



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



Faculty of Social Sciences & Humanities
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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	10
Computer Science Core	18	5
DS Core (Domain Core)	18	6
DS Electives (Domain Electives)	12	4
TOTAL	130	40

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



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Technical & Business English Writing	3
Pakistan Studies	2
Professional Practices	3
Total Credits: 19	

University Elective Courses 12 Credit Hours

Course Code	Course Title	Credit Hour
MGT-305	Entrepreneurship	3
ECON-305	Principles of Economics	3
MGT-505	Organizational Behaviour	3
CS-508	IoT in Digital Agriculture	3
MGT-609	Principles of Accounting	3
SS-609	Principles of Psychology	3
Total Credits: 22		

Math and Science Foundation courses 12 Credit Hours

Course Title	Credit Hour
Calculus & Analytical Geometry	3
Linear Algebra	3
Probability & Statistics	3
Differential Equations	3
Total Credits: 12	

Computing Core Courses (Compulsory) Courses

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	



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Computer Science Core Courses 18 Credit Hours

Course Title	Credit Hour
Artificial Intelligence	4
Digital Logic Design	4
Analysis of Algorithms	3
Computer Organization & Assembly Language	4
Parallel & Distributed Computing	3
Total Credits:	18

DS Core Courses 18 Credit Hours

Course Title	Credit Hours
Advance Statistics	3 (3-0)
Introduction to Data Science	3 (2-1)
Data Mining	3 (2-1)
Data Visualization	3 (2-1)
Data Warehousing & Business Intelligence	3 (2-1)
Big Data Analytics	3 (2-1)
TOTAL	18 (13-5)

DS Electives 12 Credit Hours

Course Title	Credit Hours
Machine Learning	3 (2-1)
Deep Learning	3 (3-0)
Theory of Automata & Formal Languages	3 (3-0)
Cloud Computing	3 (3-0)
TOTAL	12 (11-1)



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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 BSDS are:

- a) F.Sc. (Pre-engineering) /ICS/A-Level students (with mathematics)/F.Sc. (Pre-medical)
- b) Minimum 50% marks in intermediate
- c) Reserve two (02) seats for DAE (specialized in electrical, electronics, and telecommunication) students

Deficiency:

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

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.		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
	UAM-301	Social & Religious Tolerance		2(2-0)		2
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 -	Calculus &		3(3-0)	Math & Sci.	3



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	306	Analytical Geometry			Foundation	
9.	ENG-308	Communication & Presentation Skills	ENG-309	3(3-0)	Gen Edu	3
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
	UAM-301	Citizenship Education & Community Engagement		3(2-1)		3
	QS-302	Quranic Studies		1(1-0)		1
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



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Total Credit Hours:						20
	QS-302	Quranic Studies		1(1-0)		1
Semester – V						
Sr. #	Course Code	Course Title	Pre-Requisite	Cr. Division	Category	Credit Hours
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.		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	3
28.	MATH-511	Differential Equations		3(3-0)	Math & Sci. Foundation	3
Total Credit Hours:						19
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.		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
	QS-302	Quranic Studies		1(1-0)		1
Summer Semester						
Internship						
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



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38.		Uni. Elective-IV		3(3-0)	Uni. Elective	3
Total Credit Hours:						15
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
	QS-302	Quranic Studies		1(1-0)		1
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
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Text Book:

1. Deitel, P. and H. Deitel. 2013. C++ How to Program. 9 th Ed. Prentice Hall, Upper Saddle River, NJ, USA.
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Suggested Readings:

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| <ol style="list-style-type: none">1. Hanly & Koffman. 2009. Problem Solving and Program Design in C, 6th edition. Addison-Wesley. Boston, MA, USA.2. Kochan, S. G. 2014, Programming in C. 4th 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.
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Suggested Readings:

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| <ol style="list-style-type: none">1. Wu, C. T 2010. An Introduction to Object-Oriented Programming with Java, 5th Ed. McGraw-Hill, Columbus, OH, USA.2. Horton, I. 2011. Beginning Java, 7th Ed. John Willey & Sons, Hoboken, NJ, USA.3. Schildt, H. 2009. Java the Complete Reference, 7th Ed. Pearson and Education, London, UK.4. Robert, L. and S. Simonson. 2010. Object Oriented Programming in C++. 4th 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. 9th 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. 4th 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:

