

# Course Syllabus

## Computer Vision (CSCI 5520G)

Faisal Z. Qureshi

<http://faculty.ontariotechu.ca/qureshi>

Computer Science, Faculty of Science  
Ontario Tech University

**Fall 2022**



## Instructor

Faisal Z. Qureshi  
Email: [faisal.qureshi@ontariotechu.net](mailto:faisal.qureshi@ontariotechu.net)  
Office: UA4032  
Web: <http://faculty.uoit.ca/qureshi>

## Lectures

Tuesday, 2:10-5:00 pm, UA3230  
*First day of lectures, Tuesday, September 6, 2022.*

## Office hours

Tuesday, 12 pm - 1 pm, online, or by appointment.  
Use this Google Meet link for office hours <https://meet.google.com/ssi-osuu-pwg>.

## Description

This is an introductory graduate course in computer vision. The course will focus on computer vision theory and applications.

Computer vision deals with processing and analyzing digital images to extract useful properties about the real world. Computer vision, for example, can be used to extract 3D scene structure from a given set of photos, recognize people in images, identify actions in a video sequence, etc. Computer vision has also been used in specialized domains, such as medical imaging, say for analyzing CT scans or MRI photographs, satellite imaging, say for analyzing the health of an ecosystem, etc. Computer vision has also found wide-spread use in entertainment and gaming industry.

Solving computer vision, it turns out, is a tough problem. Digital images after all are little more than a collection of pixels. Recent advances in machine learning, especially in deep learning, has opened up new avenues for computer vision research. The goal is simple: design algorithms and systems that will enable a computer to “learn to see” by “looking” at example pictures and videos. With this in mind, this course will also briefly explore machine learning approaches that have found wide-spread use in computer vision applications.

This course will mix lectures on a selection of topics with paper reading and discussion. The topics are selected to help you understand and implement the papers that you are asked to read, present, and discuss. The first 45 minutes of most classes will be devoted to lectures on one of the selected topics. The remain time will be used for paper presentation and discussion. The course will cover the following topics:

- image formation and camera models;
- optical flow;
- depth analysis;
- action recognition;
- convolution (filtering);
- regression;
- classification;
- clustering;
- dimensionality reduction; and
- neural networks and deep learning.

These topics provides a decent basis for understanding the papers that we plan to read and discuss in this course.

## Pre-requisites

The course assumes that students are comfortable with statistics, basic linear algebra, and programming.

We will be using Python for the programming part of this course. For Python, I recommend the [Anaconda](#) distribution, which comes pre-loaded for nearly all the packages that we will be using in this course. Of course you are welcome to use any variant/distribution of Python that suits you.

The course also assumes that students are willing to read and comprehend large volumes of technical papers. Furthermore, that students have some experience with technical report writing.

## Grading

- Course project, 40% (**A student needs to get 60% marks in the project to successfully complete the course.**)
  - Proposal
  - Progress report
  - Presentations
  - Technical report
- Participation and interactions, 10%
  - Discussion, readings, QA, class exercises
- Paper presentation and leading discussion, 15%
- Midterm, 35%

## Important dates

- Midterm
  - Week 10, closed book in class
- Project
  - proposal: Oct. 7, midnight
  - progress report: Nov. 13, midnight
  - final report: Dec. 11, midnight
  - project presentation: last two weeks of classes
- Presentations
  - Through out the term

Ontario Tech University's academic calendar that lists important dates (and deadlines) is available at [here](#).

## Course calendar

- Week 1 - Introduction, image formation, stereo
- Week 2 - Linear regression
- Week 3 - Logistic regression, softmax
- Week 4 - Neural networks
- Week 5 - Image filtering
- Week 6 - Convolutional neural networks
- Week 7 - PCA
- Week 8 - Structure from motion
- Week 9 - Optical flow
- Week 10 - Action recognition, **midterm**
- Week 11 - Presentations
- Week 12 - Presentations

*The list of assigned papers will be available after the first week of classes. Please check the course website for details.*

## Course Work

### Midterm

- Midterm will take place in class.

