# ECE 449 Intelligent Systems Engineering

**Fall 2023 - September 05 to December 08**

Class time: MWF 13:00-13:50 Location: NRE 1-003

**Instructor:**

Scott Dick, PhD, P.Eng, He, him.
492-6216
sdick@ualberta.ca
DICE 11-239
Office Hours: MF 14:00-14:50

**Course Description:**

*3.8 (fi ) (either term, 3-0-3/2) Intelligent systems for automatic control and data analysis. The concepts of vagueness and uncertainty, approximate reasoning, fuzzy rule-based systems and fuzzy control. Strategies for learning and adaptation, supervised and reinforcement learning, self-organization and the selection of neural network architectures. Discussion of the principles of search and optimization, evolution and natural selection and genetic algorithms. Introduction to hybrid intelligence. Applications of intelligent systems for pattern recognition, classification, forecasting, decision support, and control. Credit may be obtained in only one of CMPE 449 or ECE 449

**Prerequisites:** N/A

**Course synchronous and asynchronous content delivery schedule:**

All course components with be delivered in-person. Note that Lab D42 take place in the alternating weeks versus Labs D31 and D41.

**TA Information:**

Nastaran Gholizadeh, nastaran@ualberta.ca
Pengyue Hou, pengyue@ualberta.ca
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**Lab Sections:**

| Section | Day | Time | Location |
|---|---|---|---|
| Lab D31 | Wed | 14:00 - 16:50 | ETLC E2-009 |
| Lab D41 | Thurs | 14:00 - 16:50 | ETLC E5-013 |
| Lab D42 | Thurs | 14:00 - 16:50 | ETLC E5-013 |

**Course Objectives & General Content:**

This is a 400-level technical elective course, focusing on the engineering of intelligent systems. We will study modern methods of designing, training and deploying AI-based solutions for some or all of the use cases in a built system. We will in particular focus on systems based upon Computational Intelligence; neural networks, fuzzy logic, genetic algorithms, and their various hybridizations. Five laboratory exercises, and a group-based term project, will supplement the lectures and provide hands-on experience in building modern AI systems and pipelines.

**Learning Outcomes:**

By the end of this course, students should be able to:

1. Identify different methods used to develop intelligent systems, including fuzzy systems, neural networks and evolutionary computing.
2. Outline procedures for solving problems with intelligent systems.
3. Describe the building blocks of several intelligent methods.
4. Explain the operation of several types of intelligent systems studied in this course.
5. Distinguish between different types of learning and knowledge representation.
6. Interpret results provided by techniques studied in this course.
7. Apply selected intelligent methods to analyze data, build models and control simple systems.
8. Design intelligent systems suitable for solving various engineering problems.

**Marking Scheme:**

| Activity | (A)Synchronous | Due/Scheduled | Weight |
|---|---|---|---|
| Lab #1 | Synchronous | | 6% |
| Lab #2 | Synchronous | | 6% |
| Lab #3 | Synchronous | | 6% |
| Lab #4 | Synchronous | | 6% |
| Lab #5 | Synchronous | | 6% |
| Group Project | Synchronous | December 8, 2023 | 10% |
| Mid-term Exam | Synchronous | October 23, 2023 | 20% |
| Final Exam | Synchronous | December 14, 2023 | 40% |

The Faculty recommended grade point average for a 400 level course is 3.1. Instructors have the leeway to deviate from this average and can assign grades based on their own scheme. All grades are approved by the department chair (or delegate). The office of the Dean has final oversight on all grades.

**Term Work**

All term work solutions will be posted no later than the last day of classes. All term work will be returned to students by the final day of classes, with the exception of major term work due in the last week of classes. The latter will be returned by the day of the final examination or the last day of the examination period if there is no final examination in the course as per university policy; instructors will make accommodations to return these term work. It is the responsibility of the student to pick up all their term work at the specified time and place. Any unreturned term work, shall be retained and then shredded six months after the deadline for reappraisal and grade appeals. Final examinations will be kept for one year as required by university guidelines and the Government of Alberta's Freedom of Information and Protection of Privacy Act.

**Calculator Policy**

Only approved non-programmable calculators are permitted in examinations. Any calculator taken into an examination must have a sticker identifying it as an acceptable non-programmable calculator (gold sticker). Students can purchase calculators at the University Bookstore with the stickers already affixed. Calculators purchased elsewhere can be brought to the Student Services where the appropriate sticker will be affixed to the calculator.