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|---|
| 1. Elmasri, R. and S. Navathe. 2017. Fundamentals of Database Systems, 7 th Ed. Addison-Wesley, Boston, MA, USA. |
|---|

Suggested Readings:

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|--|
| 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. 10th Ed. Addison Wesley, Boston, MA, USA

Suggested Readings:

- 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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Computer Science Core (Compulsory) Courses

CS-312	DIGITAL LOGIC DESIGN	4(3-1)	
Learning Objectives			
<ul style="list-style-type: none"> The course introduces students with digital circuit of large complexity and how such circuits could be built in a methodological way, starting from Boolean logic and applying a set of rigorous techniques. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Acquire knowledge related to the concepts, tools and techniques for the design of digital electronic circuits. 	C	1	2
<ul style="list-style-type: none"> Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques. 	C	1, 2	2, 4
<ul style="list-style-type: none"> Apply the acquired knowledge to simulate and implement small-scale digital circuits. 	P	3	5
<ul style="list-style-type: none"> Understand the relationship between abstract logic characterizations and practical electrical implementations. 	C	2	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			
Number Systems; Logic Gates; Boolean Algebra; Combination logic circuits and designs; Simplification Methods (K-Map, Quinn Mc-Cluskey method); Flip Flops and Latches; Asynchronous and Synchronous circuits; Counters; Shift Registers; Counters; Triggered devices & its types; Binary Arithmetic and Arithmetic Circuits; Memory Elements; State Machines; Introduction Programmable Logic Devices (CPLD, FPGA); Lab Assignments using tools such as Verilog HDL/VHDL; MultiSim.			
Practical			
To learn the basics of the MIPS Assembly Language and Practice its programming.			



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Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations.
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Thomas L. F. 2015. Digital Fundamentals, 11 th Ed. Pearson Education, Boston, NJ, USA.
Suggested Readings:
1. Stephen, B. and Z. Vranesic. 2014 Fundamental of Digital Logic with Verilog Design, 3 rd Ed. McGraw-Hill, New York, NY, USA. 2. Thomas L. F. 2003. Digital fundamentals with VHDL, 8 th Ed. Prentice Hall, Upper Saddle River, NJ, USA. 3. Vaibbhav, T. 2016. Digital Logic Design using Verilog: Coding and RTL Synthesis. 2 nd Ed. Springer, New Dehli, India. 4. Nikrouz, F. 2015. Digital Logic Design and Computer Organization with Computer Architecture for Security. 1 st Ed. McGraw-Hill Education, New York, NY, USA.



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CS-403	COMPUTER ORGANIZATION & ASSEMBLY LANGUAGE	4(3-1)	
Learning Objectives			
<ul style="list-style-type: none"> This course covers the basics of computer organization with emphasis on the lower level abstraction of a computer system including digital logic, instruction set and assembly language programming. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Acquire the basic knowledge of computer organization, computer architecture and assembly language. 	C	1	2
<ul style="list-style-type: none"> Understand the concepts of basic computer organization, architecture, and assembly language techniques. 	C	1, 2	2
<ul style="list-style-type: none"> Solve the problems related to computer organization and assembly language. 	P	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			
Introduction to computer systems: Information is bits and context; programs are translated by other programs into different forms; it pays to understand how compilation systems work; processors read and interpret instructions stored in memory; caches matter; storage devices form a hierarchy; the operating system manages the hardware; systems communicate with other systems using networks; Representing and manipulating information: information storage; integer representations; integer arithmetic; floating point; Machine-level representation of programs: a historical perspective; program encodings; data formats; accessing information; arithmetic and logical operations; control; procedures; array allocation and access; heterogeneous data structures; putting it together: understanding pointers; life in the real world: using the gdb debugger; out- of-bounds memory references and buffer overflow; x86-64: extending ia32 to 64 bits; machine-level representations of floating-point programs; Processor architecture: the Y86 instruction set architecture; logic design and the Hardware Control Language (HCL); sequential Y86 implementations; general principles of pipelining; pipelined Y86 implementations.			
Practical			



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To learn the basics of the MIPS Assembly Language and Practice its programming.
Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. David, A. P. and J. L. Hennessy. 2018. Computer Organization and Design the hardware/software interface. MA Morgan Kaufman Publishers, Cambridge, MA, USA.
Suggested Readings:
1. Erl, T. 2008. Soa: principles of service design. Prentice Hall, Upper Saddle River, NJ, USA. 2. Godse, A. P. and D. A. Godse. 2013. Computer Architecture Organization, Technical Publication, Pune, India. 3. Hamacher, V. C., Vranesic, Z. G., Zaky, S. G., Vransic, Z., & Zakay, S. (1996). Computer organization. McGraw-Hill, New York City, NY, USA. 4. Stallings, W. 2018. Computer Organization and architecture designing for performance. Pearson Education, Hoboken, UK.



