BS (Computer 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 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

Computing Core Courses

CS-303	PROGRAMMING FUNDAMENTALS	4(3-1)

Learning Objectives

- 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
• **Understand** basic problem-solving steps and logic constructs	C	2	2
• **Apply** basic programing concepts	C	3	2
• 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

Course Assessment:

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

Text Book:

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

Suggested Readings:

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.

CS-304	OBJECT ORIENTED PROGRAMMING	4(3-1)

Learning Objectives

- 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
• **Understand** principles of object oriented paradigm.	C	2	2
• **Identify** the objects & their relationships to build object oriented solution	C	3	3
• **Model** a solution for a given problem using object oriented principles	C	3	4
• **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

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Deitel, P.and H. Deitel. 2015. Java: How to Program 10th Ed. Prentice Hall, Upper Saddle River, NJ, USA.
Suggested Readings:
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.

CS-401	DATA STRUCTURES AND ALGORITHMS	4(3-1)

Learning Objectives

- 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
• Implement various data structures and their algorithms, and **apply** them in implementing simple applications.	C	2, 3	2
• **Analyze** simple algorithms and determine their complexities.	C	4, 5	3
• **Apply** the knowledge of data structures to other application domains.	C	3	2
• **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:

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++**. 3rd Ed. Pearson, Harlow, UK.
Suggested Readings:
1. Elliot, B.K. and A.T.Paul.2016. Data Structures: Abstraction and Design using Java. 3rd 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++. 3rd Ed. Sydney, Australia.

CS-302	DISCRETE STRUCTURES	3(3-0)

Learning Objectives

- 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
• **Understand** the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs, and Trees etc.	C	2	2
• **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
• **Apply** discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography.	C	3	2
• **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.

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. 7th Ed. Prentice Hall, New York, NY, USA.
Suggested Readings:
1. Kenneth H. R. and K.Krithivasan. 2013. Discrete Mathematics and its Applications. 7th Ed. McGraw-Hill, Singapore. 2. Ralph P.G. 1994. Discrete and Combinatorial Mathematics: An Applied Introduction. 5th 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.

CS-404	OPEARTING SYSTEM	4(3-1)

Learning Objectives

- 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
• **Understand** the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems.	C	2	2
• **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
• **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
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. Raggo, M.T and C. Hosmer. 2013. Data Hiding Exposing Concealed Data in Multimedia, Operating Systems, Mobile Devices and Network Protocols. Syngress, Waltham, MA, USA.

CS-406	DATABASE SYSTEMS	4(3-1)

Learning Objectives

- 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
• **Explain** fundamental database concepts.	C	2	2
• **Design** conceptual, logical and physical database schemas using different data models.	C	5	4
• **Identify** functional dependencies and resolve database anomalies by normalizing database tables.	C	2	3
• **Use** Structured Query Language (SQL) for database definition and manipulation in any DBMS	C	4	5

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)

Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system

Course Contents

Theory

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

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

CS-402	SOFTWARE ENGINEERING	3(3-0)

Learning Objectives

- 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
• **Describe** various software engineering processes and activities	C	1	2
• **Apply** the system modeling techniques to model a medium size software system	C	3	2
• **Apply** software quality assurance and testing principles to medium size software system.	C	4	2
• **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
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.

CS-501	COMPUTER NETWORKS	4(3-1)

Learning Objectives

- 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
• **Describe** the key terminologies and technologies of computer networks	C	2	2
• **Explain** the services and functions provided by each layer in the Internet protocol stack.	C	2	2
• **Identify** various internetworking devices and protocols, and their functions in a network.	C	4	3
• **Analyze** working and performance of key technologies, algorithms and protocols.	C	4	3
• **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.

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, 5th 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. 7th Ed. Pearson Education, Harlow, UK. 2. Stallings, W. 2004. Data and Computer Communications. 6th 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. 6th Ed. Pearson Education, Harlow, UK.

CS-507	INFORMATION SECURITY	3(3-0)

Learning Objectives

- 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
• **Explain** key concepts of information security such as design principles, cryptography, risk management, and ethics.	C	2	2
• **Discuss** legal, ethical, and professional issues in information security.	A	2	2
• **Apply** various security and risk management tools for achieving information security and privacy.	C	3	2
• **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

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.

Computer Science Core (Compulsory) Courses

CS-508	COMPILER CONSTRUCTION	3(2-1)

Learning Objectives

- Students will understand the overall structure of a compiler, and will know significant details of a number of important techniques commonly used.
- They will be aware of the way in which language features raise challenges for compiler builders.

Learning Outcomes

At the end of the course the students will be able to:	Domain	BT Level*	PLO
• **Understand** the basic techniques used in compiler construction such as lexical analysis, top-down, bottom-up parsing, context-sensitive analysis, and intermediate code generation.	C	1	2
• **Understand** the basic data structures used in compiler construction such as abstract syntax trees, symbol tables, three-address code, and stack machines.	C	1, 2	2
• **Design** and **implement** a compiler using a software engineering approach.	C	3	4
• **Use** generators (e.g., Lex and Yacc)	P	1	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

Introduction to interpreter and compiler; Compiler techniques and methodology; Organization of compilers; Lexical and syntax analysis; Parsing techniques; Types of parsers; top-down parsing; bottom-up parsing; Type checking; Semantic analyser; Object code generation and optimization; detection and recovery from errors.

Practical

Utilize tools to automate compiler construction; Comprehend how to perform parsing (top down and bottom up); Perform elementary semantic analysis checks on an abstract syntax tree; Generating code for a target assembly language.
Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Alfred, V., S. Ravi and D. Ullman. 2006. Compilers Principles Techniques and Tools. 2nd Ed. Wesley Pub, Lancing, MI, USA.
Suggested Readings:
1. Andrew, W. A. and M. Ginsburg. 2004. Modern Compiler Implementation in C. Cambridge University Press, Cambridge, UK. 2. Dick, G., E. B. Henri and J. H. Jacobs. Modern Compiler Design. 2nd Ed. John Wiley, Hoboken, NJ, USA. 3. Dick, G., E. B. Henri and J. H. Jacobs. 2012. Modern Compiler Design. 2nd Edition, John Wiley & Sons. Hoboken, NJ, USA. 4. William, M. W. 2013. Compiler construction. Springer-Verlag, New York, USA.

CS-403	COMPUTER ORGANIZATION & ASSEMBLY LANGUAGE	4(3-1)

Learning Objectives

- 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
• **Acquire** the basic knowledge of computer organization, computer architecture and assembly language.	C	1	2
• **Understand** the concepts of basic computer organization, architecture, and assembly language techniques.	C	1, 2	2
• **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

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 Organiztion, 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.

