CURRICULUM

FOR

DEPARTMENT OF COMPUTER SCIENCE

PLACED BEFORE THE BOARD OF FACULTY MEETING TO BE HELD ON

November 10th, 2020

THE BACHA KHAN UNIVERSITY CHARSADDA, PAKISTAN

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1. Associate Degree in the discipline of Computer Science

1.1 Introduction

Associate Degree in Computer Science is two years (4 semesters) program, to be offered after intermediate (12 years) or equivalent education, at the affiliated colleges and within the constituents' departments/institutes/colleges of Bacha Khan University, Charsadda, where there are no BS programs, as directed by the HEC. This program will provide an alternate option to the students of BA/BSc and may be an integrated type program among the relevant departments/institutes/colleges under one faculty or faculties.

1.2 Program Learning Outcomes (PLOs) and Degree Completion Requirements

The main goal of AD is to deliver market oriented and professional graduates to contribute to the overall development and economy of the country. Therefore, the AD program is designed to provide students with theoretical knowledge and practical skills that will increase their workplace competence and practical approach in respective discipline. In all subjects, including Gen Ed courses, students are expected to advance beyond their secondary school level, and mature and deepen their competences, including in writing, communication, mathematics, languages, analytical and intellectual discipline. To be eligible for the award of Associate candidates are required to complete at least 60 credit hours course work/project program by attending minimum 4-semesters with at least Cumulative Grade Point Average of 2.5 out of 4.0.

1.3 Options for Further Studies

There will be two possibilities for students after the completion of ADA/ADS

1. They may be admitted in the University in the 5th semester with the BS students directly or after a bridging semester of not more than 18 credit hours, if required according to the subject.
2. They may be admitted in the University or colleges in two-year program (BS 2 years) separately if the University starts a two-year program for them.

1.4 Eligibility Criteria

The minimum requirements for admission in BS Computer Science is F.Sc Pre-Engineering OR Equivalent, F.Sc. Pre-Medical, FCS/F.Sc Computer Science with at least 50% marks.

1.5 The Practical Learning Requirement

Overview:
An important objective is to make the undergraduate degree a terminal one, for which experience in a practical work environment and engagement in extracurricular activities is an invaluable complement to a student's academic training. The practical learning requirement will be fulfilled as described below.

Non-Credit:
Practical requirements will be non-credit, that is, they will not receive letter grades for these programs.

Internship:
A mandatory component of the practical requirement will be an internship. The purpose of the internship is to expose students to real life work environments before they graduate. In order to meet this requirement, internships will be governed by the following guidelines:

Standard Internship: The standard internship will typically be in the summer and after the fourth semester; it will be at least 9 weeks in duration; and will take place at a designated host institution.

Host Institution: The following may serve as a host institution: (i) A government organization, in any of the three main branches of government, executive, legislative, or judicial, in national, provincial, or local governments, or (ii) an autonomous body or attached department of a government agency, or (iii) a business enterprise, or (iv) an academic institution, or (v) an NGO.

Prior Agreement: Universities will enter into prior agreements with potential host institutions to place students in such internships.

Career and Placement: Universities will establish Career and Placement Offices to serve their student body, including students enrolled in their affiliated colleges.

Monitoring and Evaluation: Universities will assign individual faculty members to monitor and evaluate the quality of work of each student-internee (e.g., papers or reports submitted, employers feedback, or other prescribed indicators of performance), and these evaluations will be made part of the students' permanent record.

Certification: On successful completion of the internship, students will be awarded a certificate of completion.

Special Provisions: In some cases, students will have the option of fulfilling their internship requirements through other means.

Students in AD programs also have an option, either of completing a standard internship at any time after their first semester; or, to fulfil the requirement in the form of an attachment with a host institution for a total of 360 hours during the course of their studies.

PLL: The second component of the practical requirement will be fulfilled by participation in an extra-curricular PLL activity. Students will enrol in any one of the following three "labs": an entrepreneurship lab, a student club (please see below for examples), or a sport program. The labs will operate as follows:

The Entrepreneurship Lab: The Entrepreneurship Lab will be under the supervision of the Director ORIC or Director BIC or a faculty member designated specially for this purpose. Students who sign up for the entrepreneurship lab will be required to attend the lab for a minimum of 4 hours per week for at least four semesters. The lab will include lectures, teamwork, proposal writing sessions, competitions, presentation sessions, fundraising events, start-up events, and marketing events. Each student will be expected to propose a project, which he or she will take to completion.

Youth Clubs: These may be of different types. The purpose is to expose students to social engagement through participation in group activities. These may include Green Clubs, Drama Clubs, Book Reading Clubs, University Magazines or Newspapers, University TV or Radio Stations, Debating Clubs, or Student Associations. Each Club will formulate its own rules and procedures; in some cases, the students may need to compete for entering into it (e.g., in the University Magazine), while others may have open admission policies. Each of these clubs will have a faculty advisor, who will keep a record of attendance, oversee financial matters, where needed, and provide advice on university policies or regulations.

Sports: Students who wish to fulfil their lab requirements through sports will have to sign up with the Director Sports or other designated officer, and attend regular training and practice sessions, which will be treated as equivalent to "labs".

Organizational Provisions: The following provisions shall govern the organizational arrangements in regard to the practical learning requirement:

Time Commitment: The time commitment for the PLL activity will be 4 hours a week for 4 semesters for BS students and students in the Professional streams, unless waived for the latter; and 2 hours a week for 2 semesters for AD students.