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CS-409	ARTIFICIAL INTELLIGENCE			4(3-1)
Learning Objectives				
<ul style="list-style-type: none"> • This course will introduce the basic principles in artificial intelligence. • To cover simple representation schemes, problem solving paradigms. • The Prolog programming language will also be introduced 				
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 different types of AI agents. 	C	2	2	
<ul style="list-style-type: none"> • Know how to build simple knowledge-based systems. 	C	3	2	
<ul style="list-style-type: none"> • Apply knowledge representation, reasoning, and machine learning techniques to real-world problems. 	C	4	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				
Artificial Intelligence: Introduction; AI paradigms and hypothesis; Intelligent agents; Difference between cybernetic Intelligence and artificial Intelligence; Objectives; Scope of weak and strong AI; Problem solving; Solving Problems by searching; Informed search and exploration; Constraint satisfaction problems; Adversarial search; Knowledge and reasoning; Logical agents, First-order logic, Inference in first-order logic; Knowledge representation; Planning and acting in the real world; Uncertain knowledge and reasoning; Uncertainty; Probabilistic reasoning; Probabilistic reasoning over time; Making simple decisions; Making complex decisions; Learning, learning from observations; Knowledge in learning; Learning methods; Reinforcement learning; Communicating; Perceiving and acting; Probabilistic language processing; Perception and robotics; LISP/PROLOG; Expert systems (ES) and applications; Artificial general Intelligence; Issues in safe AI; Introduction to cognitive and conscious systems				
Practical				
Differences between propositional logic: first-order logic, fuzzy logic and default logic; 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:				
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam				
Text Book:				



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1. Bratko, I. 2001. Prolog Programming for Artificial Intelligence. 4th Ed. Addison Wesley, Boston, MA, USA

Suggested Readings:

1. George, F. 2008. Structures and Strategies for Complex Problem Solving 6th Ed. Pearson Education, London, UK.
2. Margulies, P. 2004. Artificial Intelligence. Blackbirch Press, Farmington Hills, MI, USA.
3. Noah, .B and T. Gale. 2011. Artificial Intelligence. Greenhaven Press, Farmington Hills, MI, USA
4. 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-408	DESIGN & ANALYSIS OF ALGORITHMS	3(3-0)	
Learning Objectives			
<ul style="list-style-type: none"> The course introduces students with the basic notions of the design of algorithms and the underlying data structures. Students will learn about several measures regarding the structure, complexity, and efficiency of 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"> Explain what is meant by “best”, “expected”, and “worst” case behavior of an algorithm. 	C	1	1, 2
<ul style="list-style-type: none"> Identify the characteristics of data and/or other conditions or assumptions that lead to different behaviors. 	C	2	2, 3
<ul style="list-style-type: none"> Determine informally the time and space complexity of simple algorithms. 	C	2	2
<ul style="list-style-type: none"> List and contrast standard complexity classes 	C	4	3
<ul style="list-style-type: none"> Use big O, Omega, Theta notation formally to give asymptotic upper bounds on time and space complexity of algorithms. 	C	4	3
<ul style="list-style-type: none"> Use of the strategies (brute-force, greedy, divide-and- conquer, and dynamic programming) to solve an appropriate problem. 	C	3	3
<ul style="list-style-type: none"> Solve problems using graph algorithms, including single- source and all-pairs shortest paths, and at least one minimum spanning tree algorithm. 	C	3	3
<ul style="list-style-type: none"> Trace and/or implement a string-matching algorithm. 	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			