CS-312	DIGITAL LOGIC DESIGN	4(3-1)

Learning Objectives

- 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
• Acquire knowledge related to the concepts, tools and techniques for the design of digital electronic circuits.	C	1	2
• Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques.	C	1, 2	2, 4
• Apply the acquired knowledge to simulate and implement small-scale digital circuits.	P	3	5
• 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.

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, 11th Ed. Pearson Education, Boston, NJ, USA.
Suggested Readings:
1. Stephen,B. and Z. Vranesic. 2014 Fundamental of Digital Logic with Verilog Design, 3rd Ed. McGraw-Hill, New York, NY, USA. 2. Thomas L. F. 2003. Digital fundamentals with VHDL, 8th Ed. Prentice Hall, Upper Saddle River, NJ, USA. 3. Vaibbhav, T. 2016. Digital Logic Design using Verilog: Coding and RTL Synthesis. 2nd Ed. Springer, New Dehli, India. 4. Nikrouz, F.2015. Digital Logic Design and Computer Organization with Computer Architecture for Security**.** 1st Ed. McGraw-Hill Education, New York, NY, USA.

CS-408	DESIGN & ANALYSIS OF ALGORITHMS	3(3-0)

Learning Objectives

- 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
• Explain what is meant by "best", "expected", and "worst" case behavior of an algorithm.	C	1	1, 2
• Identify the characteristics of data and/or other conditions or assumptions that lead to different behaviors.	C	2	2, 3
• Determine informally the time and space complexity of simple algorithms.	C	2	2
• List and contrast standard complexity classes	C	4	3
• Use big O, Omega, Theta notation formally to give asymptotic upper bounds on time and space complexity of algorithms.	C	4	3
• Use of the strategies (brute-force, greedy, divide-and- conquer, and dynamic programming) to solve an appropriate problem.	C	3	3
• Solve problems using graph algorithms, including single- source and all-pairs shortest paths, and at least one minimum spanning tree algorithm.	C	3	3
• 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
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. *Introduction to algorithms*. 3rd edition, MIT press. Cambridge, USA
Suggested Readings:
1. Alfred, V., S. Ravi and D. Ullman. 2006. Compilers Principles Techniques and Tools. 2nd Ed. Wesley Pub, Lancing, MI, USA. 2. Amet, H. 1990. The Design and Analysis of Spatial Data. Wesley Series in Computer Science. Boston, MA, USA 3. Dick, G., E. Henri and J. H. Jacobs. 2010. Modern Compiler Design, 2nd Ed. John Wiley, New York City, NY, USA. 4. Kumar, V., A. Grama, A. Gupta and G. Karypis. 1994. Introduction to Parallel Computing Design and Analysis of Algorithms. Redwood City, Benjamin. 5. Lee, R. and S. S. Tseng and R. C. Chang. 2005. Introduction to The Design and Analysis of Algorithms. McGraw Hill Higher Education, London, UK.

CS-510	PARALLEL & DISTRIBUTED COMPUTING	3(3-0)

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
• Learn about parallel and distributed computers.	C	1	2
• Write portable programs for parallel or distributed architectures using Message-Passing Interface (MPI)library	C	2	2
• 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, USA.
2. Godse, A. P. and D. A. Godse. 2013. Computer Architecture Organiztion, 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.

CS-502	ARTIFICIAL INTELLIGENCE	4(3-1)

Learning Objectives

- 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
• Understand different types of AI agents.	C	**2**	2
• Know how to build simple knowledge-based systems.	C	3	2
• 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:
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

CS-503	THEORY OF AUTOMATA	3(3-0)

Learning Objective

- The course introduces students with fundamental concepts of automata theory and formal languages.
- 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
• Explain and manipulate the different concepts in automata theory and formal languages such as formal proofs, automata, regular expressions, Turing machines etc.	C	2	2
• Prove properties of languages, grammars and automata with rigorously formal mathematical methods	C	2	3
• Design of automata, RE and CFG	C	3	4
• Transform between equivalent NFAs, DFAs and REs	C	3	3
• Define Turing machines performing simple tasks	C	2	2
• Differentiate and manipulate formal descriptions of languages, automata and grammars with focus on regular and context-free languages, 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

Finite State Models; Language definitions preliminaries: Regular expressions/Regular languages: Finite automata (FAs): Transition graphs (TGs): NFAs, Kleene's theorem: Transducers (automata with output): Pumping lemma and non-regular language Grammars and PDA; CFGs: Derivations: derivation trees and ambiguity: Simplifying CFLs: Normal form grammars and parsing: Decidability: Context sensitive languages: grammars and linear bounded automata (LBA): Chomsky's hierarchy of grammars Turing Machines Theory; Turing machines: Post machine: Variations on TM: TM encoding: Universal Turing Machine: Defining Computers by TMs.

Teaching Methodology
Lectures, Written Assignments, Semester Project, Presentations
Course Assessment
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book
1. Alfred, V., S. Ravi and D. Ullman. 2006. Compilers Principles Techniques and Tools. 2nd Ed. Wesley Pub, Lancing, MI, USA.
Suggested Readings
1. Andrew, W. and A. Appel. 2004. Modern Compiler Implementation in C. Cambridge University Press, Cambridge, UK. 2. Dick, G., E. Henri and J. H. Jacobs. 2010. Modern Compiler Design. 2nd Ed. John Wiley, New York City, NY, USA. 3. 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. 4. Masami, I. 2004. Algebraic Theory of Automata and Languages. World Scientific, River Edge, NJ, USA.

General Education Courses

ENG-309	ENGLISH COMPOSITION & COMPREHENSION	3(3-0)

Learning Objective

- 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
• Interact with academic content: reading, writing, listening and speaking.	C	1	1
• Demonstrate ability to think critically	C	1	1
• 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. 4th Ed. Heinle & Heinle Inc., Boston, MA, USA.
4. Vawdrey C. 1993. Practical Business English. 2nd Ed. Richard d Irwin Publishing, New York City, NY, USA.

ENG-407	TECHNICAL AND BUSINESS ENGLISH WRITING	3(3-0)

Learning Objective

- 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
• Enhance the Skills regarding primary and library research to discover and employ information.	C	1	1
• Enhance correspondence Skills (learning the generic conventions of each).	C	1	1
• Polish the excellent writing skills with no spelling mistakes.	C	3	7

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

SDGS addressed in the course	4(Quality Education)

Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.

Course Contents

Theory

Overview of technical reporting; use of library and information gathering: administering questionnaires: reviewing the gathered information; Technical exposition; topical arrangement: exemplification: definition: classification and division: casual analysis: effective exposition: technical narration: description and argumentation: persuasive strategy: Organizing information and generation solution; brainstorming: organizing material: construction of the formal outline: outlining conventions: electronic communication: generation solutions: Polishing style; paragraphs: listening sentence structure: clarity: length and order: pomposity: empty words: pompous vocabulary: document design; document structure: preamble: summaries: abstracts: table of contents: footnotes: glossaries: cross referencing: plagiarism: citation and bibliography: glossaries: index: appendices: typesetting systems: creating the professional report; elements: mechanical elements and graphical elements: Reports; Proposals: progress reports: Leaflets: brochures: handbooks: magazines articles: research papers: feasibility reports: project reports: technical research reports: manuals and documentation: thesis; Electronic documents: Linear verses hierarchical structure documents.

