Intelligent Tools for Engineering Applications
Department of Mechanical & Mechatronics Engineering
2023 Winter

Instructor Information

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Teaching Assistant (TA) Information: TBA

Course Identification

Course Number:	EMEC 5173
Course Name:	Intelligence Tools for Engineering Applications
Course Location:	AT-2005
Class Times:	5:30PM – 7:00PM, Monday and Wednesday
Prerequisites:	N/A

Course Description/Overview

Computational intelligence and soft computing have become the subject of rapidly growing interest in a wide range of scientific research and engineering applications including consumer products, mechatronic systems, industrial process control, information systems, pattern recognition, system state prediction, etc. This course discusses fundamentals of intelligent systems design using soft computing tools including approximate reasoning and fuzzy logic, neural networks, hybrid techniques (e.g. neuro-fuzzy schemes), machine learning, and some applications in control, system state forecasting and classification. MATALB or other related software packages can be used for programming.

Program Learner Outcomes (PLOs)

PLO (a): Develop the ability to critically evaluate existing literature in the related research field.
PLO (e): Demonstrate the ability to use the techniques, skills, and modern engineering and scientific tools necessary for research in the related field.

PLO (f): Demonstrate the ability to treat and judge complex issues based on established principles and techniques within the discipline of Mechanical Engineering.
PLO (j): Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively.

These PLOs are assessed in the course by using course marks and project reports.

Course Learning Objectives (Student Learner Outcomes, SLOs)

1) Demonstrate the ability to interpret the relationship between a conventional system and softcomputing tool-based intelligent system. (Links to Program Learner Outcomes: a)
2) Demonstrate the ability to explain artificial intelligence concept and their range of applicability. (Links to Program Learner Outcomes: a)
3) Demonstrate the knowledge of fuzzy logic. (Links to Program Learner Outcomes: a)
4) Develop the ability to construct fuzzy logic models for general reasoning problems. (Links to Program Learner Outcomes: a, e)
5) Demonstrate the knowledge of neural networks including feedforward networks, recurrent networks, and RBFN). (Links to Program Learner Outcomes: a)
6) Develop the ability to construct neural network models with the help of MATLAB or other available software. (Links to Program Learner Outcomes: a, e)
7) Develop the ability to properly integrate neural networks and fuzzy logic for hybrid reasoning paradigms such as neuro-fuzzy and fuzzy neural schemes. (Links to Program Learner Outcomes: a, e)
8) Demonstrate the ability to discuss the commonly used training methods, such as LSE, gradient algorithm, and genetic algorithms. (Links to Program Learner Outcomes: a, e)
9) Demonstrate the ability to program fuzzy logic, neural networks, and neuro-fuzzy schemes in MATLAB. (Links to Program Learner Outcomes: a, e)
10) Demonstrate the ability to program LSE and gradient algorithm to train neuro-fuzzy systems in MATLAB. (Links to Program Learner Outcomes: a, e)
11) Demonstrate the ability to apply the related softcomputing tools to solve problems of a particular domain such as modeling (e.g., forecasting), or control, or pattern classification. (Links to Program Learner Outcomes: a, e)
12) Demonstrate personal responsibility and accountability in conducting the related assignments and term project. (Links to Program Learner Outcomes: f)
13) Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively related to assignments and term project. (Links to Program Learner Outcomes: g)

Course Resources

Course Website(s)

- http://wwang3.lakeheadu.ca/emec5173.htm
- D2L

Course materials including required reading materials, class notes, teaching notes, assignments and solutions are posted on the course website. Students are required to check the course website periodically.

Required Course Text:

1) Soft Computing and Intelligent Systems Design: Theory, Tools, and Applications, F. Karray, C. deSilver, Pearson Publishing Inc., 2004.
2) Neuro-Fuzzy and Soft Computing, J. R. Jang, C. Sun, and E. Mizutani, Printice Hall, 1997
3) Class notes

Course Schedule/Outline

Week	Tentative Topic	Book 1	Book 2
1	Introduction; Crisp logic	1.1-1.4	
2	Fuzzy sets; Fuzzy logic operations	2.1-2.4	2.1-2.3
3	MFs; Generalized fuzzy operations; Implication; Extension principle	2.5-2.7; 2.9	2.4.1; 3.1
4	Fuzzy if-then rules; Fuzzy reasoning		3.2-3.4
5	Fuzzy inferences (Mamdani, Sugeno, Tsukamoto models)		4.1-4.5
6	Recursive LSE; Descent method.		5.1-5.4; 6.1-6.2
7	Gradient algorithm		6.2-6.3
8	NNs; Connectionist modeling	4.4-4.5	
9	Multilayer perceptrons	5.1-5.3, 6.1-6.4	
9	RBFN; Neuro-fuzzy systems	6.1-6.4; 7.1-7.2	12.1-12.2
10	ANFIS; System training	7.3-7.5; 3.1-3.3; 3.5	12.3-12.5
11	Application examples; Evolving fuzzy systems	6.5-6.6	12.6

- The listed is for teaching week sequence, not including the reading week and exams.
- The instructor reserves the right to modify the contents in order to satisfy the needs of the class.

- Please check the Academic Schedule of Dates (2021 – 2022) to find the last day to drop class without Academic Penalty.

Assignments and Evaluations

Item	Value
In-class Assignments (5)	10
Mid-Term Test (closed book)	25
Final Examination (closed book)	45
Project	20
Total	100

- MSc students work as a group of two for the project.
- PhD students must work individually for the project.

Late Assignments
Each assignment is due on the specified date. Late assignments will be deducted 10% each day (24 hours period) after the due date and after **three** days will be graded "0".

Course Policies
- Students responsibilities, please refer to the University Student Code of Conduct - Academic Integrity.
- It is very important that you attend each and every lecture and tutorial.
- You can call me @ (807) 766-7174 or email me at wilson.wang@lakeheadu.ca

Regulations
It is the responsibility of each student registered at Lakehead University to be familiar with, and comply with all the terms, requirements, regulations, policies and conditions in the Lakehead University Academic Calendar. This includes, but is not limited to, Academic Program Requirements, Academic Schedule of Dates, University and Faculty/School Policies and Regulations and the Fees and Refund Policies and Schedules (Lakehead University Regulations webpage, 2021-22).

Academic Integrity
A breach of Academic Integrity is a serious offence. The principle of Academic Integrity, particularly of doing one's own work, documenting properly (including use of quotation marks, appropriate paraphrasing and referencing/citation), collaborating appropriately, and avoiding misrepresentation, is a core principle in university study. Students should view the Student Code of Conduct - Academic Integrity.

Supports for Students – there are many resources available to support students. These include but are not limited to:

- Health and Wellness
- Student Success Centre
- Student Accessibility Centre
- Library
- Lakehead International
- Indigenous Initiatives

Lakehead University is committed to achieving full accessibility for persons with disabilities. Part of this commitment includes arranging academic accommodations for students with disabilities and/or medical conditions to ensure they have an equitable opportunity to participate in all of their academic activities. If you are a student with a disability and think you may need accommodations, you are strongly encouraged to contact Student Accessibility Services (SAS) and register as early as possible. For more information, please contact Student Accessibility Services (SC0003, 343-8047 or sas@lakeheadu.ca)