MODULE DESCRIPTION FORM

Module Information					
Module Title	**Neural Networks**			**Module Delivery**	
Module Type	**Core**			☑ Theory ☑ Lecture ☑ Lab ☑ Tutorial ☑ Practical ☐ Seminar	
Module Code	**AIE 415**				
ECTS Credits	**5**				
SWL (hr/sem)	**125 H/Sem.**				
Module Level	3		**Semester of Delivery**	6	
Administering Department	Artificial Intelligence Eng.		**College**	College of Engineering	
Module Leader	Firas Sabar Miftan		**e-mail**	firas@utq.edu.iq	
Module Leader's Acad. Title	Prof.		**Module Leader's Qualification**	Ph.D.	
Module Tutor	Zahraa Awad Ghani		**e-mail**	Zahraa.AwadGhani@alayen.edu.iq	
Peer Reviewer Name	Hasnaa Mohammad		**e-mail**		
Scientific Committee Approval Date			**Version Number**	1.0	

Relation with other Modules			
Prerequisite module	**NONE**	**Semester**	
Co-requisites module	**NONE**	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents	
Module Objectives	**Introduction to Neural Networks, Deep Learning Concepts, Artificial Neural Networks (ANN), Generative Artificial Intelligence (Generative AI), Perceptron Network, Multilayer Perceptron (MLP), Radial Basis Function (RBF) Networks, Recurrent Neural Networks (RNN), Activation Functions, Backpropagation, Gradient Descent, Supervised Learning, Overfitting, Bias (in Neural Networks).**

أ.م.د سعد كاظم ذياب

وزارة التعليم العالي والبحث العلمي
جامعة العين العراقية
كلية الهندسة
قسم الذكاء الاصطناعي

Module Learning Outcomes	Knowledge	A1	**A1.1** Define the fundamental concepts of Introduction to Neural Networks and explain their significance in modern intelligent systems. **A1.2** Describe the principles of Neural Networks and data-driven model development, highlighting the evolution toward advanced learning methods. **A1.3** Explain the structure and functioning of Artificial Neural Networks (ANN) and their role in computational intelligence. **A1.4** Discuss the foundations of Deep Learning (DL) and its impact on advanced representation learning. **A1.5** Introduce Generative Artificial Intelligence (Generative AI) and explain its applications in content generation and modeling. **A1.6** Describe the structure and learning mechanism of the **Perceptron Network** and its role in linear classification. **A1.7** Explain the architecture and operation of Multilayer Perceptron (MLP) and its capability to solve non-linear problems. **A1.8** Discuss the principles and applications of Radial Basis Function (RBF) Networks in classification and function approximation. **A1.9** Describe the structure and characteristics of Recurrent Neural Networks (RNN) in handling sequential data. **A1.10** Explain the purpose and mathematical properties of Activation Functions and their impact on learning performance. **A1.11** Describe the concept of Supervised Learning and its role in training neural network models. **A1.12** Explain the principles of Gradient Descent optimization and its function in minimizing loss functions. **A1.13** Discuss the Backpropagation algorithm and how it enables efficient weight adjustment in multilayer networks.
		A4	**A4.1** Demonstrate neural network training procedures using supervised datasets, including model building, training, and evaluation. **A4.2** Apply the Perceptron and Multilayer Perceptron models to solve classification and logical problems. **A4.3** Implement Radial Basis Function Networks for function approximation and pattern recognition tasks. **A4.4** Apply Recurrent Neural Networks in simple sequential or time-series modeling problems.

			A4.5 Compare different network architectures (Perceptron, MLP, RBF, RNN) based on accuracy and convergence behavior. **A4.6** Analyze the effects of learning rate and optimization parameters on Gradient Descent performance. **A4.7** Evaluate the impact of different Activation Functions on model accuracy and convergence speed. **A4.8** Implement Backpropagation in training multilayer neural networks and interpret the learning outcomes. **A4.9** Critically assess the suitability of neural network models for real-world AI and machine learning applications.
	Skills	B1	B.1.1 Function efficiently as an individual B.1.2 Function as a member of multidisciplinary and multicultural teams.
		B3	B.3.1 Acquire and apply new knowledge. B.3.2 Practice the strategies of searching for information in life – long self-learning
	Ethics	C3	C.3.1 Utilize contemporary technologies. C.3.2 Make use of codes of practice and standards, quality guidelines. C.3.3 Utilize health and safety requirements C.3.4 Show environmental issues and risk management principles.
Indicative Contents	**Unit 1**: Foundations of Artificial Intelligence and Neural Networks Artificial Intelligence, Machine Learning, Artificial Neural Networks, Deep Learning, Generative Artificial Intelligence, Neuron Model, Neural Network Applications, and Activation Functions. **[6 hours]** **Unit 2:** Feedforward Neural Networks and Learning Algorithms Perceptron Network, Multilayer Perceptron (MLP), Supervised Learning, Gradient Descent, and Backpropagation Algorithm. **[8 hours]** **Unit 3:** Advanced Neural Network Architectures and Performance Evaluation Radial Basis Function Network (RBF) Networks, Recurrent Neural Network (RNN), Practical Neural Network Training Examples, and Evaluation of Network Performance. **[6 hours]**		

Learning and Teaching Strategies	
Strategies	• Presentation • Interactive learning • Discussions • Brainstorming • Group Solving Problems • Problem-Based Learning • Self-learning

Student Workload (SWL) for 15 weeks			
Structured SWL (h/sem)	63	**Structured SWL (h/w)**	5.2
Unstructured SWL (h/sem)	62	**Unstructured SWL (h/w)**	4.8
Total SWL (h/sem)	125		

