# Course Specification of: Advanced Artificial Intelligence

# Course Code (MTE562)

## • General Information About the Course:

| | | | | | |
|---|---|---|---|---|---|
| 73. | **Course Title:** | **Advanced Artificial Intelligence** | | | |
| 74. | **Course Code and Number:** | **MTE562** | | | |
| 75. | **Credit Hours:** | **Credit Hours** | | | **Total** |
| | | Lecture | Practical | Seminar/Tutorial | |
| | | **3** | | | **3** |
| 76. | **Study Level and Semester:** | **ELEC** | | | |
| 77. | **Pre-requisites (if any):** | | | | |
| 78. | **Co-requisites (if any):** | | | | |
| 79. | **Program (s) in which the course is offered:** | MSc. In Mechatronics Engineering Program | | | |
| 80. | **Language of teaching the course:** | English | | | |
| 81. | **Study System:** | Courses & Thesis | | | |
| 82. | **Prepared By:** | Assoc. Prof. Dr. Farouk Al-Fahaidy | | | |
| 83. | **Reviewed by:** | Assoc. Prof. Dr. Radwan AL Bouthigy | | | |
| 84. | **Date of Approval:** | | | | |

## • Course Description:

**This course provides deep understanding of advanced topics in artificial intelligence and machine learning. Applied Machine learning has increasing growth and applications in a variety of environments such as, Web Searching Engines, Computational biology, Finance, E-commerce, Space Exploration, Robotics & Intelligent Control, Information extraction, and Social networks. Course covers: an overview on AI: Agents & searching, Neural Networks, Supervised learning, Unsupervised learning, Reinforcement, Deep learning and Evaluation. Through case studies and course project works, graduates develop their problem-solving, intelligent systems' development, and programming skills in the field of machine learning by presenting solutions to variant real-time applications issues and problems.**

## • Course Intended Learning Outcomes (CILOs):

Upon successful completion of **Advanced Artificial Intelligence Course**, the graduates will be able to:

**a1 - Demonstrate deep understanding of advanced AI concepts, applied mathematics and learning & classification techniques related to the field of neural and deep learning machines.**

**a2 - Explain supervised, unsupervised and reinforcement learning methods, and their issues & applications in different mechatronics systems.**

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| **b1 - Apply appropriate learning & classification techniques in the development of innovative mechatronics and intelligent control systems.**<br>**b2- Solve complex domain problems using applied machine learning methods, techniques and software tools.**<br>**c1- Develop intelligent learning algorithm based on neural & deep learning machine for integrating & constructing of intelligent mechatronics systems.**<br>**c2- Use modern programming language, classification, regression and learning techniques for solving mechatronics applications problems**<br>**d1- Prepare term-courses works/ tasks and their documents using engineering methodologies and technical writing and defend on them.**<br>**d2- Conduct independently research that advances and extends knowledge and scholarship in the fields of intelligent mechatronics systems based on machine/deep learning.** |

- **Alignment of Course Intended Learning Outcomes (CILOs) to Program Intended Learning Outcomes (PILOs )**

| CILOs | | PILOs |
|---|---|---|
| **cc. Knowledge and Understanding:** Upon successful completion of **the Advanced Artificial Intelligence Course**, the graduates will be able to: | | **CC. Knowledge and Understanding:** Upon successful completion of the **MSc. In Mechatronics Engineering Program**, the graduates will be able to: |
| **a1.** | **Demonstrate deep understanding of advanced AI concepts, applied mathematics and learning & classification techniques related to the field of neural and deep learning machines.** | **A1.** Demonstrate in-depth understanding of applied mathematics in Mechatronics engineering, control system, computer engineering and science, and electronics to design more functional, adaptable and cost-effective products. |
| **a2.** | **Explain supervised, unsupervised and reinforcement learning methods, and their issues & applications in different mechatronics systems.** | **A2.** Recognize and explain the contemporary engineering technologies and issues in the field of Mechatronics engineering. |
| **dd. Cognitive/ Intellectual Skills:** Upon successful completion of the **Advanced Artificial Intelligence Course,** the graduates will be able to: | | **DD. Cognitive/ Intellectual Skills:** Upon successful completion of the **MSc. In Mechatronics Engineering Program,** the graduates will be able to: |
| **b1.** | **Apply appropriate learning & classification techniques in the development of innovative mechatronics** | **B1.** Apply appropriate principles, methodologies, techniques, tools and packages in the analysis, |

