



Faculty of Social Sciences & Humanities
Muhammad Nawaz Sharif University of Agriculture
DEPARTMENT OF COMPUTER SCIENCE
Old Shujabad Road Multan

SCHEME OF STUDIES



BACHELOR OF SCIENCE IN DATA SCIENCE
(BSDS)
SESSION (2021-2025)

MUHAMMAD NAWAZ SHARIF UNIVERSITY OF
AGRICULTURE, MULTAN



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Curriculum of Bachelor of DATA SCIENCE (BS DS)

Program's Aims & Objectives:

The aim of BS (Data Science) is to integrate scientific methods from statistics, computer science and data-based business management to extract knowledge from data and drive decision making. Graduates are prepared to meet the challenges at the intersection between big data, business analytics, and other emerging fields. MNS University of Agriculture, Computer Science Department has felt the need to impart knowledge in this innovative area of study. A BS Program is being proposed in this area which will impart the skills of large data handling and analysis to the students. By the time of graduation, the students develop an ability to:

1. Knowledge of how to apply analytic techniques and algorithms (including statistical and data mining approaches) to large data sets to extract meaningful insights.
2. Acquisition of hands-on experience with relevant software tools, languages, data models, and environments for data processing and visualization.
3. Ability to communicate results of analysis effectively (visually and verbally) to a broad audience.
4. Ability to extract useful knowledge from data in various forms that help drive evidence-based decisions.
5. To prepare students to stand out in one of the world's fastest growing careers..



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Structure of BS Data Science:

The structure of BS (Data Science) program is dynamic and provides basis for various options including Breadth-Based and Integrated Breadth & Depth-Based specializations. Students may choose a particular option, which is the most appropriate to their planned future career. Followings are the distribution of total credit hours:

Sr.#	Category	Credit Hours
1	Computing Courses	
	Core	39
2	Data Science Courses	
	Core	18
	Elective	12
3	Computer Science Core	18
	University Elective Courses	12
	Mathematics and Science Foundation	12
	General Education Courses	19
Total Credit Hours:		130

Course Category	Credit Hrs
Comp. Core	39
General Education	19
Data Science Core	18
CS Core	18
Data Science Elective	12
University Elective	12
Mathematics and Science Foundation	12



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BS (Data Science)

Program Structure:

BS (Data Science) has a dual emphasis on basic principles of statistics and computer science, with foundational training in statistical and mathematical aspects of data analysis. This program develops foundation on broad computer science principles, including algorithms, data structures, data management and machine learning. This program will prepare graduates for a career in data analysis, combining foundational statistical concepts with computational principles from computer science.

PROPOSED CURRICULUM FOR BS (DATA SCIENCE)

Following are the proposed areas which are required to cover to complete the degree. Covered areas consist of core courses (compulsory), foundation courses, general courses and electives.

Areas Covered in BS (DS)

Course Group	Credit Hour	Min No of Courses
General Education	19	7
University Electives	12	4
Mathematics & Science Foundation	12	4
Computing Core	39	11
Computer Science Core	18	5
DS Core (Domain Core)	18	6
DS Electives (Domain Electives)	12	4
TOTAL	130	41

Data Science Core Courses

Course Title	Credit Hours	Contact Hours
Advance Statistics	3 (3-0)	3-0
Introduction to Data Science	3 (2-1)	2-3
Data Mining	3 (2-1)	2-3
Data Visualization	3 (2-1)	2-3
Data Warehousing & Business Intelligence	3 (2-1)	2-3



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Big Data Analytics	3 (2-1)	2-3
TOTAL	18 (13-5)	13-15

Data Science Elective Courses

(Must be any four courses or 12 credit hours, universities may add lab hours to elective courses, where labs are not mentioned)

Course Title	Credit Hours	Contact Hours
Advance Database Management Systems	3 (3-0)	3-0
Machine Learning	3 (2-1)	2-3
Deep Learning	3 (3-0)	3-0
Theory of Automata & Formal Languages	3 (3-0)	3-0
Artificial Neural Networks	3 (2-1)	2-3
Business Process Analysis	3 (3-0)	3-0
Platform & Architecture for Data Science	3 (3-0)	3-0
Privacy Preservation	3 (3-0)	3-0
Speech Processing	3 (3-0)	3-0
Cloud Computing	3 (3-0)	3-0
Agent Based Modeling	3 (3-0)	3-0
Text Mining	3 (3-0)	3-0
Topics in Data Science	3 (3-0)	3-0
TOTAL (Any four courses or 12 credit hours)	12 (11-1)	11-3



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Domain Courses for BS (Data Science)
Computing Core Courses (Compulsory) Courses
39 Credit Hours

Course Title	Credit Hour
Programming Fundamental	4
Object Oriented Programming	4
Discrete Structure	3
Data Structure & Algorithms	4
Software Engineering	3
Operating Systems	4
Computer Networks	4
Database Systems	4
Information Security	3
Final Year Project	6
Total	39

General Education Courses 19 Credit Hours

Course Title	Credit Hour
Introduction to Information & Communication Technology (ICT)	3
English Composition & Comprehension	3
Communication & Presentation Skills	3
Islamic Studies	2
Technical & Business English Writing	3
Pakistan Studies	2
Professional Practices	3
Total Credits:	19



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University Elective Courses 12 Credit Hours

Course Title	Credit Hour
Entrepreneurship	3
Principles of Accounting	3
Organizational Behavior	3
IoT in Digital Agriculture	3
Principles of Psychology	3
Principles of Economics	3
Foreign Language	3
Social Service	1

Total Credits: 22

Math and Science Foundation courses 12 Credit Hours

Course Title	Credit Hour
Principles of Statistics	3
Applied Physics	3
Linear Algebra	3
Calculus & Analytical Geometry	3

Total Credits: 12

Data Science Core Courses

24 Credit Hours

Course Title	Credit Hour
Database Administration & Management	4
Web Technologies	3
Information Technology Infrastructure	3
Systems & Network Administration	4
Virtual Systems & Services	4
Cyber Security	3
IT Project Management	3

Total Credits: 24



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Data Science Supporting Courses

09 Credit Hours

Course Title	Credit Hour
Software Requirements Engineering	3
Operation Research	3
Modeling and Simulation	3
Total Credits:	09

Data Science Elective Courses

Course Title	Credit Hour
Computer Organization & Assembly Language	3
Mobile Application & Development	3
Theory of Automata	3
Artificial Intelligence	3
Visual Programming	3
Data Mining & Warehousing	3
Total Credits:	18



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Scheme of Study Bachelor of Science in Data Science (BSDS)

4 years Degree Program (Bachelor of Sciences in Data Science)

40 courses covering 130 credit hours spread over 8 semesters

Eligibility Criteria:

The minimum requirements for admission in BSCS are any of the following:

a) At least 50% marks in Intermediate (HSSC) examination with Mathematics or equivalent qualification with Mathematics, certified by IBCC.

OR

b) At least 50% marks in Intermediate (HSSC) examination with Pre-Medical or equivalent qualification, certified by IBCC.

Deficiency:

“Students with pre-medical, must have to pass deficiency courses of Mathematics of 6 credit hours in first two semesters.”

c) Reserve two (02) seats for DAE (specialized in electrical, electronics, and telecommunication) students

Semester – I						
Sr. #	Course Code	Course Title	Pre-Requisite	Cr. Division	Category	Credit Hours
1.	CS-301	Introduction to Information & Communication Technology (ICT)		3 (2-1)	Gen Edu	3
2.	CS-303	Programming Fundamentals		4 (3-1)	Comp. Core	4
3.	*-305	Uni-Elective-I		3(3-0)	Uni. Elective	3
4	SSH-307	Pakistan Studies		2(2-0)	Gen Edu	2
5	ENG- 309	English Composition & Comprehension		3(3-0)	Gen Edu	3
Total Credit Hours:						15
Semester – II						
Sr. #	Course Code	Course Title	Pre-Requisite	Cr. Division	Category	Credit Hours
6.	CS-302	Discrete Structure		3(3-0)	Comp. Core	3
7.	CS-304	Object Oriented Programming	CS-303	4(3-1)	Comp. Core	4
8.	MATH - 306	Calculus & Analytical Geometry		3(3-0)	Math & Sci. Foundation	3
9.	ENG-308	Communication & Presentation Skills	ENG-309	3(3-0)	Gen Edu	3



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10.	IS 310 / SSH-310	Islamic Studies / Ethics (For foreigner / Non-Muslims)		2(2-0)	Gen Edu	2
11.	CS-312	Digital Logic Design		4(3-1)	CS Core	4
Total Credit Hours:						19
Semester – III						
Sr. #	Course Code	Course Title	Pre-Requisite	Cr. Division	Category	Credit Hours
12.	CS-401	Data Structure & Algorithms	CS-304	4(3-1)	Comp. Core	4
13.	CS- 403	Computer Organization & Assembly Language	CS-312	4(3-1)	CS Core	4
14.	MATH-405	Linear Algebra	MATH-306	3(3-0)	Math & Sci. Foundation	3
15.	ENG-407	Technical & Business English Writing		3(3-0)	Gen Edu	3
16.	CS-409	Artificial Intelligence	CS-304	4(3-1)	CS Core	4
Total Credit Hours:						18
Semester – IV						
Sr. #	Course Code	Course Title	Pre-Requisite	Cr. Division	Category	Credit Hours
17.	CS-402	Software Engineering		3(3-0)	Comp Core	3
18.	CS-404	Operating Systems	CS-401	4(3-1)	Comp. Core	4
19.	CS-406	Database Systems		4(3-1)	Comp. Core	4
20.	CS-408	Design & Analysis of Algorithms	CS-401	3(3-0)	CS Core	3
21.	CS-410	Introduction to Data Science	CS-409	3(2-1)	DS Core	3
22.	STAT-412	Probability & Statistics		3(3-0)	Math & Sci. Foundation	3
Total Credit Hours:						20
Semester – V						
Sr. #	Course Code	Course Title	Pre-Requisite	Cr. Division	Category	Credit Hours



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23.	CS-501	Computer Networks		4(3-1)	Comp. Core	4
24.	CS-503	Theory of Automata & Formal Languages		3(3-0)	DS Elective	3
25.	*-505	Uni-Elective-II		3(3-0)	Uni. Elective	3
26.	CS-507	Information Security		3(3-0)	Comp. Core	3
27.	CS-509	Advance Statistics	STAT-412	3(3-0)	DS Core	4
28.	MATH-511	Differential Equation		3(3-0)	Math & Sci. Foundation	3
Total Credit Hours:						20
Semester – VI						
Sr. #	Course Code	Course Title	Pre-Requisite	Cr. Division	Category	Credit Hours
29.	CS-502	Big Data Analytics	CS-410	3(2-1)	DS Core	3
30.	CS-504	Data Warehousing & Business Intelligence	CS-410	3(2-1)	DS Core	3
31.	CS-506	Machine Learning		3(2-1)	DS Elective	3
32.	*-508	Uni-Elective-III		3(3-0)	Uni. Elective	3
33.	CS-510	Parallel & Distributed Computing	CS-304, CS-404	3(2-1)	CS Core	3
Total Credit Hours:						15
Semester – VII						
34.	CS-601	Deep Learning		3(3-0)	DS Elective	3
35.	CS-603	Cloud Computing		3(3-0)	DS Elective	3
36.	CS-605	Data Visualization	CS-504	3(2-1)	DS Core	3
37.	SSH-607	Professional Practices		3(3-0)	Gen-Edu	3
38.	*-609	Uni-Elective-IV		3(3-0)	Uni. Elective	3
Total Credit Hours:						16
Semester – VIII						
39.	CS-602	Data Mining	CS-410, CS-509	3(2-1)	DS Core	3
40.	CS-604	Final Year Project		6(0-6)	Comp. Core	6
Total Credit Hours:						9
Total Credit Hours of the Program						130



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Courses Outline for BS Data Science (BS DS)



BS (Data Science)

Program Learning Outcomes (PLOs)

Computing programs prepare students to attain educational objectives by ensuring that students demonstrate achievement of the following outcomes (derived from Graduate Attributes define by Seoul Accord www.seoulaccord.org).