Teaching Methodology

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book
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.

ENG-308	COMMUNICATION & PRESENTATION SKILLS	3(3-0)

Learning Objective

- 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
• Enrich the thought and culture and provides us with the most important international vehicle of expression.	C	1	1
• Enhance English language skills of the students and develop their critical thinking.	C	1, 3	1
• Demonstrate ability to think critically	C	3	7

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

SDGS addressed in the course	4(Quality Education)

Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.

Course Contents

Theory

Principles of writing good English; understanding the composition process: writing clearly; words: sentence and paragraphs; Comprehension and expression; Use of grammar and punctuation; Process of writing; observing: audience collecting: composing: drafting and revising: persuasive writing: reading skills: listening skills and comprehension: skills for taking notes in class: skills for exams; Business communications; planning messages: writing concise but with impact: Letter formats; mechanics of business: letter writing: letters: memo and applications; summaries: proposals: writing resumes: styles and formats: oral communications: verbal and non-verbal communication: conducting meetings; small group communication: taking minutes: Presentation skills; presentation strategies: defining the objective: scope and audience of the presentation: material gathering material organization strategies: time management; opening and concluding: use of audio-visual aids: delivery and presentation.

Teaching Methodology

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment

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

Text Book

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

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.

SSH-607	PROFESSIONAL PRACTICES	3(3-0)

Learning Objective

- 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
• Know the scope of computing field after graduating in it and what are the common things in every organization	C	1	1
• Distinguish between various fields of computing	C	2	1
• Describe the core of any profession.	C	1	1
• Know that how business and professional environment of computing field work	A	2	1
• Adhere the responsibilities according to profession, organization, and himself/herself	A	3	9
• Know the standards, tools, and rules about IPs and information security	C	1	9
• Write and analyse software contracts as an employer or to an employer	C	3	7
• 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

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.

CS-301	INTRODUCTION TO INFORMATION & COMMUNICATION TECHNOLOGY	3(2-1)

Learning Objective

- The course introduces students to information and communication technologies and their application in the workplace.
- Students will get basic understanding of computer software, hardware, and associated technologies.
- They will also learn how computers are used in the workplace, how communications systems can help boost productivity, and how the Internet technologies can influence the workplace.

Learning Outcomes

At the end of the course the students will be able to:	Domain	BT Level*	PLO
• Understand basics of computing technology	C	1	2
• Perform number systems conversions and arithmetic	C	2	3
• Know about different types of software & hardware	C	2	2
• Apply basic computing related technologies	P	3	4

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

SDGS addressed in the course	9 (Industry, Innovation, and Infrastructure)

Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.

Course Contents

Theory

Brief history of Computer; Four Stages of History: Computer Elements; Processor: Memory: Hardware: Software; Application Software its uses and Limitations: System Software its Importance and its Types: Types of Computer (Super, Mainframe, Mini and Micro Computer); Introduction to CBIS (Computer Based Information System); Methods of Input and Processing; Class2. Organizing Computer Facility; Centralized Computing Facility: Distributed Computing Facility: Decentralized Computing Facility: Input Devices; Keyboard and its Types: Terminal (Dump, Smart, Intelligent): Dedicated Data Entry: SDA (Source Data Automation): Pointing Devices: Voice Input: Output Devices: Soft- Hard Copies: Monitors and its Types: Printers and its Types: Plotters: Computer Virus and its Forms; Storage Units; Primary and Secondary Memories: RAM and its Types; Cache: Hard Disks: Working of Hard Disk: Diskettes: RAID: Optical Disk Storages (DVD, CD ROM): Magnetic Types: Backup System; Data Communications; Data Communication Model: Data Transmission; Digital and Analog Transmission: Modems; Asynchronous and Synchronous Transmission: Simplex: 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.

SSH-412	PAKISTAN STUDIES	2(2-0)

Learning Objective

- 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
• Learn about the History and Ideology of Pakistan.	C	1	1
• Get knowledge about the political and administrative structure of Pakistan.	C	2	1
• 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

Theory

Historical background of Pakistan; Muslim society in Indo-Pakistan: the movement led by the societies: the downfall of Islamic society: the establishment of British Raj- Causes and consequences: Political evolution of Muslims in the twentieth century; Sir Syed Ahmed Khan: Muslim League: Nehru: Allama Iqbal: Independence Movement; Lahore Resolution; Pakistan culture and society: Constitutional and Administrative issues: Pakistan and its geopolitical dimension; Pakistan and International Affairs; Pakistan and the challenges ahead.

Teaching Methodology

Lectures, Written Assignments

Course Assessment

Sessional Exam, Home Assignments, Quizzes, Final Exam

Text Book

1. The Emergence of Pakistan, Chaudary M., 1967

Suggested Readings

1. The making of Pakistan, Aziz. 1976
2. A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988
3. Mehmood, S. 1994. Pakistan Political Roots and Development. 2nd Ed. Five Star

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

IS-310/SS-310	ISLAMIC STUDIES	2(2-0)

Learning Objective

- 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**
• Get the knowledge of basic teachings of Islam.	C	1	1
• Learn how to adopt Islamic life style.	C	2	1
• 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. 2nd Ed. Islamic Book Service, Karachi, Pakistan.

Computer Science SUPPORTING courses

<table>
<tr><td>MATH-511</td><td colspan="2">DIFFERENTIAL EQUATIONS</td><td>3(3-0)</td></tr>
<tr><td colspan="4">Learning Objective</td></tr>
<tr><td colspan="4">• The course develops students' fundamental skills of solving ordinary differential equations, and developing differential equations for real-world problems.</td></tr>
<tr><td colspan="4">Learning Outcomes</td></tr>
<tr><td>At the end of the course the students will be able to:</td><td>Domain</td><td>BT Level*</td><td>PLO</td></tr>
<tr><td>• Identify, analyze and subsequently solve physical situations whose behavior can be described by ordinary differential equations.</td><td>C</td><td>2, 3</td><td>2, 3</td></tr>
<tr><td>• Determine solutions to first order separable differential equations</td><td>C</td><td>2</td><td>3</td></tr>
<tr><td>• Determine solutions to first order linear differential equations.</td><td>C</td><td>2</td><td>3</td></tr>
<tr><td>• Determine solutions to first order exact differential equations.</td><td>C</td><td>2</td><td>3</td></tr>
<tr><td>• Determine solutions to second order linear homogeneous and non-homogeneous differential equations with constant coefficients.</td><td>C</td><td>2</td><td>3</td></tr>
<tr><td colspan="4">* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain</td></tr>
<tr><td colspan="2">SDGS addressed in the course</td><td colspan="2">4(Quality Education)</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="4">Course Contents</td></tr>
<tr><td colspan="4">Theory</td></tr>
<tr><td colspan="4">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.</td></tr>
</table>

Teaching Methodology
Lectures, Written Assignments, Semester Project, Presentations
Course Assessment
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
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.