| | | |
|---|---|---|
| | **and intelligent control systems.** | development and evaluation of mechatronics engineering systems. |
| **b2.** | **Solve complex domain problems using applied machine learning methods, techniques and software tools.** | **B2.** Identify, formulate and analyze research and solve complex Mechatronics engineering problems. |
| **ee. Professional and Practical Skills:** Upon successful completion of the **Advanced Artificial Intelligence Course,** the graduates will be able to: | | **EE. Professional and Practical Skills:** Upon successful completion of the **MSc. In Mechatronics Engineering Program,** the graduates will be able to: |
| **c1.** | **Develop intelligent learning algorithm based on neural & deep learning machine for integrating & constructing of intelligent mechatronics systems.** | **C1.** Conduct research to solve mechatronics engineering problems. |
| **c2.** | **Use modern programming language, classification, regression and learning techniques for solving mechatronics applications problems** | **C2.** Use advanced methodologies and skills to solve Mechatronics engineering problems. |
| **ff. Transferable Skills:** Upon successful completion of the **Advanced Artificial Intelligence Course,** the graduates will be able to: | | **FF. Transferable Skills:** Upon successful completion of the **MSc. In Mechatronics Engineering Program,** the graduates will be able to: |
| **d1.** | **Prepare term-courses works/ tasks and their documents using engineering methodologies and technical writing and defend on them.** | **D1.** Prepare a complete thesis and term-courses works/ tasks, write their documents and defend on them. |
| **d2.** | **Conduct independently research that advances and extends knowledge and scholarship in the fields of intelligent mechatronics systems based on machine/deep learning.** | **D3.** Conduct independently and communicate research that advances and extends knowledge and scholarship in related fields. |

## • Alignment of CILOs to Teaching and Assessment Strategies

**cc. Alignment of Knowledge and Understanding CILOs:**

| Knowledge and Understanding CILOs | | Teaching Strategies | Assessment Strategies |
|---|---|---|---|
| **a1.** | **Demonstrate deep understanding of advanced AI concepts, applied mathematics and learning & classification techniques related to the field of neural and deep learning machines.** | ▪ Lectures,<br>▪ Self-Learning Problems/Studies,<br>▪ Group/Individual Projects and Studies. | ▪ Oral & Writing Exams<br>▪ Reports,<br>▪ Written Exam,<br>▪ Assignments. |
| **a2.** | **Explain supervised, unsupervised and reinforcement learning methods, and** | ▪ Lectures,<br>▪ Group/Individual | ▪ Oral & Writing Exams<br>▪ Reports, |

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| | **their issues & applications in different mechatronics systems.** | Projects and Studies,<br>▪ Active learning. | ▪ Written Exam,<br>▪ Assignments |

**dd. Alignment of Intellectual Skills CILOs:**

| Intellectual Skills CILOs | | Teaching Strategies | Assessment Strategies |
|---|---|---|---|
| **b1.** | **Apply appropriate learning & classification techniques in the development of innovative mechatronics and intelligent control systems.** | ▪ Lectures,<br>▪ Project Supervision,<br>▪ Self-Learning,<br>▪ Case Study,<br>▪ Simulation Exercises,<br>▪ Independent Study,<br>▪ Analysis and Problem Solving, | ▪ Oral & Writing Exams<br>▪ Reports,<br>▪ Survey,<br>▪ Written Exam,<br>▪ Assignments |
| **b2.** | **Solve complex domain problems using applied machine learning methods, techniques and software tools.** | ▪ Lectures,<br>▪ Project Supervision,<br>▪ Self-Learning,<br>▪ Case Study,<br>▪ Simulation Exercises,<br>▪ Independent Study,<br>▪ Analysis and Problem Solving, | ▪ Oral & Writing Exams<br>▪ Reports,<br>▪ Survey,<br>▪ Written Exam,<br>▪ Assignments |

**ee. Alignment of Professional and Practical Skills CILOs:**

| Professional and Practical Skills CILOs | | Teaching Strategies | Assessment Strategies |
|---|---|---|---|
| **c1.** | **Develop intelligent learning algorithm based on neural & deep learning machine for integrating & constructing of intelligent mechatronics systems.** | ▪ Project Supervision,<br>▪ Case Study,<br>▪ Simulation Exercises,<br>▪ Independent Study,<br>▪ Analysis and Problem Solving, | ▪ Seminar Report,<br>▪ Assignments,<br>▪ Written Research Proposal. |
| **c2.** | **Use modern programming language, classification, regression and learning techniques for solving mechatronics applications problems** | ▪ Project Supervision,<br>▪ Self-Learning,<br>▪ Case Study,<br>▪ Simulation Exercises,<br>▪ Analysis and Problem Solving, | ▪ Seminar Report,<br>▪ Assignments,<br>▪ Written Research Proposal. |