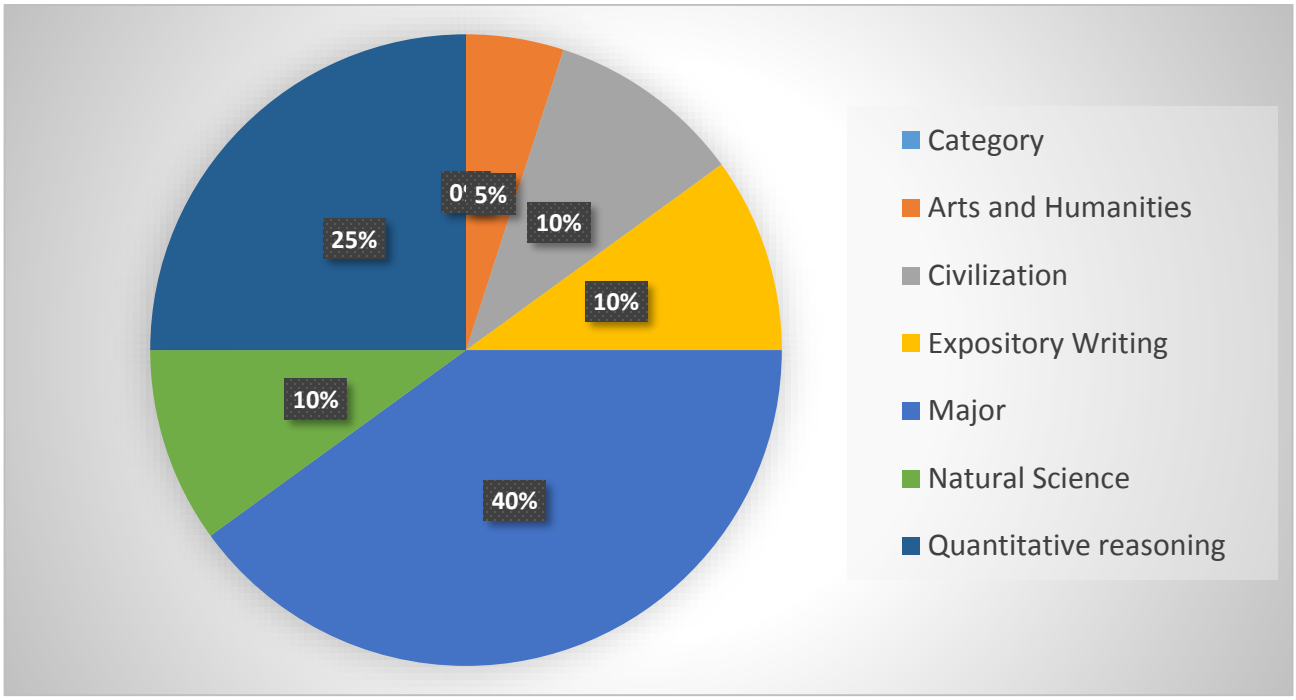
Lab Structure: The weekly activity mentioned above will be referred to as "labs". This is on the analogy of science labs, in which students undertake practical work.

Facilitation: Students will be facilitated in the labs by faculty or staff assigned to the tasks (e.g. Director ORIC/Director BIC, Director Student Clubs, Director Sports, or other designated faculty).

Evaluation: Universities will evaluate the quality of work (e.g., papers or reports submitted, patents filed, start-ups initiated, sports medals obtained, club activities promoted, and the like), and these evaluations will be made part of the students' permanent record.

Certification: On successful completion of the PLL requirement, students will be awarded a certificate of completion or sports. A graduate of the AD program who enrolls subsequently in a BS program shall receive credit towards the fulfilment of the PLL requirement for the BS program.

1.6 Summaries



S. No.	Category		No Of Courses	Theory	Practical	Total	Percentage
1	Breadth	Arts and Humanities	1	3	0	3	4.5
2	Civilization	Civilization	2	4	0	4	6
3	Functional Skills	Expository Writing	2	6	0	6	9
4	Disciplinary	Major	8	19	8	27	44.8
5	Breadth	Natural Science	2	5	1	6	9
6	Functional Skills	Quantitative Reasoning	5	15	0	5	13.4
7	Breadth	Social Sciences	2	6	0	6	9
8	Compulsory	General Education	1	2	1	5	4.5
Total			**23**	**58**	**9**	**69**	**100**

1.7 Semester wise Plan for Associate Degree in the discipline of Computer Science

Semester 1 (17 Credit Hours)

S No	Course code	Course Name	Credit Hours	Category
1	CS-311	Introduction to ICT	3(2-1)	General Education
2	CS-312	Programming Fundamentals	3(2-1)	Computing core
3	PHY-311	Physics	3(3-0)	Mathematics and Science Foundation
4	IS-312	Islamic Studies	3(3-0)	General Education
5	MATH-317	Calculus and Analytical Geometry	3(3-0)	Mathematics and Science Foundation
6	ELL-314	English composition and comprehension	3(3-0)	General Education
7		*Pre-Calculus-I	Non Credit	

* For Pre Medical Students Only

Semester 2 (17 Credit Hours)

S No	Course code	Course Name	Credit Hours	Category
1	CS-321	Discrete Structures	3(3-0)	Computing Core
2	ELL-324	Science Writing	3(3-0)	General Education
3	CS-322	Object Oriented Programming	3(2-1)	Computing Core
4	SOC-313	Citizenship Education and Community Engagement	3(3-0)	General Education
5	MATH-323	Linear Algebra and Differential Equations	3(3-0)	University Elective
6	PS-321	Pakistan Studies	3(3-0)	General Education
		*Pre-Calculus-II	Non Credit	

* For Pre Medical Students Only

Semester 3 (18 Credit Hours)

S No	Course code	Course Name	Credit Hours	Category
1	STAT-417	Probability and Statistics	3(3-0)	Mathematics and Science Foundation
2	UE-411	Introduction to Management Information System	3(3-0)	University Elective
3	HU-412	Foreign Language*	3(3-0)	University Elective
4	CS-412	Digital Logic Design	3(2-1)	Computing Core
5	CS-413	Database Systems	3(2-1)	Computing Core
6	CS-414	Data Structures and Algorithm	3(2-1)	Computing Core

* **Foreign Languages:** Arabic, Chinese, French, German, Spanish, Turkish

Semester 4 (15 Credit Hours)

S No	Course code	Course Name	Credit Hours	Category
1	UE-421	Introduction to Geographical Information Systems.	3(2-1)	University Elective
2	CS-421	Computer Networks	3(2-1)	Computing Core
3	CS-422	Operating Systems	3(2-1)	Computing Core
4	CS-423	Software Engineering	3(3-0)	Computing Core
5	MATH-424	Numerical Computing	3(3-0)	Computer Science Supporting
6		Entrepreneurship/ Internship	Non Credit	Practical Learning

1.8 Summary to Total Credit Hours for Associate Degree in the discipline of Computer Science

Semester	1st	2nd	3rd	4th	Total
Credit Hour	18	18	18	15	69

2. Course Outlines for Programs in Computer Science

CS-311 Introduction to Information and Communication Technologies			
Credit Hours:	3 (2,1)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
Understand basics of computing technology (Knowledge)	C	1
Have knowledge of types of software (Understand)	C	2
Have knowledge of computing related technologies	C	2
Have practical knowledge of use of computer and MS office.	C	3

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

Course Content:

Introduction: Brief history of Computer, Basic Computer Elements and computer types (Super, Mainframe, Mini and Micro), Digital and Analogue Computer

Computer Hardware: (Input Devices, processor, Output Devices)

Storage Devices: (Register, Cache, RAM, ROM, HDD, optical Storage devices (CD, DVD, Blue rays), Cloud)

Computer Software: System Software (Operating System, Device Drivers and Language processor) Application software

Computer Network: Types of Computer Network (LAN, MAN, WAN), Topologies (Bus, Star, Ring Mesh), Clint, Server, Hub, Switch, Router

Internet and WWW: Basic Structure of Internet, Web page, Website, Web application, Web Browser, Search engine, email, cyber security

MS Word
MS Power Point
MS Excel
Basics of program relevant tools

Teaching Methodology:

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

Course Assessment:

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

Reference Materials:

1. Charles S. Parker, Understanding Computers: Today and Tomorrow, Course Technology, 25 Thomson Place, Boston, Massachusetts 02210, USA
2. Livesley, Robert Kenneth. An introduction to automatic digital computers. Cambridge University Press, 2017.
3. Zawacki-Richter, Olaf, and Colin Latchem. "Exploring four decades of research in Computers & Education." Computers & Education 122 (2018): 136-152.

