MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

		Module Information معلومات المادة الدراسية			
Module Title		**Digital signal processing**			**Mod**
Module Type		**B**			
Module Code		**DISP312**			
ECTS Credits		**6**			
SWL (hr/sem)		**150**			
Module Level	UG1			**Semester of Delive**	
Administering Department	Type Dept. Code	**College**		Type	
Module Leader	Dr.Layth Kamil	**e-mail**	layth.k.adday@uotechnology.edu.iq	E-mail	
Module Leader's Acad. Title	Assistant Professor			**Module Leader's C**	
Module Tutor	Name (if available)	**e-mail**		E-mail	
Peer Reviewer Name	1-Dr.Ibrahim Adel 2-Dr. Saddam Kamil 3-Dr.Sahar Adil 4-Dr.Alza Abduljabbar 5-Dr.Nibras Sabih 6- Dr. Taha Raad	**e-mail**	1/Ibrahim.a.almotairi@uotechnology.edu.iq 2/saddam.k.alwane@uotechnology.edu.iq 3/ sahar.a.abboud@uotechnology.edu.iq 4/Alza.a.mahmood@uotechnology.edu.iq 5/ nibras.s.abbas@uotechnology.edu.iq 6/taha.alsheikhly@gmail.com	E-mail	
Scientific Committee Approval Date	**1 / 4 /2026**			**Version Number**	

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	This module provides students with a strong foundation in digital signal processing (DSP) principles and their implementation on DSP hardware. The course covers DSP architectures, algorithms, real-time signal processing, and applications in communication, audio, and image processing. This module aims to equip students with the necessary knowledge and skills to understand, analyze, and implement digital signal processing techniques using modern DSP processors. The specific objectives of the module are to: 1) Introduce DSP Fundamentals • Explain the basic principles of digital signal processing and its advantages over analog processing. • Provide an understanding of discrete-time signals, systems, and transforms (Z-transform, Fourier transform, etc.). 2) Develop Mathematical and Theoretical Understanding • Teach students how to analyze and design digital filters (FIR and IIR). • Explore convolution, correlation, and spectral analysis techniques. • Introduce the Fast Fourier Transform (FFT) and its applications. 3) Understand DSP Architectures and Hardware • Explain the architecture, features, and programming models of modern DSP processors. • Compare different DSP architectures, such as Harvard vs. Von Neumann and fixed-point vs. floating-point processors. 4) Implement DSP Algorithms • Provide hands-on experience in implementing signal processing algorithms on DSP platforms. • Develop skills in real-time signal processing applications. • Optimize DSP code for performance and efficiency. 5) Apply DSP in Real-World Scenarios • Introduce applications in audio and speech processing, image processing, communications, and biomedical signals.

	• Enable students to develop DSP-based projects using industry-standard tools like MATLAB and Code Composer Studio. 6) Enhance Problem-Solving and Practical Skills • Encourage students to design and test their own DSP systems. • Improve critical thinking and analytical skills through case studies and project-based learning.
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	Upon successful completion of this module, students should be able to: 1. Understand the fundamental concepts of digital signal processing. 2. Analyze discrete-time signals and systems using mathematical models. 3. Implement DSP algorithms for filtering, convolution, and Fourier analysis. 4. Understand the architecture and operation of modern DSP processors. 5. Develop real-time signal processing applications on DSP hardware. 6. Optimize DSP programs for performance and efficiency.
Indicative Contents المحتويات الإرشادية	Indicative content includes the following. ❖ Introduction to DSP • Overview of Digital Signal Processing • Comparison of Analog and Digital Processing • Applications of DSP ❖ Mathematical Foundations • Discrete-time signals and systems • Z-transform and discrete Fourier transform (DFT) • Fast Fourier Transform (FFT) ❖ Digital Filters • FIR and IIR filter design • Windowing techniques • Frequency response analysis ❖ DSP Architectures and Processors • General-purpose vs. DSP-specific processors • Harvard vs. Von Neumann architecture • Fixed-point vs. Floating-point processors ❖ Programming and Implementation • Assembly and C programming for DSPs • Code optimization techniques • Real-time constraints and challenges ❖ Applications of DSP • Audio and speech processing • Image and video processing • Biomedical signal processing

Learning and Teaching Strategies استراتيجيات التعلم والتعليم

Strategies	to ensure effective understanding and application of Digital Signal Processing (DSP) concepts, the following teaching and learning strategies can be implemented: 1. Conceptual Understanding Before Computation • Start with intuitive explanations before introducing complex mathematics. • Use real-world analogies (e.g., audio equalizers for filtering concepts). • Visualize signals and transformations using graphs and animations. 2. Hands-on Practical Approach • Integrate MATLAB, Python (SciPy), or Octave for practical simulations. • Provide real-world audio/image processing examples. • Implement DSP algorithms on actual DSP hardware (e.g., Texas Instruments processors). 3. Active Learning Techniques • Conduct group discussions on real-world DSP applications. • Implement flipped classrooms, where students study theory at home and solve problems in class. • Use problem-based learning (PBL)—assign real-world DSP problems for students to solve. 4. Incremental Complexity Approach • Start with basic signals and operations before moving to advanced topics. • Break down complex concepts like Fourier Transform and DSP architectures into smaller, manageable parts. • Reinforce learning through weekly quizzes and coding exercises. 5. Real-Time Signal Processing Applications • Encourage real-time DSP projects (e.g., speech recognition, noise reduction). • Use software-defined radio (SDR) for real-world DSP in communications. • Provide industry case studies (e.g., biomedical signal processing in ECG analysis). 6. Blended Learning & Online Resources • Use online platforms like Courser, edX, and MIT OpenCourseWare. • Encourage students to engage in DSP-related forums (e.g., DSPRelated.com, StackExchange). • Utilize YouTube tutorials for additional DSP visualization. 7. Assessment & Feedback Strategies • Use progressive assessments: small projects, lab work, and exams. • Provide immediate feedback using auto-graded coding assignments.