MATH-409	MULTIVARIATE CALCULUS	3(3-0)

Learning Objective

- 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
• Understand the basic concepts and know the basic techniques of differential and integral calculus of functions of several variables	C	2	2
• Apply the theory to calculate the gradients, directional derivatives, arc length of curves, area of surfaces, and volume of solids	C	3	2
• Solve problems involving maxima and minima, line integral and surface integral, and vector calculus	C	3	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

Functions of Several Variables and Partial Differentiation; Multiple Integrals: Line and Surface Integrals; Green's and Stoke's Theorem; Fourier Series; periodic functions: Functions of any period P-2L: Even & odd functions: Half Range expansions; Fourier Transform; Laplace Transform; Z-Transform.

Teaching Methodology

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment

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

Text Book

1. Steward. J. 2007. Multivariable Calculus. Ed. 6. Cengage Learning publishers.

Suggested Readings

1. Olinick, S. and Pence. 1994. Calculus and Analytical Geometry, 6th edition. Thomson Learning EMEA, Ltd.
2. Howard, A, A. Albert. 1995. Multivariable Calculus, 5th edition. John Wiley.

CS-506	GRAPH THEORY	3(3-0)

Learning Objective

- Introduce the fundamental concepts of Graph Theory
- Be able to describe the design issues relating to the architectural options
- Provide knowledge for application of Graph Theory in subsequent courses

Learning Outcomes

At the end of the course the students will be able to:	Domain	BT Level*	PLO
• Introduce the fundamental concepts of Graph Theory	C	1	2
• Provide knowledge for application of Graph Theory in subsequent courses in the design and analysis of algorithms, computability theory, software engineering, and computer systems.	C	2	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

Introduction to Graph Theory; Basic definitions: computer representations and properties of Graph: Data structure for representing Graphs; Fundamental theorem of Graph Theory; Isomorphic and Special Graphs: Properties of Trees and Forests; Binary tree: Balanced binary tree: Directed and Undirected rooted tree: Minimum Spanning Tree algorithms and implementation; Path and Distance in graphs; Shortest path algorithms and implementation; Cycle and distance in weighted graph and digraphs; Distance algorithms and implementation; Eulerian graphs and Hamiltonians graphs with applications; Flow networks: Max-flow Min-cut Theorem; Graph coloring: Edge coloring; Planar graphs; Four color theorem; Deadlock of computer system; Matching Algorithms; Dominance & Ramsey theory.

Teaching Methodology

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment

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

Text Book

1. Flouds, L.R, 2011. Graph Theory & Applications. 1st Ed. Springer, University of Waikato, Hamilton, New Zealand

Suggested Readings

1. Golumbic, Martin, C, 2004. Algorithmic Graph Theory and Perfect Graphs. 1st Ed. Elsevier,
2. Gross, J. L., Yellen, J. 2004. Handbook of Graph Theory. CRC press, Boca Raton, Florida, 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, YK, USA

CS-303	Theory of Programming Languages	4(3-1)

Learning Objectives

- Familiarise students with basic theory of programming languages
- Enable to design semantic model of a programming language

Learning Outcomes

At the end of the course the students will be able to:	Domain	BT Level*	PLO
• The better understating the underlying theory of programming languages	C	1	2
• Enable a student to choose the appropriate Language for a Project	C	2	5
• Learning of formal semantics design for a programming Languages	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

Programming Language Spectrum; Compilation and Interpretation; Programming Environments; Programming Language Syntax; Names: Scopes: and Bindings: Semantic Analysis; Target Machine Architecture; Control Flow; Data Types: Subroutines and Control Abstraction: Data Abstraction and Object Orientation; Functional Languages; Logic Languages: Concurrency; Scripting Languages.

Teaching Methodology:

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

Course Assessment:

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

Textbook(s):

1. Scott, M. L. M. Kaufmann. 2009. Programming Language Pragmatics. 3rd Edition. ISBN-10: 0123745144

Reference Material:

1. Reynolds, J. C. 2009. Theories of Programming Languages. Cambridge University Press; 1st Edition. ISBN-10: 0521106974.
2. Dowek, G. and J. Levy. 2010. Introduction to the Theory of Programming Languages (Undergraduate Topics in Computer Science). Springer; 1st Edition. ISBN-10: 0857290754
3. Bruce A. T. 2010. Seven Languages in Seven Weeks: A Pragmatic Guide to Learning Programming Languages (Pragmatic Programmers). Pragmatic Bookshelf; 1st Edition. ISBN-10: 193435659X

4. Mitchell. J. C. 2002. Concepts in Programming Languages. Cambridge University Press; 1st Edition. ISBN-10: 0521780985
5. Finkel. A. 1995. Advanced Programming Language. Addison-Wesley; 1st Edition. ISBN-10: 0805311912

CS-605	NUMERICAL COMPUTING	3(2-1)

Learning Objectives

- On completion of this course, students will be able to demonstrate programming proficiency using structured programming techniques to implement numerical methods for solutions using computer-based programming techniques using MATLAB for all methods.
- The course must serve the purpose of scientific software development for science and engineering problems.

Learning Outcomes

At the end of the course the students will be able to:	Domain	BT Level*	PLOs
The student would understand the fundamental concepts of Scientific Programming using programing Language(s)	C	1	2
Use a computer algebra system to investigate and solve mathematical problems relating to integration, differential equations and approximation.	C	2	3
The student would understand the fundamental concepts of Scientific Programming using programing Language(s)	C	1	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

The concepts of efficiency; Reliability and accuracy of a method; Minimizing computational errors; Theory of differences; Difference operators; Difference tables; Forward differences; Backward differences and central differences; Mathematical preliminaries; Solution of equations in one variable; Interpolation and Polynomial approximation; Numerical differentiation and numerical integration; Initial value problems for ordinary differential equations; Direct methods for solving linear systems; Iterative techniques in matrix algebra; Solution of non-linear equations.

