

BSCIS Courses

1st Semester	Code	Course Title	Credits	Category
	CIS-101	Computer Fundamentals and Programming	3+1*	Computing Core
	CIS-211	Electronics	3+1*	Mathematics and Science Foundation
	PAM-220	Calculus and Analytic Geometry	3	Mathematics and Science Foundation
	PAM-242	Linear Algebra	2	Mathematics and Science Foundation
	CMS-101/102	Islamic Studies / Ethics (for Non Muslims)	2	General Education
	CMS-104	Composition and Grammar	3	General Education
	Total Credit hours		18	
2nd Semester	Code	Course Title	Credits	Category
	PAM-126	Physics I	3	Mathematics and Science Foundation
	CIS-121	Object Oriented Programming	3+1*	Computing Core
	CMS-105	Communication Skills	3	General Education
	CMS-103	Pakistan Studies	2	General Education
	CIS-143	Discrete Mathematics	3	Computing Core
	CIS-111	Digital Logic Design	2+1*	Computer Science Core
	Total Credit hours		18	
3rd Semester	Code	Course Title	Credits	Category
	CIS-318	Data Structures and Algorithms	3+1*	Computing Core
	CIS-201	Object Oriented Analysis and Design	3	Computer Science Supporting
	CIS-202	Computer Organization and Architecture	3	Computer Science Core
	PAM-267	Probability and Statistics	2	Mathematics and Science Foundation
	CMS-207	Professional Ethics	2	General Education
	CIS- 210	Data Communications and Computer Networks	3+1*	Computing Core
	Total Credit hours		18	
4th Semester	Code	Course Title	Credits	Category
	CIS- 305	Internet Application Development	2+1*	Computer Science Supporting
	CIS- 221	Analysis of Algorithms	3	Computer Science Core
	CIS-XXX	University Elective I	2+1*	University Elective
	CIS-302	Operating Systems	3	Computing Core
	CIS-301	Software Engineering	3	Computing Core
	CMS-206	Technical Writing	3	General Education
	Total Credit hours		18	
5th Semester	Code	Course Title	Credits	Category
	CIS-317	Theory of Automata	3	Computer Science Core
	CIS-315	Introduction to AI	3	Computer Science Core
	CIS-303	Database Systems	3+1*	Computing Core
	CIS- 304	Computer Security	3	Computing Core
	PAM-255	Differential Equations	2	Computer Science Supporting
	CIS-XXX	CS Elective-I	3	Computer Science - Elective
	Total Credit hours		18	
6th Semester	Code	Course Title	Credits	Category
	CIS-XXX	University Elective II	3	University Elective
	CIS-XXX	Parallel & Distributed Computing	3	Computer Science Core
	CIS-XXX	CS Elective-II	3	Computer Science - Elective
	CIS-XXX	CS Elective-III	3	Computer Science - Elective
	CIS-322	Signals and Image Processing	3	Computer Science Supporting
	CIS-401	Compiler Construction	3	Computer Science Core
	Total Credit hours		18	
7th Semester	Code	Course Title	Credits	Category
	PAM-360	Numerical Methods	3	Computer Science Supporting
	CIS-499	Final Year Project (FYP)	2+1*	Computing Core
	CIS-XXX	CS Elective-IV	3	Computer Science - Elective
	CIS-XXX	CS Elective-V	3	Computer Science - Elective
	CIS-XXX	University Elective III	3	University Elective
		Total Credit hours		15
8th Semester	Code	Course Title	Credits	Category
	CIS-XXX	University Elective IV	3	University Elective
	CIS-XXX	Intro. to Info. & Comm. Technologies	2+1*	General Education
	CIS-499	Final Year Project (FYP)	6	Computing Core
	Total Credit hours		12	
Total Credit Hours 135				

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-101	Computer Fundamentals & Programming	3+1*	Institutional Reqt.	Univ. Common Courses

Fundamental ideas about computers and Programming, central processing unit, memory, program, data storage, program execution, fetch-decode-execute cycle, number system, input and output (I/O) devices, buses, I/O interfaces, operating systems, Programming languages, process of developing programs, algorithms, flow charts, introduction to C++, Basic constructs of the language: variables and reading/writing, expressions, operators, if statement, while statement, for statement, arrays, Functions: Function declaration, declaration scope and visibility, reference parameters, recursive functions, Types: Enumerated types, pointers, void type, object oriented program development.

