Course title	**Deep Learning**
Course number	COMP 560
Credit hours (lecture and lab)	3 (2 + 1)
ECTS (weekly contact and self-study load)	6 (3 + 3)
Prerequisites/co-requisites by course number and name	COMP 364 Introduction to Artificial Intelligence and Machine Learning
Prerequisites by topic (other than the formal prerequisites above)	None
Level and type (compulsory, elective)	BE elective course
Year of study and semester	Any
Catalogue description	Introduction to artificial neural networks. Data convolutional neural network architectures, invariance learning, deep unsupervised learning, and non-convex optimization. Mathematical, statistical, and computational challenges of building stable representations for high-dimensional data. Practical aspects of Deep Learning with applications using modern programming tools. Applications include Anomaly Detection, Time Series Forecasting, Image Recognition, Natural Language Processing, etc. Implementations using GPUs.
Objectives	This course introduces the concepts, principles, and methods of Deep Learning. The course puts emphasis on using Deep Learning techniques and their implementation to solve real problems. The students are introduced to the use of modern Deep Learning tools.
Intended learning outcomes	Upon successful completion of this course, students will be able to:

No	Intended learning Outcome (ILO)	PLO*
1	Solve problems in linear algebra, probability, optimization, machine learning, and neural networks.	1, 4
2	Evaluate, in the context of a case study, the advantages and disadvantages of deep learning neural network architectures and other approaches	1, 2
3	Implement deep learning models in Python using the PyTorch library and train them with real-world datasets.	2, 6
4	Design convolution networks for handwriting and object classification from images or video.	2, 6
5	Design recurrent neural networks with attention mechanisms for natural language classification, generation, and translation.	2, 6
6	Evaluate the performance of different deep learning models (e.g., with respect to the bias–variance tradeoff, overfitting and underfitting, estimation of test error).	6, 7

	(*) The Program learning outcome (PLOs) are listed in the appendix

7	Analyze a deep learning model's hardware node and GPU scalability in preparation for deployment.	2, 6
8	Perform regularization, training optimization, and hyperparameter selection on deep models.	2, 6, 7
9	Devise deep-learning applications to real-world problems.	2, 3, 5, 6, 7

Teaching and learning methods

Development of ILOs is promoted through the following teaching and learning methods:

- The Digital Systems Lab. is open for the students to practice the practical aspects and solve the programming homework assignments.
- The student attends the class presentations and participates in the discussions.
- The student joins the related online team/group and participates in its discussions.
- The student studies the reference material, including books and videos.
- The student solves the programming assignments in deep learning.
- The student carries out a term project for solving a problem using deep learning techniques.
- The student develops a professional report for the term report.
- The student presents the term project in class.

Learning material type

Textbook, class handouts, some instructor keynotes, selected YouTube videos, and access to a personal computer and the internet.

Resources and references

A- Required book(s), assigned reading and audio-visuals:

1. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. Cambridge: MIT Press.

B- Recommended book(s), material and media:

2. Christopher Bishop, Pattern recognition and machine learning. Springer, 2006

Topic outline and schedule

Week	Topic	ILO	Resources
1-2	Introduction to Neural Networks	1	1, 2
3-4	Deep Feedforward Networks	1	1
5	Regularization of Deep Learning	2, 6	1
6-7	Optimization for Training Deep Models	2, 6, 8	1
8-9	Convolution Networks and Transfer Learning	4	1
10-11	Recurrent and Recursive Networks	5	1
12-14	Applications of Deep Learning	2, 3, 7, 8, 9	1, 2
15	Projects	1-9	1, 2

<table>
<tr><td>Evaluation tools</td><td>Opportunities to demonstrate achievement of the ILOs are provided through the following assessment tools:
<table>
<tr><th>Assessment tool</th><th>Mark</th><th>Topic(s)</th><th>Time</th></tr>
<tr><td>Homework assignments</td><td>10%</td><td>Theoretical aspects</td><td>W1-W7</td></tr>
<tr><td>Midterm exam</td><td>30%</td><td>Applications</td><td>W8-W14</td></tr>
<tr><td>Term project report and presentation</td><td>20%</td><td>Practical and presentation aspects</td><td>W8-W15</td></tr>
<tr><td>Final exam</td><td>40%</td><td>All material</td><td>W16</td></tr>
<tr><td>Total</td><td>100%</td><td></td><td></td></tr>
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<tr><td>Student requirements</td><td>The student should have a computer and internet connection.</td></tr>
<tr><td>Course policies</td><td>A- Attendance policies:
Attendance is required. Class attendance will be taken every class and the university polices will be enforced in this regard.
B- Absences from exams and not submitting assignments on time:
A makeup exam can be arranged for students with acceptable absence causes.
Assignments submitted late, but before announcing or discussing the solution can be accepted with 25% penalty.
The project report must be handed in in time.
C- Health and safety procedures:
All health and safety procedures of the university and the school should be followed.
D- Honesty policy regarding cheating, plagiarism, misbehavior:
Open-book exams
All submitted work must be of the submitting student.
Other text or code must be properly quoted with clear source specification.
Cheating will not be tolerated.
E- Available university services that support achievement in the course:
Moodle course page
AI Lab for practicing the practical aspects and solving the programming assignments.
Program announcements Facebook group</td></tr>
<tr><td>Additional information</td><td>None</td></tr>
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