MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

Module Information معلومات المادة الدراسية					
Module Title	**Data Storage Engineering**			**Module Delivery**	
Module Type	**Elective**			☒ **Theory** ☒ **lab**	
Module Code	**IT4104**				
ECTS Credits	**6**				
SWL (hr/sem)	**150**				
Module Level	UGIIII		**Semester of Delivery**	1	
Administering Department	Information Technology		**College**	College of Computer Science and Information Technology	
Module Leader	Karrar Sadiq Mohsin		**e-mail**	karar.sadeq@uowa.edu.iq	
Module Leader's Acad. Title	Assistant Lecturer		**Module Leader's Qualification**	**MSc**	
Module Tutor	Karrar Sadiq Mohsin		**e-mail**	karar.sadeq@uowa.edu.iq	
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Scientific Committee Approval Date	01/09/2026		**Version Number**	V1.0	

Relation with other Modules العلاقة مع المواد الدراسية الأخرى			
Prerequisite module	IT112	**Semester**	2
Co-requisites module	-	**Semester**	-

Department Head Approval **Dean of the College Approval**

Module Aims, Learning Outcomes and Indicative Contents أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية	
Module Aims أهداف المادة الدراسية	1. Provide students with a comprehensive understanding of various data storage technologies and architectures. 2. Familiarize students with the principles of operation and components of different storage systems, such as Hard Disk Drives (HDDs), Solid State Drives (SSDs), Network-Attached Storage (NAS), Storage Area Networks (SAN), and cloud storage. 3. Explore the performance considerations, benchmarking techniques, and best practices associated with different storage systems. 4. Develop students' skills in configuring and administering storage systems, including RAID, NAS, SAN, and cloud storage. 5. Introduce students to data backup and recovery strategies, including the implementation of disaster recovery plans. 6. Provide students with knowledge of data deduplication and compression techniques to optimize storage utilization. 7. Familiarize students with storage virtualization concepts and the benefits and challenges associated with implementing virtualized storage environments. 8. Raise awareness about data storage security threats, access control mechanisms, and encryption techniques. 9. Introduce students to emerging trends and advancements in data storage technologies, such as NVMe and software-defined storage. 10. Enhance students' problem-solving and analytical skills through hands-on lab activities that reinforce theoretical concepts. 11. Develop students' ability to critically evaluate storage system requirements and select appropriate solutions for specific use cases. 12. Foster an understanding of the importance of performance optimization, management, and monitoring in data storage environments. 13. Provide students with real-world case studies and applications to illustrate the practical implementation of data storage systems.
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	Knowledge and Understanding: 1. Demonstrate a comprehensive understanding of various data storage technologies, architectures, and components. 2. Explain the principles of operation and performance characteristics of different storage systems, including HDDs, SSDs, NAS, SAN, and cloud storage. 3. Understand the concepts and techniques related to RAID configurations, data backup and recovery, data deduplication, storage virtualization, and data storage security.

	Cognitive Skills: 4. Analyze storage system requirements and select appropriate solutions based on specific use cases and performance considerations. 5. Evaluate and compare the advantages, disadvantages, and trade-offs associated with different data storage technologies. 6. Apply problem-solving and critical-thinking skills to design and optimize storage systems for efficient data management and retrieval. Practical Skills: 7. Configure and administer storage systems, including RAID arrays, NAS devices, SAN solutions, and cloud storage services. 8. Implement data backup and recovery strategies, including disaster recovery plans. 9. Utilize data deduplication and compression techniques to optimize storage utilization. 10. Deploy and manage virtualized storage environments using storage virtualization technologies. 11. Implement access controls, authentication mechanisms, and encryption techniques to ensure data storage security. 12. Utilize performance monitoring and management tools to optimize the performance of data storage systems. Transferable Skills: 13. Communicate effectively, both orally and in writing, about data storage concepts, technologies, and solutions. 14. Work collaboratively in a team environment, demonstrating effective teamwork and communication skills. 15. Adapt and apply knowledge and skills acquired in the module to address real-world data storage challenges and emerging trends.
Indicative Contents المحتويات الإرشادية	1. Introduction to Data Storage Systems: • Overview of data storage technologies and architectures • Types of data storage systems (HDDs, SSDs, NAS, SAN, cloud storage) • Key concepts and terminology in data storage 2. Hard Disk Drives (HDD): • Principles of operation and components of HDDs • HDD interfaces and protocols (e.g., SATA, SAS) • Performance considerations, including disk RPM, cache size, and seek time • HDD benchmarking and performance optimization techniques 3. Solid State Drives (SSD): • Introduction to flash memory technology • SSD architecture and operation, including NAND and NOR flash • Wear-leveling and garbage collection algorithms • Advantages and disadvantages of SSDs compared to HDDs