4. Sinha, Pradeep K., and Priti Sinha. Computer fundamentals. BPB publications, 2010.
5. Goel, Anita. Computer fundamentals. Pearson Education India, 2010.

CS-312 Programming Fundamentals			
Credit Hours:	3 (2,1)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. **Understand** basic problem solving steps and logic constructs	C	2
2. **Apply** basic programing concepts	C	3
3. Design and implement algorithms to **solve** real world problems.	C	3

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

Course Content:

Introduction to problem solving, Programing techniques, Problem solving techniques, Introduction to flowchart, Introduction to algorithms, Introduction to programming, Programing languages, Role of interpreter, compiler, assembler, Basic data types, keywords, Identifiers, Variables and constants, structure of a program, Operator and its types (assignment, increment/ decrement, arithmetic, relational, pointer and logical operators), Input/output statements, Conditional statements and execution flow for conditional statements, Repetitive statements and execution flow for repetitive statements, Functions, Arrays, Pointers/references, String handling and string operations, Structures, Static and dynamic memory allocation, File I/O operations.

Teaching Methodology:

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

Course Assessment:

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

Reference Materials:

1. Starting out with Python, 4th Edition, Tony Gaddis.
2. Starting out with Programming Logic & Degins, 4th Edition, Tony Gaddis,
3. The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie
4. Object Oriented Programming in C++ by Robert Lafore
5. Introduction to Computation and Programming Using Python: With Application to Understanding Data, 2nd Edition by Guttag, John
6. Practice of Computing Using Python, 3rd Edition by William Punch & Richard Enbody
7. C How to Program, 7th Edition by Paul Deitel & Harvey Deitel
8. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly & Elliot B. Koffman

PHY-311 Physics

Credit Hours:	3 (3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
Understand: Basics of electric force and its implementations in computers	C	2
Understand: Electric fields, flux, Gauss Law, charge distributions	C	2
Apply: Different mathematical models used in laws of physics	C	3

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

Course Content:

Electric Charge & Coulomb's Law, Electric Field, The flux of electric field, Gauss' Law, Spherically symmetric charge distribution, Electric Potential, Capacitors & Dielectric, Current & Resistance, AC and DC, Current density, Resistance, Resistivity and conductivity, Ohm's law and its applications, Magnetic fields, Ampere's Law and Faraday's law., The Hall effect, The magnetic force on a current, For understanding of wave theory, The basic equation of electromagnetism, Reflection and Refraction of light waves, Total internal reflection.

Teaching Methodology:

Lecturing, Written Assignments, Project, Experiments, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Experiments, Final Exam

Reference Materials:

1. Fundamentals of Physics (Extended), 10th edition, Resnick and Walker
2. Narciso Garcia, Arthur Damask, Steven Schwarz., "Physics for Computer Science Students", Springer Verlag, 1998

IS-312 Islamic Studies			
Credit Hours:	3 (3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:

1 To provide Basic information about Islamic Studies
2 To enhance understanding of the students regarding Islamic Civilization
3 To improve Students skill to perform prayers and other worships
4 To enhance the skill of the students for understanding of issues related to faith and religious life.

Course Content:

Introduction to Quranic Studies

- Basic Concepts of Quran
- History of Quran
- Uloom-ul -Quran

Study of Selected Text of Holly Quran

- Verses of Surah Al-Baqra Related to Faith(Verse No-284-286)
- Verses of Surah Al-Hujrat Related to Adab Al-Nabi(Verse No-1-18)
- Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
- Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
- Verses of Surah Al-Inam Related to Ihkam(Verse No-152-154)

Study of Selected Text of Holly Quran

- Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
- Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
- Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)

Seerat of Holy Prophet (S.A.W) I

- Life of Muhammad Bin Abdullah (Before Prophet Hood)
- Life of Holy Prophet (S.A.W) in Makkah
- Important Lessons Derived from the life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II

- Life of Holy Prophet (S.A.W) in Madina
- Important Events of Life Holy Prophet in Madina
- Important Lessons Derived from the life of Holy Prophet in Madina

Introduction ToSunnah

- Basic Concepts of Hadith
- History of Hadith
- Kinds of Hadith
- Uloom –ul-Hadith
- Sunnah & Hadith
- Legal Position of Sunnah

Introduction To Islamic Law & Jurisprudence

- Basic Concepts of Islamic Law & Jurisprudence

- History & Importance of Islamic Law & Jurisprudence
- Sources of Islamic Law & Jurisprudence
- Nature of Differences in Islamic Law
- Islam and Sectarianism

Islamic Culture & Civilization

- Basic Concepts of Islamic Culture & Civilization
- Historical Development of Islamic Culture & Civilization
- Characteristics of Islamic Culture & Civilization
- Islamic Culture & Civilization and Contemporary Issues

Islam & Science

- Basic Concepts of Islam & Science
- Contributions of Muslims in the Development of Science
- Quranic & Science

Islamic Economic System

- Basic Concepts of Islamic Economic System
- Means of Distribution of wealth in Islamic Economics
- Islamic Concept of Riba
- Islamic Ways of Trade & Commerce

Political System of Islam

- Basic Concepts of Islamic Political System
- Islamic Concept of Sovereignty
- Basic Institutions of Govt. in Islam

Islamic History

- Period of Khlaft-E-Rashida
- Period of Ummayyads
- Period of Abbasids

Social System of Islam

- Basic Concepts of Social System of Islam
- Elements of Family
- Ethical Values of Islam

Teaching Methodology:

Lecturing, Written Assignments, Project

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentation, Final Exam

Reference Materials:

1. Bhatia, H.S. (1989). Studies in Islamic Law, Religion and Society.New Delhi: Deep & Deep Publications.
2. Hasan, Ahmad. (1993) .Principles of Islamic Jurisprudence.Islamabad: Islamic Research Institute, IIU.
3. Waliullah, Mir. (1982). Muslim Jrisprudence and the Quranic Law of Crimes. Lahore: Islamic Book Service.
4. Zia-ul-Haq, Muhammad. (2001). Introduction to Al Sharia Al Islamia. Islamabad: Allama

Iqbal Open University.