No.	Program Learning Outcomes (PLOs)	Computing Professional Graduate
1.	Academic Education	To prepare graduates as computing professionals.
2.	Knowledge for Solving Computing Problems	Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.
3.	Problem Analysis	Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.
4.	Design/Development of Solutions	Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
5.	Modern Tool Usage	Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.
6.	Individual and Team Work	Function effectively as an individual and as a member or leader in diverse



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		teams and in multi-disciplinary settings.
7.	Communication	Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.
8.	Computing Professionalism and Society	Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice.
9.	Ethics	Understand and commit to professional ethics, responsibilities, and norms of professional computing practice.
10.	Life-long Learning	Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional



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Computing Core Courses

CS-303	PROGRAMMING FUNDAMENTALS		4(3-1)
Learning Objectives			
<ul style="list-style-type: none"> • To familiarize students with the basic structured programming skills • To emphasizes upon problem analysis, algorithm designing, and program development and testing 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Understand basic problem-solving steps and logic constructs 	C	2	2
<ul style="list-style-type: none"> • Apply basic programing concepts 	C	3	2
<ul style="list-style-type: none"> • Design and implement algorithms to solve real world problems. 	C	3	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Overview of computer programming; Principles of structured and modular programming; Overview of structured programming languages; Algorithms and problem solving; Program development, analyzing problem, designing algorithm/solution; Testing designed solution; Translating algorithms into programs; Fundamental programming constructs; Data types; Basics of input and output; Selection and decision (If, If-Else, Nested If-Else, switch statement and condition operator); Repetition (while and for loop, Do-While Loops); Break statement, continue statement; Control structures; Functions; Arrays; Pointers; Records; Files (Input-Output); Testing & debugging.			
Practical			
Practical exercises of building algorithms in different writing forms and converting them to programs in C language.			
Teaching Methodology:			
Lectures, Written Assignments, Practical labs, Semester Project, Presentations			



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Course Assessment:
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Deitel, P. and H. Deitel. 2013. C++ How to Program. 9 th Ed. Prentice Hall, Upper Saddle River, NJ, USA.
Suggested Readings:
1. Hanly & Koffman. 2009. Problem Solving and Program Design in C, 6 th edition. Addison-Wesley. Boston, MA, USA. 2. Kochan, S. G. 2014, Programming in C. 4 th Ed. Pearson Education, Addison-Wesley, Boston, MA, USA. 3. Mustafa T., T. Mehmood, I. Saeed and A. R. Sattar. 2008. Object Oriented Programming using C++. IT-Series publications, Faisalabad, Pakistan.



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CS-304	OBJECT ORIENTED PROGRAMMING	4(3-1)	
Learning Objectives			
<ul style="list-style-type: none"> The course aims to develop students' Object Oriented Programming skills. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Understand principles of object oriented paradigm. 	C	2	2
<ul style="list-style-type: none"> Identify the objects & their relationships to build object oriented solution 	C	3	3
<ul style="list-style-type: none"> Model a solution for a given problem using object oriented principles 	C	3	4
<ul style="list-style-type: none"> Examine an object oriented solution. 	C	4	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Introduction to object oriented design; history and advantages of object oriented design; introduction to object oriented programming concepts; classes; objects; data encapsulation; constructors; destructors; access modifiers; const vs non-const functions; static data members & functions; function overloading; operator overloading; identification of classes and their relationships; composition; aggregation; inheritance; multiple inheritance; polymorphism; abstract classes and interfaces; generic programming concepts; function & class templates; standard template library; object streams; data and object serialization using object streams; exception handling.			
Practical			
Practical exercises of building algorithms in different writing forms and converting them to programs in C++ language.			
Teaching Methodology:			
Lectures, Written Assignments, Practical labs, Semester Project, Presentations			



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Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Deitel, P. and H. Deitel. 2015. Java: How to Program 10 th Ed. Prentice Hall, Upper Saddle River, NJ, USA.
Suggested Readings:
1. Wu, C. T 2010. An Introduction to Object-Oriented Programming with Java, 5 th Ed. McGraw-Hill, Columbus, OH, USA.
2. Horton, I. 2011. Beginning Java, 7 th Ed. John Willey & Sons, Hoboken, NJ, USA.
3. Schildt, H. 2009. Java the Complete Reference, 7 th Ed. Pearson and Education, London, UK.
4. Robert, L. and S. Simonson. 2010. Object Oriented Programming in C++. 4 th Ed. McGraw-Hill Higher Education, New York, NY, USA.



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CS-401	DATA STRUCTURES AND ALGORITHMS	4(3-1)	
Learning Objectives			
<ul style="list-style-type: none"> This course provides an introduction to the theory, practice and methods of data structures and algorithm design. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Implement various data structures and their algorithms, and apply them in implementing simple applications. 	C	2, 3	2
<ul style="list-style-type: none"> Analyze simple algorithms and determine their complexities. 	C	4, 5	3
<ul style="list-style-type: none"> Apply the knowledge of data structures to other application domains. 	C	3	2
<ul style="list-style-type: none"> Design new data structures and algorithms to solve problems. 	C	6	4, 5
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Abstract data types; complexity analysis; Big Oh notation; Stacks (linked lists and array implementations); Recursion and analyzing recursive algorithms; divide and conquer algorithms; Sorting algorithms (selection, insertion, merge, quick, bubble, heap, shell, radix, bucket); queue, dequeuer, priority queues (linked and array implementations of queues); linked list & its various types; sorted linked list; searching an unsorted array; binary search for sorted arrays; hashing and indexing; open addressing and chaining; trees and tree traversals; binary search trees; heaps; M-way tress; balanced trees; graphs; breadth-first and depth-first traversal; topological order; shortest path; adjacency matrix and adjacency list implementations; memory management and garbage collection.			
Practical			
Practical exercises of searching, sorting and merging algorithms. Develop understanding of link lists, queues and stacks. Students implement projects requiring the implementation of the above data structures.			
Teaching Methodology:			



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Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Mark, A.W.2014. Data Structures and Algorithm Analysis in C++ . 3 rd Ed. Pearson, Harlow, UK.
Suggested Readings:
1. Elliot, B.K. and A.T.Paul.2016. Data Structures: Abstraction and Design using Java. 3 rd Ed. John Wiley Sons, New York, NY, USA.
2. Brijendra, K.J. 2010. Data structures and algorithms in C . Tata McGraw Hill Education, New Dehli, India.
3. Adam, D. 2012. Data Structures and Algorithms in C++. 3 rd Ed. Sydney, Australia.



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CS-302	DISCRETE STRUCTURES		3(3-0)
Learning Objectives			
<ul style="list-style-type: none"> This course provides an introduction to the theory, practice and methods of data structures and algorithm design. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Understand the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs, and Trees etc. 	C	2	2
<ul style="list-style-type: none"> Apply formal logic proofs and/or informal, but rigorous, logical reasoning to real problems, such as predicting the behavior of software or solving problems such as puzzles. 	C	3	2
<ul style="list-style-type: none"> Apply discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography. 	C	3	2
<ul style="list-style-type: none"> Differentiate various discrete structures and their relevance within the context of computer science, in the areas of data structures and algorithms, in particular. 	C	4	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Mathematical reasoning; propositional and predicate logic; rules of inference; proof by induction; proof by contraposition; proof by contradiction; proof by implication; set theory; relations; equivalence relations and partitions; partial orderings; recurrence relations; functions; mappings; function composition; inverse functions; recursive functions; Number Theory; sequences; series; counting; inclusion and exclusion principle; pigeonhole principle; permutations and combinations; elements of graph theory; planar graphs; graph coloring; Euler graph; Hamiltonian path; rooted trees; traversals.			



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Teaching Methodology:
Lectures, Written Assignments, Project, Report Writing
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Richard, J. B.2018. Discrete Mathematics. 7 th Ed. Prentice Hall, New York, NY, USA.
Suggested Readings:
1. Kenneth H. R. and K.Krithivasan. 2013. Discrete Mathematics and its Applications. 7 th Ed. McGraw-Hill, Singapore. 2. Ralph P.G. 1994. Discrete and Combinatorial Mathematics: An Applied Introduction. 5 th Ed. Addison-Wesley, Boston, MA, USA. 3. Winifred. and J.P. Remblay. 1998 Logic and Discrete Mathematics: A Computer Science Perspective. Prentice Hall, Upper saddle River, NJ, USA.



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CS-404	OPEARTING SYSTEM		4(3-1)
Learning Objectives			
<ul style="list-style-type: none"> To help students gain a general understanding of the principles and concepts governing the functions of operating systems. To extend students understating of layered approach that makes design, implementation and operation of the complex OS possible. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Understand the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems. 	C	2	2
<ul style="list-style-type: none"> Analyze and evaluate the algorithms of the core functions of the Operating Systems and explain the major performance issues with regard to the core functions. 	C	4, 5	3
<ul style="list-style-type: none"> Demonstrate the knowledge in applying system software and tools available in modern operating systems. 	C	3	5, 7
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Operating systems basics; system calls; process concept and scheduling; inter-process communication; multithreaded programming; multithreading models; threading issues; process scheduling algorithms; thread scheduling; multiple-processor scheduling; synchronization; critical section; synchronization hardware; synchronization problems; deadlocks; detecting and recovering from deadlocks; memory management; swapping; contiguous memory allocation; segmentation & paging; virtual memory management; demand paging; thrashing; memory-mapped files; file systems; file concept; directory and disk structure; directory implementation; free space management; disk structure and scheduling; swap space management; system protection; virtual machines; operating system security			
Teaching Methodology:			
Lectures, Written Assignments, Practical labs, Semester Project, Presentations			



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Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Abraham, S. and G. Gagne. 2018. Operating System Concepts. 9 th Ed. John Wiley & Sons. Hoboken, NJ, USA.
Suggested Readings:
1. Mehmood, T. and I. Saeed. 2005. A Comprehensive study of Operating systems & Networks, IT Series, Publication, Pakistan. 2. Wang, K. C. 2017. Embedded and Real-Time Operating Systems. Springer, Olympia, WA, USA. 3. Ulrich, W. 2012. Quantum Dissipative Systems. 4 th Ed. World Scientific Publisher, Singapore. 4. Raggio, M.T and C. Hosmer. 2013. Data Hiding Exposing Concealed Data in Multimedia, Operating Systems, Mobile Devices and Network Protocols. Syngress, Waltham, MA, USA.



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CS-406	DATABASE SYSTEMS	4(3-1)	
Learning Objectives			
<ul style="list-style-type: none"> The held students learn the salient features of various types of databases, transaction management, data warehousing and data mining 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Explain fundamental database concepts. 	C	2	2
<ul style="list-style-type: none"> Design conceptual, logical and physical database schemas using different data models. 	C	5	4
<ul style="list-style-type: none"> Identify functional dependencies and resolve database anomalies by normalizing database tables. 	C	2	3
<ul style="list-style-type: none"> Use Structured Query Language (SQL) for database definition and manipulation in any DBMS 	C	4	5
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Basic database concepts; Database approach vs file based system; database architecture; three level schema architecture; data independence; relational data model; attributes; schemas; tuples; domains; relation instances; keys of relations; integrity constraints; relational algebra; selection; projection; Cartesian product; types of joins; normalization; functional dependencies; normal forms; entity relationship model; entity sets; attributes; relationship; entity-relationship diagrams; Structured Query Language (SQL); Joins and sub-queries in SQL; Grouping and aggregation in SQL; concurrency control; database backup and recovery; indexes, NoSQL systems.			
Practical			
Practical work on SQL server and Oracle server with practice of all major SQL statements.			
Teaching Methodology:			
Lectures, Written Assignments, Practical labs, Semester Project, Presentations			



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Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Elmasri, R. and S. Navathe. 2017. Fundamentals of Database Systems, 7 th Ed. Addison-Wesley, Boston, MA, USA.
Suggested Readings:
1. Connolly, R. and P. Begg. 2015. Database Systems: A Practical Approach to Design, Implementation and Management. 6 th Ed. Addison-Wesley, Boston, MA, USA. 2. Mustafa, T. and A. R. Sattar. 2010. Database Management System, IT Series Publications, Pakistan. 3. Ramakrishnan, R. and J. Gehrke. 2003. Database Management Systems, 3 rd Ed. Pearson Education, Boston, MA, USA. 4. Silberschatz, A., H.F. Korth and S. Sudarshan. 2010. Database System Concepts. 6 th Ed. McGraw Hill, New York, NY, USA.