Practical

Solve nonlinear equations; Simultaneous linear equations; Data interpolation and approximation; Differential equations through programming language and by using symbolic simulator like MATLAB or Mathematica

Teaching Methodology:

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

Course Assessment:

Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Chapra, S. and Canale, R. 2014. Numerical Methods for Engineers. 7th Ed. McGraw-Hill Education, New York City, NY, USA.
Suggested Readings:
1. Overton, M. L. 2001. Numerical Computing with IEEE Floating Point Arithmetic. Siam, Philadelphia, PA, USA. 2. Shampine, L. F., Allen, R. C., and S. Pruess. 1997. Fundamentals of Numerical Computing. Wiley publisher, New York City, NY, USA. 3. William, H., A. Saul, T. William and P. Brian. 2007. The Art of Scientific Computing, 3rd Ed. Press New Dehli, India. 4. William, H. 2007. Numerical Recipes the Art of Scientific Computing. 3.03rd Ed. Cambridge University Press, Cambridge, UK.

Computer Science Elective Courses

CS-505	WEB ENGINEERING	3(2-1)

Learning Objectives

- The course is aimed to provide students with conceptual understanding required to develop web applications and web services according to international standards

Learning Outcomes			
At the end of the course the students will be able to:	**Domain**	**BT Level***	**PLOs**
• Discuss how web standards impact software development	C	1	2
• Describe the constraints that web puts on developers.	C	2	2
• Design and Implement a simple web application.	P	3, 4	4
• Review an existing web application against a current web standard.	C	4	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			

SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)

Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system

Course Contents

Theory

Introduction; Requirement engineering for web applications; Web applications; Accessibility; Client-side technologies; Developing web applications; Technologies; CGI and Perl; Server side technologies-I; Server side technologies-II; Testing; Operation & maintenance; Performance of web applications.

Practical

Improve skills in reacting appropriately to solve web related problems; Perform complex Web-application related tasks including dynamic and on demand page loading; Transfer real-life web related problems into productive solution

Teaching Methodology:

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

Course Assessment:

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

Text Book:

1. 1. Anderson, R. and B. Francis. Beginning ASP. Wrox series Publications, Hoboken, NJ, USA.

Suggested Readings:

2. Kappel, G., B. Proll, S. Reich and W. Retschitzegger. 2006. Web Engineering, 1st Ed, John Wiley & Sons, Hoboken, NJ, USA.

3. Murugesan, S., Y. Deshpande and A. Ginige. 2001. Web Engineering A new Discipline for Development of Web Based Systems. Springer, Berlin, Germany.
4. Phillip, H. JSP 2.0 The Complete Reference, 2nd Ed, McGraw Hill, New York City, NY, USA.
5. Reiner, D., M. Lother and W. Cornelius. 2003. Web Engineering. Pearson-Studium, London, UK.

CS-603 MOBILE APPLICATION & DEVELOPMENT 3(2-1)

Learning Objectives

This course will enable the students to:

- Improve ability to analyse and understand mobile software development. Improve your skills in reacting appropriately to solve mobile related problems.
- Develop efficient and state-of-the-art applications.
- Solve complex mobile programming problems and could transfer real-life mobile related problems into productive solution.

Learning Outcomes			
At the end of the course the students will be able to:	**Domain**	**BT Level***	**PLOs**
• Discuss different architectures & framework for Mobile Application development.	C	1	2
• Develop mobile applications using current software development environments.	C	3	4, 5
• Compare the different performance tradeoffs in mobile application development.	C	3	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

Mobile development concepts; Activities; Resource management and media; Services and content providers: data storage: security: Managing evolution; Tablets: graphics: speech sensors; Networking; Processes and threads: Deployment of application; Mobile application development models; Mobile network management.

Practical

Use of Android framework; Form designing in android; Database design; Front end and back end connectivity.

Teaching Methodology:

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

Course Assessment:

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

Text Book:

1. Burnette, E. 2009. Hello, Android Introducing Google's Mobile Development Platform. 2nd Ed. Oxford Press, Oxford, UK.

Suggested Readings:

1. Fling, B. 2009. Mobile Design and Development: Practical concepts and techniques for creating mobile sites and Web apps. O'Reilly Media Inc., *Sebastopol*, *CA, USA.* Lee, V., H. Schneider and R. Schell. 2004.
2. Lee, V., H. Schneider and R. Schell. 2004. Mobile applications: architecture, design, and development. Prentice Hall PTR, USA.
3. Meier, R. 2012. Professional Android for Application Development. 3rd Ed. John Wiley & Sons, Hoboken, NJ, USA.
4. Wigley, A., Moth, D., and Foot, P. 2007. Microsoft® Mobile Development Handbook. Microsoft Press, Microsoft Redmond Campus, WA, USA.

CS-601	DIGITAL IMAGE PROCESSING	3(2-1)

Learning Objectives

- 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***	**PLOs**
• Understand the basics, applications in general, working inside the digital camera, sampling and quantization, image representation, etc.	C	1, 2	2
• Implement image enhancement, image segmentation, image transformations, spatial and frequency domain processing, filtering, convolution, image registration, feature detection, pattern recognition, etc.	C	3	3
• Evaluate the performance of different image processing algorithms	C	4, 5	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; Elements of digital image processing; Image model; Sampling and quantization; Relationships between pixels; Image enhancement; Enhancement by point processing, Spatial filtering; Enhancement in the frequency domain; Color image processing; Image segmentation; Discontinuity detection; Edge linking and boundary detection; Trash holding; Region oriented segmentation; Use of motion for segmentation; Image Registration; Introduction to image registration; Techniques of image registration; Representation and Description; Boundary description; Regional description; Morphological Image Processing; Dilation and Erosion; Opening and Closing; Some basic morphological algorithms; Extensions to gray level images; Image Transforms; Discrete fourier transform; Discrete cosine transform; Haar transform.

Practical

Describe colour models and their use in practical applications; Describe image acquisition and registration; describe image processing in spatial and frequency domain; List image segmentation approaches using MATLAB/Python.

Teaching Methodology:

Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment:
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Gonzalez, R. C. and R. E. Woods. Digital Image Processing. 4th Ed, Prentice Hall, Upper Saddle River, NJ, USA.
Suggested Readings:
1. Kenneth, R. and Castleman. Digital Image Processing. Pearson Education, London, UK. 2. Nakamura, J. 2017. Image Sensors and Signal Processing for Digital still Cameras. CRC press, Boca Raton, FL, USA. 3. Richard, G., and Lyons. 2010. Understanding Digital Signal Processing. 3rd Ed, Prentice Hall, Upper Saddle River, NJ, USA. 4. Wilhelm Burger, Mark J. Burge, Principles of Digital Image Processing, Springer, Berlin, Germany.

CS-509	COMPUTER GRAPHICS	3(2-1)

Learning Objectives

- To Introduce the concepts and implementation of computer graphics and animation
- Familiarize students with tools and techniques to create effective and interactive graphics.