MATH -317 Calculus & Analytical Geometry			
Credit Hours:	3 (3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***

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

Course Content:

Limits and Continuity; Introduction to functions, Introduction to limits, Techniques of funding limits, Indeterminate forms of limits, Continuous and discontinuous functions and their applications, Differential calculus; Concept and idea of differentiation, Geometrical and Physical meaning of derivatives, Rules of differentiation, Techniques of differentiation, Rates of change, Tangents and Normals lines, Chain rule, implicit differentiation, linear approximation, Applications of differentiation; Extreme value functions, Mean value theorems, Maxima and Minima of a function for single-variable, Concavity, Integral calculus; Concept and idea of Integration, Indefinite Integrals, Techniques of integration, Riemann sums and Definite Integrals, Applications of definite integrals, Improper integral, Applications of Integration; Area under the curve, Analytical Geometry; Straight lines in R3, Equations for planes.

Teaching Methodology:

Lecturing, Written Assignments

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Calculus and Analytic Geometry by Kenneth W. Thomas.
2. Calculus by Stewart, James.
3. Calculus by Earl William Swokowski; Michael Olinick; Dennis Pence; Jeffery A. Cole.

ELL-314 English Composition & Comprehension			
Credit Hours:	3 (3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:

- Enhance comprehensibility of English language
- Seeks to develop students abilities in grammar, writing and study skills
- Heighten the awareness of correct usage of English grammar in writing, speaking and composition.
- Give oral presentation and receive feedback on their performance.
- Implement techniques of improving understanding of their studies in general and English in particular.
- Compose various forms of messages in official document writing.
- Acquire good level of proficiency of English language writing.
- Read, analyze and discuss reading with an understanding of structure and mechanics
- Employ the various stages of the writing process, including brainstorming, outlining, drafting, revising and editing.
- Identify effective writing techniques in his or her essays and peer writing .

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

Course Content:

Sentence, sentence structure, kinds of sentences, sewntence errors, subject and predicate, phrase and clauses, parts of speech, tenses, active and passive voice (use in rules regulation) direct & indirect narrations (use & rules regulation). Writing process (brainstorming, outlining, drafting, revising eediting) paragraph and essay writing, types of essays, persuasive writing presentations oral presentations , comparison and contrast essays, dialogue writing, short story writing, review writing, letter writing & application.

Teaching Methodology:

Lecturing, Written Assignments, Presentation, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Presentation, Final Exam

Reference Materials:

1. College Writing Skills with Readings, by John Langan, McGraw-Hill, 5th Edition.
2. A Textbook of English Prose and Structure by Arif Khattak, et al, GIKI Institute, 2000

Pre Calculus-I (for Pre-Medical)			
Credit Hours:	3 (3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***

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

Course Content:

Defining Set, various types of set representation and operations, Relation and function, Graphical transformation of one and two dimensional functions, Properties of functions, composition and inverses of functions, domain and range of the functions, Maximum and minimum values of functions, increasing and decreasing functions, zeros and intercept of functions, piecewise functions, continuity and Discontinuity of functions, Polynomials and rational functions, Polynomial long division and Synthetic division, Solution of rational functions, Absolute valued function, properties of absolute valued functions, Asymptotes (Horizontal, vertical and oblique), Exponential functions and their properties, Logs functions and their properties, Systems of Two Equations and Two Unknowns, Systems of Three Equations and Three Unknowns, Matrix Algebra (Add, subtract and multiply matrices), Row Operations and Row Echelon Forms, Augmented Matrices, Determinant of Matrices (2 x 2 and higher order matrices), Cramer's Rule, Inverse Matrices, Series and Sequences, Trigonometry, Angles in Radians and Degrees, Right Triangle Trigonometry, Law of Cosines & Sines, Area of Triangle, Graphs of Other Trigonometric Functions , Graphs of Inverse Trigonometric Functions, Basic Trigonometric Identities (Pythagorean, Sum and Difference, Double, Half, and Power Reducing), Trigonometric Equations, General Form of a Conic, Parabolas, Circles, Ellipses, Hyperbolas, Degenerate Conics, Polar and Parametric Equations, Polar and Rectangular Coordinates.

Teaching Methodology:

Lecturing, Written Assignments, Project

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Lab, Presentation, Final Exam

Text Books

1. Textbook of Algebra and Trigonometry Class XI is published by Punjab Textbook Board (PTB) Lahore, Pakistan.

2. Calculus and Analytic Geometry, MATHEMATICS 12 (Mathematics FSc Part 2 or HSSC-II), Punjab Text Book Board Lahore, Pakistan

Reference Materials:

1. Gilbert, S. S., B. C. Andy and B. Andrew, B. 2005. Linear Algebra and Its Applications. 4th Ed. Thomson Brooks/Cole, Belmont, CA, USA. 2
2. Chung, S. K. 2014. Understanding basic calculus. Create Space Independent Publishing Platform, 173-175.
3. Howard, Anton, Irl Bivens, Stephen Davis, Calculus, 10th Ed,2011, John Wiley & Sons, Inc. (1318 Pages)

CS-321 Discrete Structures

Credit Hours:	3 (3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. **Understand** the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs, and Trees etc.	C	2
2. **Apply** formal logic proofs and/or informal, but rigorous, logical reasoning to real problems, such as predicting the behavior of software or solving problems such as puzzles.	C	3
3. **Apply** discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography.	C	3
4. **Differentiate** various discrete structures and their relevance within the context of computer science, in the areas of data structures and algorithms, in particular.	C	4

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

Course Content:

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, recurrence relations, functions, mappings, function composition, recursive functions, Number Theory, sequences, series, permutations and combinations, elements of graph theory, planar graphs, euler graph, Hamiltonian path, rooted trees, traversals.

Teaching Methodology:

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

Course Assessment:

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

Reference Materials:

1. Discrete Mathematics and Its Applications, 7th edition by Kenneth H. Rosen
2. Discrete Mathematics with Applications, 4th Edition by Susanna S. Epp
3. Discrete Mathematics, 7th edition by Richard Johnson Baugh
4. Discrete Mathematical Structures, 4th edition by Kolman, Busby & Ross
5. Discrete and Combinatorial Mathematics: An Applied Introduction by Ralph P. Grimaldi
6. Logic and Discrete Mathematics: A Computer Science Perspective by Winifred Grassman

ELL-324 Science Writing

Credit Hours:	3 (3,0)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
Understand: Writing process, Difference Between good and bad writing	C	2
Apply: Writing in Active and Passive voices.	C	3
Understand: Successful Scientific Writing	C	2

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

Course Content:

Demystifying the Writing Process, Properties of Good Writing, Words and Word Choice, Basic Elements of Sentences and Sentence Structure, Sin and Syntax, Successful Scientific Writing, Sentences for Clarity and Brevity, The News Article, Dissecting the News Articles, Punctuation and Parallelism, Tricks of Clarity, Brevity and Fineness, Paragraphs, Logic and Organization, Organizational Strategies, Good writing Applied, The Scientific Manuscript, The Abstract, Introduction, and Discussion, Wrap-up Scientific Manuscripts plus Overview of Grant Writing, Communicating Effectively with Media and Lay Public, Peer Review.

