Jordan University of Science & Technology

Faculty of Computer & Information Technology

Department Of Computer Information Systems

Curriculum for the Bachelor Degree

In

Data Science

2022

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Vision:

To stand among the pioneers in developing and creating transformational scholars and achievers who are qualified to create and maintain a successful business.

Mission:

Our mission is to nurture a world-class society of faculty and scholars that are devoted to pioneering scientific education and research. A task done via the creation and dissemination of knowledge through collaborative associations

Objectives:

The Data Science B.Sc. program has the following program educational objectives (PEOs):

1. offer a path for scholars from diverse disciplines to fast transition to data science careers.
2. enable established computing professionals to improve development skills and technical management.
3. prepare graduates to utilize data science practice and skills for dissemination and knowledge discovery to assist decision-makers and researchers in attaining organizational goals.
4. create entrepreneurs, business professionals, and innovators who will lead the growth of the next inception information systems.

Outcomes:

The graduates of the program of Data Science will have the ability to:

1. Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
2. Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
3. Communicate effectively in a variety of professional contexts.
4. Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
5. Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.

6. Apply theory, techniques, and tools throughout the data science lifecycle and employ the resulting knowledge to satisfy stakeholders' needs.

Jordan University of Science and Technology

Study Plan for the Data Science Program 2022

A Bachelor of Science (B.Sc.) degree in Data Science at Jordan University Of Science And Technology is awarded in accordance with the statute stated by JUST regulations for B.Sc. awarding issued by the Dean's Council based on the adjusted 1987 law for awarding scientific degrees and certifications at JUST after completing (132) credit hours successfully.

Table 1: Credit Hours Distribution for Data Science Major

Requirements	Compulsory	Elective	Total
University Requirements	16	9	25
Faculty Requirements	24	0	24
Department Requirements	71	12	83
Total	**111**	**21**	**132**

1.University Requirements (25 CHs):

A) University Compulsory Requirements (16 CHs):

B) University Elective Requirements (9 CHs):

2. Faculty Requirements (24 CHs) as in table (2):

Table 2: Faculty Compulsory Requirements

Course Number	Course Title	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
MATH 101	Calculus I	3	3	0	-
MATH 102	Calculus 2	3	3	0	Passing MATH 101
MATH 241	Discrete Mathematics	3	3	0	-
CS 101	Introduction to Programming	3	3	0	CIS 99 or Concurrent
CS 211	Data Structures	3	3	0	Passing SE112 + concurrent with Math 241
SE 103	Introduction to Information Technology	3	3	0	Concurrent with CS 101
SE 112	Introduction to Object-Oriented Programming	3	3	0	Passing CS 101
CIS 221	Fundamentals of Database Systems	3	3	0	CS 211

3. Department Requirements (83 CH) classified as:

A) Department compulsory requirements (71 CH) as in table (3):

Table 3: Department Compulsory Requirements

Course Number	Course Title	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
MATH 140	Elements of Linear Algebra	3	3	0	MATH 101
MATH 233	Probability & Statistics (for computer sciences students)	3	3	0	MATH 102
CIS 201	Introduction to Web Design	1	0	3	SE 112
CIS 203	Communication and Professional Ethics	2	2	0	-
SE230	Fundamentals of Software Engineering	3	3	0	DS271
DS101	Fundamentals of Data Science	3	3	0	-
DS110	Programming for Data Science (1)	3	3	0	-
DS111	Programming for Data Science (2)	3	3	0	DS110
DS230	Machine Learning (1)	3	3	0	DS111 and DS101
DS231	Machine Learning (2)	2	2	0	DS230
DS271	Algorithms	3	3	0	DS111
DS272	Fundamentals of AI	3	3	0	DS230
DS321	Big Data	3	3	0	CIS221
DS330	Deep Learning	3	3	0	DS231
DS342	Computer Networks	3	3	0	DS271
DS360	Information Security	3	3	0	DS231
DS372	Data Engineering and Analysis	3	3	0	DS231
DS395	Practical Training	3	0	6	Complete 90 credit hours
DS410	Internet Programming	3	3	0	DS360
DS450	Natural Language Processing	3	3	0	DS330