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Course Contents
Theory
Introduction: role of algorithms in computing; Analysis on nature of input and size of input Asymptotic notations; Big-O, Big Ω , Big Θ ; little-o, little- ω ; Sorting Algorithm analysis; loop invariants; Recursion and recurrence relations; Algorithm Design Techniques: Brute Force Approach, Divide-and-conquer approach; Merge, Quick Sort; Greedy approach; Dynamic programming; Elements of Dynamic Programming; Search trees; Heaps; Hashing; Graph algorithms; shortest paths; sparse graphs; String matching; Introduction to complexity classes.
Teaching Methodology:
Lectures, Written Assignments, Semester Project.
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Final Exam
Text Book:
1. Cormen, T.H., C. E. Leiserson, E. L. Rivest, and C. Stein. 2009. <i>Introduction to algorithms</i> . 3 rd edition, MIT press. Cambridge, USA
Suggested Readings:
<ol style="list-style-type: none"> 1. Alfred, V., S. Ravi and D. Ullman. 2006. <i>Compilers Principles Techniques and Tools</i>. 2nd Ed. Wesley Pub, Lancing, MI, USA. 2. Amet, H. 1990. <i>The Design and Analysis of Spatial Data</i>. Wesley Series in Computer Science. Boston, MA, USA 3. Dick, G., E. Henri and J. H. Jacobs. 2010. <i>Modern Compiler Design</i>, 2nd Ed. John Wiley, New York City, NY, USA. 4. Kumar, V., A. Grama, A. Gupta and G. Karypis. 1994. <i>Introduction to Parallel Computing Design and Analysis of Algorithms</i>. Redwood City, Benjamin. 5. Lee, R. and S. S. Tseng and R. C. Chang. 2005. <i>Introduction to The Design and Analysis of Algorithms</i>. McGraw Hill Higher Education, London, UK.



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CS-510	PARALLEL & DISTRIBUTED COMPUTING		3(2-1)
Learning Objectives			
This course will address issues in the design of parallel and distributed systems focusing on:-Architectural Models, Software System Models, Models of Synchrony Processes and Threads and Synchronisation			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> Learn about parallel and distributed computers. 	C	1	2
<ul style="list-style-type: none"> Write portable programs for parallel or distributed architectures using Message-Passing Interface (MPI)library 	C	2	2
<ul style="list-style-type: none"> Analytical modelling and performance of parallel programs 	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			
Asynchronous/synchronous computation/communication; Concurrency control, fault tolerance; GPU architecture and programming, heterogeneity: Interconnection topologies; Load balancing; Memory consistency model; Memory hierarchies; Message passing interface (MPI); MIMD/SIMD; Multithreaded programming; Parallel algorithms & architectures, parallel I/O; Performance analysis and tuning; Programming models (data parallel, task parallel, process-centric, shared/distributed memory); Scalability and performance studies; Scheduling; Storage systems; Synchronization and tools (Cuda, Swift, Globus, Condor, Amazon AWS, OpenStack, Cilk, gdb, threads, MPICH, OpenMP, Hadoop, FUSE).			
Teaching Methodology:			
Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment:			
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam			
Textbook			
1. A. S. Tanenbaum and M. V. Steen. 2007. Distributed Systems: Principles and Paradigms, Prentice Hall, NJ, USA.			
Suggested Readings:			
1. Erl, T. 2008. Soa: principles of service design. Prentice Hall, Upper Saddle River, NJ,			



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USA.

2. Godse, A. P. and D. A. Godse. 2013. Computer Architecture Organization, Technical Publication, Pune, India.
3. Hamacher, V. C., Vranesic, Z. G., Zaky, S. G., Vransic, Z., & Zakay, S. (1996). Computer organization. McGraw-Hill, New York City, NY, USA.
4. David, A. P. and J. L. Hennessy. 2018. Computer Organization and Design the hardware/software interface. MA Morgan Kaufman Publishers, Cambridge, MA, USA.