- The midterm will be closed-book.
- **A student must receive at least 20% in the midterm pass the course.**

## Presentation

Each student will be assigned recent papers to read and present. The student will be responsible for leading the discussion for this paper. **Each student may be assigned to present multiple papers.**

### Instructions for the presenter

- Duration, 30 minutes
- Create a slideshow
  - Easy to read
  - Avoid verbosity
  - Use figures, examples
  - Clear and easily understandable structure
  - Practice your talk before the lecture!
- Key questions
  - What does the paper do?
  - What are its limitations?
  - What are its strengths?
  - Is this paper reproducible?
  - How does paper support its key arguments?
  - What software does paper uses?
  - What datasets does paper uses?
  - How does this paper fit with the larger body of literature?

### Instructions for the participants

- Read the paper before the lecture
- Be prepared to answer questions
- Be prepared to participate in the discussion
- Provide feedback to the presenter
  - Compliments, suggestions, criticism, thanks

## Project

The course project is an independent exploration of a specific problem within the context of this course. A project can be implementation oriented—where a student implements a computer vision system—or application oriented—where a student attempts to solve a problem (of suitable difficulty) by applying machine learning techniques. The project topic will be selected in consultation with the instructor.

Project grade will depend on the ideas, how well you present them in the report, how well you position your work in the related literature, how thorough are your experiments and how thoughtful are your conclusions.

**Course project is typically an individual effort.**

### Project proposal

- one page (12 pt)
- clear and concise problem statement
- discuss its relevance
- why is it an interesting problem to solve (level of difficulty)
- describe other related approaches
- sketch your approach
- list anticipated difficulties

## Progress Report

- one page (12 pt)
- describe the problem you are working on (this should include any feedback that you've received on your project proposal)
- describe your approach in more detail
- summarize your accomplishments to date
- list next steps
- list any problems that you encountered, and how you solved otherwise
- identify any problems that you expect to encounter

## Final in-class Presentation

- 15 minutes
- the problem description with a motivation
- a quick overview of related work
- the proposed solution
- a technical description of the solution
- encountered difficulties
- an evaluation
- future work and conclusion

## Final Report

For your final project write-up you must use ACM SIG Proceedings Template (available at the ACM website). Project report is at most 12 pages long, plus extra pages for references. Your report must of “publishable quality,” i.e., no typos, grammar error.

The final deadline for project report submission is 11th of December, midnight EST. *This is a firm deadline.* You will incur a penalty of 40% if you do not meet this deadline. These strict rules mimic conference submission process:

- a predefined format;
- limited amount of space to explain your ideas and contribution; and
- firm submission deadline.

## Reading material

You will find the following computer vision books useful.

- *Computer Vision: Algorithms and Applications* by Richard Szleski
- *Computer Vision: Models, Learning, and Inference* by Simon J.D. Prince.

Following books are good resources for machine learning, especially deep learning

- *Neural Networks and Deep Learning: A Textbook* by Charu C. Aggarwal.
- *Deep Learning* by Ian Goodfellow and Yoshua Bengio.
- *Machine Learning: A Probabilistic Perspective* by Kevin P. Murphy and Francis Bach.
- *Understanding Machine Learning: From Theory to Algorithms* by Shai Shalev-Shwartz and Shai Ben-David
- *Pattern Recognition and Machine Learning* by Christopher M. Bishop.
- *The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition* by Trevor Hastie and Robert Tibshirani.

These resources will not only help you understand the assigned papers. These resources may prove invaluable for your course projects.

## Programming Resources

[Here](#) you'll find a number of tutorials showcasing Python use in machine learning. I strongly recommend that you become comfortable with the following four Python packages/environment:

- `numpy`;

- [scipy](#);
- [matplotlib](#); and
- [jupyter notebook](#).

## Course policies

### Attendance

Attendance is mandatory. We will discuss topics in class that are not easily found in any single textbook.

### Course work submission

Unless otherwise instructed, all course work should be submitted via Canvas.

### Remarking

It is extremely important that all work is fairly graded. Please submit a remark request by email within 5 days of receiving the grade. The email must contain the reasons for which you think the work should be remarked. *Please note that a remark may result in a lower grade.*

### Late submissions

The penalty for a late submission is 10% per day. An assignment or project will get a **zero** if submitted more than 48 hours after the submission deadline. A doctor's note will be needed to avoid late submission penalty.

