures. 100% attendance is mandatory. There will be a single in-class exam during the evaluation week and no homework.

Full Online Syllabus

Course summary:

Date	Details	Due
Mon, 30 Sep 2024	Lecture 1: Imaging Math & Lecture 2: Image Processing (part 1)	9:00 to 12:00
Fri, 4 Oct 2024	Lecture 2 (part 2) & Laboratory 1: Basic Photography and DOF Composite	9:00 to 12:00
	Laboratory 1: Basic Photography and DOF Composite	12:30 to 15:30
	Laboratory 1 - Basic Photography and DOF Composite	due by 15:30
Mon, 7 Oct 2024	Q&A session on Lecture 1 & 2	9:00 to 12:00
Fri, 11 Oct 2024	Laboratory 2: Fourier domain and deconvolution	9:00 to 12:00
	Laboratory 2: Fourier domain and deconvolution	12:30 to 15:30
	Laboratory 2 - Fourier domain and deconvolution	due by 15:30
Mon, 14 Oct 2024	Lecture 3: Future of Imagers	9:00 to 12:00
Fri, 18 Oct 2024	Laboratory 3: 3D reconstruction / Image Processing and Computational Illumination	9:00 to 12:00
	Laboratory 3: 3D reconstruction / Image Processing and Computational Illumination	12:30 to 15:30
	Laboratory 3a - Image Processing and Computational Illumination	due by 15:30
	Laboratory 3b - 3D reconstruction	due by 15:30
Mon, 21 Oct 2024	Final Exam	9:00 to 12:00
	Final Exam	due by 12:00
Fri, 25 Oct 2024	Class	9:00 to 12:00
	Class	12:30 to 15:30
	Class partcipation	due by 23:59

Assignments are weighted by group:

Group	Weight
Computer Labs	60%
Final Exam	30%
Class participation	10%
Total	100%

Contact Info

Primary logistics contact person for all inquiries and **Canvas issues**:

Anastasia Andreitseva +7 (985) 447-20-22

(a.andreitseva@skoltech.ru)

- Teaching Assistants:
- **Vladimir Kuzmin** (Vladimir.Kuzmin@skoltech.ru)
- **Instructor: Dmitry Dylov** (d.dylov@skoltech.ru)

Physics/Math

EE/Imaging

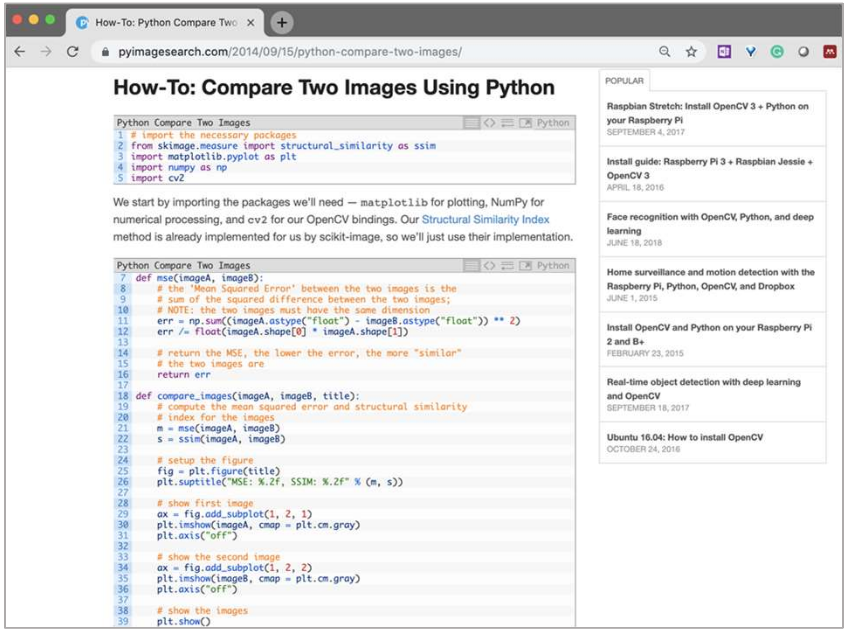
Imaging/CV
Equipment / Doctors

AI/CV

General info – “crash course”

- Fifth offering at Skoltech
- Only three weeks long
- No Homeworks, No Midterm; but a good portion of self-study is assumed
- Attempt was made to align with parallel offerings [Imaging (LS), Biophotonics (PHY), Computer Vision (CV), Deep Learning (DS)].
- The goal is to create “computational mindset” and set bookmarks in memory
- Laboratory works: in-class | independent | open book | honor code
- We will provide DSLR camera kits
- **Never coded before? Workarounds for programming tasks (see me in person!)**

How to code?