DS451	Information Retrieval	3	3	0	DS330
DS452	Data Visualization and Exploration	3	3	0	DS330
DS470	Operating Systems	3	3	0	DS342
DS471	Cloud Computing	3	3	0	DS470
DS480	Graduation Project (1)	1	1	0	Complete 90 credit hours
DS481	Graduation Project (2)	2	2	0	DS480

B) Department Elective Requirements (12 CH)* as in table (4):

Table 4: Department Elective Requirements

Course Number	Course Title	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
DS420	Data Warehousing	3	3	0	DS321
DS422	NewSQL Databases	3	3	0	DS321
DS430	Security Analytics	3	3	0	DS360
DS432	Data Mining	3	3	0	DS330
DS439	Information Governance	3	3	0	DS231
DS440	IoT Data Analytics	3	3	0	DS231
DS453	Computer Vision	3	3	0	DS372
DS454	Project Management	3	3	0	DS372
DS455	Computer Architecture and Organization	3	3	0	DS271
DS458	Business Analytics	3	3	0	DS231
DS472	Parallel and Distributed Computing	3	3	0	DS231
DS483	Health Data Analytics	3	3	0	DS231
DS484	Probabilistic Graphical Models	3	3	0	DS330
DS459	E-Marketing Analytics	3	3	0	DS330
DS491	Special Topics for Data Science (1)	1	1	0	Dept. Approval
DS492	Special Topics for Data Science (2)	2	2	0	Dept. Approval
DS493	Special Topics for Data Science (3)	3	3	0	Dept. Approval
-	Any CIT faculty course 400 or above (no more than 6 C.H)	-	-	-	Dept. Approval

* Student may select at most (6 CHs) from other CIT departments upon department approval.
* Student may be waived from up to (6 CHS) upon department approval If the student obtains international certificates.

Course Numbering Convention:

Symbol	**DS** indicates data science
Number	Consists of three digits
Ones	Course sequence number within subject area
Tens	**Course subject:**
0	Basic Principles
1	Programming
2	Database
3	Information systems
4	Networks
5	Applications
6	Information Security
7	Systems and Software
8	Miscellaneous
9	Special Topics and Training
Hundreds	**Course level:**
1	First year
2	Second year
3	Third year
4	Fourth year

Guidance Plan

1st Year

Semester 1

Course Number	Course Name	Credits Hours	Prerequisite
CS101	Introduction to Programming	3	CIS 099 or concurrent
SE103	Introduction to Information Technology	3	Concurrent with CS101
DS101	Fundamentals of Data Science	3	-
DS110	Programming for Data Science (1)	3	-
Math101	Calculus I	3	-
Total		**15**	

Semester 2

Course Number	Course Name	Credits Hours	Prerequisite
HSS110	Leader and Social responsibility	3	
MATH140	Elements of linear algebra	3	MATH 101
SE112	Introduction to Object-oriented Programming	3	Passing CS101
Math102	Calculus 2	3	Passing MATH101
DS111	Programming for Data Science (2)	3	DS110
Total		**15**	

2nd Year

Semester 1

Course Number	Course Name	Credits Hours	Prerequisite
MATH241	Discrete Mathematics	3	-
ARB102	Communication Skills In Arabic	3	-
CS211	Data Structures	3	Passing SE112 + concurrent with Math 241
DS230	Machine Learning (1)	3	DS111 and DS101
CIS203	Communication and Professional Ethics	2	-
LG101	Communication Skills In English	3	Passing LG 99 or pass English exam with 50%
Total		**17**	

Semester 2

Course Number	Course Name	Credits Hours	Prerequisite
LG 103	Life Skills	2	-
MATH 233	Probability & Statistics (for computer sciences students)	3	MATH 102
DS272	Fundamentals of AI	3	DS230
CIS201	Introduction to Web Design	1	SE112
DS271	Algorithms	3	DS111
CIS221	Fundamentals of Database Systems	3	CS211
DS231	Machine Learning (2)	2	DS230
Total		**17**	