Module Evaluation

تقييم المادة الدراسية

		Time/Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment	**Quizzes**	2	10% (10)	5 and 10	A1
	Assignments	2	10% (10)	2, 4,6,8,10,12 and 14	A1
	Projects / Lab.	2	10% (10)	2, 4,6,8,10,12 and 14	A4, B1, B3, C3
	Report	1	10% (10)	13	A1, A4, B1, B3
Summative assessment	**Midterm Exam**	1hr	10% (10)	7	A1, A4
	Final Exam	3hr	50% (50)	15	A1, A4
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus) المنهاج الاسبوعي النظري		
	Material Covered	**Los**
Week 1	Introduction to Artificial Intelligence, Machine Learning, and Deep Learning	A1.1, A1.2, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2
Week 2	Artificial Neural Networks, Neuron Model, Neural Network Applications	A1.3, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2
Week 3	Activation Functions, Logic Gate Construction, Introduction to Perceptron Network	A1.6, A1.10, A4.1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2
Week 4	Multilayer Perceptron (MLP), Supervised Learning	A1.7, A1.11, A4.2, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2
Week 5	Gradient Descent and Backpropagation Algorithm	A1.12, A1.13, A4.6, A4.8, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2
Week 6	Radial Basis Function Network (RBF) Networks and Radial Functions	A1.8, A4.3, B1.1, B1.2, B3.1, B3.2, C3.1
Week 7	Recurrent Neural Network (RNN) and Sequential Modeling	A1.9, A4.4, B1.1, B1.2, B3.1, C3.1
Week 8	Practical Neural Network Training Examples and Performance Evaluation	A4.1–A4.4, B1.1, B1.2, B3.1, C3.1
Week 9	Generative Artificial Intelligence and Applications of Deep Neural Models	A1.5, A4.9, B1.1, B1.2, B3.1, C3.1
Week 10	Mid-term Exam	A1, A4
Week 11	Advanced Neural Network Techniques and Model Optimization	A1.7–A1.13, A4.3–A4.8, B1.1, B1.2, B3.1, C3.1
Week 12	Practical Applications and Case Studies in AI and Neural Networks	A4.1–A4.9, B1.1, B1.2, B3.1, C3.1
Week 13	Integrated Project / Hands-on Exercises	A4.1–A4.9, B1.1, B1.2, B3.1, C3.1
Week 14	Rubric Exam Preparatory week before the final Exam	A1, A4
Preparatory Week	Preparation for Final Exam	A1, A4

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر		
Week	**Material Covered**	**Los**
Week 1	Deep Learning Environment Setup: Python, NumPy, Pandas, TensorFlow/Keras, Matplotlib	A4.1, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2
Week 2	Neuron Model and Activation Functions Implementation	A4.1, A4.2, B1.1, B1.2, B3.1, B3.2, C3.1, C3.2
Week 3	Logic Gate Construction (AND, OR, XOR) using Perceptron & MLP	A4.1, A4.3, B1.1, B1.2, B3.1, C3.1
Week 4	Implementation of Multilayer Perceptron and Forward Propagation	A4.3, A4.4, B1.1, B1.2, B3.1, C3.1, C3.2
Week 5	Backpropagation Algorithm Implementation	A4.4, A4.5, B1.1, B1.2, B3.1, C3.1, C3.2
Week 6	Gradient Descent Optimization and Learning Rate Analysis	A4.5, A4.6, B1.1, B1.2, B3.1, C3.1, C3.2
Week 7	Neural Network Training on Sample Datasets and Performance Evaluation	A4.1, A4.6, B1.1, B1.2, B3.1, C3.1, C3.2
Week 8	Radial Basis Function Network Implementation	A4.2, A4.7, B1.1, B1.2, B3.1, C3.1, C3.2
Week 9	Recurrent Neural Network Implementation (Simple Sequential Task)	A4.4, A4.7, B1.1, B1.2, B3.1, C3.1, C3.2
Week 10	Mid-term Practical Evaluation	A4
Week 11	Hyperparameter Tuning and Model Optimization	A4.6–A4.8, B1.1, B1.2, B3.1, C3.1, C3.2
Week 12	Generative AI Model Demonstration (Simple Text or Image Task)	A4.9, B1.1, B1.2, B3.1, C3.1, C3.2
Week 13	Mini Project: Neural Network Model Development and Evaluation	A1–A4, B1.1, B1.2, B3.1, C3.1, C3.2
Week 14	Rubric Practical Exam Preparation for Final Exam	A1,A4

Learning and Teaching Resources مصادر التعلم والتدريس		
	Text	**Available in the Library?**
Required Texts	***Howard B. Demuth,*** *Mark H. Beale, Martin Hagan, Neural Network Design, 2014.*	YES
Recommended Texts	***James Loy****, Neural Network Projects with Python: The Ultimate Guide to Using Python to Explore the True Power of Neural Networks through Six Projects, Springer, 2019.*	NO
Websites	https://eng.alayen.edu.iq//colleges/e/42	

Grading Scheme مخطط الدرجات				
Group	**Grade**	التقدير	**Marks (%)**	**Definition**
Success Group (50 - 100)	**A** - Excellent	امتياز	90 - 100	Outstanding Performance
	B - Very Good	جيد جدا	80 - 89	Above average with some errors
	C – Good	جيد	70 - 79	Sound work with notable errors
	D - Satisfactory	متوسط	60 - 69	Fair but with major shortcomings
	E - Sufficient	مقبول	50 - 59	Work meets minimum criteria
Fail Group (0 – 49)	**FX** – Fail	راسب (قيد المعالجة)	(45-49)	More work required but credit awarded
	F – Fail	راسب	(0-44)	Considerable amount of work required

Note: Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.