Google it.

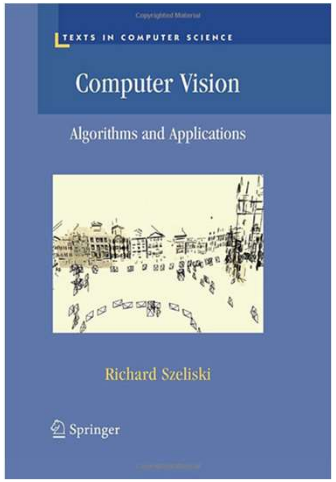
https://stackoverflow.com/

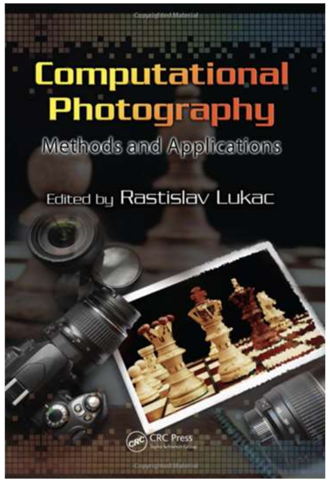
https://scikit-image.org/

https://pyimagesearch.com/

https://opencv-python-tutroals.readthedocs.io

Books





Richard Szeliski, “Computer Vision”

[ISBN-13: 978-1848829343]

Rastislav Lukac, “Computional Photography”

[ISBN-13: 978-1439817490]

Journals

- IEEE Computer Vision and Pattern Recognition (CVPR)
- IEEE Transactions on Image Processing
- International Journal of Computer Vision
- Computational Vision and Imaging

Grading

Group	Weight
Attendance	10%
Labs	60%
Final Exam	30%

Attendance policy. 100% expected. Every class, we check attendance with an easy quiz.

Academic integrity. Refer to regulations on academic integrity.

Collaboration policy. Independent work only (except when team work is announced explicitly).

Ivy League Honor Code (since 1893)

PRINCETON UNIVERSITY

"I pledge my honor that I have not violated the Honor Code during this examination."

See full text at: **https://honor.princeton.edu/**

"...under the honor system, students have a twofold obligation: individually, they must not violate the code, and as a community, they are responsible to see that suspected violations are reported..."

Week 1 – Understand Imaging Math

Lecture Date	Event	Content
September 30	Lecture on Imaging Principles and Image Processing	Imaging math, Convolution, Fourier Transform, Filtering. Object-Image Relationship. General formulation of image processing. Discrete Fourier representation. Image restoration. Signal and Noise.
October 4	Laboratory *	Learn basics of a digital camera (Exposure, Aperture, ISO, Focusing) Dataset creation for the rest of the course. Blurring and bokeh imaging. Filtering and de-convolution exercises. Point-wise and area-wise filtering.

** Bring your digital cameras*

Week 2 — Image Processing for Computational Imaging & Illumination

Week 3 — Specialized camera control (RL) & Video streams

Monday Lectures: me talking | Friday Labs: you working

Time:

9:00	Lab assignment becomes available in canvas, TAs arrive.
10:00	Lecturer arrives, Q&A
10:30	Attendance sheet distributed. Once filled in, everyone is free.
11:00 – 15:30	Do what you want (independently!). TAs and perhaps Lecturer are available for Q&A (we will sit somewhere).

You can submit after 15:30; but you will lose up to 50% of points

Space:

We have one room reserved for lectures and labs: **B4-3005**

After the assignment is discussed, work where you want.

See you on Friday! (or sooner if you need)

If you want to start playing with the camera before the first lab, sign up for individual practice session here (**ONLY 1 TIME SLOT PER STUDENT**):
https://docs.google.com/spreadsheets/d/1VSB8QuaHqeFLJIXPaeHkgPY4RAm2cMCO/edit?usp=sharing&ouid=111712398947439431412&rtpof=true&sd=true

If you still have questions after practice, you may consult with Vladimir on
Wednesday, October 3, from 14:00 till 17:00.