4. RAID (Redundant Array of Independent Disks):
   - RAID levels (e.g., RAID 0, RAID 1, RAID 5, RAID 6) and their characteristics
   - RAID implementation strategies, including hardware and software RAID
   - Performance considerations, fault tolerance, and data protection in RAID configurations
5. Network-Attached Storage (NAS):
   - NAS concepts and components, including NAS devices and file servers
   - NAS protocols (e.g., NFS, CIFS/SMB) and file sharing mechanisms
   - Configuration, administration, and security of NAS solutions
6. Storage Area Networks (SAN):
   - SAN concepts, architecture, and components (e.g., Fibre Channel switches, HBAs)
   - Fibre Channel technology, protocols, and zoning
   - SAN implementation, management, and performance optimization
7. Cloud Storage:
   - Overview of cloud storage services (e.g., Amazon S3, Azure Blob Storage)
   - Cloud storage architectures, including object storage and block storage
   - Cloud storage deployment models and considerations, such as security and data privacy
8. Data Backup and Recovery:
   - Backup strategies and methodologies (e.g., full backup, incremental backup, differential backup)
   - Backup technologies, tools, and scheduling
   - Disaster recovery planning and implementation, including offsite backup and replication
9. Data Deduplication and Compression:
   - Principles and techniques of data deduplication
   - Compression algorithms and methods (e.g., gzip, LZ77)
   - Integration of deduplication and compression in storage systems for improved efficiency
10. Storage Virtualization:
    - Concepts and benefits of storage virtualization
    - Virtualization technologies and solutions (e.g., VMware, OpenStack)
    - Configuration and management of virtual storage pools and virtual storage volumes
11. Data Storage Security:
    - Security threats and risks to data storage systems
    - Access control mechanisms, authentication, and authorization
    - Encryption techniques for data-at-rest and data-in-transit, data integrity mechanisms
12. Emerging Trends in Data Storage:
    - Overview of emerging storage technologies (e.g., NVMe, persistent memory)

	• Software-defined storage (SDS) and hyper-converged infrastructure (HCI) • Future directions and advancements in data storage, such as shingled magnetic recording (SMR) and non-volatile memory express (NVMe)

Learning and Teaching Strategies استراتيجيات التعلم والتعليم	
Strategies	1. Lectures: Traditional classroom lectures can be used to introduce theoretical concepts, provide foundational knowledge, and explain complex topics related to data storage systems. Lectures can incorporate multimedia presentations, case studies, and real-world examples to illustrate concepts effectively. 2. Practical Lab Sessions: Hands-on lab sessions are crucial for students to gain practical experience in configuring and managing different data storage systems. These sessions allow students to apply the theoretical knowledge gained in lectures to real-world scenarios. Lab activities can include setting up RAID arrays, configuring NAS and SAN solutions, performing performance benchmarking, and practicing data backup and recovery procedures. 3. Group Discussions: Encourage group discussions and interactive sessions to facilitate student engagement and collaboration. These discussions can focus on analyzing case studies, solving problems related to data storage, and sharing experiences and insights. Group discussions promote critical thinking, problem-solving, and communication skills. 4. Practical Demonstrations: Conduct practical demonstrations to showcase the setup and configuration of various storage systems. These demonstrations can be conducted by the instructor or through video tutorials, providing students with a visual understanding of the concepts and procedures involved. 5. Guest Lectures and Industry Experts: Invite guest lecturers, industry experts, or practitioners from the field of data storage to share their experiences, insights, and industry trends. These sessions provide students with real-world perspectives and industry-relevant knowledge. 6. Research Assignments and Projects: Assign research assignments or projects that require students to explore emerging trends, conduct in-depth investigations, and present their findings. This encourages independent learning, research skills, and critical analysis of data storage technologies and practices. 7. Assessments: Utilize a variety of assessment methods, such as quizzes, exams, practical assessments, and project presentations, to evaluate student understanding and application of data storage concepts. Assessments should be aligned with the module's learning outcomes and provide students with opportunities to demonstrate their knowledge, skills, and abilities.