Learning Outcomes

At the end of the course the students will be able to:	Domain	BT Level*	PLO
• Comprehend the structure of modern computer graphics systems	C	2	2
• Explain the basic principles of implementing computer graphics fundamentals	C	2	2
• Compare key algorithms for modelling and rendering graphical data	C	3	3
• Develop design and problem solving skills with applications to computer graphics	P	3	4
• Construct interactive computer graphics programs using OpenGL.	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

Fundamental Concepts: forward and backward rendering (i.e., ray-casting and rasterization), applications of computer graphics: including game engines, cad, visualization, virtual reality, polygonal representation, basic radiometry, similar triangles, and projection model, use of standard graphics APIs (see HCI GUI construction); basic rendering: rendering in nature, i.e., the emission and scattering of light and its relation to numerical integration, affine and coordinate system transformations, ray tracing, visibility and occlusion, including solutions to this problem such as depth buffering, painter's algorithm, and ray tracing, the forward and backward rendering equation, simple triangle rasterization, rendering with a shader-based API, texture mapping, including minification and magnification (e.g., trilinear MIP-mapping), application of spatial data structures to rendering, sampling and anti-aliasing,

scene graphs and the graphics pipeline; geometric modeling: basic geometric operations such as intersection calculation, proximity tests, polynomial curves and surfaces, approximation techniques such as polynomial curves, bezier curves, spline curves and surfaces, animation as a sequence of still images.
Practical
Construct interactive computer graphics programs using OpenGL.
Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment:
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Donald, D. H. Computer Graphics with Open GL.2015. 4th Ed. Prentice Hall, Upper Saddle River, NJ, USA.
Suggested Readings:
1. Gomes, J. 2012, Computer Graphics Theory and Practice. CRC Press, Boca Raton, FL, USA. 2. Godse, A.P. and D. A. Godse. 2009. Computer Graphics. Technical Publications, Sebastopol, CA, USA. 3. Schneider, P. and D. H. Eberly. 2002. Geometric tools for computer graphics. Elsevier, Amsterdam, Netherlands. 4. Watt, A. H. 1989. Fundamentals of Three-Dimensional Computer Graphics. Addison Wesley, Boston, MA, USA.

CS-504	VISUAL PROGRAMMING	3(2-1)

Learning Objectives

- Understand the basic concepts of visual programming.
- Design visual programs following software development process

Learning Outcomes

At the end of the course the students will be able to:	Domain	BT Level*	PLO
• Use the different elements of a visual programming language as building blocks to develop correct, coherent programs.	C	1	4
• Program using the fundamental software development process, including design, coding, documentation, testing and debugging.	C	3	4
• Analyze problems, develop conceptual designs that solve those problems, and transform those designs to Visual Programs.	C	4	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

Visual Programming Basics; Introduction to Events; Fundamentals of Event-driven Programming; message handling; user interfaces; graphics device interface; painting and drawing; windows management; input devices; resources; string and menu resource; dialogs and windows controls; common controls; dynamic link libraries; threads and synchronization; network programming; Building Class Libraries at the Command Line; Class Libraries; Using References; Assemblies; Private Assembly Deployment; Shared Assembly Deployment; Configuration Overview; Configuration Files; Programmatic Access to Configuration; Using SDK Tools for Signing and Deployment; Metadata; Reflection; Late Binding; Directories; Files; Serialization; Attributes; Memory Management and Garbage Collection; Threading and Synchronization; Asynchronous Delegates; Application Domains; Marshal by Value; Marshal by Reference; Authentication and Authorization; Configuring Security; Code Access Security; Code Groups; Evidence; Permissions; Role-Based Security; Principals and Identities; Using Data Readers; Using Data Sets; Interacting with XML Data; Tracing Event Logs; Using the Boolean Switch and Trace Switch Classes; Print Debugging

Information with the Debug Class; Instrumenting Release Builds with the Trace Class; Using Listeners; and Implementing Custom Listeners.
Practical
Develop Visual Programs using Visual Studio IDE.
Teaching Methodology:
Lectures, Written Assignments, Practical labs, Semester Project, Presentations
Course Assessment:
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Bradley, J. C. and A.C. Millspaugh. 2014. Programming in C# .NET. McGraw Hill, New York City, NY, USA.
Suggested Readings:
1. Deitel, H. and P. Deitel. 2010. Visual C# How to Program. Prentice Hall Press. Upper Saddle River, NJ, USA. 2. Foxall, J. 2015. Visual basic in 24 hours. Sams Publishers, Carmel, IN, USA. 3. Libetty, J. 2002. Learning Visual Basic .net. O'Reily associates Inc, Sebastopol, CA, USA. 4. Newsome, B. 2015. Beginning Visual Basic. Wrox Publishers, Hoboken, NJ, USA.

CS-602	DATA MINING & WAREHOUSING	3(3-0)

Learning Objectives

- The course introduces students with basic applications, concepts, and techniques of data mining and to develop their skills for using recent data mining software to solve practical problems in a variety of disciplines.

Learning Outcomes

At the end of the course the students will be able to:	Domain	BT Level*	PLO
• Describe the underlying concepts of data warehousing and mining.	C	2	2
• Differentiate between data warehousing, data mining, machine learning, business intelligence, artificial intelligence and statistical analysis.	C	2	3
• Identify different machine learning approaches to suit the requirement of problem at hand.	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

Fundamentals; Definition; Process; Applications examples; Data mining and ethics; Inputs rules; Outputs of data mining process representation; Tables; Trees; Rules; Basic algorithms; Clustering: hierarchical clustering, partitioned clustering; Classification: decision tree classification, Bayesian classification, nearest neighbor classification; Basic algorithms.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam

Text Book:

1. Gorunescu, F. 2011. Data Mining Concepts, Models and Techniques. Springer Science & Business Media, Berlin, Germany.

Suggested Readings:

1. Fong, J. 2006. Information Systems Re-engineering and Integration. 2nd Ed. Springer Verlag, 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.

CS-	INTRODUCTION TO DATA SCIENCE	3(2-1)

Learning Objectives

- 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
• Describe what Data Science is and the skill sets needed to be a data scientist.	C	2	2
• Apply EDA and the Data Science process in a case study.	C	3	3
• Comprehend the fundamental constructs of Python programming language.	C	2	4
• Apply basic machine learning algorithms to solve real world problems of moderate complexity.	C	3	4

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)

Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system

Course Contents

Theory

Introduction: What is Data Science? Big Data and Data Science hype; Datafication; Current landscape of perspectives; Skill sets needed; Statistical Inference: Populations and samples, Statistical modeling, probability distributions, fitting a model; Introduction to Python; Exploratory Data Analysis and the Data Science Process; Basic Machine Learning Algorithms: Linear Regression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes; Feature Generation and Feature Selection; Dimensionality Reduction: Singular Value Decomposition, Principal Component Analysis; Mining Social-Network Graphs: Social networks as graphs, Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs, Neighbourhood properties in graphs; Data Visualization: Basic principles, ideas and tools for data visualization; Data Science and Ethical Issues: Discussions on privacy, security, ethics, Next-generation data scientists.