Teaching Methodology:

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

Course Assessment:

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

Reference Materials:

Sin and Syntax, Constance Hale
Successful Scientific Writing: A step-by-step guide for biomedical scientists, Matthews and Bowen

CS-322 Object Oriented Programming

Credit Hours:	3 (2, 1)	**Prerequisites:**	Programming Fundamentals

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand principles of object oriented paradigm.	C	2
2. Identify the objects & their relationships to build object oriented solution	C	3
3. Model a solution for a given problem using object oriented principles	C	3
4. Examine an object-oriented solution.	C	4

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

Course Content:

Introduction to object-oriented design, History and advantages of object oriented design, Introduction to object oriented programming concepts, Classes, Objects, Data Encapsulation, Constructors, Destructors, Member Access Specifiers, Static data members & functions, Passing objects to function, Friend function and Friend class, Identification of classes and their relationships, Inheritance and its types, Constructor and Destructor in Inheritance, Composition, Aggregation, Polymorphism, Function Overloading, Operator Overloading, Function Overriding, Abstract classes and Interfaces, Virtual function and Virtual base class, Templates and Exception handling.

Teaching Methodology:

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

Course Assessment:

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

Reference Materials:

1. Starting Out with C++ from Control Structures to Objects, 9th Edition, Tony Gaddis
2. C++ How to Program, 10th Edition, Deitel & Deitel.
3. Object Oriented Programming in C++, 3rd Edition by Robert Lafore
4. Java: How to Program, 9th Edition by Paul Deitel
5. Beginning Java 2, 7th Edition by Ivor Horton
6. An Introduction to Object Oriented Programming with Java, 5th Edition by C. Thomas Wu

SOC-313 Citizenship Education and Community Engagement			
Credit Hours:	3 (3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

The primary outcome is inclusive development through active citizenship locally and globally,. Moreover, the following are the detailed outcomes of the course based on the three domains of Bloom's Taxonomy i.e Affective, Psychomotor and Cognitive. The students will be able to:

- Understand the overall organization of the society
- Recognize and exercise their rights, responsibilities and the significance of active citizenship in positive societal development
- Identify and critically evaluate social issues and implement practicable community based solutions
- Understand the concept of human rights and its significance
- Appreciate diverse viewpoints and inter-cultural harmony

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

Course Content:

Introduction to Citizenship Education and Community Engagement

- Meaning & History
- Attributes of Active Citizenship
- Different Approach
  i. Republican Approach
  ii. Liberal Approach

iii. Cosmopolitan Approach

- Dimensions of Active Citizenship
- Rights
- Membership
- Participation
- Identity

Identity, Culture, and Social Harmony

- Sociological Theories of Self Formation
  - i. Sigmund Freud Theory
  - ii. George Herbert Mead Theory
  - iii. Charles Horton Cooley Theory
- Cultural & Religious Harmony
- Pluralism & Diversity
- Democracy & Democratic Norms
- Concept and Development of Identity
- Components of Cultural and Social Harmony

Inter-Cultural Dialogue (me versus you)

- Principles & Purpose
- Ability to Support, learn and share through dialogue
- Policy Dialogue (encourage young people to share their opinion and perspective with policy makers and opinion makers).

Local & Global Communities

- Concept of Community
- Needs, Issues & Conflicts
- Conflict Resolution
- Communication & Networking
- Social Cohesion
- Social Capital
- Social Networking
- Advocacy
- Social Entrepreneurship & Partnership

Social Action Planning

- Skills in project Planning & Management
- Project Cycle
- Stakeholder Analysis
- Problem Identification
- Writing Project Plan
- Monitoring & Evaluation
- Risk Analysis

Population Dynamics in Pakistan

- Population Growth Pakistan
- Factors Behind High Fertility Rate
  - i. Legislative Actions
  - ii. Dearth of Medical Facilities

iii. Delayed VS Early Age Marriages
iv. Poverty
v. Women Empowerment
vi. Spreading Awareness
vii. Providing Incentives

- Population Theory
- How to Control Population Growth

Teaching Methodology:

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

Course Assessment:

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

Reference Materials:

1. Larsen A. K. Sewpaul, V., & Hole, G. O. (Eds.). (2013). Participation in community work: International Perspectives, Rutledge
2. Alan, T. (2008). Community work, London: Palgrave Macmillan
3. British Council, (2017) Active Citizen's social Action Projects Guide (Scotland: British Council)
4. Kaye, C. B. (2004). The complete guide to service learning: Proven, practical ways to engage students in civic responsibility, academic curriculum, & social action. Free spirit publishing.
5. Hans, R. (1993). Population Studies, Indian Council of Social Sciences Research, New Delhi.
6. Peterson, W. (1975). Population, New York, Macmillan.
7. United Nations Economic Commission for Europe-official web site.
8. UNO (2000) Population Trends World Population Monitoring, Population Growth Structure and Distribution 1999. Department of Economics and Social Affairs, Population Division, UNO.
9. Weeks, J. R. (1992). Population: An Introduction to Concepts and Issues, Belmart California, Wadsworth Publishing Company

MATH-323 Linear Algebra and Differential Equations

Credit Hours:	3 (3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Identify, analyze and subsequently solve physical situations whose behavior can be described by ordinary differential equations.	C	2
2. Determine solutions to first order separable differential equations.	C	2
3. Determine solutions to first order linear differential equations.	C	2

4. Determine solutions to first order exact differential equations.	C	2
5. Determine solutions to second order linear homogeneous and non-homogeneous differential equations with constant coefficients.	C	2

Course Content:

Algebra of linear transformations and matrices. determinants, rank, systems of equations, vector spaces, orthogonal transformations, linear dependence, linear Independence and bases, eigenvalues and eigenvectors, characteristic equations, Inner product space and quadratic forms.