3rd Year

Semester 1

Course Number	Course Name	Credits Hours	Prerequisite
MS 100	Military Sciences	3	-
DS321	Big Data	3	CIS221
DS330	Deep Learning	3	DS231
	Dept. Elective	3	-
	Univ. Elective	3	-
Total		**15**	

Semester 2

Course Number	Course Name	Credits Hours	Prerequisite
DS342	Computer Networks	3	DS271
SE230	Fundamentals of Software Engineering	3	DS271
DS372	Data Engineering and Analysis	3	DS231
DS360	Information Security	3	DS231
HSS119	Entrepreneurship and Innovation	2	-
	Univ. elective	3	-
Total		**17**	

Summer Semester

Course Number	Course Name	Credits Hours	Prerequisite
DS395	Practical Training	3	Complete 90 credit hours
Total		**3**	

4th Year

Semester 1

Course Number	Course Name	Credits Hours	Prerequisite
DS450	Natural Language Processing	3	DS330
DS451	Information Retrieval	3	DS330
DS470	Operating Systems	3	DS342
DS480	Graduation project (1)	1	Complete 90 credit hours
	Dept. elective	3	-
	Univ. elective	3	-
Total		**16**	

Semester 2

Course Number	Course Name	Credits Hours	Prerequisite
DS471	Cloud Computing	3	DS470
DS452	Data Visualization and Exploration	3	DS330
DS410	Internet Programming	3	DS360
DS481	Graduation Project (2)	2	DS480
	Dept. Elective	3	-
	Dept. Elective	3	-
Total		**17**	

Description of Courses

DS101: Fundamentals of Data Science (3C=3H+0L)
Prerequisite: None
This course provides students with key concepts in data science. Specific topics include: definition of data science and its relationships with other fields; importance of data science and its driving forces; data acquisition and exploration; data profiling; data cleaning; data quality; feature selection taking into consideration structured and unstructured data; model selection (including data sampling, split methods between training data and test data, and overfitting); result analysis and visualization of data and results.

DS110: Programming for Data Science (1) (3C=3H+0L)
Prerequisite: None
This course introduces student to programming and problem solving using Python. Topics include data types, procedures and functions, conditional statements, iteration, recursion, arrays and vectors, dictionaries, strings, an operational model of procedure and function calls, algorithms, exceptions, object-oriented programming, and GUIs (graphical user interfaces).

DS111: Programming for Data Science (2) (3C=3H+0L)
Prerequisite: DS110
This course introduces student to advanced python. Topics include data collection, data scraping, data exploring and data analysis and visualization in python. Python for machine learning and data science will be provided. Also the following python packages are covered: numpy, pandas, tweepy, BeautifulSoup, Matplotlip, Seaborn, and scikit-learn.

DS230: Machine Learning (1) (3C=3H+0L)
Prerequisite: DS111 and DS101
This course overviews machine learning and its importance for data science. It also provides students with theory and implementation of state-of-the-art machine learning algorithms for large-scale real-world applications. Topics include supervised learning (regression, classification). Accuracy computation alternatives, feature selection and reduction, optimization of classifiers, cross-validation will be covered.

DS231: Machine Learning (2) (2C=2H+0L)
Prerequisite: DS230
This course discussed advanced machine learning. Topics include: unsupervised learning (clustering, density estimation, and dimensionality reduction); Recommendation systems; Applying these models on structured and structured data; Time series and data streams.

DS271: Algorithms (3C=3H+0L)
Prerequisite: DS111

Fundamental techniques for designing efficient algorithms and basic mathematical methods for analyzing their performance. Paradigms for algorithm design: divide-and-conquer, greedy methods, graph search techniques, dynamic programming. Design of efficient data structures and analysis of the running time and space requirements of algorithms in the worst and average cases. Also the course covers selected topics including linear programming.

