



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

## **SCHEME OF STUDIES**



**BACHELOR OF SCIENCE IN INFORMATION  
TECHNOLOGY (BSIT)**

**SESSION (2021-25)**

**MUHAMMAD NAWAZ SHARIF UNIVERSITY OF  
AGRICULTURE, MULTAN**



*Faculty of Social Sciences & Humanities*  
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## **Curriculum of Bachelor of Information Technology (BSIT)**

### **Program's Aims & Objectives:**

The aim of the BS (IT) program is to produce entrepreneurs of great character, competence, vision and drive equip with up-to-date knowledge, marketable skills, valuable competencies, unique expertise, globally compatible dispositions and culturally and professionally acceptable values to take on appropriate professional roles in information technology domain or proceed to further or higher education or training. One of the key objectives of the program is to equip students with skills and knowledge that enable them to take on appropriate professional positions in IT and grow into leading roles. The goals of the program are to produce, in coordination with organizational management, IT graduates who have ability to:

1. Apply knowledge of computing and mathematics appropriate to the discipline.
2. Analyze a problem and identify and define the computing requirements appropriate to its solution.
3. Design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs.
4. Function effectively on teams to accomplish a common goal.
5. Understand the professional, ethical, legal, security and social issues and responsibilities.
6. Communicate effectively with a range of audiences.
7. Analyze the local and global impact of computing on individuals, organizations, and society.
8. Recognize the need for and an ability to engage in continuing professional development.
9. Use the current techniques, skills, and tools necessary for computing practice.
10. Use and apply the latest technical concepts and practices in the core information technologies.
11. Identify and analyze user needs and take them into account in the selection, creation, evaluation and administration of computer-based systems.
12. Integrate IT-based solutions into the user environment.
13. Understand the best practices and standards and their application.
14. Assist in the creation of an effective project plan.



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**Structure of BS Information Technology:**

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

Sr.#	Category	Credit Hours
<b>1</b>	<b>Computing Courses</b>	
	Core	39
<b>2</b>	<b>Information Technology Courses</b>	
	Core	24
	Supporting	9
	Elective	20
<b>3</b>	General Education Courses	19
<b>4</b>	University Elective Courses	12
<b>5</b>	Mathematics and Science Foundation	12
	<b>Total Credit Hours:</b>	<b>135</b>

Course Category	Credit Hrs
Comp. Core	39
IT Core	24
IT Supp.	9
IT Elective	20
Gen. Edu.	19
Uni. Elective	12
Math & Sci. Foundation	12



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**Domain Courses for BS (Information Technology)**

**Computing Core Courses (Compulsory) 39 Credit Hours**

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

**IT Core Courses**

**24 Credit Hours**

Course Title	Credit Hour
Database Administration & Management	4
Web Technologies	3
Information Technology Infrastructure	3
Systems & Network Administration	4
Virtual Systems & Services	4
Cyber Security	3
IT Project Management	3
Total Credits:	<b>24</b>

**IT Supporting Courses**

**09 Credit Hours**

Course Title	Credit Hour
Software Requirements Engineering	3
Operation Research	3



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Modeling and Simulation	3
<b>Total Credits:</b>	<b>09</b>

**Information Technology Elective Courses                      18 Credit Hours**

Course Title	Credit Hour
Computer Organization & Assembly Language	4
Mobile Application & Development	3
Theory of Automata	3
Artificial Intelligence	4
Visual Programming	3
Data Mining & Warehousing	3
<b>Total Credits:</b>	<b>20</b>

**General Education Courses    19 Credit Hours**

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

**University Elective Courses    12 Credit Hours**

Course Title	Credit Hour
Entrepreneurship	3
Principles of Accounting	3
Organizational Behavior	3
IoT in Digital Agriculture	3
Principles of Psychology	3
Principles of Economics	3
Foreign Language	2
Social Service	1
<b>Total Credits:</b>	<b>22</b>

**Math and Science Foundation courses    12 Credit Hours**

Course Title	Credit Hour
Principles of Statistics	3
Applied Physics	3



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Linear Algebra	3
Calculus & Analytical Geometry	3
Total Credits:	<b>12</b>



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**Scheme of Studies Bachelor of Information Technology BS(IT)**

4 years Degree Program (Bachelor of Sciences in Information Technology)

135 credit hours spread over 8 semesters

**Eligibility Criteria:**

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

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

OR

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

*Deficiency:*

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

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

**Semester – I**

Sr.#	Course Code	Course Title	Pre-Requisite	Cr.Division	Category	Credit Hours
1.	CS-301	Introduction to Information & Communication Technology (ICT)		3(2-1)	Gen Edu	3
2.	CS-303	Programming Fundamentals		4(3-1)	Comp. Core	4
3.	PHY-305	Applied Physics		3(3-0)	Math & Sci. Foundation	3
4.	SSH-307	Pakistan Studies		2(2-0)	Gen Edu	2
5.	ENG 309	English Composition & Comprehension		3(3-0)	Gen Edu	3
6.	*311	University Elective-1		3(3-0)	Uni. Elective	3
<b>Total Credits:</b>						<b>18</b>

**Semester – II**

Sr.#	Course Code	Course Title	Pre-Requisite	Cr.Division	Category	Credit Hours
7.	CS-302	Discrete Structure		3(3-0)	Comp. Core	3
8.	CS-304	Object Oriented Programming	CS-303	4(3-1)	Comp. Core	4
9.	MATH-306	Calculus & Analytical Geometry		3(3-0)	Math & Sci. Foundation	3
10.	ENG-308	Communication & Presentation Skills	ENG-309	3(3-0)	Gen Edu	3
11.	IS 310 / SSH-310	Islamic Studies / Ethics (For foreigner / Non-Muslims)		2(2-0)	Gen Edu	2



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12.	*312	University Elective-II		3(3-0)	Uni. Elective	3
<b>Total Credits:</b>						<b>18</b>





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**Semester – III**

Sr.#	Course Code	Course Title	Pre-Requisite	Cr.Division	Category	Credit Hours
13.	CS-401	Data Structure & Algorithms	CS-304	4(3-1)	Comp. Core	4
14.	CS- 403	Computer Organization & Assembly Language		4(3-1)	IT Elective	4
15.	MATH-405	Linear Algebra		3(3-0)	Math & Sci. Foundation	3
16.	ENG 407	Technical & Business English Writing		3(3-0)	Gen Edu	3
17.	*409	University Elective-III		3(3-0)	Uni. Elective	3
18.	IT- 411	Operation Research		3(3-0)	IT-Supp	3
<b>Total Credits:</b>						<b>20</b>

**Semester – IV**

Sr.#	Course Code	Course Title	Pre-Requisite	Cr.Division	Category	Credit Hours
19.	CS-402	Software Engineering		3(3-0)	Comp. Core	3
20.	CS 404	Operating Systems	CS-401	4(3-1)	Comp Core	4
21.	CS-406	Database Systems		4(3-1)	Comp. Core	4
22.	IT-408	Web Technologies		3(3-0)	IT. Core	3
23.	IT-410	Information Technology Infrastructure		3(3-0)	IT. Core	3
24.	STAT 412	Probability & Statistics		3(3-0)	Math & Sci. Foundation	3
<b>Total Credits:</b>						<b>20</b>

**Semester – V**

Sr.#	Course Code	Course Title	Pre-Requisite	Cr.Division	Category	Credit Hours
25.	CS-501	Computer Networks		4(3-1)	Comp. Core	4
26.	CS-503	Theory of Automata		3(3-0)	IT Elective	3
27.	IT-505	Database Administration & Management	CS-406	4(3-1)	IT. Core	4
28.	CS-507	Information Security		3(3-0)	Comp. Core	3
29.	IT-509	Software Requirements Engineering		3(3-0)	IT Supp	3
<b>Total Credits:</b>						<b>17</b>

**Semester – VI**

Sr.#	Course	Course Title	Pre-Requisite	Cr.Division	Category	Credit
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	Code					Hours
30.	CS-502	Artificial Intelligence	CS-302	4(3-1)	IT Elective	4
31.	CS-504	Visual Programming		3(2-1)	IT Elective	3
32.	IT-506	Virtual Systems & Services		4(3-1)	IT Core	4
33.	IT-508	Systems & Network Administration	CS-404	4(3-1)	IT Core	4
34.	IT-510	IT Project Management	CS-402	3(3-0)	IT Core	3
<b>Total Credits:</b>						<b>18</b>

**Summer Semester**

Sr.#	Course Code	Course Title	Pre-Requisite	Cr.Division	Category	Credit Hours
1.		Internship				

**Semester – VII**

Sr.#	Course Code	Course Title	Pre-Requisite	Cr.Division	Category	Credit Hours
35.	IT-601	Cyber Security		3(3-0)	IT Core	3
36.	CS-603	Mobile Application Development		3(2-1)	IT Elective	3
37.	IT-605	Modeling and Simulation		3(3-0)	IT Supp	3
38.	SSH-607	Professional Practices		3(3-0)	Gen-Edu	3
39.	* 609	University Elective-IV		3(3-0)	Uni. Elective	3
<b>Total Credits:</b>						<b>15</b>

**Semester – VIII**

Sr.#	Course Code	Course Title	Pre-Requisite	Cr.Division	Category	Credit Hours
40.	CS-602	Data Mining & Warehousing		3(2-1)	IT Elective	3
41.	CS-604	Final Year Project		6(0-6)	Comp. Core	6
<b>Total Credits</b>						<b>9</b>

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**Total Cr. Hours: 135**

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## Summary of BS (IT) Revised Scheme of Studies

Existing Courses			Proposed Course		
Course No.	Title	Credit Hours	Course No.	Title	Credit Hours
<b>Semester 1 (19 credit hrs)</b>			<b>Semester 1 (18 credit hrs)</b>		
CS-301	Introduction to Information & Communication Technology (ICT)	3(2-1)	CS-301	Introduction to Information & Communication Technology (ICT)	3(2-1)
CS 303	Programming Fundamentals	4(3-1)	CS 303	Programming Fundamentals	4(3-1)
PHY 305	Applied Physics	3(3-0)	PHY 305	Applied Physics	3(3-0)
<b>MATH 307</b>	<b>Calculus &amp; Analytical Geometry</b>	<b>3(3-0)</b>	<b>SSH-307</b>	<b>Pakistan Studies</b>	<b>2(2-0)</b>
ENG 309	English Composition & Comprehension	3(3-0)	ENG 309	English Composition & Comprehension	3(3-0)
*311	University Elective-1	3(3-0)	*311	University Elective-1	3(3-0)
<b>Semester 2 (18 credit hrs)</b>			<b>Semester 2 (18 credit hrs)</b>		
CS 302	Discrete Structure	3(3-0)	CS-302	Discrete Structure	3(3-0)
CS 304	Object Oriented Programming	4(3-1)	CS-304	Object Oriented Programming	4(3-1)
<b>MATH 306</b>	<b>Linear Algebra</b>	<b>3(3-0)</b>	<b>MATH-306</b>	<b>Calculus &amp; Analytical Geometry</b>	<b>3(3-0)</b>
ENG 308	Communication & Presentation Skills	3(3-0)	ENG 308	Communication & Presentation Skills	3(3-0)
IS 310 / SSH-310	Islamic Studies / Ethics (For foreigner / Non-Muslims)	(2-0)	IS 310 / SSH-310	Islamic Studies / Ethics (For foreigner / Non-Muslims)	(2-0)
*312	University Elective-2	3(3-0)	*312	University Elective-2	3(3-0)
<b>Semester 3 (20 credit hrs)</b>			<b>Semester 3 (20 credit hrs)</b>		
CS 401	Data Structure &	4(3-1)	CS 401	Data Structure &	4(3-1)