References

1. P. K. Sinha, Computer Fundamentals, BPB Publications, 2004.
2. Robert Lafore, Object-Oriented Programming in C++, 4/E, Sams Publisher, 2002.
3. Bjarne Stroustrup, The C++ Programming Language: Special Edition, 3/E, Addison Wesley, 2000.

Code	Course Title	Credits	Dept. Category	HEC Classification
PAM-126	Physics I	3	Institutional Reqt.	Courses from other Depts.

Measurement; motion in one-dimension; motion in two and three-dimensions; force and Newton's laws, applications of Newton's laws; momentum; system of particles; rotational kinematics, rotational dynamics; angular momentum; energy, work and power; potential energy; conservation of energy; gravitation; fluid statics; fluid dynamics; oscillations, wave motion, sound waves; thermodynamics; nature and propagation of light, spherical mirrors and lenses, interference, diffraction, grating and spectra, polarization; nature of matter.

References

1. R. Resnick, D. Halliday and K. S. Krane, Physics, Volume-One, John Wiley & Sons Inc., N. Y. 2007.
2. R. A. Serway, Physics, Volume-One, Physics for Scientists & Engineers with Modern Physics, Saunders College, Publishing, Philadelphia, 2007.
3. H. D. Young, R.A. Freedman, T. R. Sandin and A. L. Ford, University Physics, Addison-Wesley, 2006.

Code	Course Title	Credits	Dept. Category	HEC Classification
PAM-220	Calculus and Analytic Geometry	3	Institutional Reqt.	Univ. Common Courses

Lines, Functions and Graphs; Limits and Continuity; Derivatives and Applications of derivatives; Integration and Applications of integrals; Inverse functions; Vectors and analytic geometry in space; Vector-valued functions; Functions of several variables; Partial derivatives; Multiple integrals.

References

1. E. Kreyszig, Advanced Engineering Mathematics, 9/E, John Wiley and Sons, 2005.
2. G. B. Thomas, R. L. Finney, Calculus and Analytic Geometry, 10/E, AWL, 2002

3. W. Kaplan, Advanced Calculus, 5/E, Addison-Wesley, 2002.
4. R. Ellis, D. Gulick, Calculus: One and Several Variables, Saunders College Publishing, 1991.

Code	Course Title	Credits	Dept. Category	HEC Classification
PAM-242	Linear Algebra	2	Institutional Reqt.	Univ. Common Courses

Introduction to matrices, Elementary row operations, Symmetric and Hermitian matrices, Echelon forms, Rank and Inverse of a matrix, Determinants, Vector spaces, Linear combination, Complex numbers and functions, Complex vector spaces, Linear transformation, System of linear equations, Non-homogeneous and homogeneous linear equations, Gaussian elimination method, Gauss-Jordan method, Applications of linear algebra.

References

1. A. Howard, C. Rorres, Elementary Linear Algebra, 9/E, John Wiley and Sons, 2005.
2. E. Kreyszig, Advanced Engineering Mathematics, 9/E, John Wiley and Sons, 2005.