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Data Science Core (Compulsory) Courses

CS-410	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			



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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

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. Igal, 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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CS-509	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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CS-502	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*
<ul style="list-style-type: none"> • Understand the fundamental concepts of Big Data and its programming paradigm. 	C	2
<ul style="list-style-type: none"> • Hadoop/MapReduce Programming, Framework, and Ecosystem 	C	3
<ul style="list-style-type: none"> • Apache Spark Programming 	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 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 Reilly 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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CS-504	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-605	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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CS-602	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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General Education Courses

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
<ul style="list-style-type: none"> • Understand basics of computing technology 		C	1	2
<ul style="list-style-type: none"> • Perform number systems conversions and arithmetic 		C	2	3
<ul style="list-style-type: none"> • Know about different types of software & hardware 		C	2	2
<ul style="list-style-type: none"> • 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				



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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: 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-307	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*	PLO
<ul style="list-style-type: none"> • Learn about the History and Ideology of Pakistan. 		C	1	1
<ul style="list-style-type: none"> • Get knowledge about the political and administrative structure of Pakistan. 		C	2	1
<ul style="list-style-type: none"> • Get familiarity about the political transitions in Pakistan. 		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				
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				
Textbook				
1. The Emergence of Pakistan, Chaudary M., 1967				
Suggested Readings				
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. 2 nd Ed. Five Star				



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Publishing, Lahore, Pakistan.

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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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 York City, NY, 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			



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1. Practical Business English, Collen Vawdrey, 1993, ISBN = 0256192740

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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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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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			
<p>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.</p>			
Teaching Methodology			
Lectures, Written Assignments, Semester Project, Presentations			
Course Assessment			



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

Text Book

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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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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Data Science Elective Courses

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:			



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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 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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CS-506	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	
Describe basic machine learning concepts, theories and applications.	C	1	2	
Apply supervised learning techniques to solve classification problems of moderate complexity.	C	3	2	
Apply unsupervised learning techniques to solve clustering problems of moderate complexity	C	3	2	
Apply reinforcement learning algorithms to environments with complex dynamics.	C	3	2	
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				
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:				
Alpaydin, E. 2016. Machine Learning: The New AI/Ethem Alpaydin. MIT Press, USA.				
Suggested Readings:				
2. Bishop, C. 2006. Pattern Recognition and Machine Learning, Springer-Verlag, NY, USA.				



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3. 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.
 4. Marsland, S. 2015. Machine learning: An Algorithmic Perspective, CRC Press, Boca Raton, London, UK.
- Murty, M. N and V. S. Devi. 2015, Introduction to pattern recognition and machine learning, World Scientific. IISc Press, Singapore.



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CS-601	DEEP LEARNING		3(2-1)
Learning Objectives			
This course will enable the students to:			
<ul style="list-style-type: none"> • gain 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, dropoutconnect; Novel architectures, ResNet, GoogleNet, etc.			
Teaching Methodology:			
Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
Course Assessment:			



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Textbook:

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-603	CLOUD COMPUTING	3(3-0)	
Learning Objectives			
This course will enable the students to: <ul style="list-style-type: none"> • Understand the definition and essential characteristics of cloud computing, its history, the business case for cloud computing, and emerging technology usecases enabled by cloud. • Learn about the various cloud service models (IaaS, PaaS, SaaS) and deployment models (Public, Private, Hybrid) and the key components of a cloud infrastructure (VMs, Networking, Storage - File, Block, Object, CDN). • Understand basics of cloud security, monitoring, and different job roles in the cloud industry. 			
Learning Outcomes			
At the end of the course the students will be able to:	Domain	BT Level*	PLO
<ul style="list-style-type: none"> • Define cloud computing and explain its essential characteristics, history, the business case for cloud, and emerging technologies enabled by cloud. 	C	3	2
<ul style="list-style-type: none"> • Explain emerging Cloud related trends including Hybrid Multicloud, Microservices, Serverless, Cloud Native, DevOps and Application Modernization 	C	4	3
<ul style="list-style-type: none"> • Describe the cloud service (IaaS, SaaS, PaaS) & deployment models (Public, Private, Hybrid), and its infrastructure - VMs, Networking, Storage 	C	5	4
<ul style="list-style-type: none"> • Create a Cloud account and work hands-on with Cloud services, such as Object Storage 	P	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			