### Email traffic

The instructor and the TA will make every effort to respond to emails in a timely manner; however, it may take up to two working days to respond to an email. It simply means that emails sent right before a deadline may not be answered in time. Urgent emails may be sent to "faisal.queishi@ontariotechu.net" with the subject line "csci 5520g - fall 2022".

### Discussions

Appropriate use of discussion groups include clarification of lecture material and assignments and other concerns and comments about the course that might of general interest to course participants. Please do not post assignment solutions to the discussion groups.

### Collaboration

I encourage you to work together when discussing assignments/projects; however, it doesn't mean that you should share your written solutions or that you submit someone else's work as your own.

## Technology Requirements

To support online learning, the university recommends certain technology requirements for laptops, software and internet connectivity which are available at: <https://itsc.ontariotechu.ca/remote-learning.php>.

Students experiencing technical difficulties such that they are unable to meet the technology requirements may contact the IT Service Help Desk at: [servicedesk@dc-uoit.ca](mailto:servicedesk@dc-uoit.ca) Students experiencing financial difficulties such that they are unable to meet the technology requirements may contact Student Awards and Financial Aid Office at: [connect@ontariotechu.ca](mailto:connect@ontariotechu.ca)

By remaining enrolled in this course, you acknowledge that you have read, understand and agree to observe the Recommended Technology Requirements for accessing university online learning resources, including those minimum requirements that are specific to your faculty and program.

## Sensitive/Offensive Subject Matter

The classroom (both physical and virtual) is intended to provide a safe, open space for the critical and civil exchange of ideas and opinions. Some articles, media and other course materials may contain sensitive content that is offensive and/or disturbing. For example, some articles or videos may contain [Instructors should provide examples that are applicable to the course subject matter – e.g. graphical depictions of violence, profanity, human anatomy, sexual acts, matters pertaining to race, gender, or sexuality]. The Course Instructor will try to identify such material and communicate warnings to students in advance of the distribution and use of such materials, affording students the choice to either emotionally prepare for, or not to view or interact with, the content. [Instructors should publish a warning statement in advance so as to give students adequate opportunity to make a choice to avoid any such matter. The following is a sample disclaimer: “The content you are about to view contains sensitive subject matter that may be considered offensive and/or disturbing to some viewers. By viewing and/or interacting with the content you acknowledge and agree that it is your decision to view and interact with the content and to take the risk that you will experience a negative emotional response or reaction to the nature of the content.”]

## Student Support

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact [studentlife@ontariotechu.ca](mailto:studentlife@ontariotechu.ca) for support. Furthermore, please notify your professor if you are comfortable in doing so. This will enable them to provide any resources and help that they can.

## Sexual Violence Support and Education

Ontario Tech is committed to the prevention of sexual violence in all its forms. For any student who has experienced Sexual Violence, Ontario Tech can help. We will make accommodations to cater to the diverse backgrounds, cultures, and identities of students when dealing with individual cases.

If you think you have been subjected to or witnessed sexual violence: - Reach out to a Support Worker, a specially trained individual authorized to receive confidential disclosures about incidents of sexual violence. Support Workers can offer help and resolution options which can include safety plans, accommodations, mental health support, and more. To make an appointment with a Support Worker, call 905.721.3392 or email [studentlife@ontariotechu.ca](mailto:studentlife@ontariotechu.ca) - Learn more about your options at: <https://studentlife.ontariotechu.ca/sexualviolence/>

## Students with Disabilities

Accommodating students with disabilities at Ontario Tech is a responsibility shared among various partners: the students themselves, SAS staff and faculty members. To ensure that disability-related concerns are properly addressed during this course, students with documented disabilities and who may require assistance to participate in this class are encouraged to speak with me as soon as possible. Students who suspect they have a disability that may affect their participation in this course are advised to go to Student Accessibility Services (SAS) as soon as possible. Maintaining communication and working collaboratively with SAS and faculty members will ensure you have the greatest chance of academic success.

When on campus access is allowed, students taking courses on north Oshawa campus can visit Student Accessibility Services in the Student Life Building, U5, East HUB (located in the Founders North parking lot). Students taking courses on the downtown Oshawa campus can visit Student Accessibility Services in the 61 Charles St. Building, 2nd Floor, Room DTA 225 in the Student Life Suite.