DS272: Fundamentals of AI (3C=3H+0L)
Prerequisite: DS230
This course reviews the core concepts of AI, organized around building computational agents. Emphasizes the application of AI techniques. Topics include search, logic, knowledge representation, reasoning, planning, decision making under uncertainty, and machine learning.

DS321: Big Data (3C=3H+0L)
Prerequisite: CIS221
Manipulation, storage, and analysis of large-scale data with respect to issues involving volume, velocity, variety and veracity; design of large-scale databases; use of large-scale distributed file systems; design of algorithms to analyze large data sets using parallelized processing tools.

DS330: Deep Learning (3C=3H+0L)
Prerequisite: DS231
This course covers neural networks, regularization, optimization, deep sequence learning (including RNN, GRUs, and LSTM), Deep computer vision (CNN and its variants), and deep generative models (VAEs, and GANs). Tensorflow and Keras packages are covered in this course as well.

DS342: Computer Networks (3C=3H+0L)
Prerequisite: DS271
This course is an introduction to principles of data communications and networking. It covers the telecommunication systems and different protocols and computer networks required to know by business organizations. The coverage extends to communication concepts, transmission media, signal representation and modulation, packet switching and routing, network topology and architecture, network management and Internet protocols TCP/IP. Finally, basic concepts of security in networks are discussed.

DS360 Information Security (3C=3H+0L)
Prerequisite: DS231
This course introduces the principles and practices of computer security as applied to software, host systems, and networks. It covers the foundations of building, using and managing secure systems. Topics include standard cryptographic functions and protocols, threats and defenses for real-world systems, incident response and computer forensics.

DS372 Data Engineering and Analysis (3C=3H+0L)
Prerequisite: DS231
The course covers representations of data for efficient manipulation and visualization. These include, Dimensionality Reduction, Clustering, Euclidean Embedding, Graph Embedding, and Discriminant Functions, principal component analysis (PCA), singular value decomposition (SVD), and randomized techniques. The course gives an introduction to numerical optimization methods. Methods include constrained convex optimization problems, method of Lagrange multipliers, and others.

DS395: Practical Training (3C=0H+6L)
Prerequisite: Complete 90 credit hours
Students spend time training in IT companies.

DS410: Internet Programming (3C=3H+0L)
Prerequisite: DS360
This course is a continuation to what students have learned in the Introduction to Web Design course. In this course, students learn to construct robust and highly interactive web sites using the latest features of CSS and HTML5 and scripting languages. In this course students should be able to master client-side and sever-side scripting languages. For example, HTML5, JavaScript, Active Server Pages (ASP), DHTML, Ajax, and XML and PHP. A set of laboratory experiments will provide hands-on experience in the aforementioned topics.

DS420: Data Warehousing (3C=3H+0L)
Prerequisite: DS321
This course provides the student with in depth knowledge of Data Warehousing principles, Data Warehouse techniques, and Business Intelligence systems. The course introduces the topics of Data Warehouse design, Extract-Transform-Load (ETL), Data Cubes, and Data Marts. Students will create Business Intelligence using Data Warehouses with several OLAP and analytical tools.

DS422: NewSQL Databases (3C=3H+0L)
Prerequisite: DS321
This course reviews database models beyond the relational model such as key-value stores, column-stores, document stores and graph databases.

DS430: Security Analytics (3C=3H+0L)
Prerequisite: DS360
This course teaches the fundamentals of data-driven cybersecurity analytics. The course will be divided into three parts. The first part prepares students for security analytics, by refreshing or making them familiar with popular data analytics programming languages (e.g., Python). The second part focuses on understanding the key cybersecurity analytics process including data exploration, data visualization and data preparation and examining popular data mining algorithms such as linear and logistic regression, decision trees, support vector machine, and neural networks and similar techniques for security analytics. In the third part, students use analytics process and methods for selected cybersecurity problems, such as security breaches, ZeroAccess Infection, Log Analytics, Access Analytics and Web Hacking Analytics. Through

this course, the students will gain concrete understanding of security analytics processes, methodologies and how to apply these concepts and tools to real-world cybersecurity.