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	Algorithms			Algorithms	
CS 403	Comp. Organization & Assembly Language	4(3-1)	CS 403	Comp. Organization & Assembly Language	4(3-1)
<b>STAT 405</b>	<b>Probability &amp; Statistics</b>	<b>3(3-0)</b>	<b>MATH-405</b>	<b>Linear Algebra</b>	<b>3(3-0)</b>
ENG- 407	Technical & Business English Writing	3(3-0)	ENG- 407	Technical & Business English Writing	3(3-0)
* 409	University Elective-III	3(3-0)	* 409	University Elective-III	3(3-0)
IT 411	Operation Research	3(3-0)	IT 411	Operation Research	3(3-0)
<b>Semester 4 (20 credit hrs)</b>			<b>Semester 4 (20 credit hrs)</b>		
CS 402	Software Engineering	3(3-0)	CS 402	Software Engineering	3(3-0)
CS 404	Operating Systems	4(3-1)	CS 404	Operating Systems	4(3-1)
CS 406	Database Systems	4(3-1)	CS 406	Database Systems	4(3-1)
IT 408	Web Technologies	3(3-0)	IT 408	Web Technologies	3(3-0)
CS 410	Information Technology Infrastructure	3(3-0)	CS 410	Information Technology Infrastructure	3(3-0)
<b>SSH 412</b>	<b>Pakistan Studies</b>	<b>2(2-0)</b>	<b>STAT 412</b>	<b>Probability &amp; Statistics</b>	<b>3(3-0)</b>
<b>Semester 5 (18 credit hrs)</b>			<b>Semester 5 (19 credit hrs)</b>		
CS 501	Computer Networks	4(3-1)	CS 501	Computer Networks	4(3-1)
CS 503	Theory of Automata	3(3-0)	CS 503	Theory of Automata	3(3-0)
IT 505	Database Administration & Management	4(3-1)	IT 505	Database Administration & Management	4(3-1)
CS 507	Information Security	3(3-0)	CS 507	Information Security	3(3-0)
IT 509	Software Requirements Engineering	3(3-0)	IT 509	Software Requirements Engineering	3(3-0)
<b>Semester 6 (18 credit hrs)</b>			<b>Semester 6 (19 credit hrs)</b>		
CS 502	Artificial Intelligence	4(3-1)	CS 502	Artificial Intelligence	4(3-1)



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CS 504	Visual Programming	3(2-1)	CS 504	Visual Programming	3(2-1)
IT 506	Virtual Systems and Services	4(3-1)	IT 506	Virtual Systems and Services	4(3-1)
IT 508	Systems and Network Administration	4(3-1)	IT 508	Systems and Network Administration	4(3-1)
IT 510	IT Project Management	3(3-0)	IT 510	IT Project Management	3(3-0)
			<b>Summer Semester</b>		
			Internship		
<b>Semester 7 (18 credit hrs)</b>			<b>Semester 7 (18 credit hrs)</b>		
IT 601	Cyber Security	3(3-0)	IT 601	Cyber Security	3(3-0)
IT 603	Mobile Application Development	3(2-1)	IT 603	Mobile Application Development	3(2-1)
IT 605	Modeling and Simulation	3(2-1)	IT 605	Modeling and Simulation	3(2-1)
SSH 607	Professional Practices	3(3-0)	SSH 607	Professional Practices	3(3-0)
* 609	University Elective-4	3(3-0)	* 609	University Elective-4	3(3-0)
<b>Semester 8 (09 credit hrs)</b>			<b>Semester 8 (09 credit hrs)</b>		
CS 602	Data Mining and Warehousing	3(2-1)	CS 602	Data Mining and Warehousing	3(2-1)
CS-604	Final Year Project	6(0-6)	CS-604	Final Year Project	6(0-6)



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## Courses Outline for BS Information Technology (BSIT)



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## **BS (Information Technology)**

### **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](http://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



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		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





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**Computing Core Courses**

<b>CS-303</b>	<b>PROGRAMMING FUNDAMENTALS</b>	<b>4(3-1)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>• To familiarize students with the basic structured programming skills</li> <li>• To emphasizes upon problem analysis, algorithm designing, and program development and testing</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li>• <b>Understand</b> basic problem-solving steps and logic constructs</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li>• <b>Apply</b> basic programing concepts</li> </ul>	C	3	2
<ul style="list-style-type: none"> <li>• Design and implement algorithms to <b>solve</b> real world problems.</li> </ul>	C	3	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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.			
<b>Practical</b>			
Practical exercises of building algorithms in different writing forms and converting them to programs in C language.			
<b>Teaching Methodology:</b>			
Lectures, Written Assignments, Practical labs, Semester Project, Presentations			



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



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<b>CS-304</b>	<b>OBJECT ORIENTED PROGRAMMING</b>	<b>4(3-1)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>The course aims to develop students' Object Oriented Programming skills.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li><b>Understand</b> principles of object oriented paradigm.</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li><b>Identify</b> the objects &amp; their relationships to build object oriented solution</li> </ul>	C	3	3
<ul style="list-style-type: none"> <li><b>Model</b> a solution for a given problem using object oriented principles</li> </ul>	C	3	4
<ul style="list-style-type: none"> <li><b>Examine</b> an object oriented solution.</li> </ul>	C	4	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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.			
<b>Practical</b>			
Practical exercises of building algorithms in different writing forms and converting them to programs in C++ language.			



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



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<b>CS-401</b>	<b>DATA STRUCTURES AND ALGORITHMS</b>	<b>4(3-1)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>This course provides an introduction to the theory, practice and methods of data structures and algorithm design.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li>Implement various data structures and their algorithms, and <b>apply</b> them in implementing simple applications.</li> </ul>	C	2, 3	2
<ul style="list-style-type: none"> <li><b>Analyze</b> simple algorithms and determine their complexities.</li> </ul>	C	4, 5	3
<ul style="list-style-type: none"> <li><b>Apply</b> the knowledge of data structures to other application domains.</li> </ul>	C	3	2
<ul style="list-style-type: none"> <li><b>Design</b> new data structures and algorithms to solve problems.</li> </ul>	C	6	4, 5
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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.			
<b>Practical</b>			



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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++**. 3<sup>rd</sup> Ed. Pearson, Harlow, UK.

**Suggested Readings:**

1. [Elliot, B.K.](#) and A.T.Paul.2016. Data Structures: Abstraction and Design using Java. 3<sup>rd</sup> Ed. John Wiley Sons, New York, NY, USA.
2. Brijendra, K.J. 2010. **Data structures and algorithms in C**. Tata McGraw Hill Education, New Dehli, India.
3. Adam, D. 2012. Data Structures and Algorithms in C++. 3<sup>rd</sup> Ed. Sydney, Australia.



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<b>CS-302</b>	<b>DISCRETE STRUCTURES</b>		<b>3(3-0)</b>
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>This course provides an introduction to the theory, practice and methods of data structures and algorithm design.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li><b>Understand</b> the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs, and Trees etc.</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li><b>Apply</b> 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.</li> </ul>	C	3	2
<ul style="list-style-type: none"> <li><b>Apply</b> discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography.</li> </ul>	C	3	2
<ul style="list-style-type: none"> <li><b>Differentiate</b> various discrete structures and their relevance within the context of computer science, in the areas of data structures and algorithms, in particular.</li> </ul>	C	4	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			



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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. 7<sup>th</sup> Ed. Prentice Hall, New York, NY, USA.

**Suggested Readings:**

1. Kenneth H. R. and K. Krithivasan. 2013. Discrete Mathematics and its Applications. 7<sup>th</sup> Ed. McGraw-Hill, Singapore.
2. [Ralph P.G.](#) 1994. Discrete and Combinatorial Mathematics: An Applied Introduction. 5<sup>th</sup> Ed. Addison-Wesley, Boston, MA, USA.
3. Winifred. and J.P. Remblay. 1998 Logic and Discrete Mathematics: A Computer Science Perspective. Prentice Hall, Upper saddle River, NJ, USA.





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<b>CS-404</b>	<b>OPEARTING SYSTEM</b>		<b>4(3-1)</b>
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>To help students gain a general understanding of the principles and concepts governing the functions of operating systems.</li> <li>To extend students understating of layered approach that makes design, implementation and operation of the complex OS possible.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li><b>Understand</b> the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems.</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li><b>Analyze and evaluate</b> the algorithms of the core functions of the Operating Systems and explain the major performance issues with regard to the core functions.</li> </ul>	C	4, 5	3
<ul style="list-style-type: none"> <li><b>Demonstrate</b> the knowledge in applying system software and tools available in modern operating systems.</li> </ul>	C	3	5, 7
* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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			



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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. 9<sup>th</sup> Ed. John Wiley & Sons. Hoboken, NJ, USA.

**Suggested Readings:**

1. Mehmood, T. and I. Saeed. 2005. A Comprehensive study of Operating systems & Networks, IT Series, Publication, Pakistan.
2. Wang, K. C. 2017. Embedded and Real-Time Operating Systems. Springer, Olympia, WA, USA.
3. Ulrich, W. 2012. Quantum Dissipative Systems. 4<sup>th</sup> Ed. World Scientific Publisher, Singapore.
4. Raggio, M.T and C. Hosmer. 2013. Data Hiding Exposing Concealed Data in Multimedia, Operating Systems, Mobile Devices and Network Protocols. Syngress, Waltham, MA, USA.