Practical

Programming language Python has been proposed for the practical work of this course; perform programing 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. Igual, 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'Relly 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

CS-	INTRODUCTION TO IOT	3(2-1)

Learning Objectives

- To describe the basics of IoT, the technology used to build these kinds of devices, how they communicate, how they store data, and the kind of distributed systems needed to support them.
- To enable students integrate available tools & techniques to build an actual IoT system.

Learning Outcomes

At the end of the course the students will be able to:	Domain	BT Level*	PLO
• Describe what IoT is and recognize the factors contributed to the emergence of IoT	C	2	2
• Design and program IoT devices	C	3	2, 3
• Use real IoT protocols for communication	C	2	2
• Secure the elements of an IoT device	C	3	3
• Design an IoT device to work with Cloud Computing Infrastructure	P	3	4
• Transfer IoT data to the cloud and in between cloud providers	P	3	4
• Define the infrastructure for supporting Commercialization of Product	C	2	7

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)

Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system

Course Contents

Theory

Introduction: What is IoT?, Industrial IoT standards and protocols, IoT platform and applications, IoT product development for industry 4.0, IoT security in the Internet; IoT Development Platform: Introduction to RaspberryPi 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 Rasbian GUI and console; Hands-on for using general-purpose input/output pins for controlling IoT related sensors and devices (e.g., LED, Buttons, etc.); Hands on to setup and deploy multiple sensors for data collections (e.g., sensors: temperature, humidity, gas, fire, distance, water, moisture, light, current, vibration etc.); Hands on to enable sensor connectivity using machine-to-machine (M2M) communication; Hands on to extremely lightweight publish/subscibe messaging transport protocol on RaspberryPi and PC/Laptop; Hands on to publish/subscribe data from multi-sensors; Hands on controlling/monitoring IoT sensors and systems using Android 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. Hassan, Q.F. ed., 2018. *Internet of things A to Z: technologies and applications*. John Wiley & Sons, Hoboken, New Jersey
Suggested Readings:
1. Singh, R., A. Gehlot, L.R. Gupta, B. Singh and M. Swain. 2019. *Internet of Things with Raspberry Pi and Arduino*. CRC Press. 2. Liyanage, M., A. Braeken, P. Kumar and M. Ylianttila, eds., 2020. *IoT Security: Advances in Authentication*. John Wiley & Sons. UK 3. Serpanos, D. and M. Wolf. 2017. *Internet-of-things (IoT) systems: architectures, algorithms, methodologies*. Springer. Atlanta. USA

CS-	DIGITAL MARKETING	3(2-1)

Learning Objectives

- This course covers several aspects of the new digital marketing environment, including topics such as digital marketing analytics, search engine optimization, social media marketing, and 3D Printing
- Familiarize students with basics of the new digital marketing landscape and acquire a set of stories, concepts, and tools to help you digitally create, distribute, promote and price products and services

Learning Outcomes

At the end of the course the students will be able to:	Domain	BT Level*	PLO
• Gain an understanding of the motivations behind data collection and analysis methods used by marketing professionals	C	2	2
• Understand frameworks and approaches to measuring consumers' digital actions	C	2	2
• Learn to evaluate and choose appropriate web analytics tools and techniques.	C	3	3
• Apply digital marketing concepts to a real business problem	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 to Digital Marketing; Marketing in a digital world; digital marketing analytics; web analytics and its tools; Website Planning and Creation; Search Engine Optimization (SEO); digital media and marketing principles; Search Engine Marketing; Social Media Marketing; Content Strategy; Digital Media Planning and Buying; Web Remarketing; Design Essentials; Mobile Marketing; E-Commerce Management; Online Reputation Management; Adsense, Blogging, and Affiliate Marketing; Managerial Skills; Introduction to Agency; The art of Pitching; Client-oriented Strategy; Campaign Creation for Client; Reporting and Evaluation.

Practical

Semester project that combines all concepts and tools that have been learnt in the course to a real business problem.

Teaching Methodology:

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

Course Assessment:
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Text Book:
1. Bhatia, P., 2019. Fundamentals of Digital Marketing. Pearson. UK
Suggested Readings:
1. Chaffey, D., 2019. Digital marketing. Pearson UK. 2. Morris, N. 2009. Understanding digital marketing: marketing strategies for engaging the digital generation. Journal of Direct, Data and Digital Marketing Practice, 10. 384-387.

Mathematics and Science Foundation Courses

CS-303	CALCULUS & ANALYTICAL GEOMETRY	3(3-0)

Learning Objectives

- 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
• **Understand** importance of calculus	C	2	2
• **Apply** derivatives, partial derivatives or integrals	C	3	2
• 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:	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

Complex numbers; De Moivre's theorem and its applications; Simple cartesian curves; Functions and graphs; Symmetrical properties; Curve tracing; Limit and continuity; Differentiation of functions; Derivative as slope of tangent to a curve and as rate of change; Application to tangent and normal; Linearization; Maxima/Minima and point of inflexion; Taylor and maclurin expansions and their convergence; Integral as anti-derivative; Indefinite; Integration of simple functions; Methods of integration; Integration by substitution; Partial fractions; Definite integral as limit of a sum, application to area; Arc length; Volume and surface of revolution. Derivatives of Inverse Trigonometric Functions. Numerical Integration. Applications of Integrals. Transcendental Functions. Inverse Tragicomic Functions. Integrals.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam

Text Book:

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, YK, USA.
5. Callahan, J. J. 2010. Advanced Calculus: A Geometric View. Springer Science & Business Media. Northampton, UK

STAT-405	PROBABILITY & STATISTICS	3(3-0)

Learning Objectives

- 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
• **Understand** the importance of probability and statistics	C	2	2
• **Apply** probabilities related to both discrete	C	3	2
• **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, 9th Ed. Cengage Learning, Boston, MA, USA.

Suggested Readings:

1. Lay, L. D. 2015. Probability and Statistics for Engineering and the Sciences, 9th Ed. Cengage Learning, Boston, MA, USA.
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.

MATH-306	LINEAR ALGEBRA	3(3-0)

Learning Objectives

- 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
• **Understand** the importance of linear algebra	C	2	2
• **Apply** algebraic operation will be required to solve practical	C	3	2
• 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:	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

Vectors; Vector spaces; Matrices and determinants; Cofactor and inverse; Rank; Linear independence; Positive definite matrix; Linear transformations; Operations on matrices; Inner products; Orthogonally and least squares; Eigen value & eigenvectors;

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam

Text Book:

1. Cheney, W. and D.Kincai. 2009. Linear algebra: Theory and Applications. Jones & Bartlett Learning, Burlington, MA, USA.

