

COURSE DESCRIPTIONS

Faculty	Science and Information Technology				
Department	IOT			NQF level	7
Course Title	Neural Networks and Deep Learning	Code	507402	Prerequisite	507305
Credit Hours	3	Theory	3	Practical	
Course Leader	Dr. Nashat Alrefai	email	N.Alrefai@jadara.edu.jo		
Lecturers	Dr. Nashat Alrefai	emails	N.Alrefai@jadara.edu.jo		
Lecture time	08.30-10.00 AM	Classroom	Blended learning/ F212		
Semester	3 rd	Production	2024	Updated	2026
Awards	Undergraduate level			Attendance	Fulltime
Type of Teaching	☐ Face to Face ☒ Blended ☐ Online				

Short Description

This course provides a comprehensive introduction to neural networks and modern deep learning techniques. Students will learn to design, train, and evaluate neural networks for tasks in artificial intelligence, including image analysis, natural language processing, and sequential data handling. The practical implementation using frameworks such as TensorFlow, Keras and PyTorch. The course combines theoretical foundations with hands-on implementation, culminating in a project where students apply these concepts innovatively.

Course Objectives

- Explain how neural networks learn using gradient-based optimization
- Build, train, and evaluate deep learning models
- Apply CNNs to image recognition and visual tasks
- Apply RNNs/Transformers to text and sequence data
- Implement regularization, normalization, and tuning strategies
- Use GPUs and modern DL frameworks
- Present a complete deep learning research project

Learning Outcomes

A. Knowledge - Theoretical Understanding

a1: Illustrate fundamental concepts and parameters of neural networks and deep learning. (K1)

B. Knowledge - Practical Application

a2: Apply concepts learned to build neural networks with multiple features and outputs using working code. (K3)

C. Skills - Generic Problem Solving and Analytical Skills		
b1: Analyze the performance of neural networks for various tasks. (S1)		
D. Skills - Communication, ICT, and Numeracy		
b2: Select TensorFlow and Keras for building deep learning neural networks. (S3)		
E. Competence: Autonomy, Responsibility, and Context		
c1: Construct deep learning models independently and apply them to real-world problems. (C1)		
Teaching and Learning Methods (TMs)		
TM1. ☒ Face to Face	TM2. ☐ Online (synchronous)	TM3. ☐ Online (asynchronous)
TM4. ☐ Brain Storming	TM5. ☒ Using Video	TM6. ☒ Discussions
Assessment Methods (AMs)		
AM1. ☐ Formative	AM2. ☒ Quiz	AM3. ☒ Assignment
AM5. ☐ Lab Test	AM6. ☒ Project	AM7. ☒ Presentation
AM9. ☒ Midterm	AM10. ☒ Final Exam	AM4. ☐ Homework AM8. ☐ Experiment

Course Contents					
Week	Hours	CLOs	Topics	Teaching & Learning Methods	Assessment Methods
1	3	a1, a2,	Introduction - History of neural networks - What is Deep Learning? - Applications and motivation - Machine Learning vs Deep Learning - Overview of Python + NumPy/PyTorch/TensorFlow/Keras	TM1, TM5, TM6	AM9, and AM10
2	3	a1, a2, b1, b2	Artificial Neurons - Binary classification applications - Evaluating classification models - Biological neurons: inspiration - Artificial neuron: Perceptron	TM1, TM5, TM6	AM2 AM9, and AM10
3	3	a1, a2, b1, b2	Perceptrons & Activation Functions - Single-layer networks - Sigmoid, ReLU, Tanh, Softmax - Loss functions	TM1, TM5	AM3, AM9, and AM10
4	3	a2, b1, b2	Multi-Layer Networks & Forward Propagation - MLP architecture - Vectorized computations - Training data and batching	TM1, TM5	AM9, and AM10
5	3	a2, b1, b2	Backpropagation & Gradient Descent - Chain rule derivatives - SGD, Momentum, Adam - Learning rate scheduling - Vanishing/exploding gradients	TM1, TM5	AM9, and AM10