**ff. Alignment of Transferable (General) Skills CILOs:**

| Transferable (General) Skills CILOs | | Teaching Strategies | Assessment Strategies |
|---|---|---|---|
| **d1.** | **Prepare term-courses works/ tasks and their documents using engineering methodologies and technical writing and defend on them.** | ▪ Dissertation Defenses and Presentation,<br>▪ Independent Study,<br>▪ Presentation,<br>▪ Brainstorming,<br>▪ Presenting Researches. | ▪ Written Research Proposal,<br>▪ Assignments,<br>▪ Presentation,<br>▪ Written Report. |
| **d2.** | **Conduct independently research that advances and extends knowledge** | ▪ Dissertation Defenses and Presentation, | ▪ Written Research Proposal, |

| | | | |
|---|---|---|---|
| | **and scholarship in the fields of intelligent mechatronics systems based on machine/deep learning.** | ▪ Independent Study,<br>▪ Presentation,<br>▪ Brainstorming,<br>▪ Presenting Researches. | ▪ Assignments,<br>▪ Presentation,<br>▪ Written Report. |

## • Course Content

### 22. Theoretical Aspect

| Order | Topic List / Units | Sub -Topics List | Number of Weeks | Contact Hours | Course ILOs |
|---|---|---|---|---|---|
| 1 | Introduction | ▪ Course Orientations: Aims, Objectives and CLOs,<br>▪ Artificial Intelligence: Advanced Topics, Applications.<br>▪ Programming Requirements in AI,<br>▪ An overview on classical Searching Techniques and Agent Systems,<br>▪ Mathematical Backgrounds in Algebra, Calculus and Probabilities. | 1 | 3 | a1 |
| 2 | Neural Networks | ▪ Neural Networks (NNs): Neural Function, Biology of Neuron & Brain Structure,<br>▪ Neuron Model: Logistic Unit, NN Layers, Feed-Forward Process, NN Vectorization, Multiple Output Units and NN Classification,<br>▪ Understanding Representations: Representing Boolean Functions like, AND, OR and NOT.<br>▪ Combining Representations: Create Non-Linear Functions like XOR, and Layering Representations,<br>▪ Neural Network Learning: Perceptron Learning Rule, Perceptron Convergence Theorem and Batch Perceptron.<br>▪ Learning in NN: Backpropagation, Cost Function, Optimizing the NN, Forward Propagation,<br>▪ Backpropagation Intuition, Backpropagation: Gradient Computation,<br>▪ Training a Neural Network via Gradient Descent with Backprop and Implementation Details & Steps. | 3 | 9 | a1, b1, b2, c1 |
| 3 | Supervised | ▪ Introduction to Supervised Learning: Classification & Regression and Data | 3 | 9 | a1, a2, |

| | | | | | |
|---|---|---|---|---|---|
| | Learning (Classification & Regression) | with Labels,<br>▪ Decision Trees Induction & DT Overfitting,<br>▪ Logistic Regression,<br>▪ Naïve Bayes Classifier.<br>▪ K-Nearest Neighbor & Instance-based Learning,<br>▪ Support Vector Machines (SVM) & Kernel Methods,<br>▪ Examples: Email Spam Detection & Speech Recognition.<br>▪ Linear Regression,<br>▪ Ridge Regression,<br>▪ Ordinary Least Squares Regression,<br>▪ Stepwise Regression,<br>▪ Examples: Stock Market Prediction & Rainfall Prediction. | | | b1, b2, c2 |
| 4 | Midterm Theoretical Exam | ▪ Midterm Revision,<br>▪ Midterm Exam includes All Previous Topics | 1 | 3 | a1, a2, b1, b2 |
| 5 | Un-Supervised Learning | ▪ Introduction to Un-Supervised Learning: Clustering, Association Analysis & Dimensionality Reduction and Data without Label,<br>▪ Clustering: K-means, K-median, Hierarchical Clustering and Expection Maximization,<br>▪ Examples: Identifying Fake News & Document Analysis.<br>▪ Association Analysis: APRIORI, Eclat and FP-Growth,<br>▪ Example: Market Basket Analysis.<br>▪ Dimensionality Reduction: Feature Extraction Principal Component Analysis,<br>▪ Feature Selection: Wrapper, Filter and Embedded Method,<br>▪ Example: Analysis of written texts and DNA microarray data. | 3 | 9 | a2, b1, b2, c1, c2 |