Code	Course Title	Credits	Dept. Category	HEC Classification
CMS-104	Composition and Grammar	3	Institutional Reqt.	Univ. Common Courses

Elements of Rhetoric, Modes of Persuasion (Pathos, Logos, Ethos) Pre-writing techniques (cubing, looping, mind-maps, brainstorming, free-writing, narrowing and Focusing), Audience, Voice, Critical Reading and Analysis, Return to the Modes of Persuasion, Thesis Statements, Outlining and Organizing the Essay, Theory of Introductory Paragraphs (Exigence, Kairos), Developing the Essay, Paragraphing, Summary and Paraphrase, Synthesis Essays, Basic Sentence Analysis/Usage, Basic Sentence Analysis/Usage, Figures of Speech, Satire/Irony, Correct sentences, Paragraph types including exemplification, narration, comparison/contrast, cause/effect, and persuasion, Argumentative Writing, Analysis and critical thinking practice, Toulmin Model of Argument, Writer's Position in Argument, relevance and sufficiency of evidence, value of truth in argument, Fallacies in argumentation, Claim, Support, and Warrant, Counterarguments/Rebuttals, Revision Techniques and Editing, Peer Reviews, Grammar: sentence elements, sentence types, coordination & subordination, stative verbs, irregular verbs, verb tenses, sentence types, fragments, run-ons, subject-verb agreement, count/non-count nouns, comparatives/ superlatives, and social modals. Mechanics: commas, capitalization and punctuation.

References

1. P. Hartmann, Laurie Blass, Quest 2 - Reading and Writing, 2/E, McGraw-Hill ESL/ELT, 2007.
2. P. Hartmann, Laurie Blass, Quest 2 - Listening and Speaking, 2/E, McGraw-Hill ESL/ELT, 2007.
3. Kolln and Funk, Understanding English, 7/E, 2005.
4. Ellen Balleisen, Susan Kesner Bland, Intermediate Grammar: From Form to Meaning, Oxford University Press, USA; Teacher's edition, 1996.

Code	Course Title	Credits	Dept. Category	HEC Classification
CMS-101	Islamic Studies	2	Institutional Reqt.	Univ. Common Courses

Tauheed: Arguments for the existence and oneness of Allah; Purpose of creation; Impact of tauheed on human life. Risalat: Need for prophets; Finality of prophethood; Seerat (The life of the Holy Prophet (S.A.W.)); Khutba Hijjat-ul-Wida; The importance of Sunnah. Aakhirat: The life after death; The Day of judgement; The concept of accountability and its impact on daily life. The Holy Quran: Its revelation and compilation; Introduction to Aijaaz-ul-Quran and the principles of Tafseer-ul-Quran; Sura al-Fatiha; 1st Raku of Sura al-Baqarah; Sura Al-Hujraat and lessons from Sura Yaseen. Hadith: Its authenticity and importance; An introduction to Sihah-i-Sitta; Types of Ahadith; Chehal hadith (Forty Ahadith). Ibadah: The concept of Ibadah; Major Ibadaat (Salaat, Saum, Zakat, Hajj and Jihad). Moral, Social and Political Philosophy of Islam: The concept of good and evil; Akhlaq-i-Hasanah, Kasb-i-Hilal; Responsibilities of the head of state; Rights and duties of the citizens. Applications of Islamic teachings to social and economic developments of the modern age such as interest free economy, etc.

References

1. Ibn-i-Kasir, Tafseer Ibn-i-Kasir, Dar Ibn Hazam, Beirut, Lebanon, 2005.
2. Baqilani, A.B., Al-Intisaar Lil-Quran, Dar Ibn Hazam, Beirut, Lebanon, 2005.
3. Majalis-ul Abrar (for forty Ahadith), Mir Muhammad Kutubkhana, Markaz-i-Ilm-o-Adab, Karachi, 2005.
4. Nauwawi, I., Arbaeen Hadith, Mir Muhammad Kutubkhana, Markaz-i-Ilm-o-Adab, Karachi, 2005.
5. Naumani, M. (Maulana), Deen-o-Shariat, Mir Muhammad Kutubkhana, Markaz-i-Ilm-o-Adab, Karachi, 2005.