	• Encourage students to maintain a DSP project portfolio for practical learning.

Student Workload (SWL) الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	100	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	6
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	50	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	3
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	**150**		

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	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	Introduction to Digital Signal Processing • Overview of DSP and its applications • Comparison of analog vs. digital processing • Discrete-time signals. The quantization and sampling of continuous-time signals, aliasing.
Week 2	Discrete-Time Signals and Systems • Convolution and correlation. • Basic signal operations (shifting, scaling, folding) • Classification of signals (periodic, aperiodic, even, odd) • Discrete-time LTI systems: Impulse response, difference equations, causality, stability, etc.
Week 3	Z-Transform and Its Applications • Definition and properties of the Z-transform • Region of convergence (ROC) and inverse Z-transform • System analysis using the Z-transform
Week 4	• Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) • Fourier representation of discrete-time signals • Properties of the DFT • Efficient computation using FFT
Week 5	• FFT algorithms. • Radix-2 and Radix-4 • Use of FFT algorithms in Linear Filtering and correlation
Week 6-7	Digital Filters – FIR Filters • Introduction to digital filtering • Design of Finite Impulse Response (FIR) filters • Structure for FIR systems
Week 7-8	Symmetric & Anti-symmetric FIR filters • Linear phase filter. • Windowing techniques – rectangular, triangular, Blackman and Kaiser windows.
Week 9	Midterm Exam & Review
Week 10-11	Digital Filters – IIR Filters • Infinite Impulse Response (IIR) filter characteristics • Design using Butterworth, Chebyshev, and Elliptic methods • Impulse Invariance and Bilinear Transform methods
Week 12	DSP Processor Architectures • General-purpose vs. DSP-specific processors • Harvard vs. Von Neumann architecture • Fixed-point vs. floating-point processors
Week 13	Introduction to DSP Programming • Programming models for DSP processors • Assembly vs. high-level programming (C, MATLAB) • Code Composer Studio and other development tools
Week 14	Real-Time Signal Processing • Real-time constraints and challenges • Buffering and sampling rate considerations • Implementation of real-time filtering and FFT
Week 14	Audio and Speech Processing Applications • Basics of audio signal processing • Speech recognition and synthesis • Echo cancellation and noise reduction techniques
Week 15	Project Implementation & Case Studies

	• Hands-on project development using DSP hardware/software • Industry case studies and emerging trends in DSP • Student presentations and discussions
Week 16	Final Exam & Course Wrap-Up • Review session for the final exam • Final examination

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر	
	Material Covered
Week 1	**Lab 1: Generation of discrete and continuous time Signals** ● **Unit Impulse** ● **Unit step** ● **Ramp** ● **Exponential** ● **Sawtooth**
Week 2	**Lab 2: Generate sum of two sinusoidal Signals.**
Week 3	**Lab 3: Linear and Circular Convolutions between two given signals.**
Week 4	**Lab 4: Autocorrelation for the given sequence and Cross Correlation between two given signals.**
Week 5	**Lab 5: Defining Transfer Function** ● **Continuous-time systems** ● **Discrete-time systems**
Week 6	**Lab 6: Continuous-time LTI Models and Discrete-time LTI Models.**
Week 7	**Lab 7: Introduction to Simulink.**
Week 8	**Lab 8: N-point DFT and N-point IFFT of a given Sequence.**
Week 9	**Lab 9: Design and implementation of IIR Butterworth (LP/HP) filter.**
Week 10	**Lab 10: Design and implementation of IIR Chebyshev (LP/HP) filter.**
Week 11	**Lab 11: Design and implementation of FIR filter with (LP/HP) filter using any three windowing techniques. Plot its magnitude and phase responses**
Week 12	**Lab 12: Filter (IIR and FIR) frequency response by using Filter design and Analysis Tool.** ● **Butterworth** ● **Chebyshev** ● **Other filters**
Week 13	**Week 13: Sampling Theorem and Quantization**

Week 14	**Lab 14: Decimation and Interpolation for the given signal**
Week 15	**Lab 15: Applications of DSP (Speech Processing).**

Learning and Teaching Resources
مصادر التعلم والتدريس

	Text	Available in the Library?
Required Texts	• "Digital Signal Processing: Principles, Algorithms, and Applications" – John G. Proakis, Dimitris G. Manolakis • "Understanding Digital Signal Processing" – Richard G. Lyons • "DSP First: A Multimedia Approach" – James H. McClellan, Ronald W. Schafer, Mark A. Yoder	Yes
Recommended Texts	• "Digital Signal Processing: A Practical Guide for Engineers and Scientists" – Steven W. Smith • "Embedded Signal Processing with the Micro Signal Architecture" – Woon-Seng Gan, Sen M. Kuo	yes
Websites	• https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-341-discrete-time-signal-processing-fall-2005/ • https://www.coursera.org/courses?query=digital%20signal%20processing • https://www.mathworks.com/products/dsp-system.html	

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.