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<b>CS-406</b>	<b>DATABASE SYSTEMS</b>		<b>4(3-1)</b>
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>The held students learn the salient features of various types of databases, transaction management, data warehousing and data mining</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li><b>Explain</b> fundamental database concepts.</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li><b>Design</b> conceptual, logical and physical database schemas using different data models.</li> </ul>	C	5	4
<ul style="list-style-type: none"> <li><b>Identify</b> functional dependencies and resolve database anomalies by normalizing database tables.</li> </ul>	C	2	3
<ul style="list-style-type: none"> <li><b>Use</b> Structured Query Language (SQL) for database definition and manipulation in any DBMS</li> </ul>	C	4	5
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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.			
<b>Practical</b>			



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Practical work on SQL server and Oracle server with practice of all major SQL statements.
<b>Teaching Methodology:</b>
Lectures, Written Assignments, Practical labs, Semester Project, Presentations
<b>Course Assessment:</b>
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
<b>Text Book:</b>
1. Elmasri, R. and S. Navathe. 2017. Fundamentals of Database Systems, 7 <sup>th</sup> Ed. Addison-Wesley, Boston, MA, USA.
<b>Suggested Readings:</b>
1. Connolly, R. and P. Begg. 2015. Database Systems: A Practical Approach to Design, Implementation and Management. 6 <sup>th</sup> Ed. Addison-Wesley, Boston, MA, USA. 2. Mustafa, T. and A. R. Sattar. 2010. Database Management System, IT Series Publications, Pakistan. 3. Ramakrishnan, R. and J. Gehrke. 2003. Database Management Systems, 3 <sup>rd</sup> Ed. Pearson Education, Boston, MA, USA. 4. Silberschatz, A., H.F. Korth and S. Sudarshan. 2010. Database System Concepts. 6 <sup>th</sup> Ed. McGraw Hill, New York, NY, USA.



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<b>CS-402</b>	<b>SOFTWARE ENGINEERING</b>	<b>3(3-0)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>To familiarise students with various software development models and software development life cycles.</li> <li>To emphasize upon understanding of concepts of project management, change control, process management, software development and testing through hands-on team Projects.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li><b>Describe</b> various software engineering processes and activities</li> </ul>	C	1	2
<ul style="list-style-type: none"> <li><b>Apply</b> the system modeling techniques to model a medium size software system</li> </ul>	C	3	2
<ul style="list-style-type: none"> <li><b>Apply</b> software quality assurance and testing principles to medium size software system.</li> </ul>	C	4	2
<ul style="list-style-type: none"> <li><b>Discuss</b> key principles and common methods for software project management such as scheduling, size estimation, cost estimation and risk analysis</li> </ul>	C	2	3
* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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;			



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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.
<b>Teaching Methodology:</b>
Lectures, Written Assignments, Project, Report Writing
<b>Course Assessment:</b>
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
<b>Text Book:</b>
1. Ian, S. 2016. Software Engineering. 10 <sup>th</sup> Ed. Addison Wesley, Boston, MA, USA
<b>Suggested Readings:</b>
1. Gary, B. S., T. J, Cashman and H. J. Rosenblatt. 2017. Systems Analysis and Design. 9 <sup>th</sup> Ed. Cengage Learning, Boston, MA, USA. 2. Roger, S.P. 2016. Software Engineering: A Practitioner's Approach. 8 <sup>th</sup> Ed. McGraw-Hill. Beijing, China. 3. Craig, L. 2001. Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and the Unified Process. 2 <sup>nd</sup> Ed. Prentice Hall, Upper Saddle River, NJ, USA. 4. Dines, B. 2011. <b>Software Engineering Domains Requirements, and Software Design</b> , Springer, Berlin, Germany.



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<b>CS-501</b>	<b>COMPUTER NETWORKS</b>	<b>4(3-1)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>• To familiarize students with concepts related to network layers, network models, and protocol standards.</li> <li>• To emphasizes upon understanding of modern network concepts.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li>• <b>Describe</b> the key terminologies and technologies of computer networks</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li>• <b>Explain</b> the services and functions provided by each layer in the Internet protocol stack.</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li>• <b>Identify</b> various internetworking devices and protocols, and their functions in a network.</li> </ul>	C	4	3
<ul style="list-style-type: none"> <li>• <b>Analyze</b> working and performance of key technologies, algorithms and protocols.</li> </ul>	C	4	3
<ul style="list-style-type: none"> <li>• <b>Build</b> Computer Network on various Topologies</li> </ul>	P	3	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			



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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.
<b>Practical</b>
Lab exercises using tools such as Wireshark, OpNet and Packet tracer
<b>Teaching Methodology:</b>
Lectures, Written Assignments, Practical labs, Semester Project, Presentations
<b>Course Assessment:</b>
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
<b>Text Book:</b>
1. Behrouz A. F. 2013, Data Communications and Networking, 5 <sup>th</sup> Ed. McGraw-Hill, New York, NY, USA.
<b>Suggested Readings:</b>
<ol style="list-style-type: none"> <li>1. James F.K. and K. W. Ross. 2017. Computer Networking a Top-Down Approach Featuring the Internet. 7<sup>th</sup> Ed. Pearson Education, Harlow, UK.</li> <li>2. Stallings, W. 2004. Data and Computer Communications. 6<sup>th</sup> Ed. McGraw Hill, New York, NY, USA.</li> <li>3. Terry S. and B. Burton and W. Burton. 2000. Advanced IP Routing in Cisco Networks. Prentice Hall, Upper Saddle River, NJ, USA.</li> <li>4. William Stallings. 2014. Data and Computer Communications. 6<sup>th</sup> Ed. Pearson Education, Harlow, UK.</li> </ol>





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<b>CS-507</b>	<b>INFORMATION SECURITY</b>	<b>3(3-0)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>To enhance students understanding about the essentials of information security and the algorithms for implementing security</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li><b>Explain</b> key concepts of information security such as design principles, cryptography, risk management, and ethics.</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li><b>Discuss</b> legal, ethical, and professional issues in information security.</li> </ul>	A	2	2
<ul style="list-style-type: none"> <li><b>Apply</b> various security and risk management tools for achieving information security and privacy.</li> </ul>	C	3	2
<ul style="list-style-type: none"> <li><b>Identify</b> appropriate techniques to tackle and solve problems in the discipline of information security.</li> </ul>	C	4	3
* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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.			
<b>Teaching Methodology:</b>			



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Lectures, Written Assignments, Semester Project, Presentations
<b>Course Assessment:</b>
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
<b>Text Book:</b>
1. Bishop, M. 2015. Computer Security Art and Science. Wesley Professional, Addison, London, UK.
<b>Suggested Readings:</b>
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 4 <sup>th</sup> Ed. Cengage Learning, Boston, MA, USA.
5. Stalling, W. 2012. Cryptography and Network Security, 6 <sup>th</sup> Ed, Pearson Education, UK.



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**Information Technology Core (Compulsory) Courses**

IT 601	<b>CYBER SECURITY</b>			<b>3(3-0)</b>
<b>Learning Objectives</b>				
The learner will gain knowledge about securing both clean and corrupted systems, protect personal data, and secure computer networks. The learner will understand key terms and concepts in cyber law, intellectual property and cybercrimes, trademarks and domain theft.				
<b>Learning Outcomes</b>				
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>	
<ul style="list-style-type: none"> <li>• Apply the TCP/IPV6 protocols, addressing, and troubleshooting</li> </ul>	C	1	2	
<ul style="list-style-type: none"> <li>• Use security technologies such as firewalls, VPNs, virtualization, virus scanning, and intrusion protection from a security perspective</li> </ul>	C	2	2	
<ul style="list-style-type: none"> <li>• Develop network security architectures and explain how to use layering and segmentation to improve security</li> </ul>	C	3	4	
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)			
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system				
<b>Course Contents</b>				
<b>Theory</b>				
Introduction to Cybersecurity, Cybersecurity objectives, Cybersecurity roles, Differences between Information Security & Cybersecurity, Cybersecurity Principles, Confidentiality, integrity, & availability, Authentication & nonrepudiation, Information Security (IS) within Lifecycle Management, Lifecycle management landscape, Security architecture processes, Security architecture tools, Intermediate lifecycle management concepts, Risks & Vulnerabilities, Basics of risk management, Operational threat environments, Classes of attacks, Incident Response				
<b>Teaching Methodology:</b>				
Lectures, Written Assignments, Practical labs, Semester Project, Presentations				
<b>Course Assessment:</b>				
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam				
<b>Textbook</b>				
1. P. W. Singer (2013) Cybersecurity and Cyberwar, Oxford University Press.				
<b>Suggested Readings:</b>				
1. R. Meeuwisse (2017) Cybersecurity for Beginners, Cyber Simplicity Limited				
2. D. Franke (2016) Cyber Security Basics: Protect Your Organization by Applying the Fundamentals, CreateSpace Independent Publishing				



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3. S. Michael (2012) Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software, No Starch Press
4. L. Krutz, (2009) Industrial Automation and Control Systems Security Principles.

<b>IT-505</b>	<b>DATABASE ADMINISTRATION &amp; MANAGEMENT</b>			<b>4(3-1)</b>
<b>Learning Objectives</b>				
<ul style="list-style-type: none"> <li>To familiarize students about the concepts and technical issues of Database Administration.</li> <li>To emphasize on understanding of internal functionality of Database Management System.</li> <li>To enable students to perform Database administration tasks and performance tuning of databases.</li> </ul>				
<b>Learning Outcomes</b>				
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>	
<ul style="list-style-type: none"> <li>Install, create, and manage Oracle database.</li> </ul>	C	3	2, 5	
<ul style="list-style-type: none"> <li>Define and devise transaction and concurrency control systems.</li> </ul>	C	3	2	
<ul style="list-style-type: none"> <li>Manage storage structures and controlling users' security.</li> </ul>	C	3	2	
<ul style="list-style-type: none"> <li>Design database backup and recovery procedures.</li> </ul>	C	3	4	
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)			
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system				
<b>Course Contents</b>				
<b>Theory</b>				
Introduction to advance data models such as object relational, object oriented. File organizations concepts, Transactional processing and Concurrency control				



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techniques, Recovery techniques, Query processing and optimization, Database Programming, Integrity and security, Database Administration, Physical database design and tuning, Distributed database systems, Emerging research trends in database systems.
<b>Practical</b>
Hands on practical on database administration and database design and tuning.
<b>Teaching Methodology:</b>
Lectures, Written Assignments, Practical labs, Semester Project, Presentations.
<b>Course Assessment:</b>
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
<b>Text Book:</b>
1. Elmasri, R., S. Navathe. 2015. Fundamentals of Database System. 7 <sup>th</sup> edition. Pearson. Atlanta, USA
<b>Suggested Readings:</b>
1. Lightstone, T. 2007. Physical database design, Elsevier. 2. Edward, S. 2008. Database design and implementation. Wiley. 3. Bernstein, L. 2001. Database and Transaction Processing, Addison-Wesley