| | | | | | |
|---|---|---|---|---|---|
| 6 | Reinforcement Learning | ▪ Introduction to Reinforcement Learning: Model-Free & Model-Based and State & Action,<br>▪ Model-Free: Q-Learning, Hybrid and Policy Optimization,<br>▪ Model-Based: Learn the Model and Given the Model. | 1 | 3 | a2, b1 c1 |
| 7 | Deep Learning | ▪ Introduction to Deep Learning (DL): Wrong with Back-Propagation & Motivations, Belief Nets, Stochastic Binary Neurons, Restricted Boltzmann Machines,<br>▪ Training a Deep Belief Network, Greedy Learning, A Neural Network model of Digit Recognition, Fine-tuning with a Contrastive Version of the "wake-sleep" Algorithm,<br>▪ Convolutional Neural Network, LongShort-Term Memory (LSTM). | 1 | 3 | a1, b1, b2, c1, c2 |
| 8 | Evaluation | ▪ Accuracy, Precision and recall, Squared Error, Likelihood, Posterior probability, Cost/Utility, Margin, Entropy, K-L Divergence. | 1 | 3 | a1, b2 |
| 9 | Case Studies & Course-Project Presentation | ▪ Students Presents in an individual and in Groups their course Projects, Implementation and Paper Presentations works. | 1 | 3 | a1, a2, b1, b2, c1, c2, d1, d2 |
| 10 | Final Theoretical Exam | ▪ ALL Topics | 1 | 3 | a1, a2, b1, b2 |
| Number of Weeks /and Contact Hours Per Semester | | | 16 | 48 | |

**23. Practical Aspect**

| Order | Practical / Tutorials topics | Number of Weeks | Contact Hours | Course ILOs |
|---|---|---|---|---|
| 1 | ▪ NONE | | | |
| 2 | ▪<br>▪ | | | |
| Number of Weeks /and Contact Hours Per Semester | | | | |

**24. Tutorial Aspect:**

| No. | Tutorial | Number of Weeks | Contact Hours | Learning Outcomes (CILOs) |
|---|---|---|---|---|
| 1 | NONE | | | |
| 2 | | | | |
| Number of Weeks /and Units Per Semester | | | | |

## • Teaching Strategies:

- Lectures,
- Seminars,
- Project Supervision,
- Self-Learning,
- Case Study,
- Simulation Exercises,
- Dissertation Defenses and Presentation,
- Independent Study,
- Analysis and Problem Solving,
- Brainstorming,
- Presenting Researches,
- Presentations,
- Group/Individual Projects and Studies,
- Active learning.

## • Assessment Methods of the Course:

- Oral & Writing Exams
- Reports,
- Survey,
- Written Exam,
- Assignments
- Seminar Report,
- Written Research Proposal.

## • Tasks and Assignments:

| No | Assignments/ Tasks | Individual/ Group | Mark | Week Due | CILOs (symbols) |
|---|---|---|---|---|---|
| 1 | **Assignments:**<br>**Assignments 1: Neural Networks Programming in Python,**<br>**Assignments 2: Supervised Learning Programming in Python,**<br>**Assignments 3: Un-Supervised Learning Programming in Python,**<br>**Assignments 4: Reinforcement Learning & Deep Learning Programming in Python.** | Individual | 10 | 4th, 7th, 11th & 13th | a1, a2, b1, b2, c1, c2, d1, d2 |
| 2 | **Course Project:**<br>**Graduates work individually or within groups to search for practical and fields problems related to machine learning and solve them, preparing reports and defend on.** | Individual / Group | 15 | From the 4th to 15th | a1, a2, b1, b2, c1, c2, d1, d2 |
| 3 | **Tasks:**<br>**By searching Web, selecting research papers in the field of ML, implement that work done by the paper and presenting them** | Individual / Group | 10 | From 4th to 14th | a1, a2, b1, b2, c1, c2, d1, d2 |
| | **Total Score** | | 35 | == | === |

## • Learning Assessment:

| No. | Assessment Tasks | Week due | Mark | Proportion of Final Assessment | CILOs |
|---|---|---|---|---|---|
| 1 | **Tasks and Assignments** | 4th to 15th | 35 | 35% | a1, a2, b1, b2, c1, c2, d1, d2 |
| 2 | **Quizzes** | 6th & 12th | 5 | 5% | a1, a2, b1, b2 |
| 3 | **Midterm Exam** | 8th | 20 | 20% | a1, a2, b1, b2 |
| 4 | **Final Exam (Theoretical)** | 16th | 40 | 40% | a1, a2, b1, b2 |
| **Total** | | | 100 | 100% | === |

## • Learning Resources :

**21.Required Textbook(s) :**


12. **Shalev-Schwartz & Ben-David, 2014, "Understanding Machine Learning" Cambridge University Press.**
13. **Goodfellow, Bengio &Courville, 2016, "Deep Learning", MIT Press.**

**22. Essential References:**

12. **Bishop, 2007, "Pattern Recognition and Machine Learning", Springer.**
13. **Hastie, Tibshirani & Friedman, 2009, "The Elements of Statistical Learning: Data Mining, Inference", and Prediction, 2nd Edition. Springer.**