Ordinary Differential Equations of the First Order: Geometrical Considerations, Isoclines, Separable Equations, Equations Reducible to Separable Form, Exact Differential Equations, Integrating Factors, Linear First-Order Differential Equations, variation of Parameters. Ordinary Linear Differential Equations; Homogeneous Linear Equations of the Second Order, Homogeneous Second-Order Equations with Constant Coefficients, General Solution, Real Roots, Complex Roots, Double Root of the Characteristic Equation, Differential Operators, Cauchy Equation, Homogeneous Linear Equations of Arbitrary Order, Homogeneous Linear Equations of Arbitrary Order with Constant Coefficients, Non-homogeneous Linear Equations. Modelling of Electrical Circuits. Systems of Differential Equations. Series Solutions of Differential Equations. Partial Differential Equations: Method of Separation of variables, wave, Heat & Laplace equations and their solutions by Fourier series method

Teaching Methodology:

Lecturing, Written Assignments

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Final Exam

Reference Materials:

1. Elementary Linear Algebra by Howard Anton
2. Linear Algebra and its Applications by Gibert Strang
3. *Advanced Engineering Mathematics* Michael, G.th edition, Erwin, K. 1993, John Wiley &*1996*, Prentice Hall Publishers. Sons
4. *Advanced Engineering Mathematics*, 7 Inc.
5. *A First Course in Differential Equation* Zill. Prindle. Weber. Schmidt.1996. Brooks/Cole Publishing.
6. *Differential Equations with Boundary-Value Problems*, Dennis. G. Zill, Michael, R. Cullen. 1996, Brooks/Cole Publishing,
7. *Elementary Differential Equations with Applications* C. H. Edwards. David, E. 1993. Penney, Prentice Hall.

PS-321 Pakistan Studies			
Credit Hours:	3(3,0)	Prerequisites:	None

Course Learning Outcomes (CLOs):

The outcome of this subject is purely the understanding of emergence of Muslims in Sub-Continents, Pakistan History, Culture. Society politics and its ideological basis. A part from these considering the national and international politics, this course also thoroughly explains the status and position of Pakistan and its importance in the global village.

The highlighted points are as given below:

- Advent of Islam in sub-continent
- The rise and fall of Muslims in India
- The emergence of imperial power Britain
- Political emergence of Muslim as nation
- Role of religion in the freedom movement of Pakistan
- Geo strategic importance of Pakistan

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

Course Content:

Historical Perspective

- Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.
- Factors leading to Muslim separatism
- People and Land
  i. Indus Civilization
  ii. Muslim advent
  iii. Location and geo-physical features.

Government and Politics in Pakistan

- Political and constitutional phases:
- 1947-58
- 1958-71
- 1971-77
- 1977-88
- 1988-99
- 1999 onward

Contemporary Pakistan

- Economic institutions and issues
- Society and social structure
- Ethnicity
- Foreign policy of Pakistan and challenges

- Futuristic outlook of Pakistan

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

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

Reference Materials:

1. Amin, Tahir. (1999). Ethno-National Movement in Pakistan. Islamabad: Institute of Policy Studies, Islamabad.
2. Burke,S.M and Ziring,Lawrence. (1993). Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press,
3. Mehmood, Safdar. (2001). Pakistan Kayyun Toota. Lahore: Idara-e-Saqafat-e-Islamia. Club Road Press.
4. Mehmood, Safdar. (1994). Pakistan Political Roots & Development. Lahore.
5. Waseem ,Muhammad. (1987). Pakistan Under Martial Law. Lahore: Vanguard.
6. Zaidi,Akbar. S.(2000). Issue in Pakistan's Economy. Karachi: Oxford University Press.

Pre Calculus-II (for Pre-Medical)

Credit Hours:	3 (3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**Domain**	**BT Level***
• Understand the basic concept of Complex numbers and its arithmetic properties • Learn about the idea of sequence and series, and their properties • Learn about Permutations and Combinations, Basic Probability • Understand the basic concept of Limits of functions, and its properties • Understand the basic concept of continuity and discontinuity of functions, and their properties • Understand the concept of derivatives, formulas and properties related to derivative • Under the concept of Increase, Decrease, Concavity, Relative Extrema, Absolute Maxima and Minima • Understand the Basic definitions of definite and indefinite Integrals, • Learn about the Fundamental Theorem of Calculus • Learn how to Evaluate Definite Integrals by Substitution • Learn how to Evaluate the integral of Logarithmic and Other Functions		

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

Course Content:

Complex Numbers, Arithmetic with Complex Numbers (Add, subtract, multiply and divide complex numbers), Trigonometric Polar Form of Complex Numbers, De Moivre's Theorem and nth Roots, Recursion, Arithmetic and Geometric Sequences, Sigma Notation, Arithmetic Series, Geometric Series (Sum infinite and finite geometric series and categorize geometric series), Counting with Permutations and Combinations, Basic Probability, Binomial Theorem, Limit Notation, Graphs to Find Limits, Tables to Find Limits, Substitution to Find Limits, Rationalization to Find Limits, One Sided Limits and Continuity, Instantaneous Rate of Change, Tangent Lines and Rates of Change, The Derivative Function, Introduction to Techniques of Differentiation, The Product and Quotient Rules, Derivatives of Trigonometric Functions, The Chain Rule, Derivatives of Logarithmic Functions, Derivatives of Exponential and Inverse Trigonometric Functions, Increase, Decrease, and Concavity, Relative Extrema, Absolute Maxima and Minima, An Overview of the Area Problem, Area Under a Curve, The Indefinite Integral, Integration by Substitution, The Definition of Area as a Limit; Sigma Notation, The Definite Integral.

Teaching Methodology:

Lecturing, Written Assignments, Project

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Lab, Presentation, Final Exam

Text Books

1. Textbook of Algebra and Trigonometry Class XI is published by Punjab Textbook Board (PTB) Lahore, Pakistan.
2. Calculus and Analytic Geometry, MATHEMATICS 12 (Mathematics FSc Part 2 or HSSC-II), Punjab Text Book Board Lahore

` Reference Materials:

1. Mark J. Christensen, Computing for Calculus, 1st Edition, Academic Press, (1st January 1981), 240pages, ISBN: 9781483271088.
2. Lay, L. D. 2015. Probability and Statistics for Engineering and the Sciences, 9th Ed. Cengage Learning, Boston, MA, USA.
   Howard, Anton, Irl Bivens, Stephen Davis, Calculus, 10th Ed, 2011, John Wiley & Sons, Inc. (1318 Pages)

STAT-417 Probability & Statistics			
Credit Hours:	3 (3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***

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

Course Content:

Introduction to Statistics and Data Analysis, Statistical Inference, Samples, Populations, and the Role of Probability. Sampling Procedures. Discrete and Continuous Data. Statistical Modeling. Types of Statistical Studies. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes' Rule. Random Variables and Probability Distributions. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem. Discrete Probability Distributions. Continuous Probability Distributions. Fundamental Sampling Distributions and Data Descriptions: Random Sampling, Sampling Distributions, Sampling Distribution of Means and the Central Limit Theorem. Sampling

Teaching Methodology:

Lecturing, Written Assignments, Presentation, Final Exam

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Report Writing, Presentation, Final Exam

Reference Materials:

1. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, Pearson; 9th Edition (January 6, 2011). ISBN-10: 0321629116
2. Probability and Statistics for Engineers and Scientists by Anthony J. Hayter, Duxbury Press; 3rd Edition (February 3, 2006), ISBN-10:0495107573
3. Schaum's Outline of Probability and Statistics, by John Schiller, R. Alu Srinivasan and Murray Spiegel, McGraw-Hill; 3rd Edition (2008). ISBN-10:0071544259

UE-411 Introduction to Management Information System

Credit Hours:	3(3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Understand and articulate concepts of information technology management.	C	2
2. Assess and apply IT to solve common business problems.	C	2
3. Suggest and defend effective solutions to business problems, and design a database application to solve a business problem.	C	3
4. Explain in details the ethical aspects of information technology use in the organization and its governance issues.	C	2

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

Course Content:

Introduction to Information Systems in Organizations; Business Process and Decision Making; Productivity, Innovation and Strategy; Database and Content Management; Decision Making and Business Intelligence; Competitive Advantage and Business Processes; Networks and Collaboration; ERP and E-commerce, Social Networking, and Web 3.0; Acquiring Information Systems Through Projects; Structure, Governance, and Ethics; Managing Information Security and Privacy

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

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

Reference Materials:

1. Experiencing MIS, D. M. Kroenke, A. Gemino and P. Tingling. P. 4th Edition. Toronto: Pearson.2016.
2. Business driven information systems, P. Baltzan, B. Detlor, and C. Welsh, 4th Ed., McGraw Hill Ryerson Press, 2015.

HU-412 Foreign Language (Chinese)			
Credit Hours:	3(3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***

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

Course Content:

Syllable components ,Tones ,Initial consonants ,Rhymes , Miscellany ,Writing connected text in pinyin ,Recapitulation ,Conventions ,Pronunciation ,Numbers (cardinal and ordinal) ,Stative verbs ,Time and tense ,Pronouns ,Action verbs ,Conventional greetings ,Greeting and taking leave ,Tones ,Rhymes and rhythms

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam
Reference Materials:
1. Learning Chinese JULIAN K . WHEATLEY A FOUNDATION COURSE IN MANDARIN YALE UNIVERSITY PRESS NEW HAVEN & LONDON

Foreign Language (Turkish)					
Credit Hours:	3(3,0)	**Prerequisites:**			
Course Learning Outcomes (CLOs):					
At the end of the course the students will be able to:				**Domain**	**BT Level***
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain					

Course Content:

Introducing yourself : greetings – saying “Hello”, “Goodbye” and “How are you?”; The Turkish alphabet, Numbers: 10-100, Basic colours , Spelling names,Basic phrases in daily life situations, Question words, Titles: Mr, Mrs, Ms, Offering & ordering drinks and snacks at a bar or café, Eating out, ordering meals at a restaurant, asking for the bill, Enquiring what dishes there are at a restaurant and what’s in them, Talking about professions and making profession names using suffixes “cı / ci / cu / cü”, Asking what something means. **Grammar:** Introducing the main characteristics of Turkish, “Bir” as the indefinite article,“Değil” means “Not”,Question tag “değil mi?”, Verbless sentences (“be”), Personal and demonstrative pronouns, Personal endings in the present tense, “There is/are…” / “There is/are not…”, The plural suffix “–ler / -lar”, Numbers: 100s and 1000s, Five cases of a noun, Question forms, The plural suffix, Word order, The negative suffix –ma / –me, Talking about yourself, Making country, nationality and language names using suffixes, Cultural Content:, The language family that Turkish belongs to, The relationship between Turkish, European and Middle Eastern languages, Titles – Mr, Mrs; addressing others in appropriate ways, Difference between singular and plural “you”, Greetings, Turkish snacks and drinks, Turkish food and drinks, Reading signs, Place names in Istanbul, Map of Turkey, Skills Work, Speaking activities: Using classroom conversation regularly, Simple chats about the weather, Listening activities, Writing practice: Describing pictures, finding differences between pictures, etc.,Basic rules of pronunciation, Pronunciation of the letters in the alphabet

Teaching Methodology:

Lecturing, Written Assignments,

Course Assessment:

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

Reference Materials:

1. Kazakh for Beginners: A Comprehensive Self-Study Course Kindle Edition
2. *Nasrettin Hoca Hikâyeleri* (Beginner)
3. Turkish Penfriends

CS-412 Digital Logic Design			
Credit Hours:	3(2,1)	**Prerequisites:**	Applied Physics

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***

1. Acquire knowledge related to the concepts, tools and techniques for the design of digital electronic circuits		
2. Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques		
3. Apply the acquired knowledge to simulate and implement small-scale digital circuits		
4. Understand the relationship between abstract logic characterizations and practical electrical implementations.		
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

Number Systems, Logic Gates, Boolean Algebra, Combination logic circuits and designs, Simplification Method (K-Map), Flip Flops, Asynchronous and Synchronous circuits, Shift Registers, Counters, Triggered devices & its types. Binary Arithmetic and Arithmetic Circuits, Memory Elements. Lab Assignments using tools such as Verilog HDL/VHDL, MultiSim.

Teaching Methodology:

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

Course Assessment:

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

Reference Materials:

1. Digital Fundamentals by Floyd, 11/e.
2. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e.

CS-413 Database Systems

Credit Hours:	3(2,1)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. **Explain** fundamental database concepts.	C	2
2. **Design** conceptual, logical and physical database schemas using different data models.	C	5
3. **Identify** functional dependencies and resolve database anomalies by normalizing database tables.	C	2

4. **Use** Structured Query Language (SQL) for database definition and manipulation in any DBMS	C	4

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

Course Content:

Basic database concepts, Database approach vs file based system, database architecture, three level schema architecture, 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), Grouping and aggregation in SQL, concurrency control, database backup and recovery, NoSQL systems.

Teaching Methodology:

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

Course Assessment:

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

Reference Materials:

1. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg
2. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom
3. Database System Concepts, 6th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan.
4. Database Management Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke

CS-414 Data Structures and Algorithms

Credit Hours:	3 (2,1)	**Prerequisites:**	Programming Fundamentals

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Implement various data structures and their algorithms, and **apply** them in implementing simple applications.	C	2,3
2. **Analyze** simple algorithms and determine their complexities.	C	4,5

3. **Apply** the knowledge of data structures to other application domains.	C	3
4. **Design** new data structures and algorithms to solve problems.	C	6
* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain		

Course Content:

Abstract data types, complexity analysis, Stacks (linked lists and array implementations), Recursion, 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, trees and tree traversals, binary search trees, heaps, M-way tress, balanced trees, graphs, breadth-first and depth-first traversal, adjacency matrix and adjacency list implementations.