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<b>IT-510</b>	<b>INFORMATION TECHNOLOGY PROJECT MANAGEMENT</b>		<b>3(3-0)</b>
<i>Learning Objective</i>			
<ul style="list-style-type: none"> <li>To develop students' ability to plan and manage software development projects successfully, maximizing the return from each stage of the software development life cycle.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li>Manage the scope, cost, timing, and quality of the project, at all times focused on project success as defined by project stakeholders.</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li>Align the project to the organization's strategic plans and business justification throughout its lifecycle</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li>Identify project goals, constraints, deliverables, performance criteria, control needs, and resource requirements in consultation with stakeholders.</li> </ul>	C	2	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.			
<b>Course Contents</b>			
<b>Theory</b>			
Introduction to Project Management; The Project Management and Information Technology Context; The Project Management Process Groups; Project Integration Management: Project Scope Management: Project Time Management; Project Cost Management: Project Quality Management: Project Human Resource Management: Project Communications Management; Project Risk Management: Project Procurement Management: Project Management Tools.			
<b>Teaching Methodology</b>			
Lectures, Written Assignments, Practical labs, Semester Project, Presentations			
<b>Course Assessment</b>			



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Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
<b>Text Book</b>
1. Kerzner, H. and H.R. Kerzner. 2017. Project management: A Systems Approach to Planning, Scheduling and Controlling. John Wiley & Sons, Hoboken, NJ, USA.
<b>Suggested Readings</b>
1. Phillips, J. 2002. It Project Management: On Track from Start to Finish. 3 <sup>rd</sup> Ed. McGraw-Hill, India.
2. Schwalbe, K. 2015. Information technology project management. 6 <sup>th</sup> Ed. Cengage Learning, Boston, MA, USA.
3. Schwalbe, K. 2015. Information Technology Project Management. 3 <sup>rd</sup> Ed. Cengage Learning, Boston, MA, USA.
4. Wysocki, R. K. 2011. Effective Project Management: Traditional, Agile, Extreme. 7 <sup>th</sup> Ed. John Wiley & Sons, Hoboken, NJ, USA.



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<b>IT-410</b>	<b>INFORMATION TECHNOLOGY INFRASTRUCTURE</b>	<b>3(3-0)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>• To familiarize students with Information Technology Infrastructure.</li> <li>• To emphasize on understanding IT infrastructure performance, management, security &amp; service delivery issues and support processes.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
• <b>Discuss</b> in-depth knowledge of IT infrastructure.	C	2	2
• <b>Manage</b> latest computing environment and IT systems.	C	3	3
• <b>Establish</b> business value of information system.	C	4	3
• <b>Resolve</b> security and storage issues.	C	3	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
Definition of IT Infrastructure; Non-functional Attributes; Availability Concepts; Sources of Unavailability; Availability Patterns; Performance; Security Concepts; Data centres; Servers: Availability, Performance, Security; Networking: Building Blocks, Availability, Performance, Security; Storage: Availability, Performance, Security; Virtualization: Availability, Performance, Security; Operating Systems: Building Blocks, Implementing Various OSs, OS availability, OS Performance, OS Security; End User Devices: Building Blocks, Device Availability, Performance, Security; IT Infrastructure Management; Service Delivery Processes; Service Support Processes; Ethics, Trends, organizational and technical issues related to IT infrastructure.			





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<b>Teaching Methodology:</b>
Lectures, Written Assignments, Presentations.
<b>Course Assessment:</b>
Sessional Exam, Home Assignments, Quizzes, Presentations, Final Exam
<b>Text Book:</b>
1. K. Surendra Keshari, N. Kumar (2013) IT Infrastructure & Management, I.K. International Publishing House.
<b>Suggested Readings:</b>
1. Gupta (2010) It Infrastructure & Its Management, Tata McGraw-Hill Education. 2. S. Laan (2013) It Infrastructure Architecture - Infrastructure Building Blocks and Concepts, 2nd Edition, Sjaak Laan 3. W. Stallings and Case (2013) Business Data Communications: Infrastructure, Networking and Security, 7th edition, Prentice Hall, Upper Saddle River, USA. 4. D. Comer (2006) Internetworking with TCP/IP volume 1: Principles, Protocols and Architecture, 5 <sup>th</sup> edition. Prentice Hall.



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<b>IT-508</b>	<b>SYSTEMS AND NETWORK ADMINISTRATION</b>	<b>4(3-1)</b>
<b>Learning Objectives</b>		
This course will enable the students to design a class A; B; or C IPv4 networking scheme and be able to subnet the network based upon requirements for number of networks and number of hosts required		
<b>Learning Outcomes</b>		
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>
<ul style="list-style-type: none"> <li>Demonstrate an understanding of the principles, practices and goals of system administration</li> </ul>	C	2
<ul style="list-style-type: none"> <li>Demonstrate an understanding of the major approaches to computer management in the network environment.</li> </ul>	C	3
<ul style="list-style-type: none"> <li>Configure &amp; troubleshoot services (e.g.; DNS; DHCP; routing; printing) in a networked environment.</li> </ul>	C	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)	
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system		
<b>Course Contents</b>		
<b>Theory</b>		
Introduction to system administration; SA components; Server environment (Microsoft and Linux); Reliable products; Server hardware costing; Maintenance contracts and spare parts; Maintaining data integrity; Client server OS configuration; Providing remote console access; Comparative analysis of OS; Important attributes; Key features; Pros and cons; Linux installation and verification; Configuring local services and managing basic system issues; Administer users and groups; Software management; Managing network services and network monitoring tools; Boot 148 management and process management; IP tables and filtering; Securing network traffic; Advanced file systems and logs; Bash shell scripting; Configuring servers (FTP; NFS; Samba; DHCP; DNS and Apache).		
<b>Practical</b>		
<b>Teaching Methodology:</b>		
Lectures, Written Assignments, Practical labs, Semester Project, Presentations		
<b>Course Assessment:</b>		
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam		
<b>Text Book:</b>		
1. Hunt, C. 2002. TCP/IP Network Administration. O'Reilly Media, Inc, Sebastopol, CA, USA.		
<b>Suggested Readings:</b>		
<ol style="list-style-type: none"> <li>Limoncelli, T., C.J Hogan and S.R. Chalup. 2007. The Practice of System and Network Administration, Pearson Education, London, UK.</li> <li>Kirch, O. and T. Dawson. 2000. Linux Network Administrator's Guide, O'Reilly Media, Sebastopol, CA, USA.</li> </ol>		



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3. Petersen, R. 2005. Red Hat Enterprise Linux & Fedora Core 4: The Complete Reference. McGraw-Hill, New York City, NY, USA.
4. Wiley, L. 2009. Networking Systems Design and Development. 1<sup>st</sup> Ed, CRC Press, Boca Raton, FL, USA.



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IT 506	<b>VIRTUAL SYSTEMS AND SERVICES</b>			<b>4(3-1)</b>
<b>Learning Objectives</b>				
This course will focus on the creation and development of a cohesive, innovative visual system applied across a variety of media formats.				
<b>Learning Outcomes</b>				
At the end of the course the students will be able to:		<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
• Manage VMware and Microsoft Virtual Machine (VM) technologies		C	2	2
• Leverage VMs to build testing, support, and training environments		C	3	2
• Partition physical servers to decrease operating costs and migrate from physical to virtual machines		C	4	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
<b>SDGS addressed in the course:</b>		9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system				
<b>Course Contents</b>				
<b>Theory</b>				
Virtualization Concepts, defining virtual machines (servers and workstations), Advantages of deploying Vms, Creating Virtual Machines, Partitioning shared resources, Accessing raw and virtual disks, Virtualizing CPU and memory resources, Planning for automatic installations, Designing virtual networks, Bridged, NAT and host-only networking, Allocating host resources, Configuring virtual hard drives, Managing peripheral devices, Exploiting Virtual Workstation Functionality, Ready multiple operating systems, Suspending and resuming virtual workstations				
<b>Practical</b>				
Practical implementation of virtual machines concepts on different virtual machines like VM ware, virtual box etc.				
<b>Teaching Methodology:</b>				
Lectures, Written Assignments, Practical labs, Semester Project, Presentations				
<b>Course Assessment:</b>				
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam				
<b>Text Book:</b>				
1. D. Iain (2010) Virtual Machines, Springer Science & Business Media				
<b>Suggested Readings:</b>				
1. S. Jim Smith, N. Ravi ( 2005), Virtual Machines: Versatile Platforms for Systems and Processes, Elsevier.				
2. Tim Lindholm (2013) The Java Virtual Machine Specification, Java SE 7 Edition, Addison-Wesley.				
3. G. Theodor G. Wyeld, K. Sarah (2007) Virtual Systems and Multimedia, Springer Science & Business Media				



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<b>IT-408</b>	<b>WEB TECHNOLOGIES</b>		<b>3(3-0)</b>
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>To familiarize students with Web Systems and Technologies.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li>Understand WWW technologies and web-based applications architecture</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li>Development, deployment and management concepts</li> </ul>	C	3	4
<ul style="list-style-type: none"> <li>Perform analysis modeling and design modeling for web application</li> </ul>	C	4	3
<ul style="list-style-type: none"> <li>Identify candidate's tools and technologies for developing web application</li> </ul>	C	5	3
<ul style="list-style-type: none"> <li>Developing user interface for web application</li> </ul>	C	6	4
<ul style="list-style-type: none"> <li>Describe and transform data using XML and its related technologies</li> </ul>	C	3	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
Introduction to Web Applications; TCP/IP Application Services; Web Servers: Basic Operation, Virtual hosting, Chunked transfers, Caching support, Extensibility: SGML, HTML5, CSS3; XML Languages and Applications: Core XML, XHTML, XHTML MP; Web Service: SOAP, REST, WML, XSL; Web Services: Operations, Processing HTTP Requests, Processing HTTP Responses, Cookie Coordination, Privacy and P3P, Complex HTTP Interactions, Dynamic Content Delivery; Server Configuration: Server Security; Web Browsers Architecture and Processes; Active Browser Pages: JavaScript, DHTML, AJAX,			



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JSON; Approaches to Web Application Development; Programming in any Scripting language; Search Technologies; Search Engine Optimization; XML Query Language; Semantic Web; Future Web Application Framework.
<b>Teaching Methodology:</b>
Lectures, Written Assignments, Presentations.
<b>Course Assessment:</b>
Sessional Exam, Home Assignments, Quizzes, Report Writing, Presentations, Final Exam
<b>Text Book:</b>
1. Nixon, R. 2012. Learning PHP, MySQL, JavaScript, and CSS: A step-by-step guide to creating dynamic websites. O'Reilly Media, Inc.
<b>Suggested Readings:</b>
1. H.M Dietel & P.J. Dietel, A.B Goldber, (2008) Internet and World Wide Web How to Program, 4th Edition 2. Sambells & A. Gustafson. (2007) Advance DOM Scripting Dynamic Web Design Techniques. 3. H.M Dietel & P.J. Dietel. (2001) XML How to program, .Pearson Education Inc. 4. G. Kappel, B.Proll, S. Reich and W. Retschitzegger (eds) (2006) Web Engineering- The Discipline of Systematic Development of Web Application.