**23. Electronic Materials and Web Sites *etc.***

13. **Some Courses on Web:**
    **www.cs.mcgill.ca/~jpineau/comp551**
14. **Use https://cmt3.research.microsoft.com/ for project reports and peer-reviews.**
15. **Sample publication –See**
    **paper: http://homes.cs.washington.edu/~pedrod/papers/cacm12.pdf**
    **http://www.cs.mcgill.ca/~jpineau/publications.html**
    **IEEE Publisher**
    **https://www.ieee.org**
    **Elsevier Publisher**
    **https://www.elsevier.org**
    **Science Direct Publisher**
    **https://www.Sciencedirect.com**
16. **Review basic algebra, probability, statistics:**
    **http://www.cs.mcgill.ca/~dprecup/courses/ML/Materials/prob-review.pdf**
    **http://www.cs.mcgill.ca/~dprecup/courses/ML/Materials/linalg-review.pdf**
17. **Applications: Stanford Autonomous Helicopter**
    **http://heli.stanford.edu/**
    **https://www.youtube.com/watch?v=VCdxqn0fcnE**
    **Autonomous Cars: Nevada Autonomous Car**
18. **Movie of the network generating digits available at (www.cs.toronto/~hinton)**
19. **Software Tools: Many software packages are available, including broad ML libraries in Java, C++, Python and R Languages.**

| ix. الضوابط والسياسات المتبعة في المقرر Course Policies | |
|---|---|
| بعد الرجوع للوائح الجامعة يتم كتابة السياسة العامة للمقرر فيما يتعلق بالآتي: | |
| 1 | **سياسة حضور الفعاليات التعليمية Class Attendance:**<br>- يلتزم الطالب بحضور 75% من المحاضرات ويحرم في حال عدم الوفاء بذلك.<br>- يقدم أستاذ المقرر تقريرا بحضور وغياب الطلاب للقسم ويحرم الطالب من دخول الامتحان في حال تجاوز الغياب 25% ويتم اقرار الحرمان من مجلس القسم. |
| 2 | **الحضور المتأخر Tardy:**<br>- يسمح للطالب حضور المحاضرة إذا تأخر لمدة ربع ساعة لثلاث مرات في الفصل الدراسي، وإذا تأخر زيادة عن ثلاث مرات يحذر شفويا من أستاذ المقرر، وعند عدم الالتزام يمنع من دخول المحاضرة. |
| 3 | **ضوابط الامتحان Exam Attendance/Punctuality:**<br>- لا يسمح للطالب دخول الامتحان النهائي إذا تأخر مقدار (20) دقيقة من بدء الامتحان<br>- إذا تغيب الطالب عن الامتحان النهائي تطبق اللوائح الخاصة بنظام الامتحان في الكلية. |
| 4 | **التعيينات والمشاريع Assignments & Projects:**<br>- يحدد أستاذ المقرر نوع التعيينات في بداية الفصل ويحدد مواعيد تسليمها وضوابط تنفيذ التكليفات وتسليمها.<br>- إذا تأخر الطالب في تسليم التكليفات عن الموعد المحدد يحرم من درجة التكليف الذي تأخر في تسليمه. |
| 5 | **الغش Cheating:**<br>- في حال ثبوت قيام الطالب بالغش في الامتحان النصفي أو النهائي تطبق عليه لائحة شؤون الطلاب.<br>- في حال ثبوت قيام الطالب بالغش او النقل في التكليفات والمشاريع يحرم من الدرجة المخصصة للتكليف. |
| 6 | **الانتحال Plagiarism:**<br>– في حالة وجود شخص ينتحل شخصية طالب لأداء الامتحان نيابة عنه تطبق اللائحة الخاصة بذلك |
| 7 | **سياسات أخرى Other policies:**<br>- أي سياسات أخرى مثل استخدام الموبايل أو مواعيد تسليم التكليفات ..... الخ |

Academic Year: 2021/2022

# Course Plan (Syllabus): Advanced Artificial Intelligence

## • Information about Faculty Member Responsible for the Course:

| Name | Farouk Al-Fahaidy | Office Hours | | | | | |
|---|---|---|---|---|---|---|---|
| Location &Telephone No. | 777909815 | SAT | SUN | MON | TUE | WED | THU |
| E-mail | farouqakh@gmail.com | | | | | | |

## • General information about the course:

| | | | | | |
|---|---|---|---|---|---|
| | Course Title | Advanced Artificial Intelligence | | | |
| 2. | Course Code and Number | MTE562 | | | |
| 3. | Credit Hours | Credit Hours | | | Total |
| | | Lecture | Practical | Seminar/Tutorial | |
| | | 3 | | | 3 |
| 4. | Study Level and Semester | ELEC | | | |
| 5. | Pre-requisites | | | | |
| 6. | Co –requisite | | | | |
| 7. | Program (s) in which the course is offered | Ms. of Science in Mechatronics Engineering Program | | | |
| 8. | Language of teaching the course | English | | | |
| 9. | Location of teaching the course | Mechatronics Department Classrooms | | | |