	8. Online Resources and Learning Platforms: Utilize online resources, interactive learning platforms, and e-learning materials to supplement classroom learning. This can include access to relevant textbooks, online articles, video tutorials, and simulations that provide students with additional learning materials and opportunities for self-paced learning. 9. Field Visits and Industry Visits: Organize field visits or industry visits to data centers, storage facilities, or companies specializing in data storage. These visits expose students to real-world data storage environments and industry practices, allowing them to observe and interact with professionals in the field. 10. Continuous Feedback and Support: Provide regular feedback and support to students throughout the module. This can include individualized feedback on assignments, lab performance, and progress. Encourage students to seek clarification, ask questions, and provide opportunities for one-on-one discussions.

Student Workload (SWL)

الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا

Structured SWL (h/sem) الحمل الدرا يس المنتظم للطالب خلال الفصل	65	**Structured SWL (h/w)** الحمل الدرا يس المنتظم للطالب أسبوعيا	5
Unstructured SWL (h/sem) الحمل الدرا يس غ ري المنتظم للطالب خلال الفصل	85	**Unstructured SWL (h/w)** الحمل الدرا يس غ ري المنتظم للطالب أسبوعيا	6
Total SWL (h/sem) الحمل الدرا يس الك يل للطالب خلال الفصل	150		

Module Evaluation

تقييم المادة الدراسية

		Time/Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment	**Quizzes**	4	2 (8%)	all	1,5
	Onsite Assignments	1	2 (2%)	all	1,5
	Projects	1	5 (5%)	all	1,5
	Lab	5	3 (15%)	all	1,2,3,4
	Home Work	5	2 (10%)	all	1,5
Summative assessment	**Midterm Exam**	2hr	10% (10)	7	
	Final Exam	3hr	50% (50)	16	

Total assessment	100% (100 Marks)		

Delivery Plan (Weekly Syllabus)

المنهاج الاسبوعي النظري

	Material Covered
Week 1	Introduction to Data Storage Systems
Week 2	Hard Disk Drives (HDD) Fundamentals
Week 3	Solid State Drives (SSD) Technology
Week 4	RAID Concepts and Implementations
Week 5	Network-Attached Storage (NAS) Administration
Week 6	Storage Area Networks (SAN) Configuration
Week 7	Cloud Storage Architectures and Services
Week 8	Data Backup and Recovery Strategies
Week 9	Data Deduplication and Compression Techniques
Week 10	Storage Virtualization and Software-Defined Storage
Week 11	Data Storage Security and Access Controls
Week 12	Emerging Trends in Data Storage Technologies
Week 13	Performance Optimization in Data Storage Systems
Week 14	Data Storage Management and Monitoring
Week 15	Case Studies and Real-World Applications in Data Storage

Delivery Plan (Weekly Lab. Syllabus)

المنهاج الاسبوعي للمختبر

	Material Covered
Week 1	Introduction to Data Storage Systems Lab
Week 2	HDD Performance and Benchmarking Lab
Week 3	SSD Architecture and Operation Lab
Week 4	RAID Configuration and Performance Lab
Week 5	NAS Configuration and Administration Lab
Week 6	SAN Implementation and Fibre Channel Lab
Week 7	Cloud Storage Deployment Lab

Week 8	Backup and Recovery Strategies Lab
Week 9	Data Deduplication and Compression Lab
Week 10	Storage Virtualization Lab
Week 11	Data Storage Security Lab
Week 12	Emerging Trends in Data Storage Lab
Week 13	Performance Optimization Lab
Week 14	Data Storage Management and Monitoring Lab
Week 15	Case Studies and Real-World Applications Lab

Learning and Teaching Resources مصادر التعلم والتدريس		
	Text	**Available in the Library?**
Required Texts	Title: "Data Storage Networking: Real World Skills for the CompTIA Storage+ Certification and Beyond" Author: Nigel Poulton	No
Recommended Texts		No
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.