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Theory
Overview of cloud computing: Definition and Essential Characteristics of Cloud Computing; History and Evolution of Cloud Computing; Key Considerations for Cloud Computing; Key Cloud Service Providers and Their Services; Cloud Adoption - No longer a choice; Cloud Adoption - Some case studies; Internet of Things in the Cloud; Artificial Intelligence on the Cloud; Blockchain and Analytics in the Cloud. Cloud Computing Models: IaaS - Infrastructure as a Service; PaaS - Platform as a Service; SaaS - Software as a Service; Public Cloud; Private Cloud; Hybrid Cloud. Components of Cloud Computing: <u>Overview of Cloud Infrastructure</u> ; Virtualization and Virtual Machines Explained; Types of Virtual Machines; Bare Metal Servers; Secure Networking in Cloud; Containers; Basics of Storage on Cloud; File Storage; Block Storage; Object Storage Overview; Object Storage - Tiers and APIs; CDN - Content Delivery Networks. Emergent Trends and Practices: <u>Hybrid Multi-cloud</u> ; Microservices; Serverless Computing; Cloud Native Applications; DevOps on the Cloud; Application Modernization. Cloud Security and Monitoring: What is Cloud Security; Identity and Access Management; Cloud Encryption; Cloud Monitoring Basics and Benefits; Case Studies in Different Industry Verticals; Career Opportunities and Job Roles in Cloud Computing.
Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment:
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam
Textbook:
Dowling, J. 2019. Introduction to Cloud Computing. Royal Institute of Technology. KTH. (https://www.kth.se/social/files/554fa451f276544829be2e5e/9-cloud-computing.pdf)
Suggested Readings:
<ol style="list-style-type: none"> 1. Lee-Post, A., and Pakath, R. 2014. Cloud computing: a comprehensive introduction. In <i>Security, Trust, and Regulatory Aspects of Cloud Computing in Business Environments</i> (pp. 1-23). IGI Global. 2. Hurwitz, J., Kaufman, M., and Halper, F. Cloud Services for Dummies, IBM Limited Edition. John and Wiley Sons. Hoboken. New Jersey, USA. (https://www.ibm.com/cloud-computing/files/cloud-for-dummies.pdf) 3. Krutz, R. L., & Vines, R. D. 2010. <i>Cloud security: A comprehensive guide to secure cloud computing</i>. Wiley Publishing.



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Mathematics and Science Foundation Courses

MATH-306	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:			
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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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MATH-405	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.Kincaid. 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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STAT-412	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-511	DIFFERENTIAL EQUATIONS			3(3-0)
Learning Objective				
<ul style="list-style-type: none"> The course develops students' fundamental skills of solving ordinary differential equations, and developing differential equations for real-world 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"> Identify, analyze and subsequently solve physical situations whose behavior can be described by ordinary differential equations. 	C	2, 3	2, 3	
<ul style="list-style-type: none"> Determine solutions to first order separable differential equations 	C	2	3	
<ul style="list-style-type: none"> Determine solutions to first order linear differential equations. 	C	2	3	
<ul style="list-style-type: none"> Determine solutions to first order exact differential equations. 	C	2	3	
<ul style="list-style-type: none"> Determine solutions to second order linear homogeneous and non-homogeneous differential equations with constant coefficients. 	C	2	3	
* 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				
Ordinary differential equations of the first order; Geometrical considerations; Isoclines; Separable equations; Equations reducible to separable form; Exact differential equations; Integrating factors; Linear first-order differential equations; Variation of parameters; Ordinary linear differential equations; Homogeneous linear equations of the second order; Homogeneous second order equations with constant coefficients; General solution; Real roots; Complex roots; Double root of the characteristic equation; Differential operators; Cauchy equation; Homogeneous linear equations of arbitrary order; Homogeneous linear equations of arbitrary order with constant coefficients; Non-homogeneous linear equations; Modeling of electrical circuits; Systems of differential equations; Series solutions of differential equations; Partial differential equations; Method of separation of variables; Laplace equations and their solutions by fourier series method.				
Teaching Methodology				
Lectures, Written Assignments, Semester Project, Presentations				
Course Assessment				



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Text Book

1. Dennis, G. Z. and R. C. Michael. 1996. Differential Equations with Boundary Value Problems. Brooks/Cole Publishing, New York City, NY, USA.

Suggested Readings

1. Edwards, C. H. and E. David. 1993. Elementary Differential Equations with Applications. Penney, Prentice Hall, Upper Saddle River, NJ, USA.
2. Erwin, K. 1993, Advanced Engineering Mathematics. 7th Ed. John Wiley & Sons Inc, Hoboken, NJ, USA.
3. Michael, G. 1996. Advanced Engineering Mathematic, Prentice Hall Publishers, Upper Saddle River, NJ, USA.
4. Prindle, Z. and W. Schmidt. 1996. A First Course in Differential Equation. Brooks/Cole Publishing, New York City, NY, USA.