## • Course Description:

This course provides deep understanding of advanced topics in artificial intelligence and machine learning. Applied Machine learning has increasing growth and applications in a variety of environments such as, Web searching engines, Computational biology, Finance, E-commerce, Space exploration, Robotics & Intelligent Control, Information extraction, and Social networks. Course covers: an overview on AI: Agents & searching, Neural Networks, Supervised learning, Unsupervised learning, Reinforcement, Deep learning and Evaluation. Through case studies and course project works, graduates develop their problem-solving, intelligent systems' development, and programming skills in the field of machine learning by presenting solutions to variant real-time applications issues and problems.

## • Course Intended Learning Outcomes (CILOs):

Upon successful completion of the **Advanced Artificial Intelligence** course, graduate students will be able to:

**a1 - Demonstrate deep understanding of advanced AI concepts, applied mathematics and learning & classification techniques related to the field of neural and deep learning machines.**

**a2 - Explain supervised, unsupervised and reinforcement learning methods, and their issues & applications in different mechatronics systems.**

**b1 - Apply appropriate learning & classification techniques in the development of innovative mechatronics and intelligent control systems.**

**b2- Solve complex domain problems using applied machine learning methods, techniques and software tools.**

**c1- Develop intelligent learning algorithm based on neural & deep learning machine for integrating & constructing of intelligent mechatronics systems.**

**c2- Use modern programming language, classification, regression and learning techniques for solving mechatronics applications problems**

**d1- Prepare term-courses works/ tasks and their documents using engineering methodologies and technical writing and defend on them.**

**d2- Conduct independently research that advances and extends knowledge and scholarship in the fields of intelligent mechatronics systems based on machine/deep learning.**

## • Course Content

**25. Theoretical Aspect**

| Order | Topic List / Units | Sub -Topics List | Number of Weeks | Contact Hours |
|---|---|---|---|---|
| 1 | Introduction | ▪ Course Orientations: Aims, Objectives and CLOs,<br>▪ Artificial Intelligence: Advanced Topics, Applications.<br>▪ Programming Requirements in AI,<br>▪ An overview on classical Searching Techniques and Agent Systems,<br>▪ Mathematical Backgrounds in Algebra, Calculus and Probabilities. | 1 | 3 |
| 2 | Neural Networks | ▪ Neural Networks (NNs): Neural Function, Biology of Neuron & Brain Structure,<br>▪ Neuron Model: Logistic Unit, NN Layers, Feed-Forward Process, NN Vectorization, Multiple Output Units and NN Classification,<br>▪ Understanding Representations: Representing Boolean Functions like, AND, OR and NOT. | 3 | 9 |
| | | ▪ Combining Representations: Create Non-Linear Functions like XOR, and Layering | | |

| | | | | |
|---|---|---|---|---|
| | | Representations,<br>▪ Neural Network Learning: Perceptron Learning Rule, Perceptron Convergence Theorem and Batch Perceptron. | | |
| | | ▪ Learning in NN: Backpropagation, Cost Function, Optimizing the NN, Forward Propagation,<br>▪ Backpropagation Intuition, Backpropagation: Gradient Computation,<br>▪ Training a Neural Network via Gradient Descent with Backprop and Implementation Details & Steps. | | |
| 3 | Supervised Learning (Classification & Regression) | ▪ Introduction to Supervised Learning: Classification & Regression and Data with Labels,<br>▪ Decision Trees Induction & DT Overfitting,<br>▪ Logistic Regression,<br>▪ Naïve Bayes Classifier. | 3 | 9 |
| | | ▪ K-Nearest Neighbor & Instance-based Learning,<br>▪ Support Vector Machines (SVM) & Kernel Methods,<br>▪ Examples: Email Spam Detection & Speech Recognition. | | |
| | | ▪ Linear Regression,<br>▪ Ridge Regression,<br>▪ Ordinary Least Squares Regression,<br>▪ Stepwise Regression,<br>▪ Examples: Stock Market Prediction & Rainfall Prediction. | | |
| 4 | Midterm Theoretical Exam | ▪ Midterm Revision,<br>▪ Midterm Exam includes All Previous Topics | 1 | 3 |
| 5 | Un-Supervised Learning | ▪ Introduction to Un-Supervised Learning: Clustering, Association Analysis & Dimensionality Reduction and Data without Label,<br>▪ Clustering: K-means, K-median, Hierarchical Clustering and Expection Maximization,<br>▪ Examples: Identifying Fake News & Document Analysis. | 3 | 9 |
| | | ▪ Association Analysis: APRIORI, Eclat and FP-Growth,<br>▪ Example: Market Basket Analysis. | | |