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CS-402	SOFTWARE ENGINEERING	3(3-0)	
Learning Objectives			
<ul style="list-style-type: none"> To familiarise students with various software development models and software development life cycles. To emphasize upon understanding of concepts of project management, change control, process management, software development and testing through hands-on team Projects. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Describe various software engineering processes and activities 	C	1	2
<ul style="list-style-type: none"> Apply the system modeling techniques to model a medium size software system 	C	3	2
<ul style="list-style-type: none"> Apply software quality assurance and testing principles to medium size software system. 	C	4	2
<ul style="list-style-type: none"> Discuss key principles and common methods for software project management such as scheduling, size estimation, cost estimation and risk analysis 	C	2	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Nature of Software; Overview of Software Engineering; Professional software development; Software engineering practice; Software process structure; Software process models; Agile software Development; Agile process models; Agile development techniques; Requirements engineering process; Functional and non-functional requirements; Context models; Interaction models; Structural models; behavioral models; model driven engineering; Architectural design; Design and implementation; UML diagrams; Design patterns; Software testing and quality assurance; Software evolution; Project management and project planning; configuration management; Software Process improvement.			
Teaching Methodology:			
Lectures, Written Assignments, Project, Report Writing			



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Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Ian, S. 2016. Software Engineering. 10 th Ed. Addison Wesley, Boston, MA, USA
Suggested Readings:
<ul style="list-style-type: none">· Gary, B. S., T. J, Cashman and H. J. Rosenblatt. 2017. Systems Analysis and Design. 9th Ed. Cengage Learning, Boston, MA, USA.· Roger, S.P. 2016. Software Engineering: A Practitioner's Approach. 8th Ed. McGraw-Hill. Beijing, China.· Craig, L. 2001. Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and the Unified Process. 2nd Ed. Prentice Hall, Upper Saddle River, NJ, USA.· Dines, B. 2011. Software Engineering Domains Requirements, and Software Design, Springer, Berlin, Germany.



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CS-501	COMPUTER NETWORKS		4(3-1)
Learning Objectives			
<ul style="list-style-type: none"> • To familiarize students with concepts related to network layers, network models, and protocol standards. • To emphasizes upon understanding of modern network concepts. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Describe the key terminologies and technologies of computer networks 	C	2	2
<ul style="list-style-type: none"> • Explain the services and functions provided by each layer in the Internet protocol stack. 	C	2	2
<ul style="list-style-type: none"> • Identify various internetworking devices and protocols, and their functions in a network. 	C	4	3
<ul style="list-style-type: none"> • Analyze working and performance of key technologies, algorithms and protocols. 	C	4	3
<ul style="list-style-type: none"> • Build Computer Network on various Topologies 	P	3	4
* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Introduction and protocols architecture; basic concepts of networking; network topologies; layered architecture; physical layer functionality; data link layer functionality; multiple access techniques; circuit switching and packet switching; LAN technologies; wireless networks; MAC addressing; networking devices; network layer protocols; IPv4 and IPv6; IP addressing; sub netting; CIDR; routing protocols; transport layer protocols, ports and sockets; connection establishment; flow and congestion control; application layer protocols; latest trends in computer networks.			



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Practical
Lab exercises using tools such as Wireshark, OpNet and Packet tracer
Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Behrouz A. F. 2013, Data Communications and Networking, 5 th Ed. McGraw-Hill, New York, NY, USA.
Suggested Readings:
1. James F.K. and K. W. Ross. 2017. Computer Networking a Top-Down Approach Featuring the Internet. 7 th Ed. Pearson Education, Harlow, UK. 2. Stallings, W. 2004. Data and Computer Communications. 6 th Ed. McGraw Hill, New York, NY, USA. 3. Terry S. and B. Burton and W. Burton. 2000. Advanced IP Routing in Cisco Networks. Prentice Hall, Upper Saddle River, NJ, USA. 4. William Stallings.2014. Data and Computer Communications. 6 th Ed. Pearson Education, Harlow, UK.



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CS-507	INFORMATION SECURITY		3(3-0)
Learning Objectives			
<ul style="list-style-type: none"> To enhance students understanding about the essentials of information security and the algorithms for implementing security 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Explain key concepts of information security such as design principles, cryptography, risk management, and ethics. 	C	2	2
<ul style="list-style-type: none"> Discuss legal, ethical, and professional issues in information security. 	A	2	2
<ul style="list-style-type: none"> Apply various security and risk management tools for achieving information security and privacy. 	C	3	2
<ul style="list-style-type: none"> Identify appropriate techniques to tackle and solve problems in the discipline of information security. 	C	4	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Information security foundations; security design principles; security mechanisms; symmetric and asymmetric cryptography; encryption; hash functions; digital signatures; key management; authentication and access control; software security; vulnerabilities and protections; malware; database security; network security, firewalls; intrusion detection; security policies; policy formation and enforcement; risk assessment; cybercrime, law and ethics in information security; privacy and anonymity of data.			
Teaching Methodology:			
Lectures, Written Assignments, Semester Project, Presentations			
Course Assessment:			
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam			



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Text Book:

1. Bishop, M. 2015. Computer Security Art and Science. Wesley Professional, Addison, London, UK.

Suggested Readings:

2. Bidgoli, H., 2006. Handbook of Information Security. John Wiley, Hoboken, NJ, USA.
3. John, D. S. 2000. Principles of Global Security. Brookings Institution Press, WA. USA.
4. Michael, E. W. and H. J. Mattord. 2014. Principles of Information Security 4th Ed. Cengage Learning, Boston, MA, USA.
5. Stalling, W. 2012. Cryptography and Network Security, 6th Ed, Pearson Education, UK.



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Data Science Core (Compulsory) Courses

DS-	ADVANCE STATISTICS	3(3-0)	
Learning Objectives			
<ul style="list-style-type: none"> To familiarize students with statistical methods used for analysis of different datasets for forecasting the values, predicting the unknowns, relating the variables for getting deeper insights and relating data differences with real world complexities. To emphasize on extracting knowledge from data on the basis of hidden patterns which can be made explicit by incorporating the statistical algorithms in it. To prepare students on statistical techniques with a purview of artificial intelligence and data science. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Describe what part of statistics is meant for data scientist and what the applications of statistics in data science are. 	C	1	
<ul style="list-style-type: none"> Apply Statistical techniques in real life problems. 	C	3	
<ul style="list-style-type: none"> Analyze, Correlate, Forecast data by using different statistical techniques 	C	2	
<ul style="list-style-type: none"> Apply basic data science statistical techniques by using SPSS on real world datasets. 	C	3	
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	4(Quality Education)& 8(Decent work & Economic Growth)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Introduction to Statistics; Use of Statistics in Data Science; Experimental Design; Statistical Techniques for Forecasting; Interpolation/ Extrapolation; Introduction to Probability; Conditional Probability; Prior and Posterior Probability; Random number generation (RNG); Techniques for RNG; Correlation analysis; Chi Square Dependency tests; Diversity Index; Data Distributions Multivariate Distributions; Error estimation; Confidence Intervals; Linear transformations; Gradient Descent and Coordinate Descent; Likelihood inference; Revision of linear regression and			



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likelihood inference; Fitting algorithms for nonlinear models and related diagnostics; Generalized linear model; exponential families; variance and link functions; Proportion and binary responses; logistic regression; Count data and Poisson responses; log-linear models; Over-dispersion and quasi-likelihood; estimating functions; Mixed models; random effects; generalized additive models and penalized regression; Introduction to SPSS; Probability/ Correlation analysis/ Dependency tests/ Regression in SPSS.

Teaching Methodology:

Lectures, Written Assignments, Project.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam

Text Book:

1. Miller, J.D. 2017. *Statistics for Data Science: Leverage the power of statistics for Data Analysis, Classification, Regression, Machine Learning, and Neural Networks*. Packt Publishing Ltd. Birmingham, UK.

Suggested Readings:

1. Hardin, J., R. Hoerl, N.J. Horton, D. Nolan, B. Baumer, O. Hall-Holt, P. Murrell. R. Peng, P. Roback. L. D. Temple, and M. D. Ward. 2015. Data science in statistics curricula: Preparing students to “think with data”. *The American Statistician*, 69(4), pp.343-353.
2. Mendenhall, W., R.J.Beaver and B.M. Beaver. 2012. *Introduction to Probability and Statistics*. Cengage Learning, Boston, MA, USA.
3. Ronald, W. and Y. Myer.2008. *Probability & Statistics for Engineers & Scientists*. 8th Ed. Prentice Hall, Upper Saddle River, NJ, USA.
4. Serdobolskii, V.2008. *Multiparametric Statistics*. Elsevier, Amsterdam, Netherlands.
5. Sandra, K. M. 2010. *Statistics*, McGraw-Hill, New York, NY, USA.



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DS-	INTRODUCTION TO DATA SCIENCE	3(2-1)	
Learning Objectives			
<ul style="list-style-type: none"> • To introduce students to the rapidly growing field and equip them with some of its basic principles and tools as well as its general mindset. • to explain the significance of exploratory data analysis in data science. • To identify common approaches used for Feature Generation as well as Feature Selection. • To discuss the Ethical and Privacy issues. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Describe what Data Science is and the skill sets needed to be a data scientist. 	C	2	2
<ul style="list-style-type: none"> • Apply EDA and the Data Science process in a case study. 	C	3	3
<ul style="list-style-type: none"> • Comprehend the fundamental constructs of Python programming language. 	C	2	4
<ul style="list-style-type: none"> • Apply basic machine learning algorithms to solve real world problems of moderate complexity. 	C	3	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Introduction: What is Data Science? Big Data and Data Science hype; Datafication; Current landscape of perspectives; Skill sets needed; Statistical Inference: Populations and samples, Statistical modeling, probability distributions, fitting a model; Introduction to Python; Exploratory Data Analysis and the Data Science Process; Basic Machine Learning Algorithms: Linear Regression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes; Feature Generation and Feature Selection; Dimensionality Reduction: Singular Value Decomposition, Principal Component Analysis; Mining Social-Network Graphs: Social networks as graphs, Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs, Neighbourhood properties in graphs; Data Visualization: Basic principles, ideas and tools for data visualization; Data Science and Ethical Issues: Discussions on privacy, security, ethics, Next-generation data scientists.			
Practical			



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Programming language Python has been proposed for the practical work of this course; perform programming exercises to apply machine learning algorithms to solve real world problems.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Text Book:

1. Iguar, L. S. Segui. 2017. Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications. 1st edition, Springer. Cham. ISBN 978-3-319-50016-4.