Code	Course Title	Credits	Dept. Category	HEC Classification
CMS-102	Ethics (for Non-Muslims)	2	Institutional Reqt.	Univ. Common Courses

Ethics, Values, Individualism versus Altruism, Self Interest, Benevolence, Authority versus Freedom, Duty to the State, The Private Domain, The Autonomy of Conscience, Law and Morals, The Need for Enforcement, Social Justice, Individual Liberty, Liberty & Equality, Business Ethics, Benefits of the Profit Motive, Profits before Ethics, Ethics before Profits, Meta-Ethics and the problem of Justification, Indefinability of Good, Validation and Vindication: An Analysis of the Nature and the Limits of Ethical Arguments, Prolegomena to a Theory of the Moral Criterion, Moral and Non-moral Values: A Study in the First Principles of Axiology, War and Peace, The Golden rule of Ethics, Compassion, Apology, Social justice.

References

1. T. Donaldson, P. Werhane, Ethical Issues in Business: A Philosophical Approach, 7/E, Pearson, 2007.
2. R. Abelson, Marie-Lousie, Ethics for Modern Life, 6/E, St. Martin's Press, 2003.
3. D. Kolak, R. Martin, Wisdom without Answers, 5/E, Wadsworth Publishing Company, 2001.

Code	Course Title	Credits	Dept. Category	HEC Classification
PAM-127	Physics II	3+1*	Institutional Reqt.	Courses from other Depts.

Electric Charges & Coulomb's Law; The electric field; Gauss's law; electric potential energy and electric potential; electrical properties of materials; capacitance; DC-circuits; magnetic field; magnetic properties of materials; magnetic field of current; Faraday's law of induction; inductance; alternating current circuits; Maxwell's equations and electromagnetic waves; conductors, semiconductors, insulators and super conductors; energy band theory; N- and P-type semi conductors; diffusion current; drift generation; Recombination; PN-Junction; diode equation; electrons in potential wells; atomic physics, hydrogen atom; the atom and the nucleus; nuclear properties.

References

1. R. Resnick, D. Halliday and K. S. Krane, Physics, Volume-One, John Wiley & Sons Inc., N. Y. 2007.
2. R. A. Serway, Physics, Volume-One, Physics for Scientists & Engineers with Modern Physics, Saunders College, Publishing, Philadelphia, 2007.
3. H. D. Young, R.A. Freedman, T. R. Sandin and A. L. Ford, University Physics, Addison-Wesley, 2006.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-121	Object Oriented Programming	3+1*	Foundation	Discipline Specific

Introduction to OOP, brief discussion of other OOP languages, comparison with other programming methodologies and OOP's superiority, key concepts (abstract data types, encapsulation, polymorphism, inheritance, early and late binding), friend functions, operator overloading (VC++), inheritance and composition, virtual functions, pure virtual and abstract base classes, serial / multiple derivation, virtual destructors, templates, exception handling.

References

1. Harvey M. Deitel, Paul J. Deitel, C++ How to Program, 6th Ed., Prentice Hall, 2008.
2. Robert Lafore, Object Oriented Programming in C++, 4th Ed., Sams Publishing, 2002.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-122	Data Structures	3+1*	Foundation	Discipline Specific

A detailed study of the basic structures commonly used in data processing, Development of more advanced structures such as Stacks, Queues, Linked lists, Trees, and Graphs and their applications, Internal sorting, External sorting and hash table methods, Searching and merging files, Emphasis will be on design, implementation, and evaluation of various programming assignments, trees and related algorithms, graphs and related algorithms.

References

1. Mark Allen Weiss, Data structures and Algorithms analysis in C++, 2nd edition, Pearson Education, 2006.
2. D. Samanja, Classic Data structures, 2nd edition, Prentice Hall Inc., 2002.

