MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

Module Information معلومات المادة الدراسية					
Module Title	Information Theory			**Module Delivery**	
Module Type	Core			☒ **Theory** ☐ **Lecture** ☐ **Lab** ☐ **Tutorial** ☐ **Practical** ☐ **Seminar**	
Module Code	ATU11608				
ECTS Credits	5				
SWL (hr/sem)	125				
Module Level	UGIII		**Semester of Delivery**	2	
Administering Department			**College**		
Module Leader			**e-mail**		
Module Leader's Acad. Title			**Module Leader's Qualification**		
Module Tutor	Name (if available)		**e-mail**		
Peer Reviewer Name	Nasir Hussein Selman		**e-mail**	Coj.nas@atu.edu.iq	
Scientific Committee Approval Date	01/05/2025		**Version Number**	1.0	

Relation with other Modules العلاقة مع المواد الدراسية الأخرى			
Prerequisite module	None	**Semester**	
Co-requisites module	None	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية	
Module Objectives أهداف المادة الدراسية	1- To provide a comprehensive understanding of the fundamental concepts of information theory. 2- To introduce students to the mathematical foundations of information, entropy, and channel capacity. 3- To equip students with the ability to design and analyze source coding and channel coding schemes. 4- To explore the applications of information theory in communication systems and related fields.
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	Upon successful completion of this course, students will be able to: • Define and calculate entropy, conditional entropy, and mutual information. • Understand and apply Shannon's theorems for source and channel coding. • Analyze the capacity of various communication channels. • Design and implement efficient source coding schemes (Huffman, Shannon-

	Fano). • Design and analyze linear block codes (Hamming, cyclic codes) for error detection and correction. • Apply the Kraft-McMillan inequality and understand uniquely decodable codes. • Understand and utilize Fano's Inequality. • Understand syndrome decoding. • Understand the applications of information theory.
Indicative Contents المحتويات الإرشادية	1- **Entropy and Mutual Information:** • This covers the fundamental measures of information: entropy (a measure of uncertainty), joint entropy (uncertainty of multiple variables), conditional entropy (uncertainty given another variable), and mutual information (amount of information shared between variables). Students will learn how to calculate these measures and understand their significance in quantifying information. 2- **Channel Capacity and Shannon's Theorems:** • This focuses on the theoretical limits of communication. Students will learn about the concept of channel capacity, which defines the maximum rate at which information can be reliably transmitted over a noisy channel. Shannon's source coding theorem and channel coding theorem will be covered, demonstrating the possibility of achieving these limits. 3- **Source Coding (Data Compression):** • This section deals with techniques for efficiently representing information sources. Students will learn about variable-length coding schemes like Huffman coding and Shannon-Fano coding, and the Kraft-McMillan inequality, which provides criteria for uniquely decodable codes. The goal is to minimize the average number of bits required to represent the source output. 4- **Channel Coding (Error Correction):** • This focuses on techniques for adding redundancy to transmitted data to enable error detection and correction. Students will learn about linear block codes (including Hamming codes and cyclic codes), Hamming distance, and decoding algorithms (especially syndrome decoding). This section emphasizes reliable communication in the presence of noise.

Learning and Teaching Strategies استراتيجيات التعلم والتعليم	
Strategies	The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, interactive tutorials and by considering types of simple experiments involving some sampling activities that are interesting to the students.

Student Workload (SWL) الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	48	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	77	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	**125**		

Module Evaluation
تقييم المادة الدراسية

		Time/Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment	Quizzes	2	10% (10)	5 and 10	LO #1, #2 and #10, #11
	Assignments	2	10% (10)	2 and 12	LO #3, #4 and #6, #7
	Projects /Siminar	1	10% (10)	Continuous	All
	Report	1	10% (10)	13	LO #5, #8 and #10
Summative assessment	Midterm Exam	2hr	10% (10)	7	LO #1 - #7
	Final Exam	3hr	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus)
المنهاج الاسبوعي النظري

	Material Covered
Week 1	General model of communication system.
Week 2	Information Source, Self Information, Entropy, Information Rate, Joint Entropy
Week 3 -4	Conditional Entropy and Mutual Information
Week 5-6	Communication Channel, Discrete Channel, Binary Symmetric Channel (BSC), Ternary Symmetric Channel (TSC), Lossless Channel, Deterministic Channel, Binary Erasure Channel (BEC), Noiseless Channels, Shannon's theorem, Channel Capacity (Discrete channel), Channel capacity of Symmetric channels, Channel capacity of Nonsymmetric channels, Cascading of Channel.
Week 7-8	Source Coding: Source coding of discrete sources, Fixed Length Code, Variable Length Code, Minimum Code Length, Code Efficiency and Redundancy
Week 9	Average Code Length, Requirements for a useful symbol code: Uniquely Decodable, Prefix Code, Kraft-McMillan Inequality.
Week 10	**Mid -Term Exam**
Week 11	Shannon-Fano code, Huffman Code, Huffman vs. Shannon.
Week 12-13	Channel coding: error detecting codes; error correcting codes; systematic and nonsystematic codes; Hamming distance; Hamming bound; Hamming weight; linear block codes; encoding of linear block codes; decoding of linear block codes; cyclic codes; systematic and nonsystematic codes; encoding with an (n-k) stage shift register; encoding with a k-stage shift register; syndrome calculation and error detection;
Week 14	Channel Coding: Hamming Codes
Week 15	Channel Coding: Cyclic Codes
Week 16	**Final Exam**

Learning and Teaching Resources
مصادر التعلم والتدريس

	Text	Available in the Library?
Required Texts	"Elements of Information Theory" by Thomas M. Cover and Joy A. Thomas	No
Recommended Texts	• "Information Theory, Inference, and Learning Algorithms" by David J.C. MacKay • "A First Course in Information Theory" by Raymond W.	No

	Yeung	
Websites		

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.