Suggested Readings:

1. Saltz, J.S., J. M. 2017. Stanton, An Introduction to Data Science, SAGE Publications.
2. Subramanian, G. 2015. Python Data Science Cookbook. Packt Publishing, 1st Edition. ISBN 978-1-78439-640-4
3. Grus, J. 2015. Data Science from Scratch, O'Reilly Media, 1st Edition, 2015; ISBN 978-1-491-90142-7
4. Zaki. M. J., W. Meira. 2014. Data Mining and Analysis: Fundamental Concepts and Algorithms. 1st edition. Cambridge University Press. ISBN 978-0-521-76633-3



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DS-	DATA MINING	3(2-1)	
Learning Objectives			
<ul style="list-style-type: none"> • To expand on the student's understanding and awareness of the concepts of data mining basics, techniques, and application. • To introduce the concepts of Data Pre-processing and Summary Statistics. • To introduce the concepts of Frequent Item Set Generation, Associations and Correlations measures. • To introduce the concepts of Classification, Prediction, and Clustering algorithms 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Describe what Data Science is and the skill sets needed to be a data scientist. 	C	2	2
<ul style="list-style-type: none"> • Apply EDA and the Data Science process in a case study. 	C	3	2
<ul style="list-style-type: none"> • Comprehend the fundamental constructs of Python programming language. 	C	2	3
<ul style="list-style-type: none"> • Apply basic machine learning algorithms to solve real world problems of moderate complexity. 	C	3	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Introduction to data mining and basic concepts; Pre-Processing Techniques & Summary Statistics; Association Rule mining using Apriori Algorithm and Frequent Pattern Trees; Introduction to Classification Types; Supervised Classification (Decision trees, Naïve Bae Classification, K-Nearest Neighbors, Support Vector Machines etc.); Unsupervised Classification (K Means, K Median, Hieratical and Divisive Clustering, Kohonan Self Organizing maps); outlier & anomaly detection; Web and Social Network Mining; Data Mining Trends and Research Frontiers; Implementing concepts using Python.			
Practical			



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Programming language Python has been proposed for the practical work of this course; build on the programming and problem-solving skills developed in previous subjects studied by the student, practical part of this course aims to achieve an understanding of the development of Classification, Prediction, and Clustering applications by practical exercises.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations.

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Text Book:

1. Iguar, L. S. Segui. 2017. Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications. 1st edition, Springer. Cham. ISBN 978-3-319-50016-4.

Suggested Readings:

1. Saltz, J.S., J. M. 2017. Stanton, An Introduction to Data Science, SAGE Publications.
2. Subramanian, G. 2015. Python Data Science Cookbook. Packt Publishing, 1st Edition. ISBN 978-1-78439-640-4
3. Grus, J. 2015. Data Science from Scratch, O'Reilly Media, 1st Edition, 2015; ISBN 978-1-491-90142-7
4. Zaki. M. J., W. Meira. 2014. Data Mining and Analysis: Fundamental Concepts and Algorithms. 1st edition. Cambridge University Press. ISBN 978-0-521-76633-3



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DS-	DATA VISUALIZATION	3(2-1)	
Learning Objectives			
Students will be able <ul style="list-style-type: none"> • to prepare data for visualization • to design visualizations • to use web technology to create visualizations 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
• Provides knowledge about importance, necessity, and justification of performing exploratory data analysis and visualization	C	2	2
• Introduce various type of charts along with their alternatives solution to show same data from versatile aspects.	C	2	2
• Improving the competency of the students to analyze different problems and select the most appropriate solution.	C	3	4
• Use of R, various recent tools, and technologies to develop hands-on skills for exploratory data analysis and visualization.	C	3	
* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:		9 (Industry, Innovation, and Infrastructure)	
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Introduction of Exploratory Data Analysis and Visualization, Building Blocks and Basic Operations; Types of Exploratory Graphs, single and multi-dimensional summaries, five number summary, box plots, histogram, bar plot and others; Distributions, their representation using histograms, outliers, variance; Probability Mass Functions and their visualization; Cumulative distribution functions, percentile-based statistics, random numbers; Modelling distributions, exponential, normal, lognormal, pareto; Probability density functions, kernel density estimation; Relationship between variables, scatter plots, correlation, covariance; Estimation and Hypothesis Testing; Clustering using K-means and Hierarchical; Time series and survival analysis; Implementing concepts with R (or similar language)			
Teaching Methodology:			
Lectures, Written Assignments, Practical Labs Semester Project, Presentations			
Course Assessment:			
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam			
Textbook			
1. D. Peng Roger. Exploratory Data Analysis with R.			



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Suggested Readings:

1. Gorunescu, F. 2011. Data Mining Concepts, Models and Techniques. Springer Science & Business Media, Berlin, Germany.
2. Han, J., J. Pei and M. Kamber. 2011. Data mining Concepts and Techniques. 3rd Ed. Elsevier, Amsterdam, Netherlands.
3. Miller, H. J. and J. Han. 2001. Geographic Data Mining and Knowledge Discovery. Taylor & Francis, London, UK.
4. Ponniah, P. 2004. Data Warehousing Fundamentals. John Wiley & Sons, Hoboken, NJ, USA..



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DS-	DATA WAREHOUSING & BUSINESS INTELLIGENCE			3(2-1)
Learning Objectives				
<ul style="list-style-type: none"> The course will enhance students understanding regarding the evolution, need and benefits of business intelligence. Students will also learn about various technical aspects of BI and understand the processes involving in planning, designing, building and maintaining BI environment. 				
Learning Outcomes				
At the end of the course the students will be able to:	Domain	BT Level*	PLO	
<ul style="list-style-type: none"> Demonstrate an appreciation of the role that Data Warehouses and Business Intelligence play in enhancing the decision-making process 	C	3	2	
<ul style="list-style-type: none"> Demonstrate an understanding of the fundamental concepts of the Star and the Snowflake Schema; learn how to design the schema of a DW based on these two models. 	C	3	2	
<ul style="list-style-type: none"> Understand the architecture of DW Systems and be able to specify the advantages and potential problem areas 	C	2	4	
<ul style="list-style-type: none"> Use Analytic SQL to aggregate, analyze and report, and model data. 	C	2	4	
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
SDGS addressed in the course: 9 (Industry, Innovation, and Infrastructure)				
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system				
Course Contents				
Theory				
Introduction to Data Warehouse and Business Intelligence; Necessities and essentials of Business Intelligence; DW Life Cycle and Basic Architecture; DW Architecture in SQL Server; Logical Model; Indexes; Physical Model; Optimizations; OLAP Operations, Queries and Query Optimization; Building the DW; Data visualization and reporting based on Datawarehouse using SSAS and Tableau; Data visualization and reporting based on Cube; Reports and Dashboard management on PowerBI; Dashboard Enrichment; Business Intelligence Tools.				
Teaching Methodology:				



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Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment:
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam
Textbook
1. Brian, L.2016. Delivering Business Intelligence with Microsoft SQL Server 2016. 4th Ed. McGraw- Hill Education, London, UK.
Suggested Readings:
1. Jeremy, K.M. 2012. Business Intelligence in Plain Language: A Practical Guide to Data Mining and Business Analytics. Applied Data Labs Inc, USA. 2. Robert, L. 2012. The Data Warehouse Mentor: Practical Data Warehouse and Business Intelligence Insights. 1 st Ed. McGraw-Hill Companies, NY, USA. 3. Müller, R. M. and H.J.Lenz. 2013. Business Intelligence. 2 nd Ed. Springer, Berlin, Germany. 4. Turban, E., R. Sharda and D. Delen.2011.Decision Support and Business Intelligence Systems. 9 th Ed. Pearson Education, India.



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CS-	BIG DATA ANALYTICS	3(2-1)	
Learning Objectives			
This course provides a platform for the dissemination of research, current practices, and future trends in the emerging discipline of big data analytics .			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Understand the fundamental concepts of Big Data and its programming paradigm. 	C	2	2
<ul style="list-style-type: none"> • Hadoop/MapReduce Programming, Framework, and Ecosystem 	C	3	2
<ul style="list-style-type: none"> • Apache Spark Programming 	C	3	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:		9 (Industry, Innovation, and Infrastructure)	
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Introduction and Overview of Big Data Systems; Platforms for Big Data, Hadoop as a Platform, Hadoop Distributed File Systems (HDFS), MapReduce Framework, Resource Management in the cluster (YARN), Apache Scala Basic, Apache Scala Advances, Resilient Distributed Datasets (RDD), Apache Spark, Apache Spark SQL, Data analytics on Hadoop / Spark, Machine learning on Hadoop / Spark, Spark Streaming, Other Components of Hadoop Ecosystem			
Teaching Methodology:			
Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment:			
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam			
Textbook			
1. Leskovec, J., A. Rajaraman and U. Jeff, 2011. Mining of Massive Datasets, 2 nd Ed. Cambridge University Press, UK.			
Suggested Readings:			
1. Tom W.2003. Hadoop: The Definitive Guide, 4 th Ed. O Reily Media, Sebastopol, CA, USA			
2. Jimmy Lin and Chris, 2010. Data-Intensive Text Processing with Map Reduce, 3 rd Ed. Morgan & Claypool, UK			
3. Ramakrishnan,R. and J. Gehrke. 2003. Database Management Systems, 3 rd Ed. Pearson Education, Boston, MA, USA.			
4. Silberschatz, A., H.F. Korth and S. Sudarshan. 2010. Database System Concepts. 6 th Ed. McGraw Hill, NY, USA.			



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General Education Courses

ENG-309	ENGLISH COMPOSITION & COMPREHENSION	3(3-0)	
Learning Objective			
<ul style="list-style-type: none"> • Interact with academic content: reading, writing, listening and speaking. • Demonstrate ability to think critically. • Utilize information and digital literacy skills. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Interact with academic content: reading, writing, listening and speaking. 	C	1	1
<ul style="list-style-type: none"> • Demonstrate ability to think critically 	C	1	1
<ul style="list-style-type: none"> • Utilize information and digital literacy skills. 	C	3	7
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course	4(Quality Education)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.			
Course Contents			
Theory			
Paragraph and Essay Writing; Descriptive Essays; Sentence Errors: Persuasive Writing; How to give presentations: Sentence Errors; Oral Presentations: Comparison and Contrast Essays: Dialogue Writing: Short Story Writing: Review Writing; Narrative Essays: Letter Writing.			
Teaching Methodology			
Lectures, Written Assignments, Semester Project, Presentations			
Course Assessment			
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam			
Text Book			
1. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition			
Suggested Readings			
1. A Textbook of English Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000			
2. Rivers, W. M. and M.S Temperley. 1978. A Practical Guide to the Teaching of English as a Second or Foreign Language. Oxford University Press, Oxford, UK.			
3. Smalley, R. L., M. K Ruetten and D. Kozyrev. 2001. Refining Composition Skills. 4 th Ed. Heinle & Heinle Inc., Boston, MA, USA.			
4. Vawdrey C. 1993. Practical Business English. 2 nd Ed. Richard d Irwin Publishing, New			



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ENG-407	TECHNICAL AND BUSINESS ENGLISH WRITING	3(3-0)	
Learning Objective			
<ul style="list-style-type: none"> To effectively plan and structure technical reports and to recognize the various stages in writing a technical report. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Enhance the Skills regarding primary and library research to discover and employ information. 	C	1	1
<ul style="list-style-type: none"> Enhance correspondence Skills (learning the generic conventions of each). 	C	1	1
<ul style="list-style-type: none"> Polish the excellent writing skills with no spelling mistakes. 	C	3	7
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course	4(Quality Education)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.			
Course Contents			
Theory			
Overview of technical reporting; use of library and information gathering: administering questionnaires: reviewing the gathered information; Technical exposition; topical arrangement: exemplification: definition: classification and division: casual analysis: effective exposition: technical narration: description and argumentation: persuasive strategy: Organizing information and generation solution; brainstorming: organizing material: construction of the formal outline: outlining conventions: electronic communication: generation solutions: Polishing style; paragraphs: listening sentence structure: clarity: length and order: pomposity: empty words: pompous vocabulary: document design; document structure: preamble: summaries: abstracts: table of contents: footnotes: glossaries: cross referencing: plagiarism: citation and bibliography: glossaries: index: appendices: typesetting systems: creating the professional report; elements: mechanical elements and graphical elements: Reports; Proposals: progress reports: Leaflets: brochures: handbooks: magazines articles: research papers: feasibility reports: project reports: technical research reports: manuals and documentation: thesis; Electronic documents: Linear verses hierarchical structure documents.			
Teaching Methodology			
Lectures, Written Assignments, Semester Project, Presentations			
Course Assessment			
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam			
Text Book			



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1. Technical Report Writing, by Pauley and Riordan, Houghton Mifflin Company, 8th Edition.