Suggested Readings:

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.

PHY-305	APPLIED PHYSICS	3(3-0)

Learning Objectives

- 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
• **Understand** the importance of linear algebra	C	2	2
• **Apply** algebraic operation	C	3	2
• Design and implement algorithms to **solve** system of equations through programming language.	C	3	4

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)

Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system

Course Contents

Theory

Electricity and Magnetism: Voltage, current, resistance, power, single phase and 3 phase A.C. supply; Series and parallel circuits; Vector addition and subtraction of A.C. voltages; A.C/D.C. motors: Concept of rotating fields, polyphase induction motor, lap and wave winding of single phase and three phase motors; torque and starting characteristics; measuring instruments; transformers; A.C power generators; Electrical distribution and wiring for farm buildings; Electric controls, motor controls, and protection; Selection of farm motors; applications of electricity at farm; Electronics: Semi-conductors, PN-junction; Transistor; its characteristics and uses; Amplifiers; Power supplies; Magnetism: Electro-Magnetic induction and radiation; Radioactivity: Radioisotopes; Biological effects of radiation; Laser: Introduction, generation and uses of Laser; Fibre optics–characteristics.

Practical

1. Construction of wiring systems, fuses, switches of various types insulators
2. Circuits design and drawing of a typical farm electrical system.
3. Selection of motor for various farm equipment such as forage cutter, feed-grinders, and shop tools.
4. Practice on repair and adjustment of electric motors, switches, fuses, transmission wiring controls
5. Study of 3 phase induction motor
6. Study of star and delta connections
7. Study of semi-conductor, triode, diode valve and transistors.

8. Use of AVO meter, CRO, planimeter
9. Fabrication of full wave rectifier and inductance study of its wave-shape.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam

Text Book:

1. Cheney, W. and D.Kincai. 2009. Linear algebra: Theory and Applications. Jones & Bartlett Learning, Burlington, MA, USA.

Suggested Readings:

1. Cheney, W. and D.Kincai. 2009. Linear algebra: Theory and Applications. Jones & Bartlett Learning, Burlington, MA, USA.
2. David, K.H.2007. Elementary Linear Algebra with Applications. 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.

University Elective Courses

MGT-602	ENTREPRENEURSHIP	3(3-0)

Learning Objectives

- This course provides an understanding of the entrepreneurship process
- The course gives students the tools. Necessary to think creatively, to plan out whether their idea is marketable to investors.
- This will be accomplished through a combination of readings, cases studies and projects designed to convey the unique environment of the entrepreneurs and new ventures.

Learning Outcomes

At the end of the course the students will be able to:	Domain	BT Level*	PLO
• **Understand** processes, and resources within a diverse organization	C	2	2
• **Apply** knowledge of leadership concepts in an integrated manner	C	3	2
• **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

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; 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.

MGT-308	PRINCIPLES OF ACCOUNTING	3(3-0)

Learning Objectives

- 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
• Develop and understand the nature and purpose of financial statements in relationship to decision making.	C	2	2
• 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
• 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
• Develop the ability to use accounting concepts, principles, and frameworks to analyze and effectively communicate information to a variety of audiences.	C	3	2
• Develop the ability to use accounting information to solve a variety of business problems.	C	3	2
• 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

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.

SS-411	PRINCIPLES OF PSYCHOLOGY	3(3-0)

Learning Objectives

- 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
• **Understand** the major fields of study and theoretical perspectives	C	2	2
• **Differentiate** between the major observational, correlation, and experimental designs.	C	3	2
• **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

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.

MGT-	PRINCIPLES OF MARKETING	3(3-0)

Learning Objectives

- To provide students with a broad introduction to marketing concepts
- To help them understand the factors that influence marketing decisions
- Focus attention on the vital role of marketing in today's global economy

Learning Outcomes

At the end of the course the students will be able to:	Domain	BT Level*	PLO
• Identify some of the basic approaches to formulating a marketing strategy in order to participate effectively when working with marketing policy coordinators.	C	4	2
• Use an understanding of marketing and the market driven enterprise to differentiate market.	C	2	2
• Identify key stages of the market planning process in order to create marketing plans through development of key sections common to most plans.	C	4	2

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)

Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system

Course Contents

Theory

Marketing in Changing World, Core marketing concepts, Creating Customer Value and Satisfaction, Strategic Planning and the Marketing Process, Micro and Macro Marketing Environment, Marketing Research and Information Systems, Consumer Markets and Consumer Buyer Behavior, Business Markets and Business Buyer Behavior, Marketing Segmentation, Targeting, and Positioning for Competitive Advantage Product and Services strategy, New Products Development and Product Life-Cycle Strategies, Pricing Products: Pricing Considerations and Approaches, Pricing Strategies, Distribution Channels and Logistics Management, Retailing and Wholesaling, Integrated Marketing Communication Strategy, Advertising, Sales Promotion and Public Relations, Personal Selling and Sales Management, Direct and Online Marketing, Competitive Strategies: Building Lasting Customer Relationships.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

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

SSH-	HUMAN RESOURCE MANAGEMENT	3(3-0)

Learning Objectives

- To enable the students to understand the human resource Management and system at various levels in general and in certain specific industries or organizations.
- To help the students focus on and analyse the issues and strategies required to select and develop manpower resources
- To develop relevant skills necessary for application in HR related issues
- To Enable the students to integrate the understanding of various HR concepts along with the domain concept in order to take correct business decisions

Learning Outcomes

At the end of the course the students will be able to:	Domain	BT Level*	PLO
• Understand the basic and core human resource management practices	C	4	2
• To develop necessary skill set for applications of various HR issues	C	2	2
• Develop basic understanding about the reward systems of cultivators, agriculture labors and marginal workers.	C	4	2

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

SDGS addressed in the course:	9 (Industry, Innovation, and Infrastructure)

Teaching Mode: the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system

Course Contents

Theory

Marketing in Changing World, Core marketing concepts, Creating Customer Value and Satisfaction, Strategic Planning and the Marketing Process, Micro and Macro Marketing Environment, Marketing Research and Information Systems, Consumer Markets and Consumer Buyer Behavior, Business Markets and Business Buyer Behavior, Marketing Segmentation, Targeting, and Positioning for Competitive Advantage Product and Services strategy, New Products Development and Product Life-Cycle Strategies, Pricing Products: Pricing Considerations and Approaches, Pricing Strategies, Distribution Channels and Logistics Management, Retailing and Wholesaling, Integrated Marketing Communication Strategy, Advertising, Sales Promotion and Public Relations, Personal Selling and Sales Management, Direct and Online Marketing, Competitive Strategies: Building Lasting Customer Relationships.

Teaching Methodology:

Lectures, Written Assignments, Presentations

Course Assessment:

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