Code	Course Title	Credits	Dept. Category	HEC Classification
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CIS-143	Discrete Mathematics	3	Foundation	Discipline Specific
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Logic, Sets and Functions, Algorithms and Matrices, Mathematical Reasoning, Recursive Definitions, Recursive Algorithms, Basics of Counting, The Pigeonhole Principle, Discrete Probability, Advanced Counting Techniques, Relations, Recurrence Relations, Mathematical Induction, Graph theory, Trees, Optimization and Matching, Rings and Modular Arithmetic, Boolean Algebra, Boolean Algebra and Combinatorial Circuits, Modelling Computation, Finite-State Machines

References

1. R. H. Rosen, Discrete Mathematics and its Applications, 6/E, McGraw-Hill 2006
2. Jiri Matousek and Jaroslav Nesetril, An Invitation to Discrete Mathematics, 2/E, Oxford University Press, 2008, ISBN-10: 0198570422, ISBN-13: 978-0198570424
3. Laszlo Lovasz, Jozsef Pelikan and Katalin L. Vesztergombi, Discrete Mathematics, 1/E, Springer, 2003

Code	Course Title	Credits	Dept. Category	HEC Classification
CMS-105	Communication Skills	3	Institutional Reqt.	Univ. Common Courses

Overview and Importance of Effective Communications, Business Communication and the Ethical Context, Business Communication and the Technology Context, Successful Listening, Communicating in Teams and Mastering Listening and Nonverbal Communication Skills, Strategies for Successful Speaking and Successful Listening, Leading by Feel, Logical Fallacies and the Art of Debate, General principles of Communication, The Seven C's of Effective Communication, Format and Layout of Business Documents, Preparing Effective Business Messages, Good News, Bad News and Neutral Messages, Persuasive Written Messages, Writing Resumes and Application Letters, Interviewing for Employment and Following Up, Reports, Proposals and Presentations, Research Process, Communicating Information Through Visuals, Short Reports, Formal Reports, Proposals, Oral Communication, Impromptu & Extempore Talks , Onion Ring Activity, Individual Talks, Meetings and Group Dynamics, Member Roles and Leadership in Groups, Member Roles and Leadership in Groups, Communicating in Teams, Mastering Listening, Nonverbal Communication Skills, Strategies for Business and Group Meetings, Preparation for Presentations, Planning, writing, and Completing Oral Presentations, Strategies for Successful Speaking and Successful Listening.

References

1. John V. Thill, Courtland L. Bovee, Business Communication Today, Prentice-Hall, 8/E, 2004.
2. H. A. Murphy, H. W. Hildebrandt, J.P. Thomas, Effective Business Communications, 8/E, Mcgraw-Hill/Irwin, 1997.

Code	Course Title	Credits	Dept. Category	HEC Classification
CMS-206	Technical Writing	3	Institutional Reqt.	Univ. Common Courses

Overview of the Field, Manuals and Handbooks, Technical Reports, Technical Articles, Technical Sales Literature, Technical Training Material, Technical Presentations, Educational Textbooks, Software Documentation, Outline and Design, The Requirement, Specification, The Outline Design, Sources of Information, Library Classifications, Contacts, Meetings, Information Gathering, Verbal Information, Visual Information, The Synopsis, The Work Schedule, Costing, Development Phase: First Draft, Style of Writing, Technical Vetting, Editing, Final Draft, Commercial Books, Production Phase: Camera Copy, Proofreading, Printing; Illustrations: Technical Illustrations, Diagrams/Line Illustrations, Perspective

Drawings, Half-tones, Validating Illustrations, Miscellaneous Topics: Materials and Equipment, Translations, Abstracting and Abridging, Indexing, Development of a Documentation System, Diagnostic/Maintenance Documentation, Network Planning, Copyright, Contracts.

References

1. Tech Biz Writing, "TechBiz Writing Course: A Free Course in Technical and Business Writing which builds gradually into a valuable resource", [Online]. Available: <http://www.techbizwriting.com>.
2. R. W. Kristin, Writing for the Technical Professions, 4/E, Longman, 2007.