Suggested Readings

1. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill.
2. Ellis, M. and C. Johnson. 1994. Teaching Business English. 3rd Ed. Oxford Press, Oxford, UK.
3. Ray E. 2010. Technical and Business Writing for Working Professionals. 2nd Ed. Xlibris Corporation, Bloomington, IN, USA.



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ENG-308	COMMUNICATION & PRESENTATION SKILLS	3(3-0)	
Learning Objective			
<ul style="list-style-type: none"> • Evaluate information and its sources critically. • Incorporate selected information into one's knowledge base. • Use information effectively to accomplish a specific purpose. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Enrich the thought and culture and provides us with the most important international vehicle of expression. 	C	1	1
<ul style="list-style-type: none"> • Enhance English language skills of the students and develop their critical thinking. 	C	1, 3	1
<ul style="list-style-type: none"> • Demonstrate ability to think critically 	C	3	7
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course	4(Quality Education)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.			
Course Contents			
Theory			
Principles of writing good English; understanding the composition process: writing clearly; words: sentence and paragraphs; Comprehension and expression; Use of grammar and punctuation; Process of writing; observing: audience collecting: composing: drafting and revising: persuasive writing: reading skills: listening skills and comprehension: skills for taking notes in class: skills for exams; Business communications; planning messages: writing concise but with impact: Letter formats; mechanics of business: letter writing: letters: memo and applications; summaries: proposals: writing resumes: styles and formats: oral communications: verbal and non-verbal communication: conducting meetings; small group communication: taking minutes: Presentation skills; presentation strategies: defining the objective: scope and audience of the presentation: material gathering material organization strategies: time management; opening and concluding: use of audio-visual aids: delivery and presentation.			
Teaching Methodology			
Lectures, Written Assignments, Semester Project, Presentations			
Course Assessment			
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam			
Text Book			
1. Practical Business English, Collen Vawdrey, 1993, ISBN = 0256192740			



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Suggested Readings

1. Effective Communication Skills: The Foundations for Change, John Nielsen, 2008, ISBN = 1453506748
2. Smalley, R. L., M. K Ruetten and D. Kozyrev. 2001. Refining Composition Skills. 4th Ed. Heinle & Heinle Inc., Boston, MA, USA.
3. Schriver, K. A. 1997. Dynamics in Document Design. 3rd Ed. Wiley Inc. New York City, NY, USA.
4. Henri, E. B., C. J. Jacobs, K. G. Langendoen and D. Grune. 2012. Modern Compiler Design. 2nd Ed, John Wiley & Sons. New York City, NY, USA.
5. Masami, I. 2004. Algebraic Theory of Automata and Languages. World Scientific, River Edge, NJ, USA.



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SSH-607	PROFESSIONAL PRACTICES	3(3-0)	
Learning Objective			
<ul style="list-style-type: none"> • To develop student understanding of historical, social, economic, ethical, and professional issues related to the discipline of Computing. • To identify key sources for information and opinion about professionalism and ethics. • To enable students to analyze, evaluate, and assess ethical and professional computing case studies. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Know the scope of computing field after graduating in it and what are the common things in every organization 	C	1	1
<ul style="list-style-type: none"> • Distinguish between various fields of computing 	C	2	1
<ul style="list-style-type: none"> • Describe the core of any profession. 	C	1	1
<ul style="list-style-type: none"> • Know that how business and professional environment of computing field work 	A	2	1
<ul style="list-style-type: none"> • Adhere the responsibilities according to profession, organization, and himself/herself 	A	3	9
<ul style="list-style-type: none"> • Know the standards, tools, and rules about IPs and information security 	C	1	9
<ul style="list-style-type: none"> • Write and analyse software contracts as an employer or to an employer 	C	3	7
<ul style="list-style-type: none"> • Know the business and professional environment of software house 	A	2	9
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course	4(Quality Education)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.			
Course Contents			
Theory			



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Computing Profession; Computing Ethics; Philosophy of Ethics; The Structure of Organizations; Finance and Accounting; Anatomy of a Software House; Computer Contracts; Intellectual Property Rights: The Framework of Employee Relations Law and Changing Management Practices; Human Resource Management and IT; Health and Safety at Work: Software Liability: Liability and Practice: Computer Misuse and the Criminal Law: Regulation and Control of Personal Information; Overview of the British Computer Society Code of Conduct; IEEE Code of Ethics; ACM Code of Ethics and Professional Conduct: ACM/IEEE Software Engineering Code of Ethics and Professional Practice: Accountability and Auditing; Social Application of Ethics.

Teaching Methodology

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Text Book

1. Professional Issues in Software Engineering by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, CRC Press; 3rd Edition (2000). ISBN-10: 0748409513

Suggested Readings

1. Computer Ethics by Deborah G. Johnson, Pearson; 4th Edition (January 3, 2009). ISBN-10: 0131112414
2. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet (3rd Edition) by Sara Baase, Prentice Hall; 3rd Edition (2008). ISBN-10: 0136008488
3. Applied Professional Ethics by Gregory R. Beabout, University Press of America (1993). ISBN-10: 0819193747.



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CS-301	INTRODUCTION TO INFORMATION & COMMUNICATION TECHNOLOGY			3(2-1)
Learning Objective				
<ul style="list-style-type: none"> • The course introduces students to information and communication technologies and their application in the workplace. • Students will get basic understanding of computer software, hardware, and associated technologies. • They will also learn how computers are used in the workplace, how communications systems can help boost productivity, and how the Internet technologies can influence the workplace. 				
Learning Outcomes				
At the end of the course the students will be able to:		Domain	BT Level*	PLO
• Understand basics of computing technology		C	1	2
• Perform number systems conversions and arithmetic		C	2	3
• Know about different types of software & hardware		C	2	2
• Apply basic computing related technologies		P	3	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
SDGS addressed in the course		9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.				
Course Contents				
Theory				
Brief history of Computer; Four Stages of History: Computer Elements; Processor: Memory: Hardware: Software; Application Software its uses and Limitations: System Software its Importance and its Types: Types of Computer (Super, Mainframe, Mini and Micro Computer); Introduction to CBIS (Computer Based Information System); Methods of Input and Processing; Class2. Organizing Computer Facility; Centralized Computing Facility: Distributed Computing Facility: Decentralized Computing Facility: Input Devices; Keyboard and its Types: Terminal (Dump, Smart, Intelligent): Dedicated Data Entry: SDA (Source Data Automation): Pointing Devices: Voice Input: Output Devices: Soft- Hard Copies: Monitors and its Types: Printers and its Types: Plotters: Computer Virus and its Forms; Storage Units; Primary and Secondary Memories: RAM and its Types; Cache: Hard Disks: Working of Hard Disk: Diskettes: RAID: Optical Disk Storages (DVD, CD ROM): Magnetic Types: Backup System; Data Communications; Data Communication Model: Data Transmission; Digital and Analog Transmission: Modems; Asynchronous and Synchronous Transmission: Simplex:				



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Half Duplex: Full Duplex Transmission: Communications; Medias (Cables, Wireless): Protocols; Network Topologies (Star, Bus, Ring); LAN: LAN: Internet; A Brief History: Birthplace of ARPA Net: Web Link: Browser; Internet Services provider and Online Services Providers: Function and Features of Browser: Search Engines; Some Common Services available on Internet.

Practical

Practical work on Microsoft Office and web designing using HTML.

Teaching Methodology

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Text Book

1. Baldauf, K. 2011. Succeeding with Technology: Computer System Concepts for your Life. 2nd Ed. Cengage Learning. Boston, MA, USA.

Suggested Readings

1. Capron, H. L. and J.A, Johnson 1990. Computers: Tools for an Information Age. 8th Ed. Benjamin/Cummings Publishing Company, San Francisco, CA, USA.
2. Long, L. E and Long, N. 2001. Computers: Information Technology in Perspective. 11th Ed. Pearson Education, Trenton, NJ, USA.
3. Meyer, M. and R. Baber. 1998. Computers in your Future. Cisco press, Trenton, NJ, USA.
4. Snyder, L. 2008. Fluency with Information Technology, John Wiley & Sons, New York, NY, USA.



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SSH-412	PAKISTAN STUDIES	2(2-0)
Learning Objective		
<ul style="list-style-type: none"> • Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan. • Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan 		
Learning Outcomes		
At the end of the course the students will be able to:	Domain	BT Level*
<ul style="list-style-type: none"> • Learn about the History and Ideology of Pakistan. 	C	1
<ul style="list-style-type: none"> • Get knowledge about the political and administrative structure of Pakistan. 	C	2
<ul style="list-style-type: none"> • Get familiarity about the political transitions in Pakistan. 	C	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		
SDGS addressed in the course	4(Quality Education)	
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.		
Course Contents		
Historical background of Pakistan; Muslim society in Indo-Pakistan: the movement led by the societies: the downfall of Islamic society: the establishment of British Raj- Causes and consequences: Political evolution of Muslims in the twentieth century; Sir Syed Ahmed Khan: Muslim League: Nehru: Allama Iqbal: Independence Movement; Lahore Resolution; Pakistan culture and society: Constitutional and Administrative issues: Pakistan and its geopolitical dimension; Pakistan and International Affairs; Pakistan and the challenges ahead.		
Teaching Methodology		
Lectures, Written Assignments		
Course Assessment		
Sessional Exam, Home Assignments, Quizzes, Final Exam		
Text Book		
1. The Emergence of Pakistan, Chaudary M., 1967		
Suggested Readings		
<ol style="list-style-type: none"> 1. The making of Pakistan, Aziz. 1976 2. A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988 3. Mehmood, S. 1994. Pakistan Political Roots and Development. 2nd Ed. Five Star Publishing, Lahore, Pakistan. 		



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4. S.M. Burke and L. Ziring. 1993. Pakistan's Foreign Policy: An Historical Analysis. 2nd Ed. Oxford University Press, Oxford, U.K.



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IS-310/SS-310	ISLAMIC STUDIES			2(2-0)
Learning Objective				
<ul style="list-style-type: none"> • To enhance understanding of the students regarding Islamic Civilization • To improve Students skill to perform prayers and other worships • To enhance the skill of the students for understanding of issues related to faith and religious life. 				
Learning Outcomes				
At the end of the course the students will be able to:		Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Get the knowledge of basic teachings of Islam. 		C	1	1
<ul style="list-style-type: none"> • Learn how to adopt Islamic life style. 		C	2	1
<ul style="list-style-type: none"> • Know the rights of individuals given by the Islam. 		C	2	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
SDGS addressed in the course		4(Quality Education)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.				
Course Contents				
Theory				
Basic Themes of Quran; Introduction to Sciences of Hadith; Introduction to Islamic Jurisprudence; Primary & Secondary Sources of Islamic Law; Makken & Madnian life of the Prophet; Islamic Economic System; Political theories: Social System of Islam.				
Teaching Methodology				
Lectures, Written Assignments				
Course Assessment				
Sessional Exam, Home Assignments, Quizzes, Final Exam				
Text Book				
1. Introduction to Islam by Dr Hamidullah, Papular Library Publishers Lahore				
Suggested Readings				
1. Principles of Islamic Jurisprudence by Ahmad Hassan, Islamic Research Institute, IIUI				
2. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services				
3. Waliullah M., 1982. Muslim Jurisprudence and the Quranic Law of Crimes. 2 nd Ed. Islamic Book Service, Karachi, Pakistan.				