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**General Education Courses**

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





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



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<b>Teaching Methodology</b>
Lectures, Written Assignments, Semester Project, Presentations
<b>Course Assessment</b>
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
<b>Text Book</b>
1. Technical Report Writing, by Pauley and Riordan, Houghton Mifflin Company, 8th Edition.
<b>Suggested Readings</b>
1. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill. 2. Ellis, M. and C. Johnson. 1994. Teaching Business English. 3 <sup>rd</sup> Ed. Oxford Press, Oxford, UK. 3. Ray E. 2010. Technical and Business Writing for Working Professionals. 2 <sup>nd</sup> Ed. Xlibris Corporation, <u>Bloomington</u> , IN, USA.



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<b>ENG-308</b>	<b>COMMUNICATION &amp; PRESENTATION SKILLS</b>			<b>3(3-0)</b>
<i>Learning Objective</i>				
<ul style="list-style-type: none"> <li>Evaluate information and its sources critically.</li> <li>Incorporate selected information into one's knowledge base.</li> <li>Use information effectively to accomplish a specific purpose.</li> </ul>				
<b>Learning Outcomes</b>				
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>	
<ul style="list-style-type: none"> <li>Enrich the thought and culture and provides us with the most important international vehicle of expression.</li> </ul>	C	1	1	
<ul style="list-style-type: none"> <li>Enhance English language skills of the students and develop their critical thinking.</li> </ul>	C	1, 3	1	
<ul style="list-style-type: none"> <li>Demonstrate ability to think critically</li> </ul>	C	3	7	
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
<b>SDGS addressed in the course</b>	4 (Quality Education)			
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.				
<b>Course Contents</b>				
<b>Theory</b>				
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.				
<b>Teaching Methodology</b>				
Lectures, Written Assignments, Semester Project, Presentations				



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<b>Course Assessment</b>
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
<b>Text Book</b>
1. Practical Business English, Collen Vawdrey, 1993, ISBN = 0256192740
<b>Suggested Readings</b>
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. 4 <sup>th</sup> Ed. Heinle & Heinle Inc., Boston, MA, USA.
3. Schriver, K. A. 1997. Dynamics in Document Design. 3 <sup>rd</sup> 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. 2 <sup>nd</sup> Ed, John Wiley & Sons. New York City, NY, USA.
5. Masami, I. 2004. Algebraic Theory of Automata and Languages. World Scientific, River Edge, NJ, USA.



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



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

**Teaching Methodology**

Lectures, Written Assignments, Semester Project, Presentations

**Course Assessment**

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

**Text Book**

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

**Suggested Readings**

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



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<b>CS-301</b>	<b>INTRODUCTION TO INFORMATION &amp; COMMUNICATION TECHNOLOGY</b>	<b>3(2-1)</b>	
<i>Learning Objective</i>			
<ul style="list-style-type: none"> <li>The course introduces students to information and communication technologies and their application in the workplace.</li> <li>Students will get basic understanding of computer software, hardware, and associated technologies.</li> <li>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.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li><i>Understand basics of computing technology</i></li> </ul>	C	1	2
<ul style="list-style-type: none"> <li><i>Perform number systems conversions and arithmetic</i></li> </ul>	C	2	3
<ul style="list-style-type: none"> <li><i>Know about different types of software &amp; hardware</i></li> </ul>	C	2	2
<ul style="list-style-type: none"> <li><i>Apply basic computing related technologies</i></li> </ul>	P	3	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.			
<b>Course Contents</b>			
<b>Theory</b>			
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			





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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**

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

**Suggested Readings**

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



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<b>SSH-307</b>	<b>PAKISTAN STUDIES</b>			<b>2(2-0)</b>
<i>Learning Objective</i>				
<ul style="list-style-type: none"> <li>• Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.</li> <li>• Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan</li> </ul>				
<b>Learning Outcomes</b>				
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>	
<ul style="list-style-type: none"> <li>• Learn about the History and Ideology of Pakistan.</li> </ul>	C	1	1	
<ul style="list-style-type: none"> <li>• Get knowledge about the political and administrative structure of Pakistan.</li> </ul>	C	2	1	
<ul style="list-style-type: none"> <li>• Get familiarity about the political transitions in Pakistan.</li> </ul>	C	2	1	
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
<b>SDGS addressed in the course</b>	4(Quality Education)			
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.				
<b>Course Contents</b>				
<b>Theory</b>				
<i>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.</i>				
<b>Teaching Methodology</b>				
Lectures, Written Assignments				
<b>Course Assessment</b>				
Sessional Exam, Home Assignments, Quizzes, Final Exam				



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<b>Text Book</b>
1. The Emergence of Pakistan, Chaudary M., 1967
<b>Suggested Readings</b>
1. The making of Pakistan, Aziz. 1976 2. A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988 3. Mehmood, S. 1994. Pakistan Political Roots and Development. 2 <sup>nd</sup> Ed. Five Star Publishing, Lahore, Pakistan. 4. S.M. Burke and L. Ziring. 1993. Pakistan's Foreign Policy: An Historical Analysis. 2 <sup>nd</sup> Ed. Oxford University Press, Oxford, U.K.



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<b>IS-310/SS-310</b>	<b>ISLAMIC STUDIES</b>	<b>2(2-0)</b>	
<i>Learning Objective</i>			
<ul style="list-style-type: none"> <li>• To enhance understanding of the students regarding Islamic Civilization</li> <li>• To improve Students skill to perform prayers and other worships</li> <li>• To enhance the skill of the students for understanding of issues related to faith and religious life.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li>• Get the knowledge of basic teachings of Islam.</li> </ul>	C	1	1
<ul style="list-style-type: none"> <li>• Learn how to adopt Islamic life style.</li> </ul>	C	2	1
<ul style="list-style-type: none"> <li>• Know the rights of individuals given by the Islam.</li> </ul>	C	2	1
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course</b>	4(Quality Education)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.			
<b>Course Contents</b>			
<b>Theory</b>			
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.			
<b>Teaching Methodology</b>			
Lectures, Written Assignments			
<b>Course Assessment</b>			
Sessional Exam, Home Assignments, Quizzes, Final Exam			
<b>Text Book</b>			
1. Introduction to Islam by Dr Hamidullah, Papular Library Publishers Lahore			
<b>Suggested Readings</b>			
1. Principles of Islamic Jurisprudence by Ahmad Hassan, Islamic Research Institute, IIUI			



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2. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services
3. Waliullah M., 1982. Muslim Jurisprudence and the Quranic Law of Crimes. 2<sup>nd</sup> Ed. Islamic Book Service, Karachi, Pakistan.



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**Information Technology SUPPORTING courses**

<b>IT 605</b>	<b>MODELING AND SIMULATION</b>	<b>3(3-0)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>• Prepare comprehensive report and an oral presentation with accurate visual representations of a model and its results.</li> <li>• Understand the Role of Modeling</li> <li>• Construct difference-based computer models.</li> <li>• Utilize MATLAB as a computational tool - Create tabular and graphical results.</li> <li>• Analyze modeling and simulation</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLOs</b>
• Explain the model classification at different levels.	C	1	2
• Analyze complex engineering systems and associated issues (using systems thinking and modelling techniques)	C	3	3
• Apply advanced theory-based understanding of engineering fundamentals and specialist bodies of knowledge in the selected discipline area to predict the effect of engineering activities.	C	4	4
• Analyze the simulation results of a medium sized engineering problem.	C	4	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
Introduction to modelling and simulation; System analysis: Classification of systems: System theory basics: its relation to simulation: Model classification at conceptual: abstract: and simulation models levels: Methodology of model building; Simulation systems and languages: Means for model and experiment description; Principles of			



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simulation system design: Parallel process modeling using Petri nets and finite automata in simulation; Models of queuing systems; Discrete simulation models; Model time; Simulation experiment control; Overview of numerical methods used for continuous simulation; System Dymola/ Modelica: Combined simulation; Special model classes: Models of heterogeneous systems: Cellular automata and simulation: Checking model validity; Verification of models: Analysis of simulation results: simulation results visualization: model optimization; generating: transformation: and testing of pseudorandom numbers with overview of commonly used simulation systems.

**Teaching Methodology:**

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

**Course Assessment:**

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

**Text Book:**

1. Modeling and Simulation, Bungartz, H.-J., Zimmer, S., Buchholz, M., Pflüger, D., Springer-Verlag, 2014.

**Suggested Readings:**

1. Simulation Modeling Handbook, A Practical Approach, Christopher A. Chung, CRC Press, 2004. Kochan, S. G. 2014, Programming in C. 4<sup>th</sup> Ed. Pearson Education, Addison-Wesley, Boston, MA, USA.
2. System design, modeling and simulation using Ptolemy II, Claudius Ptolemaeus, , Ver 2.0, Creative Commons Attribution-ShareAlike 3.0 Unported, 2014.
3. Applied Simulation Modeling, Andrew F. Seila, Vlatko Ceric, Pandu Tadikamalla, Thomson Learning Inc., 2003



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IT 411	<b>OPERATION RESEARCH</b>			3(3-0)
<b>Learning Objectives</b>				
•				
<b>Learning Outcomes</b>				
This course will enable the students to	<b>Domain</b>	<b>BT Level*</b>	<b>PLOs</b>	
• Identify and develop operational research models from the verbal description of the real system Development, deployment and management concepts.	C	2	2	
• Understand the mathematical tools that are needed to solve optimization problems.	C	2,	2	
• Use mathematical software to solve the proposed models.	C	3	3	
• Develop a report that describes the model and the solving technique, analyses the results and propose recommendations in language understandable to the decision-making processes in Management and Engineering.	C	4	4, 7	
<b>SDGS addressed in the course:</b> 9 (Industry, Innovation, and Infrastructure)				
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system				
<b>Course Contents</b>				
<b>Theory</b>				
An overview and background; Process; Techniques and Application; Networks; Inventory Control Models; Linear Programming; Dual Analysis; Transportation Problems; Assignments Problems; Methodology of Operations Research: Linear programming; solving methods; duality: and sensitivity analysis: Integer Programming; Network flows; Multi-criteria decision techniques; Decision making under uncertainty and risk; Game theory; Dynamic programming.				
<b>Teaching Methodology:</b>				
Lectures, Written Assignments, Presentations				
<b>Course Assessment:</b>				
Sessional Exam, Home Assignments, Final Exam				