6,7	6	a1, a2, b1, b2	Regularization & Optimization • Overfitting vs Underfitting • Dropout, Early stopping, BatchNorm • Weight initialization • Bias-variance tradeoff	TM1, TM5, TM6	AM9, and AM10
7	2	a1, a2, b1, b2	Midterm Exam		AM9
8	3	a1, a2, b1, b2	Convolutional Neural Networks • Convolution, pooling, padding, stride • Image datasets (MNIST, CIFAR-10) • Build a simple CNN	TM1, TM5, TM6	AM2 ,AM10
9	3	a1, a2, b1, b2	Advanced CNN Architectures • LeNet, AlexNet, VGG(16-19), ResNet • Transfer learning • Fine-tuning a pre-trained model	TM1, TM5, TM6	AM3, AM10
10	3	a1, a2, b1, b2	Sequence & Language Models RNNs, LSTM, GRU • Sequence modeling • Applications: time-series, speech, NLP • Sentiment analysis	TM1, TM5, TM6	AM10
11	3	a1, a2, b1, b2	Sequence & Language Models Attention & Transformers • Self-attention • Encoder-decoder • BERT / GPT / modern NLP • Text classification with transformers	TM1, TM5, TM6	AM10
12	3	a1, a2, b1, b2	Unsupervised and Generative Models: Autoencoders • Denoising, Variational Autoencoders • Feature learning • Anomaly detection	TM1, TM5, TM6	AM10
13	3	a1, a2, b1, b2	Unsupervised and Generative Models: Generative Adversarial Networks (GANs) • GAN architecture • Training instability and tricks • Simple GAN for image generation	TM1, TM5, TM6	AM10
14		b2	Real-World Applications • Computer Vision: CNN-based detectors • NLP: machine translation, text classification • Time-series forecasting	TM1, TM6	AM10
15		c1	Deep Learning and neural network Implementing Solution in TensorFlow and Keras (Student Project)	TM1, TM6	AM6 AM7
	2	a1, a2, b1, b2	Final Exam		AM10
Final Exam					

Infrastructure	
Textbook	"Neural Networks and Deep Learning" by Charu C. Aggarwal "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
References	"Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron "Pattern Recognition and Machine Learning" by Christopher M. Bishop
Required reading	- Research papers on recent advancements in neural networks and deep learning techniques. - Articles from reputable journals and conferences in the field of artificial intelligence.
Electronic materials	http://elearning.jadara.edu.jo
Other	- Online resources such as interactive coding platforms and forums for community discussion and support. - Practical exercises and coding assignments to reinforce learning and application of concepts. - Access to relevant software tools and libraries for implementing neural networks and deep learning models.

Assessment Method		Grade	a1	a2	b1	b2	c1
First (Midterm)		30	8	8	7	7	
Second (if applicable)							
Final Exam		40	5	5	10	10	10
Coursework		30					
Coursework assessment methods	Assignments						10
	Case study						
	Discussion and interaction						
	Group work activities (project)						5
	Lab tests and assignments						
	Presentations						5
	Quizzes		5	5			
Total		100	18	18	17	17	30

Plagiarism
Plagiarism is claiming that someone else's work is your own. The department has a strict policy regarding plagiarism and, if plagiarism is indeed discovered, this policy will be applied. Note that punishments apply also to anyone assisting another to commit plagiarism (for example by knowingly allowing someone to copy your code). Plagiarism is different from group work in which a number of individuals share ideas on how to carry out the coursework. You are strongly encouraged to work in small groups, and you will certainly not be penalized for doing so. This means that you may work together on the program. What is important is that you have a full understanding of all aspects of the completed program. In order to allow proper assessment that this is indeed the case, you must adhere strictly to the course work requirements as outlined above and detailed in the coursework problem description. These requirements are in place to encourage individual understanding, facilitate individual assessment, and deter plagiarism.