Teaching Methodology:

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

Course Assessment:

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

Reference Materials:

1. Data Structures and Algorithms in C++ by Adam Drozdek
2. Data Structures and Algorithm Analysis in Java by Mark A. Weiss
3. Data Structures and Abstractions with Java by Frank M. Carrano & Timothy M. Henry
4. Data Structures and Algorithm Analysis in C++ by Mark Allen Weiss
5. Java Software Structures: Designing and Using Data Structures by John Lewis and Joseph Chase

UE-421 Introduction to Geographical Information Systems.

Credit Hours:	3(2,1)	Prerequisites:	None

Course Learning Outcomes (CLOs):		
	Domain	BT Level*
Understand: Basics of GIS, Maps, spatial analysis and Map Projections **Implement:** Basic skills necessary to work with GIS, ESRI's ArcGIS software .	C C	2 3

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

Course Content:

What is GIS?, Understanding ArcGIS & GIS terminology, Making Maps: Maps & Spatial Analysis ArcGIS to Illustrator, Working with Maps& Data, Data Classification; Map Projections; Reading Metadata, Joining Tables to Boundary Files Working with Data and Creating Maps, Working with Census Data, Working with Tables: Joining Data & Querying, Interpreting Census Variables; Charts & Graphs for Data Display, Buffers, Clips, Unions, What is Address Mapping? Location-based Services, Editing features: Point, Line, and Polygon; Rubbersheeting & Georeferencing, Working with Google; Web mapping; QGIS, Raster Data, Field Surveys; GPS; Aerial Imagery; Creating Metadata

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Presentations

Course Assessment:

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

Reference Materials:

CS-421 Computer Networks

Credit Hours:	3(2,1)	**Prerequisites:**	None

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. **Describe** the key terminologies and technologies of computer networks	C	2
2. **Explain** the services and functions provided by each layer in the Internet protocol stack.	C	2
3. **Identify** various internetworking devices and protocols, and their functions in a network.	C	4
4. **Analyze** working and performance of key technologies, algorithms and protocols.	C	4
5. **Build** Computer Network on various Topologies	P	3

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

Course Content:

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.

Teaching Methodology:

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

Course Assessment:

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

Reference Materials:

1. Computer Networking: A Top-Down Approach Featuring the Internet, 6th edition by James F. Kurose and Keith W. Ross
2. Computer Networks, 5th Edition by Andrew S. Tanenbaum
3. Data and Computer Communications, 10th Edition by William Stallings
4. Data Communication and Computer Networks, 5th Edition by Behrouz A. Forouzan

CS-422 Operating Systems

Credit Hours:	3(2,1)	**Prerequisites:**	Data Structures and Algorithms

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. **Understand** the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems.	C	2
2. **Analyze** and **evaluate** the algorithms of the core functions of the Operating Systems and explain the major performance issues with regard to the core functions.	C	4,5
3. **Demonstrate** the knowledge in applying system software and tools available in modern operating systems.	C	3

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

Course Content:

Operating systems basics, system calls, process concept and scheduling, inter-process communication, multithreaded programming, multithreading models, process scheduling algorithms, thread scheduling, multiple-processor scheduling, synchronization, deadlocks, detecting and recovering from deadlocks, memory management, swapping, segmentation & paging, virtual memory management, file systems, file concept, directory and disk structure, directory implementation, disk structure and scheduling, , 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

Reference Materials:

1. Operating Systems Concepts, 9th edition by Abraham Silberschatz
2. Modern Operating Systems, 4th edition by Andrew S. Tanenbaum
3. Operating Systems, Internals and Design Principles, 9th edition by William Stallings

CS -423 Software Engineering

Credit Hours:	3 (3,0)	**Prerequisites:**	

Course Learning Outcomes (CLOs):		
At the end of the course the students will be able to:	**Domain**	**BT Level***
1. Describe various software engineering processes and activities	C	1
2. Apply the system modeling techniques to model a medium size software system	C	3
3. Apply software quality assurance and testing principles to medium size software system.	C	4
4. Discuss key principles and common methods for software project management such as scheduling, size estimation, cost estimation and risk analysis	C	2

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

Course Content:

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, Structural models, behavioral models, Architectural design, Design and implementation, UML diagrams, Software testing and quality assurance, Software evolution, Project management and project planning, configuration management, Software Process improvement.

Teaching Methodology:

Lecturing, Written Assignments, Project, Report Writing

Course Assessment:

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

Reference Materials:

1. Software Engineering, Sommerville I., 10th Edition, Pearson Inc., 2014
2. Software Engineering, A Practitioner's Approach, Pressman R. S.& Maxim B. R., 8th Edition, McGraw-Hill, 2015.

MATH-424 Numerical Computing

Credit Hours:	3(3,0)	**Prerequisites:**	Calculus and Analytical Geometry

Course Learning Outcomes (CLOs):

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

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

Course Content:

Mathematical preliminaries and error analysis, round-off errors and computer arithmetic, Calculate Divided Differences. Use Divided-difference Table. Find Newton's Interpolation Polynomial. Calculate Interpolation with Equally Spaced Data. Find the Difference Table. Calculate, Newton's Forward & Backward Difference Formulae. Use Gauss Formulae. Use Stirling's Interpolation Formula. Use Bessel's Interpolation Formula. Use Everett's Interpolation Formula. Solve Nonlinear Equations. Solve Equations by Bisection Method. Solve Equations by Regula Falsi Method. Solve Equations by Secant Method. Solve Equations by Newton-Raphson Method. Find Fixed Point Iteration. Solve Equations by Jacobi Iterative Methods. Solve Equations by Gauss Seidel Method Calculate Numerical Differentiation. Find Numerical Differentiation Formulae Based on Equally Spaced Data. Find Numerical Differentiation Based on Newton's Forward Differences. Find Numerical Differentiation Based on Newton's Backward Differences. Find Numerical Differentiation Based on Stirling's Formula. Find Numerical Differentiation Based on Bessel's Formula. Find Numerical Differentiation Based on Lagrange's Formula. Calculate Error Analysis of Differentiation Formulae. Solve Richardson Extrapolation. Calculate Numerical Integration. Use Trapezoidal Rule with Error Term. Use Simpson's 1/3 Rule with Error Term. Use Simpson's 3/8 Rule with Error Term. Use Composite Numerical Integration. Use Composite Trapezoidal Rule. Use Composite Simpson's Rule. Find Richardson's Extrapolation. Find Newton-Cotes Closed Quadrature Formulae.

Teaching Methodology:

Lectures, Written Assignments, Semester Project, Lab Assignments, Presentations

Course Assessment:

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

Reference Materials:

1. *Numerical Analysis* (9th Edition) by Richard L. Burden, J. Douglas Faires by Brooks/Cole Boston USA, 2011
2. *Numerical Methods for Scientific Computing* by J.H. Heinbockel Trafford Publishing USA, 2006