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<b>Text Book:</b>				
1. Fredrick s. Hillier, Liebeman Hillier. (2001), Introduction to Operation Research, 7 <sup>th</sup> Prentice Hall				
IT 509	<b>SOFTWARE REQUIREMENT ENGINEERING</b>	3(3-0)		
<b>Learning Objectives</b>				
<ul style="list-style-type: none"> <li>• To understand issues in requirements engineering</li> <li>• To apply requirements engineering process</li> <li>• To understand and use requirements elicitation and specification</li> <li>• To understand and use formal techniques of software engineering</li> <li>• To understand modeling and analysis of Non-Functional Requirements.</li> </ul>				
<b>Learning Outcomes</b>				
At the end of the course the students will be able to:		<b>Domain</b>	<b>BT Level*</b>	<b>PLOs</b>
• Describe the requirements engineering process		C	1	2
• Effectively analyze software requirements for the development of cost-effective and efficient technical solutions		C	4	3
• Prepare both functional and non-functional requirements along with validation for a medium-size software system.		C	3	3
• Document effective requirements in Software Requirements Specification (SRS) using clear, unambiguous requirements.		C	3	7
* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
<b>SDGS addressed in the course:</b>		9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system				
<b>Course Contents</b>				
<b>Theory</b>				
Definition of requirements engineering and role in system development; Fundamental concepts and activities of requirements engineering; Information elicitation techniques; Modeling scenarios: Fundamentals of goal-oriented requirements engineering: Modeling behavioral goals; Modeling quality goals: Goal modeling heuristics; Object modeling for				



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requirements engineering: Object modeling notations; Object modeling heuristics: Identifying objects from goals: Modeling use cases and state machines: Deriving operational requirements from goals; Requirements Specification: Requirements verification and validation. Management of inconsistency and conflict; requirements engineering risks: the role of quality goals in the requirements selection process: Techniques for requirements evaluation; selection and prioritization; Requirements management; Requirements traceability and impact analysis.

**Teaching Methodology:**

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

**Course Assessment:**

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

**Text Book:**

1. [Alan M. Davis](#) (1993) Software Requirements: Objects, Functions, and States, 2<sup>nd</sup> Edition, PTR Prentice Hall

**Suggested Readings:**

2. [C. Bailin](#) (1997) Software Requirements Engineering, 2nd Edition, Wiley.
3. B. Brian (2009) Software & Systems Requirements Engineering in Practice, ISBN 978-0-07-160547-2
4. D. Leffingwell, D. Widrig, (2006) Managing Software Requirements: A Use Case Approach, 2<sup>nd</sup> Edition, ISBN 0-321-12247-X
5. J. Preece, R. Yvonne (2007) Interaction Design: beyond human-computer interaction, 3<sup>rd</sup> Edition



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**Information Technology Elective Courses**

<b>CS-403</b>	<b>COMPUTER ORGANIZATION &amp; ASSEMBLY LANGUAGE</b>	<b>4(3-1)</b>
<b>Learning Objectives</b>		
<ul style="list-style-type: none"> <li>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.</li> </ul>		
<b>Learning Outcomes</b>		
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>
<ul style="list-style-type: none"> <li><b>Acquire</b> the basic knowledge of computer organization, computer architecture and assembly language.</li> </ul>	C	2
<ul style="list-style-type: none"> <li><b>Understand</b> the concepts of basic computer organization, architecture, and assembly language techniques.</li> </ul>	C	2
<ul style="list-style-type: none"> <li><b>Solve</b> the problems related to computer organization and assembly language.</li> </ul>	C	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)	
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system		
<b>Course Contents</b>		
<b>Theory</b>		



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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 Organization, Technical Publication, Pune, India.
3. Hamacher, V. C., Vranesic, Z. G., Zaky, S. G., Vransic, Z., & Zakay, S. (1996). Computer organization. McGraw-Hill, New York City, NY, USA.
4. Stallings, W. 2018. Computer Organization and architecture designing for performance. Pearson Education, Hoboken, UK.



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<b>CS-603</b>	<b>MOBILE APPLICATION &amp; DEVELOPMENT</b>	<b>3(2-1)</b>
<b>Learning Objectives</b>		
<p>This course will enable the students to:</p> <ul style="list-style-type: none"> <li>• Improve ability to analyse and understand mobile software development. Improve your skills in reacting appropriately to solve mobile related problems.</li> <li>• Develop efficient and state-of-the-art applications.</li> <li>• Solve complex mobile programming problems and could transfer real-life mobile related problems into productive solution.</li> </ul>		
<b>Learning Outcomes</b>		
At the end of the course the students will be able to:		
	<b>Domain</b>	<b>BT Level*</b>
	<b>PLOs</b>	
<ul style="list-style-type: none"> <li>• Discuss different architectures &amp; framework for Mobile Application development.</li> </ul>	C	1
<ul style="list-style-type: none"> <li>• Develop mobile applications using current software development environments.</li> </ul>	C	3
<ul style="list-style-type: none"> <li>• Compare the different performance tradeoffs in mobile application development.</li> </ul>	C	3
* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A=Affective domain		
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)	
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system		
<b>Course Contents</b>		
<b>Theory</b>		
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.		
<b>Practical</b>		
Use of Android framework; Form designing in android; Database design; Front end and back end connectivity.		
<b>Teaching Methodology:</b>		
Lectures, Written Assignments, Practical labs, Semester Project, Presentations		
<b>Course Assessment:</b>		
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam		



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**Text Book:**

1. Burnette, E. 2009. Hello, Android Introducing Google's Mobile Development Platform. 2<sup>nd</sup> 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. 3<sup>rd</sup> 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.



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<b>CS-503</b>	<b>THEORY OF AUTOMATA</b>			<b>3(3-0)</b>
<i>Learning Objective</i>				
<ul style="list-style-type: none"> <li>The course introduces students with fundamental concepts of automata theory and formal languages.</li> <li>Form basic models of computation which provide foundation of many branches of computer science, e.g. compilers, software engineering, concurrent systems, etc.</li> </ul>				
<b>Learning Outcomes</b>				
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>	
<ul style="list-style-type: none"> <li>Explain and manipulate the different concepts in automata theory and formal languages such as formal proofs, automata, regular expressions, Turing machines etc.</li> </ul>	C	2	2	
<ul style="list-style-type: none"> <li>Prove properties of languages, grammars and automata with rigorously formal mathematical methods</li> </ul>	C	2	3	
<ul style="list-style-type: none"> <li>Design of automata, RE and CFG</li> </ul>	C	3	4	
<ul style="list-style-type: none"> <li>Transform between equivalent NFAs, DFAs and REs</li> </ul>	C	3	3	
<ul style="list-style-type: none"> <li>Define Turing machines performing simple tasks</li> </ul>	C	2	2	
<ul style="list-style-type: none"> <li>Differentiate and manipulate formal descriptions of languages, automata and grammars with focus on regular and context-free languages, finite automata and regular expressions.</li> </ul>	C	3	4	
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
<b>SDGS addressed in the course</b>	9 (Industry, Innovation, and Infrastructure)			
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system.				
<b>Course Contents</b>				
<b>Theory</b>				



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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. 2<sup>nd</sup> Ed. Wesley Pub, Lancing, MI, USA.

**Suggested Readings**

4. Andrew, W. and A. Appel. 2004. Modern Compiler Implementation in C. Cambridge University Press, Cambridge, UK.
5. Dick, G., E. Henri and J. H. Jacobs. 2010. Modern Compiler Design. 2<sup>nd</sup> Ed. John Wiley, New York City, NY, USA.
6. Henri, E. B., C. J. Jacobs, K. G. Langendoen and D. Grune. 2012. Modern Compiler Design. 2<sup>nd</sup> Ed, John Wiley & Sons. New York City, NY, USA.
7. Masami, I. 2004. Algebraic Theory of Automata and Languages. World Scientific, River Edge, NJ, USA.





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<b>CS-502</b>	<b>ARTIFICIAL INTELLIGENCE</b>		<b>4(3-1)</b>
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>• This course will introduce the basic principles in artificial intelligence.</li> <li>• To cover simple representation schemes, problem solving paradigms.</li> <li>• The Prolog programming language will also be introduced</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li>• Understand different types of AI agents.</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li>• Know how to build simple knowledge-based systems.</li> </ul>	C	3	2
<ul style="list-style-type: none"> <li>• Apply knowledge representation, reasoning, and machine learning techniques to real-world problems.</li> </ul>	C	4	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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			
<b>Practical</b>			
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			



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discussion of the questionable claims.
<b>Teaching Methodology:</b>
Lectures, Written Assignments, Practical labs, Semester Project, Presentations
<b>Course Assessment:</b>
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam
<b>Text Book:</b>
1. Bratko, I. 2001. Prolog Programming for Artificial Intelligence. 4 <sup>th</sup> Ed. Addison Wesley, Boston, MA, USA
<b>Suggested Readings:</b>
1. George, F. 2008. Structures and Strategies for Complex Problem Solving 6 <sup>th</sup> 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. 3 <sup>rd</sup> Ed. Prentice Hall, Upper Saddle River, NJ, USA



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<b>CS-504</b>	<b>VISUAL PROGRAMMING</b>	<b>3(2-1)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>• Understand the basic concepts of visual programming.</li> <li>• Design visual programs following software development process</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li>• Use the different elements of a visual programming language as building blocks to develop correct, coherent programs.</li> </ul>	C	1	4
<ul style="list-style-type: none"> <li>• Program using the fundamental software development process, including design, coding, documentation, testing and debugging.</li> </ul>	C	3	4
<ul style="list-style-type: none"> <li>• Analyze problems, develop conceptual designs that solve those problems, and transform those designs to Visual Programs.</li> </ul>	C	4	3, 4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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;			



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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.
<b>Practical</b>
Develop Visual Programs using Visual Studio IDE.
<b>Teaching Methodology:</b>
Lectures, Written Assignments, Practical labs, Semester Project, Presentations
<b>Course Assessment:</b>
Sessional Exam Home Assignments, Quizzes, Project, Presentations, Final Exam
<b>Text Book:</b>
1. Bradley, J. C. and A.C. Millspaugh. 2014. Programming in C# .NET. McGraw Hill, New York City, NY, USA.
<b>Suggested Readings:</b>
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.