Code	Course Title	Credits	Dept. Category	HEC Classification
CMS-201	Object Oriented Analysis and Design	3	Advanced Core	Major Courses

Object-Oriented Concepts, Abstraction and Modelling, (object modelling identification, classification, association, generalisation and aggregation), Inheritance, meta-data and notation for object modelling, Dynamic modelling state transition diagrams and object lifecycles, Object-Oriented Development Methodologies- object modelling technique (Rumbaugh and others), Object- Oriented Analysis (Schlaer and Mellor), Object-Oriented design, Object Communication Models, and Integration of Models.

References

1. John Deacon, Object-Oriented Analysis and Design, 2005, Addison-Wesley, 0-321-26317-0.
2. Brett McLaughlin, Gary Pollice, and David West, Head First Object-Oriented Analysis and Design, O'Reilly Media, Inc., 2006, ISBN: 0-596-00867-8
3. Grady booch, Object-Oriented Analysis and Design with Applications, 2/E, Addison-Wesley, 1993, ISBN-10: 0805353402, ISBN-13: 978-0805353402
4. Bertrand Meyer, Object-Oriented Software Construction, 2/E, Prentice Hall PTR, 2000, ISBN-10: 0136291554, ISBN-13: 978-0136291558

Code	Course Title	Credits	Dept. Category	HEC Classification
CMS-111	Digital Logic Design	2+1*	Foundation	Discipline Specific

Digital Concepts, Number Systems & Codes, Binary Arithmetic, Logic Gates, Boolean Algebra and Reduction Techniques, Combinational Circuits /Logic, Flip Flops And Registers, Counters and its Applications, Multivibrators and the 555 Timer, Shift Registers, Memories, Programmable Logic Devices and Arrays, Interfacing (Analog to Digital and Digital to Analog Conversion), Microprocessor Fundamentals.

References

1. Thomas L. Floyd, Digital Fundamentals, 8th Ed., Pearson Education, 2004.
2. Ronald J. Tocci, Digital Systems: Principles and Application:, 8th Ed., Prentice Hall, 2003.
3. William Kleitz, Digital Electronics: A Practical Approach, 6th Ed., Pearson Education, 2003.

Code	Course Title	Credits	Dept. Category	HEC Classification
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CMS-211	Electronics	3+1*	Foundation	Discipline Specific
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Electronics quantities and units, Electrical Resistance, Ohm's Law, Series and Parallel resistive networks and their analysis using Kirchhoff's laws, Alternating Currents and Voltages, Capacitors, Inductors, RCL Circuits, Network Analysis of AC Circuit, Introduction to Semiconductors Devices, Diodes and Their Applications, Clipping and Clamping Circuits, Bipolar Junction Transistors, Field Effect Transistors as Amplifiers, Multistage Amplifiers, Difference amplifiers, Operational Amplifiers, Applications of Operational Amplifiers.

References

1. Bernard Grob, Basic Electronics, 10th Ed., McGraw Hill, 2006.
2. Paul Horowitz, The Art of Electronics, 2nd Ed., Cambridge University Press, 2002.
3. Albert P. Malvino, Electronic Principles, 6th Ed., McGraw Hill, 2003.

Code	Course Title	Credits	Dept. Category	HEC Classification
PAM-267	Probability and Statistics	2	Foundation	Courses from other Depts.

Frequency Distributions, Histograms, and Frequency Polygons, Mean, Median, Mode, and Other Measures of Central Tendency, Standard Deviation and Other Measures of Dispersion, Moments, Skewness and Kurtosis, Combinatorial Analysis, Probability and Conditional Probability, Dependent and Independent Events, Mutually Exclusive Events, Probability Distributions, Binomial, Normal, and Poisson Distribution, Mathematical Expectation, Curve fitting and Method of Least Squares.

References

1. David Freedman, Robert Pisani and Roger Purves, Statistics, 4/E, W. W. Norton, 2007, ISBN-10: 0393929728, ISBN-13: 978-0393929720
2. Charles M. Grinstead and J. Laurie Snell, Introduction to Probability, American Mathematical Society, 1997.

Code	Course Title	Credits	Dept. Category	HEC Classification
PAM-255	Differential Equations	2	Foundation	Courses from other Depts.