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Data Science Elective Courses

CS-406	ADVANCED DATABASE SYSTEMS	4(3-1)	
Learning Objectives			
<ul style="list-style-type: none"> • Design and implement advanced queries using Structured Query Language • To study the usage and applications of Object-Oriented database • To acquire knowledge on variety of No SQL databases 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
• Explain fundamental database concepts.	C	2	2
• Design conceptual, logical and physical database schemas using different data models.	C	5	4
• Identify functional dependencies and resolve database anomalies by normalizing database tables.	C	2	3
• Use Structured Query Language (SQL) for database definition and manipulation in any DBMS	C	4	5
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Advance normal forms; Multivalued dependency: 4 th and 5 th normal forms; Domain key normal form; Hierarchical structure of DBMS; Storage and file organization; Storage indexing and hashing; Relational calculus; Query processing transaction processing; ACID properties: Serializability: recoverability; Concurrency control and recovery; Protocols (Lock-based: Graph-based: timestamp-based: validation-based); Deadlock handling techniques and prevention; Log-based Recovery; Failure with loss of nonvolatile storage.			
Practical			
Practical work on SQL server and Oracle server with practice of all major SQL statements.			
Teaching Methodology:			



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Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Connolly, R. and P. Begg. 2015. Database Systems: A Practical Approach to Design, Implementation and Management. 6 th Ed. Addison-Wesley, N J, USA.
Suggested Readings:
2. Elmasri, R and S. Navathe, 2011. Fundamentals of Database Systems, 6 th Ed. Willey, Hoboken, NJ, USA.
3. Mustafa, T. and A. R. Sattar. 2010. Database Management System, IT Series Publications, Pakistan.
4. Ramakrishnan,R. and J. Gehrke. 2003. Database Management Systems, 3 rd Ed. Pearson Education, Boston, MA, USA.
5. Silberschatz, A., H.F. Korth and S. Sudarshan. 2010. Database System Concepts. 6 th Ed. McGraw Hill, NY, USA.



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CS-712	DEEP LEARNING		3(2-1)
Learning Objectives			
This course will enable the students to:			
<ul style="list-style-type: none"> • To provide a comprehensive review of the theories, practical implementations for problem-solving, and a focused introduction of at least one application area. • Visual perception, speech or natural languages processing using the machine learning technology that has resulted in what is arguably responsible for the eternal spring of artificial spring. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Apply deep learning algorithms to real-world problems 	C	3	2
<ul style="list-style-type: none"> • Analyze results from deep learning to select appropriate solutions 	C	4	3
<ul style="list-style-type: none"> • Code the novel neural network architectures from scratch and evaluating the performance on application specific standard benchmarks 	C	5	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Basics of deep learning, learning networks, Shallow vs. Deep learning etc.; Machine learning theory – training and test sets, evaluation, etc. Theory of Generalization; Multi-layer perceptrons, error back-propagation; Deep convolutional networks, Computational complexity of feed forward and deep convolutional neural networks; Unsupervised deep learning including auto-encoders; Deep belief networks; Restricted Boltzman Machines; Deep Recurrent Neural Networks (BPTT, LSTM, etc.); GPU programming for deep learning CuDNN; Generative adversarial networks (GANs); Sparse coding and auto-encoders; Data augmentation, elastic distortions, data normalization; Mitigating overfitting with dropout, batch normalization, dropconnect; Novel architectures, ResNet, GoogleNet, etc.			
Teaching Methodology:			
Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment:			



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Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam

Text Book:

1. Goodfellow, I., Y. Bengio, A. Courville and Y. Bengio. 2016. Deep learning (Vol. 1, No. 2). Cambridge: MIT press (<http://www.deeplearningbook.org/>)

Suggested Readings:

1. Beysolow, T. 2017. [Introduction to Deep Learning using R](#). CA Apress, CA, USA.
2. Chollet, F. 2017. Deep Learning with Python. Manning Publications, NY, USA.
3. Josh. P and A. Gibson. 2017. Deep Learning: A Practitioner's Approach. 1st Ed. O'Reilly Media, Inc, Sebastopol, CA, USA.
4. Julius, P. 2016. [Deep Learning: Fundamentals, Methods and Applications](#). Nova Science Publishers, NY, USA.
5. Sugomori, Y., B. Kaluza, F.M. Soares and A.M. F. Souza. 2017. Deep Learning, Packt Publishing, Birmingham, UK.



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CS-713	MACHINE LEARNING			3(3-0)
Learning Objectives				
This course will enable the students to:				
<ul style="list-style-type: none"> • Present the basic machine learning concepts • Present a range of machine learning algorithms along with their strengths and weaknesses • Apply machine learning algorithms to solve problems of moderate complexity. 				
Learning Outcomes				
At the end of the course the students will be able to:	Domain	BT Level*	PLO	
<ul style="list-style-type: none"> • Describe basic machine learning concepts, theories and applications. 	C	1	2	
<ul style="list-style-type: none"> • Apply supervised learning techniques to solve classification problems of moderate complexity. 	C	3	2	
<ul style="list-style-type: none"> • Apply unsupervised learning techniques to solve clustering problems of moderate complexity 	C	3	2	
<ul style="list-style-type: none"> • Apply reinforcement learning algorithms to environments with complex dynamics. 	C	3	2	
<ul style="list-style-type: none"> • Develop a reasonable size project using suitable machine learning technique 	C	6	4	
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)			
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system				
Course Contents				
Theory				



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Introduction to machine learning; concept learning: General-to-specific ordering of hypotheses, Version spaces Algorithm, Candidate elimination algorithm; Supervised Learning: decision trees, Naive Bayes, Artificial Neural Networks, Support Vector Machines, Overfitting, noisy data, and pruning, Measuring Classifier Accuracy; Linear and Logistic regression; Unsupervised Learning: Hierarchical Agglomerative Clustering. k-means partitional clustering; Self-Organizing Maps (SOM) k-Nearest-neighbor algorithm; Semi- supervised learning with EM using labeled and unlabeled data; Reinforcement Learning: Hidden Markov models, Monte Carlo inference Exploration vs. Exploitation Trade-off, Markov Decision Processes; Ensemble Learning: Using committees of multiple hypotheses. Bagging, boosting.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations

Course Assessment:

Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam

Text Book:

1. Alpaydin, E. 2016. Machine Learning: The New AI/Ethem Alpaydin. MIT Press, USA.

Suggested Readings:

1. Bishop, C. 2006. Pattern Recognition and Machine Learning, Springer-Verlag, NY, USA.
2. Luger, G.F., P. Johnson, C. Stern, C. Newman and R. Yeo. 1994. Cognitive Science: The Science of Intelligent Systems. Academic Press, Boston, MA, USA.
3. Marsland, S. 2015. Machine learning: An Algorithmic Perspective, CRC Press, Boca Raton, London, UK.
4. Murty, M. N and V. S. Devi. 2015, Introduction to pattern recognition and machine learning, World Scientific. IISc Press, Singapore.



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	Artificial Neural Networks	3(2-1)	
Learning Objectives			
<ul style="list-style-type: none"> The student should be able to understand neural network architectures Learning algorithms and also be able to apply neural networks to real classification problems. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Understand the fundamentals of neural networks in AI 	C	2	2
<ul style="list-style-type: none"> Explain how simple ANNs can be designed 	C	2	2
<ul style="list-style-type: none"> Apply ANN for classification Problems 	C	3	2
<ul style="list-style-type: none"> Differentiate between different Networks and their learning laws 	C	4	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Introduction and history of neural networks, Basic architecture of neural networks, Perceptron and Adaline (Minimum Error Learning) for classification, Gradient descent (Delta) rule, Hebbian, Neo-Hebbian and Differential Hebbian Learning, Drive Reinforcement Theory, Kohonen Self Organizing Maps, Associative memory, Bi-directional associative memory (BAM), Energy surfaces, The Boltzmann machines, Backpropagation Networks, Feedforward Networks; Introduction to Deep learning and its architecture.			
Practical			
Focus on artificial neural network and machine learning; Study of the Turing machine and a discussion of the questionable claims.			
Teaching Methodology:			
Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment:			



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Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam

Text Book:

1. Demuth, H. B., Beale, M. H., De Jess, O., & Hagan, M. T. (2014). *Neural network design*. Martin Hagan.)

Suggested Readings:

1. Anderson, B. (2014). An Introduction to Neural Networks.
2. Hassoun, M. H. (1995). *Fundamentals of artificial neural networks*. MIT press.
3. Margulies, P. 2004. Artificial Intelligence. Blackbirch Press, Farmington Hills, MI, USA.
4. Noah, .B and T. Gale. 2011. Artificial Intelligence. Greenhaven Press, Farmington Hills, MI, USA
5. Stuart, J., N. Peter and F. Canny. Artificial Intelligence: a Modern Approach. 3rd Ed. Prentice Hall, Upper Saddle River, NJ, USA



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CS-503	THEORY OF AUTOMATA & FORMAL LANGUAGES	3(3-0)	
Learning Objectives			
<ul style="list-style-type: none"> The course introduces students with fundamental concepts of automata theory The course introduces students with formal languages to form basic models of computation which provide foundation of many branches of computer science, e.g. compilers, software engineering, concurrent systems, etc. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Prove properties of languages, grammars and automata with rigorously formal mathematical methods. 	C	2	2, 3
<ul style="list-style-type: none"> Design automata, regular expressions and context-free grammars accepting or generating a certain language. 	C	3	4
<ul style="list-style-type: none"> Transform between equivalent deterministic and non-deterministic finite automata and regular expressions. 	C	3	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Introduction to Automata: The Methods and the Madness, Introduction to Formal Proof, Inductive Proofs, The Central Concepts of Automata Theory. Finite Automata: Introduction of Finite Automata, Deterministic Finite Automata, Nondeterministic Finite Automata, Finite Automata With Epsilon Transitions. Regular Expressions and Languages, Regular Expressions, Finite Automata and Regular Expressions, Applications of Regular Expressions, Algebraic Laws for Regular Expressions. Properties of Regular Languages, Proving Languages Not to Be Regular, Closure Properties of Regular Languages, Decision Properties of Regular Languages, Equivalence and Minimization of Automata. Context-Free Grammars and Languages: Context-Free Grammars, Parse Trees, Applications of Context-Free Grammars, Ambiguity in Grammars and Languages, Pushdown Automata: Definition of the Pushdown Automaton, The Languages of a PDA, Equivalence of PDAs and CFGs, Deterministic Pushdown Automata. Properties of Context-Free Languages: Normal Forms for Context-Free Grammars, The Pumping Lemma for Context-Free Languages, Closure Properties of Context-Free Languages, Decision Properties of CFLs. Introduction to Turing Machines: Problems That Computers Cannot Solve, The Turing			



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Machine, Programming Techniques for Turing Machines, Extensions to the Basic Turing Machine, Restricted Turing Machines, Turing Machines and Computers. Un-decidability: A Language That Is Not Recursively Enumerable, Un-decidable Problem That Is RE, Un-decidable Problems About Turing Machines, Posts Correspondence Problem, Other Un-Decidable Problems.

Intractable Problems: The Classes P and NP, An NP-Complete Problem, A Restricted Satisfiability Problem.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam

Text Book:

1. Linz, P. 2006. An Introduction to Formal Language and Automata. 4th Ed.

Suggested Readings:

1. Automata and Formal Languages: An Introduction by Dean Kelley, Prentice Hall (1995). ISBN-10: 0134977777
2. Alfred, V., S. Ravi and D. Ullman. 2006. Compilers Principles Techniques and Tools. 2nd Ed. Wesley Pub, Lancing, MI, USA.
3. Andrew, W. and A. Appel. 2004. Modern Compiler Implementation in C. Cambridge University Press, Cambridge, UK.
4. Dick, G., E. Henri and J. H. Jacobs. 2010. Modern Compiler Design. 2nd Ed. John Wiley, New York City, NY, USA.
5. Henri, E. B., C. J. Jacobs, K. G. Langendoen and D. Grune. 2012. Modern Compiler Design. 2nd Ed, John Wiley & Sons. New York City, NY, USA.
6. Masami, I. 2004. Algebraic Theory of Automata and Languages. World Scientific, River Edge, NJ, USA.