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<b>CS-602</b>	<b>DATA MINING &amp; WAREHOUSING</b>	<b>3(3-0)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>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.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li>Describe the underlying concepts of data warehousing and mining.</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li>Differentiate between data warehousing, data mining, machine learning, business intelligence, artificial intelligence and statistical analysis.</li> </ul>	C	2	3
<ul style="list-style-type: none"> <li>Identify different machine learning approaches to suit the requirement of problem at hand.</li> </ul>	C	3	3
* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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.			
<b>Teaching Methodology:</b>			
Lectures, Written Assignments, Presentations			
<b>Course Assessment:</b>			
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam			



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<b>Text Book:</b>
1. Gorunescu, F. 2011. Data Mining Concepts, Models and Techniques. Springer Science & Business Media, Berlin, Germany.
<b>Suggested Readings:</b>
1. Fong, J. 2006. Information Systems Re-engineering and Integration. 2 <sup>nd</sup> 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.



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<b>CS-</b>	<b>INTRODUCTION TO DATA SCIENCE</b>	<b>3(2-1)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>• 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.</li> <li>• to explain the significance of exploratory data analysis in data science.</li> <li>• To identify common approaches used for Feature Generation as well as Feature Selection.</li> <li>• To discuss the Ethical and Privacy issues.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
• 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			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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			



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networks as graphs, Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs, Neighborhood properties in graphs; Data Visualization: Basic principles, ideas and tools for data visualization; Data Science and Ethical Issues: Discussions on privacy, security, ethics, Next-generation data scientists.

**Practical**

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

**Teaching Methodology:**

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

**Course Assessment:**

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

**Text Book:**

1. Igual, L. S. Segui. 2017. Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications. 1<sup>st</sup> 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, 1<sup>st</sup> Edition. ISBN 978-1-78439-640-4
3. Grus, J. 2015. Data Science from Scratch, O'Reilly Media, 1<sup>st</sup> Edition, 2015; ISBN 978-1-491-90142-7
4. Zaki. M. J., W. Meira. 2014. Data Mining and Analysis: Fundamental Concepts and Algorithms. 1<sup>st</sup> edition. Cambridge University Press. ISBN 978-0-521-76633-3





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<b>CS-</b>	<b>DIGITAL MARKETING</b>	<b>3(2-1)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>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</li> <li>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</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li>Gain an understanding of the motivations behind data collection and analysis methods used by marketing professionals</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li>Understand frameworks and approaches to measuring consumers' digital actions</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li>Learn to evaluate and choose appropriate web analytics tools and techniques.</li> </ul>	C	3	3
<ul style="list-style-type: none"> <li>Apply digital marketing concepts to a real business problem</li> </ul>	P	3	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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.			
<b>Practical</b>			
Semester project that combines all concepts and tools that have been learnt in the course to a real business problem.			



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<b>Teaching Methodology:</b>
Lectures, Written Assignments, Practical labs, Semester Project, Presentations.
<b>Course Assessment:</b>
Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
<b>Text Book:</b>
1. Bhatia, P., 2019. Fundamentals of Digital Marketing. Pearson. UK
<b>Suggested Readings:</b>
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.



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**Mathematics and Science Foundation Courses**

<b>CS-306</b>	<b>CALCULUS &amp; ANALYTICAL GEOMETRY</b>	<b>3(3-0)</b>
<b>Learning Objectives</b>		
<ul style="list-style-type: none"> <li>To provide foundation and basic ground for calculus and analytical geometry background</li> </ul>		
<b>Learning Outcomes</b>		
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>
<ul style="list-style-type: none"> <li><b>Understand</b> importance of calculus</li> </ul>	C	2
<ul style="list-style-type: none"> <li><b>Apply</b> derivatives, partial derivatives or integrals</li> </ul>	C	3
<ul style="list-style-type: none"> <li>Design and implement algorithms to <b>solve</b> practical problems.</li> </ul>	C	3
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)	
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system		
<b>Course Contents</b>		
<b>Theory</b>		
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.		
<b>Teaching Methodology:</b>		
Lectures, Written Assignments, Presentations		
<b>Course Assessment:</b>		



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Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam
<b>Text Book:</b>
1. Thomas and Finny. 2010. Calculus and Analytical Geometry. 6 <sup>th</sup> Ed. Pearson Education, New Delhi, India
<b>Suggested Readings:</b>
1. Thomas and Finny. 2010. Calculus and Analytical Geometry. 6 <sup>th</sup> Ed. Pearson Education, New Delhi, India. 2. Erwin, K. 2013. Advanced Engineering Mathematics. 10 <sup>th</sup> 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. 2 <sup>nd</sup> Ed. Springer, New York, NY, USA. 5. Callahan, J. J. 2010. Advanced Calculus: A Geometric View. Springer Science & Business Media. Northampton, UK



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<b>STAT-412</b>	<b>PROBABILITY &amp; STATISTICS</b>			<b>3(3-0)</b>
<b>Learning Objectives</b>				
<ul style="list-style-type: none"> <li>To provide foundation and basic ground for calculus and analytical geometry background</li> </ul>				
<b>Learning Outcomes</b>				
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>	
<ul style="list-style-type: none"> <li><b>Understand</b> the importance of probability and statistics</li> </ul>	C	2	2	
<ul style="list-style-type: none"> <li><b>Apply</b> probabilities related to both discrete</li> </ul>	C	3	2	
<ul style="list-style-type: none"> <li><b>Compare</b> and analyze data sets using descriptive statistics.</li> </ul>	C	3	3	
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
<b>SDGS addressed in the course:</b>	4(Quality Education)& 8(Decent work & Economic Growth)			
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system				
<b>Course Contents</b>				
<b>Theory</b>				
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.				
<b>Teaching Methodology:</b>				
Lectures, Written Assignments, Presentations				
<b>Course Assessment:</b>				
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam				
<b>Text Book:</b>				



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

**Suggested Readings:**

1. Lay, L. D. 2015. Probability and Statistics for Engineering and the Sciences, 9<sup>th</sup> 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. 8<sup>th</sup> Ed. Prentice Hall, Upper Saddle River, NJ, USA.
4. Serdobolskii, V.2008. Multiparametric Statistics. Elsevier, Amsterdam, Netherlands.
5. Sandra, K. M. 2010. Statistics, McGraw-Hill, New York, NY, USA.



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<b>MATH-405</b>	<b>LINEAR ALGEBRA</b>			<b>3(3-0)</b>
<b>Learning Objectives</b>				
<ul style="list-style-type: none"> <li>• <i>To provide fundamentals of solution for system of linear equations.</i></li> <li>• <i>To apply operations on system of equations, matrix properties, solutions and study of their properties.</i></li> </ul>				
<b>Learning Outcomes</b>				
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>	
<ul style="list-style-type: none"> <li>• <b>Understand</b> the importance of linear algebra</li> </ul>	C	2	2	
<ul style="list-style-type: none"> <li>• <b>Apply</b> algebraic operation will be required to solve practical</li> </ul>	C	3	2	
<ul style="list-style-type: none"> <li>• Design and implement symbolic simulator to <b>solve</b> system of equations through programming language.</li> </ul>	C	3	4	
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain				
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)			
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system				
<b>Course Contents</b>				
<b>Theory</b>				
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;				
<b>Teaching Methodology:</b>				
Lectures, Written Assignments, Presentations				
<b>Course Assessment:</b>				
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam				
<b>Text Book:</b>				
1. Cheney, W. and D.Kincai. 2009. Linear algebra: Theory and Applications. Jones & Bartlett Learning, Burlington, MA, USA.				



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**Suggested Readings:**

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





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<b>PHY-305</b>	<b>APPLIED PHYSICS</b>	<b>3(3-0)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>• To familiarize students with the basic structured programming skills</li> <li>• To emphasizes upon problem analysis, algorithm designing, and program development and testing</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li>• <b>Understand</b> the importance of linear algebra</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li>• <b>Apply</b> algebraic operation</li> </ul>	C	3	2
<ul style="list-style-type: none"> <li>• Design and implement algorithms to <b>solve</b> system of equations through programming language.</li> </ul>	C	3	4
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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.			
<b>Practical</b>			
<ol style="list-style-type: none"> <li>1. Construction of wiring systems, fuses, switches of various types insulators</li> <li>2. Circuits design and drawing of a typical farm electrical system.</li> <li>3. Selection of motor for various farm equipment such as forage cutter, feed-grinders, and shop tools.</li> <li>4. Practice on repair and adjustment of electric motors, switches, fuses, transmission</li> </ol>			



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wiring controls 5. Study of 3 phase induction motor 6. Study of star and delta connections 7. Study of semi-conductor, triode, diode valve and transistors. 8. Use of AVO meter, CRO, planimeter 9. Fabrication of full wave rectifier and inductance study of its wave-shape.
<b>Teaching Methodology:</b>
Lectures, Written Assignments, Presentations
<b>Course Assessment:</b>
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam
<b>Text Book:</b>
1. Cheney, W. and D.Kincai. 2009. Linear algebra: Theory and Applications. Jones & Bartlett Learning, Burlington, MA, USA.
<b>Suggested Readings:</b>
1. Cheney, W. and D.Kincai. 2009. Linear algebra: Theory and Applications. Jones & Bartlett Learning, Burlington, MA, USA. 2. David, K.H.2007. Elementary Linear Algebra with Applications. 9 <sup>th</sup> Ed. Prentice Hall, Prentice Hall, Harlow, UK. 3. Gilbert, S. S., B. C. Andy and B. Andrew, B. 2005. Linear Algebra and Its Applications. 4 <sup>th</sup> 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. <b>Linear Algebra with Applications</b> . Pearson Learning Solution, New York, NY, USA.



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**University Elective Courses**

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



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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. 2<sup>nd</sup> Ed. Prentice Hall Inc. Upper Saddle River, NJ, USA.

**Suggested Readings:**

1. Dollinger, M. 2007. Entrepreneurship: Strategies and Resources. 2<sup>nd</sup> Ed. Prentice Hall Inc. Upper Saddle River, NJ, USA.
2. Kuratko, D. and R. Hodgetts. 2006. Entrepreneurship: A Contemporary Approach. 7<sup>th</sup> Ed. Prentice Hall, Inc., Upper Saddle River, NJ, USA.
3. Naqi, S. M. 2012. Entrepreneurs. 3<sup>rd</sup> 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. 2<sup>nd</sup> Ed. Interstate Publishers, Boston, MA, USA.