**Text and References (Mandatory):**

Rudolf Kruse, Sanaz Mostaghim, Christian Borgelt, Christian Braune, Matthias Steinbrecher, "Computational Intelligence: A Methodological Introduction, 3rd Ed.," Springer Nature: Cham, Switzerland, 2022

Cuantum Technologies, "Machine Learning with Python: Keras, PyTorch, and TensorFlow," 2023 (independently published). ISBN 979-8397584081

**Previous Examples of Evaluative Materials:**

N/A

**Lab Information:**

| Lab Topic | Date |
|---|---|
| Lab 1: AI pipelines in Scikit-learn | 2023-09-06 |
| Lab 2: Shallow Neural Networks in Scikit-learn | 2023-09-20 |
| Lab 3: Deep Learning in Tensorflow/Keras | 2023-10-04 |
| Lab 4: Fuzzy Trees | 2023-10-18 |
| Lab 5: Genetic-Fuzzy systems | 2023-11-01 |

*Did you know that the University of Alberta has various low-to-no-cost services to help students succeed? Visit http://www.deanofstudents.ualberta.ca/ for information about the academic, wellness, and various other support services available to U of A students. It's never too early or too late to seek help!*

## Course Policies

• Students are expected to attend all lectures, and complete all assigned readings. Absences do not need to be excused, but you are responsible for obtaining notes and completing assigned readings for any lectures missed.

• Five laboratory assignments will be assigned in the lab sections. These are to be completed individually. There will be one group assignment assigned in the lecture, to be completed in three-person teams; teams are not permitted to collaborate with one another. Please note, LATE WORK IS NOT ACCEPTED; late assignments will receive a grade of '0.'

• All coursework except the group project is to be completed individually. Any collaboration OTHER THAN PERMISSIBLE DISCUSSION AS BELOW will be considered plagiarism.

• Discussion of coursework amongst students is often a valuable aid to learning, and I do not intend or desire to prohibit it. For clarity, the rule on permissible discussion is that all communication must be ephemeral; no record of any conversation, in whole or in part, in any medium, is permitted.

• Academic dishonesty in any form is harmful to the class. Thus, any student who is found to have engaged in academic dishonesty will be referred to the Dean's office for disciplinary action, in accordance with the provisions of the current regulations of the GFC. The MINIMUM sanction that I will recommend to the Dean is that the student fails the course; based on the severity of the offense, a stronger sanction may be recommended.

• Grades will be assigned according to the University of Alberta letter grading system, based on relative class standing in terms of overall performance.

## Laboratory Schedules

**Lab D31 (ETLC E2-009)**

Lab #1: Wednesday, Sept. 6
Lab #2: Wednesday, Sept. 20
Lab #3: Wednesday, Oct. 4
Lab #4: Wednesday, Oct. 18
Lab #5: Wednesday, Nov. 1

**Lab D41 (ETLC E5-013)**

Lab #1: Thursday, Sept.7
Lab #2: Thursday, Sept. 21
Lab #3: Thursday, Oct. 5
Lab #4: Thursday, Oct. 19
Lab #5: Thursday, Nov. 2

**Lab D42 (ETLC E5-013)**

Lab #1: Thursday, Sept. 14
Lab #2: Thursday, Sept. 28
Lab #3: Thursday, Oct. 12
Lab #4: Thursday, Oct. 26
Lab #5: Thursday, Nov. 9

Lab assignments for Labs #1-4 will be due at the beginning of the next lab session in your section. Due to the scheduling of the Fall term reading week this year, Lab #5 will be due three weeks after the laboratory session for Lab #5 in your section.

# UNIVERSITY AND FACULTY POLICIES

## COURSE OUTLINE POLICY

The policy about course outlines can be found in Course Requirements, Evaluation Procedures and Grading of the University Calendar, see https://calendar.ualberta.ca/

## RESPECT AND PROFESSIONALISM

The Faculty of Engineering is committed to fostering and protecting an equitable, inclusive, and respectful work and study environment in line with University of Alberta policies and professional engineering industry standards. University is an opportunity for students to explore areas of interest and to potentially pursue a career in a specific field. The Faculty of Engineering prepares students to uphold industry standards to become a Professional Engineer (P. Eng). Respect, professionalism, and accountability must be upheld within the Faculty of Engineering.

Harassment and discrimination are serious issues that have a negative effect on culture and therefore the Student Conduct Policy states that no student shall discriminate against or harass any person or group of persons. The Faculty expects an environment free of harassment, discrimination, and bullying. Please refer to the Definitions for Discrimination, Accommodation and Harassment.

## SAFETY DURING LEARNING ACTIVITIES

In all Faculty of Engineering courses, labs, seminars or other learning activities, safety is of paramount importance. In some cases, laboratory work in a program requires high standards for risk management to keep potential hazards safely under control. Anyone found to be unable to function safely, due to intoxication, harassment or discriminatory behaviour, or other reasons, in the class, lab, seminar or other learning activity may be asked to leave or be removed for their and the safety of other participants and instructors in alignment with the Student Code of Behaviour or Student Conduct Policy. As members, or prospective members, of the engineering profession, it is your responsibility to identify and inform the proper authorities of an unsafe work/learning environment.

## AUDIO/VIDEO RECORDING

Audio or video recording, digital or otherwise, of lectures, labs, seminars or any other teaching environment by students is allowed only with the prior written consent of the instructor or as a part of an approved accommodation plan. Student or instructor content, digital or otherwise, created and/or used within the context of the course is to be used solely for personal study, and is not to be used or distributed for any other purpose without prior written consent from the content author(s).