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Mathematics and Science Foundation Courses

CS-303	CALCULUS & ANALYTICAL GEOMETRY	3(3-0)	
Learning Objectives			
<ul style="list-style-type: none"> To provide foundation and basic ground for calculus and analytical geometry background 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Understand importance of calculus 	C	2	2
<ul style="list-style-type: none"> Apply derivatives, partial derivatives or integrals 	C	3	2
<ul style="list-style-type: none"> Design and implement algorithms to solve practical problems. 	C	3	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Complex numbers; De Moivre's theorem and its applications; Simple cartesian curves; Functions and graphs; Symmetrical properties; Curve tracing; Limit and continuity; Differentiation of functions; Derivative as slope of tangent to a curve and as rate of change; Application to tangent and normal; Linearization; Maxima/Minima and point of inflexion; Taylor and maclurin expansions and their convergence; Integral as anti-derivative; Indefinite; Integration of simple functions; Methods of integration; Integration by substitution; Partial fractions; Definite integral as limit of a sum, application to area; Arc length; Volume and surface of revolution. Derivatives of Inverse Trigonometric Functions. Numerical Integration. Applications of Integrals. Transcendental Functions. Inverse Tragicomic Functions. Integrals.			
Teaching Methodology:			
Lectures, Written Assignments, Presentations			
Course Assessment:			
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam			
Text Book:			



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1. Thomas and Finny. 2010. Calculus and Analytical Geometry. 6th Ed. Pearson Education, New Delhi, India

Suggested Readings:

1. Thomas and Finny. 2010. Calculus and Analytical Geometry. 6th Ed. Pearson Education, New Delhi, India.
2. Erwin, K. 2013. Advanced Engineering Mathematics. 10th Ed. Jones & Bartlett Learning, Burlington, MA, USA.
3. Schenck, H. 2003. Computational Algebraic Geometry. Cambridge University Press, Cambridge, UK
4. Dineen, S. and S. Dineen. 2001. Multivariate Calculus and Geometry. 2nd Ed. Springer, New York, NY, USA.
5. Callahan, J. J. 2010. Advanced Calculus: A Geometric View. Springer Science & Business Media. Northampton, UK



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STAT-405	PROBABILITY & STATISTICS	3(3-0)	
Learning Objectives			
<ul style="list-style-type: none"> To provide foundation and basic ground for calculus and analytical geometry background 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Understand the importance of probability and statistics 	C	2	2
<ul style="list-style-type: none"> Apply probabilities related to both discrete 	C	3	2
<ul style="list-style-type: none"> Compare and analyze data sets using descriptive statistics. 	C	3	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	4(Quality Education)& 8(Decent work & Economic Growth)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Introduction to statistics; Descriptive statistics; Statistics in decision making; Graphical representation of data stem-and lead plot, box-cox plots; Measures of central tendencies and dispersion, moments of frequency distribution; Counting techniques; Introduction to probability, sample space, events, laws of probability; Conditional probability and Baye's theorem with application to random variable (Discrete and continuous) binomial; Poisson; Geometric; Negative binomial distributions; Exponential gamma and normal distributions; Regression and correlation; Estimation and testing of hypotheses; Elementary statistical packages for explanatory data analysis.			
Teaching Methodology:			
Lectures, Written Assignments, Presentations			
Course Assessment:			
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam			
Text Book:			
Lay, L. D. 2015. Probability and Statistics for Engineering and the Sciences, 9 th Ed. Cengage Learning, Boston, MA, USA.			



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Suggested Readings:

6. Lay, L. D. 2015. Probability and Statistics for Engineering and the Sciences, 9th Ed. Cengage Learning, Boston, MA, USA.
7. Mendenhall, W., R.J.Beaver and B.M. Beaver. 2012. Introduction to Probability and Statistics. Cengage Learning, Boston, MA, USA.
8. Ronald, W. and Y. Myer.2008. Probability & Statistics for Engineers & Scientists. 8th Ed. Prentice Hall, Upper Saddle River, NJ, USA.
9. Serdobolskii, V.2008. Multiparametric Statistics. Elsevier, Amsterdam, Netherlands.
10. Sandra, K. M. 2010. Statistics, McGraw-Hill, New York, NY, USA.



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MATH-306	LINEAR ALGEBRA		3(3-0)
Learning Objectives			
<ul style="list-style-type: none"> • To provide fundamentals of solution for system of linear equations. • To apply operations on system of equations, matrix properties, solutions and study of their properties. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Understand the importance of linear algebra 	C	2	2
<ul style="list-style-type: none"> • Apply algebraic operation will be required to solve practical 	C	3	2
<ul style="list-style-type: none"> • Design and implement symbolic simulator to solve system of equations through programming language. 	C	3	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Vectors; Vector spaces; Matrices and determinants; Cofactor and inverse; Rank; Linear independence; Positive definite matrix; Linear transformations; Operations on matrices; Inner products; Orthogonally and least squares; Eigen value & eigenvectors;			
Teaching Methodology:			
Lectures, Written Assignments, Presentations			
Course Assessment:			
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam			
Text Book:			
1. Cheney, W. and D.Kincai. 2009. Linear algebra: Theory and Applications. Jones & Bartlett Learning, Burlington, MA, USA.			
Suggested Readings:			



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1. Cheney, W. and D.Kincai. 2009. Linear algebra: Theory and Applications. Jones & Bartlett Learning, Burlington, MA, USA.
2. David, K.H.2007. Elementary Linear Algebra with Applications. 9th Ed. Prentice Hall, Prentice Hall, Harlow, UK.
3. Gilbert, S. S., B. C. Andy and B. Andrew, B. 2005. Linear Algebra and Its Applications. 4th Ed. Thomson Brooks/Cole, Belmont, CA, USA.
4. Hoffman, K. and R.A. Kunze. 2015. Pearson India Education Services, Noida, India.
5. Steven, J. L., I. Bica and T. Hohn. 2014. Linear Algebra with Applications. Pearson Learning Solution, New York, NY, USA.



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PHY-305	APPLIED PHYSICS			3(3-0)
Learning Objectives				
<ul style="list-style-type: none"> • To familiarize students with the basic structured programming skills • To emphasizes upon problem analysis, algorithm designing, and program development and testing 				
Learning Outcomes				
At the end of the course the students will be able to:	Domain	BT Level*	PLO	
<ul style="list-style-type: none"> • Understand the importance of linear algebra 	C	2	2	
<ul style="list-style-type: none"> • Apply algebraic operation 	C	3	2	
<ul style="list-style-type: none"> • Design and implement algorithms to solve system of equations through programming language. 	C	3	4	
* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)			
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system				
Course Contents				
Theory				
Electricity and Magnetism: Voltage, current, resistance, power, single phase and 3 phase A.C. supply; Series and parallel circuits; Vector addition and subtraction of A.C. voltages; A.C/D.C. motors: Concept of rotating fields, polyphase induction motor, lap and wave winding of single phase and three phase motors; torque and starting characteristics; measuring instruments; transformers; A.C power generators; Electrical distribution and wiring for farm buildings; Electric controls, motor controls, and protection; Selection of farm motors; applications of electricity at farm; Electronics: Semi-conductors, PN-junction; Transistor; its characteristics and uses; Amplifiers; Power supplies; Magnetism: Electro-Magnetic induction and radiation; Radioactivity: Radioisotopes; Biological effects of radiation; Laser: Introduction, generation and uses of Laser; Fibre optics–characteristics.				
Practical				
<ol style="list-style-type: none"> 1. Construction of wiring systems, fuses, switches of various types insulators 2. Circuits design and drawing of a typical farm electrical system. 3. Selection of motor for various farm equipment such as forage cutter, feed-grinders, and shop tools. 4. Practice on repair and adjustment of electric motors, switches, fuses, transmission 				



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wiring controls 5. Study of 3 phase induction motor 6. Study of star and delta connections 7. Study of semi-conductor, triode, diode valve and transistors. 8. Use of AVO meter, CRO, planimeter 9. Fabrication of full wave rectifier and inductance study of its wave-shape.
Teaching Methodology:
Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam
Text Book:
1. Cheney, W. and D.Kincai. 2009. Linear algebra: Theory and Applications. Jones & Bartlett Learning, Burlington, MA, USA.
Suggested Readings:
1. Cheney, W. and D.Kincai. 2009. Linear algebra: Theory and Applications. Jones & Bartlett Learning, Burlington, MA, USA. 2. David, K.H.2007. Elementary Linear Algebra with Applications. 9 th Ed. Prentice Hall, Prentice Hall, Harlow, UK. 3. Gilbert, S. S., B. C. Andy and B. Andrew, B. 2005. Linear Algebra and Its Applications. 4 th Ed. Thomson Brooks/Cole, Belmont, CA, USA. 4. Hoffman, K. and R.A. Kunze. 2015. Pearson India Education Services, Noida, India. 5. Steven, J. L., I. Bica and T. Hohn. 2014. Linear Algebra with Applications. Pearson Learning Solution, New York, NY, USA.



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University Elective Courses

MGT-602	ENTREPRENEURSHIP	3(3-0)	
Learning Objectives			
<ul style="list-style-type: none"> • This course provides an understanding of the entrepreneurship process • The course gives students the tools. Necessary to think creatively, to plan out whether their idea is marketable to investors. • This will be accomplished through a combination of readings, cases studies and projects designed to convey the unique environment of the entrepreneurs and new ventures. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Understand processes, and resources within a diverse organization 	C	2	2
<ul style="list-style-type: none"> • Apply knowledge of leadership concepts in an integrated manner 	C	3	2
<ul style="list-style-type: none"> • Analyze the internal/external factors affecting a business. 	C	3	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
<p>Evolution and importance of entrepreneurship; Difference between intrapreneurship and entrepreneurship; Entrepreneurial process; Agribusiness ventures, practices and characteristics; Methods of new idea generation; Opportunities, innovations; change, fantasies, Environment of small businesses in agriculture; Sources and resolutions, corporate entrepreneurship in business sector; Risk failure and new venture unit; Feasibility and concepts of planning; Stages of growth model; Responsibility of feasibility plan; Product and services concepts; Product servicing concepts and commercial opportunities (macro over view); Products and technology; Identification of opportunities; Product development life cycle; Product protection; Trade mark and patents; Validity of property rights and accessing government information; Human resources side of enterprise; Infrastructure of services, Types of service venture; Success factors; Marketing and new venture development; Situation analysis for new ventures, Marketing concepts, startup of marketing research; Market focused on organization; Sources of market intelligence;</p>			



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Competitive analysis and implications of market research; Marketing strategies; Functions and product concepts; Changing international ventures; Entrepreneurial team and business formation, Human resource and relations, Board of directors, Legal aspects; Evaluation of acquisition opportunities and methods of valuation; Financial resources and asset management, Different types of financing, buy or lease, Organization cycle and growth of organization; Strategic management for success of enterprise; Looking towards agricultural entrepreneurial career, Agricultural business plan contents and details.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam

Text Book:

Dollinger, M. 2007. Entrepreneurship: Strategies and Resources. 2nd Ed. Prentice Hall Inc. Upper Saddle River, NJ, USA.

Suggested Readings:

1. Dollinger, M. 2007. Entrepreneurship: Strategies and Resources. 2nd Ed. Prentice Hall Inc. Upper Saddle River, NJ, USA.
2. Kuratko, D. and R. Hodgetts. 2006. Entrepreneurship: A Contemporary Approach. 7th Ed. Prentice Hall, Inc., Upper Saddle River, NJ, USA.
3. Naqi, S. M. 2012. Entrepreneurs. 3rd Ed. A-One Publishers, Lahore, Pakistan.
4. Peters, M. and R. D. Hishrich. 2009. Entrepreneurship. 8th Ed. Irwin/McGraw-Hill, New York City, NY, USA.
5. Wills, W.J. and M. E. Newman. 1998. Agribusiness Management and Entrepreneurship. 2nd Ed. Interstate Publishers, Boston, MA, USA.