Disability-related and accommodation support is available for students with mental health, physical, mobility, sensory, medical, cognitive, or learning challenges. Office hours are 8:30am-4:30pm, Monday to Friday, closed Wednesday's 8:30am – 10:00am. For more information on services provided, you can visit the SAS website at <https://studentlife.ontariotechu.ca/services/accessibility/index.php>. Students may contact Student Accessibility Services by calling 905-721-3266, or email [studentaccessibility@ontariotechu.ca](mailto:studentaccessibility@ontariotechu.ca).

When on campus access is allowed, students who require the use of the Test Centre to write tests, midterms, or quizzes MUST register online using the SAS test/exam sign-up module, found here

<https://disabilityservices.ontariotechu.ca/uoitclockwork/custom/misc/home.aspx>. Students must sign up for tests, midterms, or quizzes AT LEAST seven (7) days before the date of the test.

Students must register for final exams by the registration deadline, which is typically two (2) weeks prior to the start of the final examination period. SAS will notify students of the registration deadline date.

## Professional Conduct (if applicable)

Additional information on professional suitability can be found at <https://calendar.ontariotechu.ca/content.php?catoid=48&navoid=2004>

## Academic Integrity

Students and faculty at Ontario Tech University share an important responsibility to maintain the integrity of the teaching and learning relationship. This relationship is characterized by honesty, fairness and mutual respect for the aim and principles of the pursuit of education. Academic misconduct impedes the activities of the university community and is punishable by appropriate disciplinary action.

Students are expected to be familiar with and abide by Ontario Tech University's regulations on Academic Conduct which sets out the kinds of actions that constitute academic misconduct, including plagiarism, copying or allowing one's own work to be copied, use of unauthorized aids in examinations and tests, submitting work prepared in collaboration with another student when such collaboration has not been authorized, among other academic offences. The regulations also describe the procedures for dealing with allegations, and the sanctions for any finding of academic misconduct, which can range from a resubmission of work to a failing grade to permanent expulsion from the university. A lack of familiarity with these regulations on academic conduct does not constitute a defense against its application. This information can be found at <https://calendar.ontariotechu.ca/content.php?catoid=48&navoid=2004#academic-conduct-and-professional-suitability>

Extra support services are available to all Ontario Tech University students in academic development, study skills, counseling, and peer mentorship. More information on student support services can be found at <https://studentlife.ontariotechu.ca/services/academic-support/index.php>

## Turnitin (if applicable)

Ontario Tech University and faculty members reserve the right to use electronic means to detect and help prevent plagiarism. Students agree that by taking this course all assignments are subject to submission for textual similarity review by Turnitin.com. Assignments submitted to Turnitin.com will be included as source documents in Turnitin.com's restricted access database solely for the purpose of detecting plagiarism in such documents. The instructor may require students to submit their assignments electronically to Turnitin.com or the instructor may submit questionable text on behalf of a student. The terms that apply to Ontario Tech University's use of the Turnitin.com service are described on the Turnitin.com website.

Students who do not wish to have their work submitted to Turnitin.com must provide with their assignment at the time of submission to the instructor a signed Turnitin.com Assignment Cover sheet: <https://shared.uoit.ca/shared/department/academic-integrity/Forms/assignment-cover-sheet.pdf>

## Online Test and Exam Proctoring (Virtual Proctoring)

Ontario Tech University will conduct virtual monitoring of examinations in accordance with Ontario privacy legislation and all approved policy instruments.

## Final Examinations (if applicable)

Final examinations are held during the final examination period at the end of the semester and when on campus access is allowed, may take place in a different room and on a different day from the regularly scheduled class. Check the published Examination Schedule for a complete list of days and times.

Students are required to show their Student ID card (campus ID) when in-person examinations are allowed. Students are advised to obtain their Student ID Card well in advance of the examination period as they will not be able to write their examinations without it. More information on ID cards can be found at <https://registrar.ontariotechu.ca/campus-id/index.php>.