Only those items specifically authorized by the instructor may be brought into the exam facility. The use of unauthorized personal listening, communication, recording, photographic and/or computational devices is strictly prohibited. Students should refrain from bringing any unauthorized electronic device into an examination room, including cell phones, high tech watches, high tech glasses or other such devices.

Engineering at Alberta

# ACADEMIC INTEGRITY

Students at the University of Alberta must follow, in its entirety, the **Code of Student Behavior.** Failure to know the Code is not an acceptable excuse for breaking the Code.

If you have not already done so, make sure you review the Code, which is found here along with other resources: https://www.ualberta.ca/natural-applied-sciences/portfolio/education/academic-integrity-and-discipline.html

Engineering students studying in the province of Alberta should also follow the **Code of Ethics** by The Association of Professional Engineers and Geoscientists of Alberta (APEGA), which is found here: https://www.apega.ca/members/legal-obligations

The Code of Student Behavior should not be too hard to follow. Listen to your instructor, be a good person, and do your own work, as this will lead you toward a path to success. Failure to follow the Code can result in a grade of 'F' for the course, a transcript remark, suspension, and even expulsion from the university.

"Integrity is doing the right thing, even when no one is watching"
C.S. Lewis

Engineering at Alberta

# NEED HELP?

There are a lot of services available to students on campus and in Edmonton, and sometimes it's hard to know where to go. While this isn't a comprehensive list, the services shown here should at least give you some ideas about where to start. If you're still not sure, check out the services just beneath this box—they'll give you the guidance you're looking for.

# DON'T KNOW WHERE TO GO?

## Student Service Centre

The U of A's central hub to find the right help for your needs.
**uab.ca/ask**

# 24/7 HELP

## Empower Me (international)
1-833-628-5589

## Edmonton Distress Line
780-482-4357 (HELP)

# WELLNESS

## Wellness Supports
Free 1:1 support for students in the areas of housing, finances, academics, personal wellness, life skill development, family dynamics, system navigation, and any area of life where there is a desire to invite change.
P: 780-492-1619 | E: wellness@ualberta.ca
M-F, 8:30am-4:30pm (Sep-April), 8:00am-4:00pm (May-Aug)

## Counselling and Clinical Services
Free, short-term, appointment-based counselling and psychiatric services. Also offers drop-in workshops. Book an initial consultation.
P: 780-492-5205 | M, R, F, 8:00am-4:00pm; T, W, 8:00am-7:00pm

## Interfaith Chaplains' Association
Get guidance, care, and support, whether or not you identify with a particular faith. Make an appointment.
P: 780-492-0339 | E: interfaithchaplains@ualberta.ca

## The Landing
Offers drop-in support on matters of gender and sexual diversity.
P: 780-492-4949 | E: thelanding@su.ualberta.ca | M-R, hours vary

## Peer Support Centre
Anonymous, confidential help from trained students. By appointment only.
P:780-492-4268 | E: psc@su.ualberta.ca | M-F, 9:00am-8:00pm

## Sexual Assault Centre
Free, anonymous, and confidential drop-in counselling.
P: 780-492-9771 | E: sexualassaultcentre@ualberta.ca
M-F, 9:00am-8:00pm

## University Health Centre
An on-campus health clinic that provides medical services to staff, students, and their spouses and children.
P: 780-492-2612 | E: hws@ualberta.ca | M-F, 8:30am-4:00pm

# ACADEMIC

## Engineering Student Services
Drop-in, first-come, first-served advising.
E: enggadvising@ualberta.ca

## Engineering Student Success Centre
Drop-in tutoring for first-year courses.
E: dessc@ualberta.ca

## Academic Success Centre
Many services to maximize your academic success. E: success@ualberta.ca | M-F, 8:30am-4:30pm

## Academic Accommodations
Connects students with disabilities to accommodations. E: arrec@ualberta.ca
M-F, 8:30am-4:30pm

## Office of the Student Ombuds
Call for complex problems and conflict mediation.
P: 780-492-4689 | E: ombuds@ualberta.ca

# FINANCIAL

## Student Service Centre
For awards and other funding supports.
uab.ca/ask

## Campus Food Bank
Many food support options available. E: info@campusfoodbank.com

# SOCIAL

## Unitea
Arrange a time to socialize with a peer.
E: unitea@ualberta.ca

## BearsDen
U of A webpage. Find student groups, local events, and volunteer opportunities.

# WORRIED ABOUT SOMEONE?

## Helping Individuals at Risk (HIAR)
If you're worried about someone because of the things they've been saying or doing, or there's a noticeable change in their behaviour (often in multiple ways), contact HIAR, who will protect your confidentiality and help decide how best to support the person.

780-492-4372
hiarua@ualberta.ca

# CONFIDENTIAL SUPPORT

## Office of Safe Disclosure and Human Rights

The OSDHR advises confidentially on sensitive issues you may not feel comfortable solving on your own. Contact the OSDHR if you want to get help or to make a report while keeping your privacy.

780-492-7357
osdhr@ualberta.ca