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University Elective Courses

MGT-305	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*
<ul style="list-style-type: none"> • Understand processes, and resources within a diverse organization 	C	2
<ul style="list-style-type: none"> • Apply knowledge of leadership concepts in an integrated manner 	C	3
<ul style="list-style-type: none"> • Analyze the internal/external factors affecting a business. 	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		
<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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ECON-305	Principles of Economics		3(3-0)
Learning Objectives			
This course will enable the students to:			
<ul style="list-style-type: none"> • Make students understand the key sectors of economy of Pakistan and contemporary issues in agriculture, industry and financial and social sector. • Make students understand current policies in trade, commerce, fiscal/monetary policy, industry and agriculture. • Let the students have a comprehensive knowledge about the current statistics of the various aspects of the 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"> • 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			
Introduction to Pakistan economy; Concept of economic development and economic growth; What is the difference between the both terms; Measurement of economic development; Determinants of economic development; What are the major determinants of economic development; What are the main measurement of economic development and common characteristics of under-develop economics; Theories of development; What is the theory of vicious circle of poverty; What is demand side vicious circle of poverty and supply side vicious circle of poverty; Capital formation; Main sources of capital formation; Importance of capital formation, causes of low capital formation in Pakistan, suggestions how to improve it; Explain the small & large industry growth, how it is growing. Problems of small & large scale industry ; Foreign Trade; Why it is important for economy; Export promotion measures and BOT & BOP. ; Foreign debt and foreign aid; Role, importance, types, problems, solutions; Transportation and communication; How transportation and communication plays an important role in development.			



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Teaching Methodology:
Lectures, Written Assignments, Presentations
Course Assessment:
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam
Text Book:
Baye, M. R., J. Prince and J.Squalli. 2006. Managerial Economics and Business Strategy, 5th Ed. McGraw-Hill, NY, USA.
Suggested Readings:
1. Donald.N.S.2011, Managerial Economics: Concepts and Principles. 1st Ed. Business Expert Press, New York, NY, USA. 2. 3. Ivan. P. 2016. Managerial Economics. 5th Ed. Abingdon, Oxon, Routledge, NY, USA. 3. 4. Keat, P., and P. K. Young. 2008. Managerial Economics. 6th Ed. Prentice Hall, Upper Saddle River, NJ, USA. 4. 5. Thomas, C. and S. C. Maurice. 2010. Business Economics, 10th Ed. Mc Graw-Hill, India.



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MGT-505	ORGANISATIONAL BEHAVIOUR		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
• Provide a basic knowledge of main ideas	C	2	2
• Develop an understanding of these and of related ideas and concepts	C	3	2
• Develop skills in diagnosis and problem solving	C	4	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 OB; People-centered organizations and ethical conduct; Organizational culture; Socialization; Mentoring; Key individual differences; Values, attitudes, job satisfaction and counterproductive work behaviors; Social perceptions and attributions; Foundations of motivation; Improving job performance with goals, feedback, rewards, and positive reinforcement; Group dynamics; Developing and leading effective teams; Individual and group decision making; Managing conflict and negotiating; Communicating in the digital age; Leadership, influence, empowerment, and politics; Organizational design.			
Teaching Methodology:			
Lectures, Written Assignments, Presentations			
Course Assessment:			
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam			
Text Book:			
1. Huczynski, A. and A.D.Buchanan 2010. Organizational Behaviour. Financial Times Prentice Hall, Upper Saddle River, NJ, USA.			



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Suggested Readings:

1. Johnson, C.E.2011. Meeting the Ethical Challenges of Leadership: Casting Light or Shadow. 4th Ed. SAGE Publications, Thousand Oaks, CA, USA.
2. Kreitner, R. and A. Kinicki.2012. Organizational Behavior. 10th Ed. McGraw- Hill, New York, NY, USA.
3. Parikh,P. 2009. Value Investing and Behavioral Finance. Tata McGraw-Hill Education, India.
4. Robbins, P. and T.A. Judge. 2012. Organizational Behavior. 15th Ed. Prentice Hall, Upper Saddle River, NJ, USA.



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CS-508	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			



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Course Contents
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,</i>



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algorithms, methodologies. Springer. Atlanta. USA



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MGT-609	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-609	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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