Students who are unable to write a final examination when scheduled due to religious publications may make arrangements to write a deferred examination. These students are required to submit a Request for Accommodation for Religious Obligations to the Faculty concerned as soon as possible and no later than three weeks prior to the first day of the final examination period.

Further information on final examinations can be found at <https://usgc.ontariotechu.ca/policy/policy-library/policies/academic/procedures-for-final-examination-administration.php>

## Freedom of Information and Protection of Privacy Act

The following is an important notice regarding the process for submitting course assignments, quizzes, and other evaluative material in your courses in the Faculty of Science.

Ontario Tech University is governed by the Freedom of Information and Protection of Privacy Act (“FIPPA”). In addition to providing a mechanism for requesting records held by the university, this legislation also requires that the University not disclose the personal information of its students without their consent.

FIPPA’s definition of “personal information” includes, among other things, documents that contain both your name and your Banner (student) ID. For example, this could include graded test papers or assignments. To ensure that your rights to privacy are protected, the Faculty of Science encourages you to use only your Banner ID on assignments or test papers being submitted for grading. This policy is intended to prevent the inadvertent disclosure of your information where graded papers are returned to groups of students at the same time. If you still wish to write both your name and your Banner ID on your tests and assignments, please be advised that Ontario Tech University will interpret this as an implied consent to the disclosure of your personal information in the normal course of returning graded materials to students.

If you have any questions or concerns relating to the new policy or the issue of implied consent addressed above, please contact [accessandprivacy@ontariotechu.ca](mailto:accessandprivacy@ontariotechu.ca)

Notice of Collection and Use of Personal Information Throughout this course, personal information may be collected through the use of certain technologies under the authority of the University of Ontario Institute of Technology Act, SO 2002, c. 8, Sch. O. and will be collected, protected, used, disclosed and retained in compliance with Ontario’s Freedom of Information and Protection of Privacy Act R.S.O. 1990, c. F.31.

This course will use the following technologies that may collect, use, disclose and retain personal information (including images) for the purposes described below: [Instructors should edit this section according to the systems and technologies to be used in this specific course (e.g. If using Proctortrack, remove any reference to Respondus)] - Respondus Monitor and Proctortrack to maintain academic integrity for examinations; - Google Meet and Kaltura Virtual Classroom to facilitate remote instruction and interactive learning; - Peer-shared applications, services or technologies that may be reviewed, assessed, or used as part of coursework. - Other applications, services, or technologies that support or enhance online learning that include, but are not limited to, the following: [Instructor to list all relevant components]. For more information relating to these technologies, we encourage you to visit <https://tlc.ontariotechu.ca>. Questions regarding personal information may be directed to: Ontario Tech University Access and Privacy Office, 2000 Simcoe Street North, Oshawa, ON L1G 0C5, email: [accessandprivacy@ontariotechu.ca](mailto:accessandprivacy@ontariotechu.ca).

By remaining enrolled in this course, you acknowledge that you have read, understand, and agree to the terms and conditions under which the technology provider(s) may collect, use, disclose and retain your personal information. You agree to the university using the technologies and using your personal information for the purposes described in this course outline.

## Freedom of Expression

Pursuant to Ontario Tech’s Freedom of Expression Policy all students are encouraged to express ideas and perspectives freely and respectfully in university space and in the online university environment, subject to certain limitations.

Students are reminded that the limits on Freedom of Expression include speech or behaviour that: is illegal or interferes with the university's legal obligations; defames an individual or group; constitutes a threat, harassment or discrimination; is a breach of fiduciary, contractual, privacy or confidentiality obligations or commitments; and unduly disrupts and interferes with the functioning of the university. In the context of working online, different forms of communication are used. Where permitted, students using "chat" functions or other online forms of communication are encouraged to ensure that their communication complies with the Freedom of Expression Policy.

## **Student Course Feedback Surveys**

Student evaluation of teaching is a highly valued and helpful mechanism for monitoring the quality of Ontario Tech University's programs and instructional effectiveness. To that end, course evaluations are administered by an external company in an online, anonymous process during the last few weeks of classes. Students are encouraged to participate actively in this process and will be notified of the dates. Notifications about course evaluations will be sent via e-mail, and posted on Canvas, Weekly News, and signage around the campus.