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MGT-308	PRINCIPLES OF ACCOUNTING		3(3-0)
Learning Objectives			
<ul style="list-style-type: none"> To introduce students with knowledge of accounting required to help them to understand the process of financial management required to develop modern accounting information systems. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Develop and understand the nature and purpose of financial statements in relationship to decision making. 	C	2	2
<ul style="list-style-type: none"> Develop the ability to use the fundamental accounting equation to analyze the effect of business transactions on an organization's accounting records and financial statements. 	C	3	2
<ul style="list-style-type: none"> Develop the ability to use a basic accounting system to create (record, classify, and summarize) the data needed to solve a variety of business problems. 	C	3	2
<ul style="list-style-type: none"> Develop the ability to use accounting concepts, principles, and frameworks to analyze and effectively communicate information to a variety of audiences. 	C	3	2
<ul style="list-style-type: none"> Develop the ability to use accounting information to solve a variety of business problems. 	C	3	2
<ul style="list-style-type: none"> Develop the ability to interact well with team members 	A	3	6, 9
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			



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Course Contents
Theory
Introduction to accounting; Accounting principles; Book keeping; Basics of financial statements; Adjustments to financial statements; The cash book; Bank reconciliation; Control accounts; Statement of cash flows; Financial activities; Property; Plant and equipment (PPE); Accounting errors; Accounting for partnerships; Balance sheet.
Teaching Methodology:
Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam
Text Book:
1. Ghani, M. A. 2006. Principles of Accounting. Pak Imperial Book Depot, Lahore, Pakistan
Suggested Readings:
1. Meighs and Meighs. 2006. Accounting: The Basis of Business Decisions. 11th Ed. McGraw-Hill, New York, NY, USA.
2. Horne, V.J. and M. Wachowicz. 2013. Fundamentals of Financial Management. 13th Ed. Prentice Hall, Upper Saddle River, NJ, USA.
3. Kaluza, J. 2008. Accounting: A Systems Approach. 8th Edition, McGraw-Hills, New York. NY, USA.
4. Wild, J. J., K. D. Larson, B. Chiappetta. 2007. Fundamental Accounting Principles. McGraw- Hill, New York, NY, USA.



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SS-411	PRINCIPLES OF PSYCHOLOGY		3(3-0)
Learning Objectives			
<ul style="list-style-type: none"> • To provides an overview of the history and major issues of psychology • To emphasizes upon learning and perception, personality theories, abnormal behaviour, motivation and emotion, human development, social psychology 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Understand the major fields of study and theoretical perspectives 	C	2	2
<ul style="list-style-type: none"> • Differentiate between the major observational, correlation, and experimental designs. 	C	3	2
<ul style="list-style-type: none"> • Identify the major parts of the nervous system 	C	3	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Basics concepts of psychology and research methods; Brain and behavior; Human development; Sensation and perception; States of consciousness; Conditioning and learning; Memory cognition, language, creativity and intelligence; Motivation and emotion; Sex, gender, sexuality; Personality, health, stress and coping; Social behavior.			
Practical			
Practical exercises of building algorithms in different writing forms and converting them to programs in C language.			
Teaching Methodology:			
Lectures, Written Assignments, Presentations			
Course Assessment:			
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam			



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Text Book:

1. Dennis, C. and O.M. John. 2011. Psychology, Modules for Active Learning. 12th Ed. Wadsworth Publishing, Nelson Education, Toronto, Canada

Suggested Readings:

1. Dennis, C. and O.M. John. 2011. Psychology, Modules for Active Learning. 12th Ed. Wadsworth Publishing, Nelson Education, Toronto, Canada.
2. Kalat, J. W. 2016. Introduction to Psychology. 11th Ed. Cengage Learning, Boston, MA, USA.
3. Plotnik, R. and H. Kouyoumdjian. 2013. Introduction to Psychology. 10th Ed. Cengage Learning, Belmont, CA, USA.
4. David G. M. 2009. Psychology. 9th Ed. Worth Publishers, Basingstoke, UK.
5. Kassin, S. 2017. Psychology in Modules. 12th Ed. Pearson Custom Publishing, Australia.



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MGT-	PRINCIPLES OF MARKETING		3(3-0)
Learning Objectives			
<ul style="list-style-type: none"> • To provide students with a broad introduction to marketing concepts • To help them understand the factors that influence marketing decisions • Focus attention on the vital role of marketing in today's global economy 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Identify some of the basic approaches to formulating a marketing strategy in order to participate effectively when working with marketing policy coordinators. 	C	4	2
<ul style="list-style-type: none"> • Use an understanding of marketing and the market driven enterprise to differentiate market. 	C	2	2
<ul style="list-style-type: none"> • Identify key stages of the market planning process in order to create marketing plans through development of key sections common to most plans. 	C	4	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Marketing in Changing World, Core marketing concepts, Creating Customer Value and Satisfaction, Strategic Planning and the Marketing Process, Micro and Macro Marketing Environment, Marketing Research and Information Systems, Consumer Markets and Consumer Buyer Behavior, Business Markets and Business Buyer Behavior, Marketing Segmentation, Targeting, and Positioning for Competitive Advantage Product and Services strategy, New Products Development and Product Life-Cycle Strategies, Pricing Products: Pricing Considerations and Approaches, Pricing Strategies, Distribution Channels and Logistics Management, Retailing and Wholesaling, Integrated Marketing Communication Strategy, Advertising, Sales Promotion and Public Relations, Personal Selling and Sales Management, Direct and Online Marketing, Competitive Strategies: Building Lasting Customer Relationships.			
Teaching Methodology:			



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Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam

Text Book:

1. Kotler P., H. Ehsan and P. Y. Agnihotri. 2014. Principles of Marketing: A South Asian Perspective. 14th Ed. Pearson Education, India.

Suggested Readings:

1. Cannon, T. 2009. Basic Marketing Principles and practices. 12th Ed. Jon Wiley and Sons, New York, NY, USA.
2. Evans, J. 2008. Principles of Marketing. 9th Ed. Prentice Hall International Inc. Upper Saddle River, NJ, USA
3. Stanton, W. J. 2009. Principles of Marketing. 14th Ed. McGraw Hill Pub, New York, NY, USA.
3. Meighs and Meighs. 2006. Accounting: The Basis of Business Decisions. 11th Ed. McGraw-Hill, New York, NY, USA.



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SSH-	HUMAN RESOURCE MANAGEMENT	3(3-0)	
Learning Objectives			
<ul style="list-style-type: none"> • To enable the students to understand the human resource Management and system at various levels in general and in certain specific industries or organizations. • To help the students focus on and analyse the issues and strategies required to select and develop manpower resources • To develop relevant skills necessary for application in HR related issues • To Enable the students to integrate the understanding of various HR concepts along with the domain concept in order to take correct business decisions 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Understand the basic and core human resource management practices 	C	4	2
<ul style="list-style-type: none"> • To develop necessary skill set for applications of various HR issues 	C	2	2
<ul style="list-style-type: none"> • Develop basic understanding about the reward systems of cultivators, agriculture labors and marginal workers. 	C	4	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			
Theory			
Marketing in Changing World, Core marketing concepts, Creating Customer Value and Satisfaction, Strategic Planning and the Marketing Process, Micro and Macro Marketing Environment, Marketing Research and Information Systems, Consumer Markets and Consumer Buyer Behavior, Business Markets and Business Buyer Behavior, Marketing Segmentation, Targeting, and Positioning for Competitive Advantage Product and Services strategy, New Products Development and Product Life-Cycle Strategies, Pricing Products: Pricing Considerations and Approaches, Pricing Strategies, Distribution Channels and Logistics Management, Retailing and Wholesaling, Integrated Marketing Communication Strategy, Advertising, Sales Promotion and Public Relations, Personal Selling and Sales Management, Direct and Online Marketing, Competitive Strategies: Building Lasting Customer Relationships.			



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Teaching Methodology:
Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam
Text Book:
1. Kotler P., H. Ehsan and P. Y. Agnihotri. 2014. Principles of Marketing: A South Asian Perspective. 14th Ed. Pearson Education, India.
Suggested Readings:
1. Cannon, T. 2009. Basic Marketing Principles and practices. 12th Ed. Jon Wiley and Sons, New York, NY, USA. 2. Evans, J. 2008. Principles of Marketing. 9th Ed. Prentice Hall International Inc. Upper Saddle River, NJ, USA 3. Stanton, W. J. 2009. Principles of Marketing. 14th Ed. McGraw Hill Pub, New York, NY, USA. 3. Meighs and Meighs. 2006. Accounting: The Basis of Business Decisions. 11th Ed. McGraw-Hill, New York, NY, USA.



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CS-	IOT IN DIGITAL AGRICULTURE	3(2-1)	
Learning Objectives			
To enable students to understand:			
<ul style="list-style-type: none"> • Basics of digital latest digital agriculture technologies (DATs) • Develop an understanding about underlying processes in digital technologies focus on agricultural issues and challenges related to precision management. • To describe the basics of IoT, the technology used to build smart devices, how they communicate, how they store data, and the kind of distributed systems needed to support them. • Develop and apply the simple decision support system (DSS) for better utilization of resources in agriculture and crop production. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Know about basics understanding of core concepts of DATs focused on case study and potential impacts 	C	2	2
<ul style="list-style-type: none"> • Describe what IoT is and recognize the factors contributed to the emergence of IoT 	C	2	2
<ul style="list-style-type: none"> • Design and program IoT devices 	C	3	2, 3
<ul style="list-style-type: none"> • Use real IoT protocols for communication 	C	2	2
<ul style="list-style-type: none"> • Develop a simple DSS using IoT to gather agriculture generated data 	P	3	4
<ul style="list-style-type: none"> • Transfer IoT data to the cloud and in between cloud providers 	P	3	4
<ul style="list-style-type: none"> • Define the infrastructure for supporting Commercialization of Product 	C	2	7
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)		
Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
Course Contents			



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Theory
Introduction: Overview and basics concepts of ICT, IoT and DSS in agriculture, Understanding of innovative and latest digital technologies including sensors, unmanned aerial vehicle (UAVs) robotics, communication networks, artificial intelligence, machine learning and big data analysis tools for agriculture and sustainable crop production; Basics of IoT: What is IoT?, IoT standards and protocols, IoT platform and applications, IoT product development for agriculture, IoT security in the Internet; IoT Development Platform: Introduction to Raspberry Pi as the core development platform; IoT Programming for Multi Sensors: Introduction to Python programming for IoT development, Introduction to GrovePi+/PiHat Shields as the multi-sensor platforms; Introduction to the Standard Lightweight IoT Protocol (MQTT): Open source industry IoT communication protocol namely Message Queue Telemetry Transport (MQTT); Polishing IoT systems for product pitching.
Practical
Basic hands-on for Raspberry Pi Operating system; Hands-on for using input/output pins for controlling IoT related sensors and devices (e.g., LED, Buttons, etc.) to gather agriculture-generated data; Hands on to setup and deploy multiple sensors for data collections (e.g., sensors: temperature, humidity, soil moisture, greenhouse gases, water, rainfall, light, current, vibration etc.); Hands on to enable sensor connectivity using machine-to-machine (M2M) communication; Hands on to extremely lightweight publish/subscribe messaging transport protocol on Raspberry Pi and PC/Laptop; Hands on to publish/subscribe data from multi-sensors; Hands on controlling/monitoring IoT sensors and systems using Mobile Application; Hands on to enhance the integration of IoT sensors and systems for seamless connectivity; Hands on to polishing the GUI for user-friendly interface; Commercialization pitching of the proposed IoT projects by students.
Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations.
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Singh, Garima and Gurjit Kaur. 2021. Digital Technologies for Smart Agriculture; Artificial Intelligence and IoT-Based Technologies for Sustainable Farming and Smart Agriculture, edited by Pradeep Tomar and Gurjit Kaur, IGI Global, pp. 54-67. http://doi:10.4018/978-1-7998-1722-2.ch004
Suggested Readings:
1. Hassan, Q.F. ed., 2018. <i>Internet of things A to Z: technologies and applications</i> . John Wiley & Sons, Hoboken, New Jersey 2. Singh, R., A. Gehlot, L.R. Gupta, B. Singh and M. Swain. 2019. <i>Internet of Things with Raspberry Pi and Arduino</i> . CRC Press. 3. Liyanage, M., A. Braeken, P. Kumar and M. Ylianttila. 2020. <i>IoT Security: Advances in Authentication</i> . John Wiley & Sons. UK 4. Serpanos, D. and M. Wolf. 2017. <i>Internet-of-things (IoT) systems: architectures, algorithms, methodologies</i> . Springer. Atlanta. USA