Introduction to Differential Equations, Formation of differential equations, Initial and boundary conditions, Methods of solution of differential equation of first order and first-degree, Homogeneous linear equations of order n with constant coefficients, Auxiliary/characteristic equations, Solution of higher order differential equation according to the roots of auxiliary equation, Non-homogeneous linear equations, Working rules for finding particular integral, Cauchy-Euler equation, Method of variation of parameters, Systems of differential equations, Series solution of differential equations.

References

1. E. Kreyszig, Advanced Engineering Mathematics, 9/E, John Wiley & Sons, 2005.
2. D. D. Benice, Brief Calculus and its Applications, 2/E, Houghton Mifflin Company, 1996.
3. William Mendenhall, Robert J. Beaver, Barbara M. Beaver, Introduction to Probability and Statistics, 12/E, 2006, Duxbury Press, ISBN-10: 0534395198, ISBN-13: 978-0534395193

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-221	Analysis of Algorithms	3	Advance Core	Major Courses

The Role of Algorithms in Computing, Insertion sort, Analyzing Algorithms, Designing Algorithms, Growth of Functions, Asymptotic notation, The substitution Method, Recursive Method, Master Method, Heaps, Heapsort Algorithm, Priority Queues, Description and Performance of Quicksort, Analysis of Quicksort, Counting sort, Radix sort, Bucket sort, Dynamic Programming, Greedy Algorithms, Representation of graphs, Depth-First search, Breadth-first search, Topological sort, Strongly-connected components, minimum spanning trees, Algorithms of Kruskal and Prim, Bellman-ford Algorithm, Single-source shortest path in DAGs, Dijkstra's Algorithm, All-pairs shortest path, Floyd-Warshall's Algorithms, NP-completeness, Approximation Algorithms.

References

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, Introduction to Algorithms, 2/E, MIT press, 2001.
2. S. Skiena, The Algorithms Design Manual, Springer, 1998.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-202	Computer Organization and Architecture	3	Advanced Core	Major Courses

Introduction to computer architecture and organization, performance measuring issues, single processor architectures, the computer family concept, instruction-set design, data representation, addressing techniques, bus organization, bus transfers and control signals and arbitration, organization of CPU & CPU components, organization of I/O systems, Disk Performance Parameters (RAID), DMA I/O, memory-mapped I/O, physical I/O devices, interrupts, memory organization and its management, caches, virtual memory, memory speed and cost performance issues, RISC Processors, historical perspective, RISC-CISC controversy, arithmetic-unit and instruction-unit, Introduction to performance enhancements topics.

References

1. William Stallings, Computer Organization and Architecture, 7/E, Prentice Hall, 2006.
2. Patterson & Hennessy, Computer Architecture: A Quantitative Approach, 3/E, San Mateo, CA: Morgan Kaufman, 2002.
3. Patterson and Hennessy, Computer Organization and Design: The Hardware / Software Interface, 3/E, San Mateo, CA: Morgan Kaufman, 2004.
4. David L. Tarnoff, Computer Organization and Design Fundamentals, Johnson City, Tennessee, USA, Publisher: Lulu.com, 2005, (soft copy).

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-312	Signals and Systems	3+1*	Foundation	Courses from other Depts.

Fundamentals, Elementary Signals, Mathematical representation of signals and systems, Types of systems, Sampling and quantization, Concept of Aliasing, Continuous and discrete time signals and system, Linear time invariant (LTI) systems, Convolution, Time-domain and frequency-domain concepts, Modeling systems with differential equations, Laplace Transforms, Fourier series in signal analysis, Fourier Series Transforms, Discrete Fourier Transforms (DFT), Fast Fourier Transform (FFT), Modeling

systems with difference equations, Z-Transforms, Concept of stability by Laplace and Z-transform, Programming for signals and systems in MATLAB.