DS432 Data Mining (3C=3H+0L)
Prerequisite: DS330
This course introduces the basic concepts, principles, methods, implementation techniques, and applications of data mining. It focuses on pattern discovery and cluster analysis. In pattern discovery, the following topics will be covered: Pattern Discovery Basic Concepts; Efficient Pattern Mining Methods; Pattern Evaluation; Mining Diverse Frequent Patterns; Sequential Pattern Mining; Mining Spatiotemporal and Trajectory Patterns; Constraint-Based Mining; Graph Pattern Mining; Pattern-Based Classification. In cluster analysis the following topics will be covered: Cluster Analysis Overview; Cluster; Analysis Introduction; Similarity Measures for Cluster Analysis; Partitioning-Based Clustering Methods; Hierarchical; Density Based and Grid-Based Clustering Methods; Methods for Clustering Validation.

DS439 Information Governance (3C=3H+0L)
Prerequisite: DS231
This course introduces the basic concepts, principles, methods of information governance. The course discuss the types of data in enterprise and how to apply AI to support decision making.

DS440: IoT Data Analytics (3C=3H+0L)
Prerequisite: DS231
This course will first give an introduction to the concept of IoT and smart technologies and then provide students with the knowledge of how to handle the data deluge related to IoT smart technology. Students will learn how to utilize the data generated by IoT technologies, and how to implement machine learning techniques to gain some insights to different applications this data can be used for. Students will also apply the fundamentals of machine learning and statistics to extract value from IoT data. They will also understand different business use-cases for IoT data and understand different types of IoT data

DS450: Natural Language Processing (3C=3H+0L)
Prerequisite: DS330
This course covers linguistic fundamentals of natural language processing (NLP), part of speech tagging, hidden Markov models, syntax and parsing, lexical semantics, compositional semantics, word sense disambiguation, machine translation. Additional topics such as sentiment analysis, text generation, and deep learning for NLP.

DS451: Information Retrieval (3C=3H+0L)
Prerequisite: DS330
This course covers background and recent advances in information retrieval (IR): indexing, processing, querying, classifying data. Basic retrieval models, algorithms, and IR system implementations. Focuses on textual data, but also looks at images/videos, music/audio, and geospatial information. Web search, including Web crawling, link analysis, search engine development, social media, and crowdsourcing.

DS452: Data Visualization and Exploration (3C=3H+0L)
Prerequisite: DS330
This course provides student with fundamentals of information visualization. Topics include data and image models, multidimensional and multivariate data, design principles for visualization, hierarchical, network, textual and collaborative visualization, the visualization pipeline, data processing for visualization, visual representations, visualization system interaction design, and impact of perception. Emphasizes construction of systems using graphics application programming interfaces (APIs) and analysis tools.

DS453: Computer Vision (3C=3H+0L)
Prerequisite: DS372
The course addresses the extraction of useful information from images. Topics include representations of visual content (e.g., functions, points, graphs); visual invariance; mathematical and computational models of visual content; optimization methods for vision. It covers both theoretical treatment and concrete examples, e.g., feature learning, segmentation image stitching.

Ds454: Project Management (3C=3H+0L)
Prerequisite: DS372
Project Management is an introductory course which examines project management in theory and practice and the roles and responsibilities of the project manager. The course offers a practical approach to managing projects, focusing on organizing, planning, and controlling the efforts of the project. An introduction to the 10 Knowledge areas (i.e. Integration Management, Scope Management, Schedule Management, Cost Management, Quality Management, Resource Management, Communications Management, Risk Management, Project Procurement Management, Stakeholder Management) will be provided.