| | | | | |
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| | | ▪ Dimensionality Reduction: Feature Extraction Principal Component Analysis,<br>▪ Feature Selection: Wrapper, Filter and Embedded Method,<br>▪ Example: Analysis of written texts and DNA microarray data. | | |
| 6 | Reinforcement Learning | ▪ Introduction to Reinforcement Learning: Model-Free & Model-Based and State & Action,<br>▪ Model-Free: Q-Learning, Hybrid and Policy Optimization,<br>▪ Model-Based: Learn the Model and Given the Model. | 1 | 3 |
| 7 | Deep Learning | ▪ Introduction to Deep Learning (DL): Wrong with Back-Propagation & Motivations, Belief Nets, Stochastic Binary Neurons, Restricted Boltzmann Machines,<br>▪ Training a Deep Belief Network, Greedy Learning, A Neural Network model of Digit Recognition, Fine-tuning with a Contrastive Version of the "wake-sleep" Algorithm,<br>▪ Convolutional Neural Network, Long Short-Term Memory (LSTM). | 1 | 3 |
| 8 | Evaluation | ▪ Accuracy, Precision and recall, Squared Error, Likelihood, Posterior probability, Cost/Utility, Margin, Entropy, K-L Divergence. | 1 | 3 |
| 9 | Case Studies & Course-Project Presentation | ▪ Students Presents in an individual and in Groups their course Projects, Implementation and Paper Presentations works. | 1 | 3 |
| 10 | Final Theoretical Exam | ▪ ALL Topics | 1 | 3 |
| Number of Weeks /and Contact Hours Per Semester | | | 16 | 48 |

## 12.Practical Aspect

| Order | Practical / Tutorials topics | Number of | Contact | Course ILOs |
|---|---|---|---|---|

| | | Weeks | Hours | |
|---|---|---|---|---|
| 1 | ▪ NONE | | | |
| 2 | ▪<br>▪ | | | |
| 3 | ▪<br>▪ | | | |
| 4 | • | | | |
| 5 | ▪ | | | |
| 6 | •<br>▪ | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Number of Weeks /and Contact Hours Per Semester | | | | |

## 13. Training/ Tutorials/ Exercises Aspects:

| Order | Tutorials/ Exercises | Week Due | Contact Hours |
|---|---|---|---|
| 1 | ▪ NONE | | |
| 2 | ▪ | | |
| 3 | ▪ | | |
| 4 | ▪ | | |
| 5 | ▪ | | |
| 6 | • | | |
| 7 | | | |
| 8 | ▪ | | |
| 9 | ▪ | | |
| 10 | ▪ | | |
| 11 | ▪ | | |
| 12 | ▪ | | |
| 13 | ▪ | | |
| 14 | | | |
| Number of Weeks /and Contact Hours Per Semester | | | |

## • Teaching Strategies:

- Lectures,
- Seminars,

- Project Supervision,
- Self-Learning,
- Case Study,
- Simulation Exercises,
- Dissertation Defenses and Presentation,
- Independent Study,
- Analysis and Problem Solving,
- Brainstorming,
- Presenting Researches,
- Presentations,
- Group/Individual Projects and Studies,
- Active learning.

## • Assessment Methods of the Course:

- Oral & Writing Exams
- Reports,
- Survey,
- Written Exam,
- Assignments
- Seminar Report,
- Written Research Proposal.

## • Tasks and Assignments:

| No | Assignments | Individual /Groups | Mark | Week Due |
|---|---|---|---|---|
| 1 | **Assignments:**<br>**Assignments 1: Neural Networks Programming in Python,**<br>**Assignments 2: Supervised Learning Programming in Python,**<br>**Assignments 3: Un-Supervised Learning Programming in Python,**<br>**Assignments 4: Reinforcement Learning & Deep Learning Programming in Python.** | **Individual** | **10** | **4th, 7th, 11th & 13th** |
| 2 | **Course Project:**<br>**Graduates work individually or within groups to search for practical and fields problems related to** | **Individual / Group** | **15** | **From the 4th to 15th** |

| | | | | |
|---|---|---|---|---|
| | machine learning and solve them, preparing reports and defend on. | | | |
| 3 | Tasks:<br>By searching Web, selecting research papers in the field of ML, implement that work done by the paper and presenting them | Individual / Group | 10 | From 4th to 14th |
| | Total Score | | 35 | |

## • Learning Assessment:

| No | Assessment Method | Week Due | Mark | Proportion of Final Assessment % |
|---|---|---|---|---|
| 1 | Tasks and Assignments | 4th to 15th | 35 | 35% |
| 2 | Quizzes | 6th & 12th | 5 | 5% |
| 3 | Midterm Exam | 8th | 20 | 20% |
| 4 | Final Exam (Theoretical) | 16th | 40 | 40% |
| | المجموعTotal | | 100 | 100 % |

## • Learning Resources:

**12. Required Textbook(s) :**

1. Shalev-Schwartz & Ben-David, 2014, "Understanding Machine Learning" Cambridge University Press.
2. Goodfellow, Bengio &Courville, 2016, "Deep Learning", MIT Press.