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<b>MGT-308</b>	<b>PRINCIPLES OF ACCOUNTING</b>		<b>3(3-0)</b>
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>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.</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li>Develop and understand the nature and purpose of financial statements in relationship to decision making.</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li>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.</li> </ul>	C	3	2
<ul style="list-style-type: none"> <li>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.</li> </ul>	C	3	2
<ul style="list-style-type: none"> <li>Develop the ability to use accounting concepts, principles, and frameworks to analyze and effectively communicate information to a variety of audiences.</li> </ul>	C	3	2
<ul style="list-style-type: none"> <li>Develop the ability to use accounting information to solve a variety of business problems.</li> </ul>	C	3	2
<ul style="list-style-type: none"> <li>Develop the ability to interact well with team members</li> </ul>	A	3	6, 9
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			



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Introduction to accounting; Accounting principles; Book keeping; Basics of financial statements; Adjustments to financial statements; The cash book; Bank reconciliation; Control accounts; Statement of cash flows; Financial activities; Property; Plant and equipment (PPE); Accounting errors; Accounting for partnerships; Balance sheet.

**Teaching Methodology:**

Lectures, Written Assignments, Presentations

**Course Assessment:**

Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam

**Text Book:**

1. Ghani, M. A. 2006. Principles of Accounting. Pak Imperial Book Depot, Lahore, Pakistan

**Suggested Readings:**

1. Meighs and Meighs. 2006. Accounting: The Basis of Business Decisions. 11th Ed. McGraw-Hill, New York, NY, USA.
2. Horne, V.J. and M. Wachowicz. 2013. Fundamentals of Financial Management. 13th Ed. Prentice Hall, Upper Saddle River, NJ, USA.
3. Kaluza, J. 2008. Accounting: A Systems Approach. 8th Edition, McGraw-Hills, New York. NY, USA.
4. Wild, J. J., K. D. Larson, B. Chiappetta. 2007. Fundamental Accounting Principles. McGraw- Hill, New York, NY, USA.



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<b>SS-411</b>	<b>PRINCIPLES OF PSYCHOLOGY</b>	<b>3(3-0)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>• To provides an overview of the history and major issues of psychology</li> <li>• To emphasizes upon <i>learning and perception, personality theories, abnormal behaviour, motivation and emotion, human development, social psychology</i></li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
<ul style="list-style-type: none"> <li>• <b>Understand</b> the major fields of study and theoretical perspectives</li> </ul>	C	2	2
<ul style="list-style-type: none"> <li>• <b>Differentiate</b> between the major observational, correlation, and experimental designs.</li> </ul>	C	3	2
<ul style="list-style-type: none"> <li>• <b>Identify</b> the major parts of the nervous system</li> </ul>	C	3	2
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
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.			
<b>Practical</b>			
Practical exercises of building algorithms in different writing forms and converting them to programs in C language.			
<b>Teaching Methodology:</b>			
Lectures, Written Assignments, Presentations			
<b>Course Assessment:</b>			



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Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam
<b>Text Book:</b>
1. Dennis, C. and O.M. John. 2011. Psychology, Modules for Active Learning. 12 <sup>th</sup> Ed. Wadsworth Publishing, Nelson Education, Toronto, Canada
<b>Suggested Readings:</b>
1. Dennis, C. and O.M. John. 2011. Psychology, Modules for Active Learning. 12 <sup>th</sup> Ed. Wadsworth Publishing, Nelson Education, Toronto, Canada. 2. Kalat, J. W. 2016. Introduction to Psychology. 11 <sup>th</sup> Ed. Cengage Learning, Boston, MA, USA. 3. Plotnik, R. and H. Kouyoumdjian. 2013. Introduction to Psychology. 10 <sup>th</sup> Ed. Cengage Learning, Belmont, CA, USA. 4. David G. M. 2009. Psychology. 9 <sup>th</sup> Ed. Worth Publishers, Basingstoke, UK. 5. Kassin, S. 2017. Psychology in Modules. 12 <sup>th</sup> Ed. Pearson Custom Publishing, Australia.





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



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



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<b>MGT-502</b>	<b>ORGANISATIONAL BEHAVIOUR</b>	<b>3(3-0)</b>	
<b>Learning Objectives</b>			
<ul style="list-style-type: none"> <li>• To familiarize students with the basic structured programming skills</li> <li>• To emphasizes upon problem analysis, algorithm designing, and program development and testing</li> </ul>			
<b>Learning Outcomes</b>			
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>	<b>PLO</b>
• <b>Provide</b> a basic knowledge of main ideas	C	2	2
• <b>Develop</b> an understanding of these and of related ideas and concepts	C	3	2
• <b>Develop</b> skills in diagnosis and problem solving	C	4	4
* BT= Bloom’s Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
Introduction to OB; People-centered organizations and ethical conduct; Organizational culture; Socialization; Mentoring; Key individual differences; Values, attitudes, job satisfaction and counterproductive work behaviors; Social perceptions and attributions; Foundations of motivation; Improving job performance with goals, feedback, rewards, and positive reinforcement; Group dynamics; Developing and leading effective teams; Individual and group decision making; Managing conflict and negotiating; Communicating in the digital age; Leadership, influence, empowerment, and politics; Organizational design.			
<b>Teaching Methodology:</b>			
Lectures, Written Assignments, Presentations			
<b>Course Assessment:</b>			
Sessional Exam Home Assignments, Quizzes, Presentations, Final Exam			
<b>Text Book:</b>			



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1. Huczynski, A. and A.D.Buchanan 2010. Organizational Behaviour. Financial Times Prentice Hall, Upper Saddle River, NJ, USA.
<b>Suggested Readings:</b>
1. Johnson, C.E.2011. Meeting the Ethical Challenges of Leadership: Casting Light or Shadow. 4 <sup>th</sup> Ed. SAGE Publications, <u>Thousand Oaks</u> , CA, USA.
2. Kreitner, R. and A. Kinicki.2012. Organizational Behavior. 10 <sup>th</sup> Ed. McGraw- Hill, New York, NY, USA.
3. Parikh,P. 2009. Value Investing and Behavioral Finance. Tata McGraw-Hill Education, India.
4. Robbins, P. and T.A. Judge. 2012. Organizational Behavior. 15 <sup>th</sup> Ed. Prentice Hall, <u>Upper Saddle River</u> , NJ, USA.

<b>CS-</b>	<b>IoT in Digital Agriculture</b>	<b>3(2-1)</b>
<b>Learning Objectives</b>		
To enable students to understand: <ul style="list-style-type: none"> <li>• Basics of digital latest digital agriculture technologies (DATs)</li> <li>• Develop an understanding about underlying processes in digital technologies focus on agricultural issues and challenges related to precision management.</li> <li>• To describe the basics of IoT, the technology used to build smart devices, how they communicate, how they store data, and the kind of distributed systems needed to support them.</li> <li>• Develop and apply the simple decision support system (DSS) for better utilization of resources in agriculture and crop production.</li> </ul>		
<b>Learning Outcomes</b>		
At the end of the course the students will be able to:	<b>Domain</b>	<b>BT Level*</b>
• Know about basics understanding of core concepts of DATs focused on case study and potential impacts	C	2
• Describe what IoT is and recognize the factors contributed to the emergence of IoT	C	2
• Design and program IoT devices	C	3
• Use real IoT protocols for communication	C	2
		<b>PLO</b>
		2
		2, 3
		2



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<ul style="list-style-type: none"> <li>Develop a simple DSS using IoT to gather agriculture generated data</li> </ul>	P	3	4
<ul style="list-style-type: none"> <li>Transfer IoT data to the cloud and in between cloud providers</li> </ul>	P	3	4
<ul style="list-style-type: none"> <li>Define the infrastructure for supporting Commercialization of Product</li> </ul>	C	2	7
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain			
<b>SDGS addressed in the course:</b>	9 (Industry, Innovation, and Infrastructure)		
<b>Teaching Mode:</b> the course will be taught in hybrid learning mode offering a substantial portion of contents and course activities online through learning management system			
<b>Course Contents</b>			
<b>Theory</b>			
Introduction: Overview and basics concepts of ICT, IoT and DSS in agriculture, Understanding of innovative and latest digital technologies including sensors, data driven approach and data analytics, unmanned aerial vehicle (UAVs) robotics, communication networks, artificial intelligence, machine learning and big data analysis tools for agriculture and sustainable crop production; Basics of IoT: What is IoT?, IoT standards and protocols, IoT platform and applications, IoT product development for agriculture, IoT security in the Internet; IoT Development Platform: Introduction to Raspberry Pi as the core development platform; IoT Programming for Multi Sensors: Introduction to Python programming for IoT development, Introduction to GrovePi+/PiHat Shields as the multi-sensor platforms; Introduction to the Standard Lightweight IoT Protocol (MQTT): Open source industry IoT communication protocol namely Message Queue Telemetry Transport (MQTT); Polishing IoT systems for product pitching.			
<b>Practical</b>			
Basic hands-on for Raspberry Pi Operating system; Hands-on for using input/output pins for controlling IoT related sensors and devices (e.g., LED, Buttons, etc.) to gather agriculture-generated data; Hands on to setup and deploy multiple sensors for data collections (e.g., sensors: temperature, humidity, soil moisture, greenhouse gases, water, rainfall, light, current, vibration etc.); Hands on to enable sensor connectivity using machine-to-machine (M2M) communication; Hands on to extremely lightweight publish/subscribe messaging transport protocol on Raspberry Pi and PC/Laptop; Hands on to publish/subscribe data from multi-sensors; Hands on controlling/monitoring IoT sensors and systems using Mobile Application; Hands on to enhance the integration of IoT sensors and systems for seamless connectivity; Hands on to polishing the GUI for user-friendly interface; Commercialization pitching of the proposed IoT projects by			



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students.

**Teaching Methodology:**

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

**Course Assessment:**

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

**Text Book:**

1. Singh, Garima and Gurjit Kaur. 2021. Digital Technologies for Smart Agriculture; Artificial Intelligence and IoT-Based Technologies for Sustainable Farming and Smart Agriculture, edited by Pradeep Tomar and Gurjit Kaur, IGI Global, pp. 54-67. <http://doi:10.4018/978-1-7998-1722-2.ch004>

**Suggested Readings:**

1. Hassan, Q.F. ed., 2018. *Internet of things A to Z: technologies and applications*. John Wiley & Sons, Hoboken, New Jersey
2. Singh, R., A. Gehlot, L.R. Gupta, B. Singh and M. Swain. 2019. *Internet of Things with Raspberry Pi and Arduino*. CRC Press.
3. Liyanage, M., A. Braeken, P. Kumar and M. Ylianttila. 2020. *IoT Security: Advances in Authentication*. John Wiley & Sons. UK
4. Serpanos, D. and M. Wolf. 2017. *Internet-of-things (IoT) systems: architectures, algorithms, methodologies*. Springer. Atlanta. USA