DS455: Computer Architecture and Organization (3C=3H+0L)
Prerequisite: DS271
This course covers basic topics about computer architecture and organization. The course provides the study of the structure, characteristics and operation of modern day computer systems including a basic background on the computers evolution, its design process and its internal characteristics which includes processor components, control unit architecture, memory organization and system organization. All internal components of a computer including processors, cache memories, random access memories, magnetic disks, optical memories and input/output connections are considered from an architectural perspective. Integer and floating point representation in arithmetic logic unit (ALU) with arithmetical operations are explained. Virtual memory management, and I/O systems are also described.

DS458: Business Analytics (3 C.H)
prereq: DS231
This course introduces the student to the business and its surrounding envirnment. Types of data influences the workflow of business. Financial data analysis. Stock market data analysis. How the data is useful to improve decision making in organization. How to analyze business data and generate useful insights to support decision making process.

DS459: E-Marketing Analytics (3 C.H)

prereq: DS330

The process of measuring, managing, and analyzing marketing performance to maximize effectiveness and optimize investment return. This supports the business to improve its operations and customer experience by providing complete view of the customer's needs. The course will help anticipate demand and other significant trends that generate more revenue for the business. The course explains some basic terminologies used in marketing and discusses the application of analytics in E-marketing.

DS470: Operating Systems (3C=3H+0L)
Prerequisite: DS342

Introduction to fundamental issues in design and development of parallel programs for various types of parallel computers. Various programming models according to both machine type and application area. Cost models, debugging, and performance evaluation of parallel programs with actual application examples. Emphasis will be on MPI parallel programming language.

DS471: Cloud Computing (3C=3H+0L)
Prerequisite: DS470

This course gives an introduction to cloud computing and its techniques, issues, ecosystem and case studies. This course covers a series of current cloud computing technologies, including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Business Process as a Service (BPaaS), Cloud security and privacy. For different layers of the cloud technologies, practical solutions such as Google, Amazon, Microsoft, SalesForce.com, etc. solutions as well as theoretical solutions are introduced.

DS472: Parallel and Distributed computing (3C=3H+0L)
Prerequisite: DS231

This course covers general introductory concepts in the design and implementation of parallel and distributed systems, covering all the major branches such as Cloud Computing, Grid Computing, Cluster Computing, Supercomputing, and Many-core Computing. The specific topics that this course will cover are: asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, and synchronization.

DS480: Graduation Project (1) (1C=1H+0L)
Prerequisite: Complete 90 credit hours

Student identifies the topics of their capstone projects and assess the feasibility of their ideas.

DS481: Graduation Project (2) (2C=2H+0L)
Prerequisite: DS480

Student continues working on their capstone project which they initiated in DS480.

DS483: Health Data Analytics (3C=3H+0L)
Prerequisite: DS231
This course introduces students to the conceptual foundation of health informatics and analytics. The student will learn different types of healthcare data including structured and unstructured data and sources of healthcare data such as EHR, Sensors, Medical Records, PHR, M-Health. Basic health terminologies and standards will be discussed. The courses will discuss machine learning techniques and how to implement them in health care settings. The students will learn supervised, unsupervised machine learning algorithms. Also, the implementation of deep learning algorithms will be reviewed. The student will use appropriate python to carry out a project on health care context.

DS484: Probabilistic Graphical Models (3C=3H+0L)
Prerequisite: DS330
The course covers Probabilistic graphical models such as Bayesian and Markov networks. Probabilistic inference techniques including variable elimination, belief propagation and its generalizations, and sampling-based algorithms such as importance sampling and Markov Chain Monte Carlo sampling. Statistical learning techniques for learning the structure and parameters of graphical models. Sequential models such as Hidden Markov models and Dynamic Bayesian networks.

DS491: Special Topics for Data Science (1) (1C=1H+0L)
Prerequisite: Dept. Approval
This course covers topics of current interest selected by the faculty at introductory level.

DS492: Special Topics for Data Science (2) (2C=2H+0L)
Prerequisite: Dept. Approval
This course covers topics of current interest selected by the faculty at intermediate level.

DS493: Special Topics for Data Science (3) (3C=3H+0L)
Prerequisite: Dept. Approval
This course covers topics of current interest selected by the faculty at advanced level.