**13. Essential References:**

1. Bishop, 2007, "Pattern Recognition and Machine Learning", Springer.
2. Hastie, Tibshirani & Friedman, 2009, "The Elements of Statistical Learning: Data Mining, Inference", and Prediction, 2nd Edition. Springer.

**14. Electronic Materials and Web Sites etc.**

1. Some Courses on Web:
   www.cs.mcgill.ca/~jpineau/comp551
2. Use https://cmt3.research.microsoft.com/ for project reports and peer-reviews.
3. Sample publication –See
   paper: http://homes.cs.washington.edu/~pedrod/papers/cacm12.pdf
   http://www.cs.mcgill.ca/~jpineau/publications.html
   IEEE Publisher
   https://www.ieee.org
   Elsevier Publisher
   https://www.elsevier.org
   Science Direct Publisher
   https://www.Sciencedirect.com
4. Review basic algebra, probability, statistics:
   http://www.cs.mcgill.ca/~dprecup/courses/ML/Materials/prob-review.pdf

http://www.cs.mcgill.ca/~dprecup/courses/ML/Materials/linalg-review.pdf

5. **Applications: Stanford Autonomous Helicopter**
   http://heli.stanford.edu/
   https://www.youtube.com/watch?v=VCdxqn0fcnE
   **Autonomous Cars: Nevada Autonomous Car**
6. **Movie of the network generating digits available at (www.cs.toronto/~hinton)**
7. **Software Tools: Many software packages are available, including broad ML libraries in Java, C++, Python and R Languages.**

| **x. الضوابط والسياسات المتبعة في المقرر Course Policies** | |
|---|---|
| **بعد الرجوع للوائح الجامعة يتم كتابة السياسة العامة للمقرر فيما يتعلق بالآتي:** | |
| **سياسة حضور الفعاليات التعليمية Class Attendance:**<br>- يلتزم الطالب بحضور 75% من المحاضرات ويحرم في حال عدم الوفاء بذلك.<br>- يقدم أستاذ المقرر تقريرا بحضور وغياب الطلاب للقسم ويحرم الطالب من دخول الامتحان في حال تجاوز الغياب 25% ويتم اقرار الحرمان من مجلس القسم. | 1 |
| **الحضور المتأخر Tardy:**<br>- يسمح للطالب حضور المحاضرة إذا تأخر لمدة ربع ساعة لثلاث مرات في الفصل الدراسي، وإذا تأخر زيادة عن ثلاث مرات يحذر شفويا من أستاذ المقرر، وعند عدم الالتزام يمنع من دخول المحاضرة. | 2 |
| **ضوابط الامتحان Exam Attendance/Punctuality:**<br>- لا يسمح للطالب دخول الامتحان النهائي إذا تأخر مقدار (20) دقيقة من بدء الامتحان<br>- إذا تغيب الطالب عن الامتحان النهائي تطبق اللوائح الخاصة بنظام الامتحان في الكلية. | 3 |
| **التعيينات والمشاريع Assignments & Projects:**<br>- يحدد أستاذ المقرر نوع التعيينات في بداية الفصل ويحدد مواعيد تسليمها وضوابط تنفيذ التكليفات وتسليمها.<br>- إذا تأخر الطالب في تسليم التكليفات عن الموعد المحدد يحرم من درجة التكليف الذي تأخر في تسليمه. | 4 |
| **الغش Cheating:**<br>- في حال ثبوت قيام الطالب بالغش في الامتحان النصفي أو النهائي تطبق عليه لائحة شؤون الطلاب.<br>- في حال ثبوت قيام الطالب بالغش او النقل في التكليفات والمشاريع يحرم من الدرجة المخصصة للتكليف. | 5 |
| **الانتحال Plagiarism:**<br>– في حالة وجود شخص ينتحل شخصية طالب لأداء الامتحان نيابة عنه تطبق اللائحة الخاصة بذلك | 6 |
| **سياسات أخرى Other policies:**<br>- أي سياسات أخرى مثل استخدام الموبايل أو مواعيد تسليم التكليفات ..... الخ | 7 |