References

1. Alan V. Oppenheim, Alan S. Willsky and S. Hamid, Signals and Systems, 2nd Edition, Prentice-Hall Signal Processing Series.
2. Vinay K. Ingle, John G. Proakis, Digital Signal Processing Using MATLAB, Bookware Companion Series.

Code	Course Title	Credits	HEC Classification
CIS-401	Compiler Construction	3	Computer Science – Core
Language and Syntax, Regular Languages, Analysis of Context-Free Languages, Attribute-Grammars and Semantics, Expressions and Assignments, Conditional and Repeated Statements, Boolean Expressions, Procedures and the Concept of Locality, Elementary Data Types, Open Arrays, Pointers and Procedures Types, Modules and Separate Compilations, Code Optimization. References 1. Aho, Alfred V. <i>Compilers; Principles, Techniques and Tools</i> 2nd ed. Addison Wesley, 2007.			

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-211	Data communication	3+1*	Foundation	Major Courses

Classification of communication networks, The variety and description of telecommunications traffic, The conversion of analogue and digital signals, The transmission of information, The relationship between information, bandwidth and noise, The description and types of communication channels, Digital transmission and switching Standards, Digital modulation demodulation, Noise in communication systems, Design limitations on maximum data-rate and channel capacity, Communication channels, Microwave link communication, Satellite communication, Optical fibre cables, Mobile communications, Information and Coding Theory, Information Sources and Entropy, Broadband ISDN, Switching, High Speed Networks.

References

1. Computer and Data Communication, William Stallings, Prentice-Hall (Pearson Education), 7/E, 2004. ISBN-81-203-2355-6
2. Computer Networks, Andrew S. Tanenbaum, Pearson Education, 4/E, 2003. ISBN-10: 0130661023
3. Data Communications and Networking, Behrouz A. Forouzan, McGraw-Hill 2003, 3/E, ISBN:0072923547

Code	Course Title	Credits	Dept. Category	HEC Classification
PAM-360	Numerical Methods	3	Foundation	Courses from other Depts.

Floating point number system, Sources of errors, Error definitions and analysis, Taylor's theorem, Solutions of equations of one variable, Interpolation and polynomial approximation, Numerical differentiation and integration, Iterative methods for system of linear equations, Approximating eigenvalues, Numerical solution of ordinary and partial differential equations.

References

1. E. Kreyszig, Advanced Engineering Mathematics, 9/E, John Wiley & Sons, 2005.
2. R. L. Burden, J. D. Faires, Numerical Methods, 3/E, PWS, 2002.
3. R. L. Burden, J. D. Faires, Numerical Analysis, 7/E, Brooks Cole, 2001.

Code	Course Title	Credits	Dept. Category	HEC Classification
CMS-103	Pakistan Studies	2	Institutional Reqt.	Univ. Common Courses

Important geological and geographical features of Pakistan; Pakistan's geographical location in a regional and global perspective. Earliest human settlements in Pakistan; The Indus Valley civilization; Aryan settlement and the Gandhara civilization; The advent of Islam in Pakistan; The work of Al-Beruni and early sufi-savants in Pakistani lands. The British domination and its causes; Brief chronology of the freedom movement; The founding documents of Pakistan including Allama Iqbal's 1930 Allahabad address, the Lahore Resolution of 23rd March 1940, and Quaid-i-Azam's presidential address to the Constituent Assembly of Pakistan. Political and constitutional phases in Pakistan since 1947; Important features of the 1973 constitution and its current status. Current issues in Pakistan including: Administrative infra-structure; Population growth; Water, energy and mineral resources; Agricultural resources and industrial infra-structure; Educational problems; economic growth pattern and budgetary issues; Environmental problems; Foreign policy issues.

References

1. K. A. Saeed, The Economy of Pakistan, Oxford University Press, Karachi, 2007.
2. J. Briscoe and U. Qamar, Pakistan's Water Economy: Running Dry, Oxford University Press, 2006.
3. Jinnah: Speeches and Statements 1947-48, Oxford University Press, Karachi, 2000.
4. The New Oxford Atlas for Pakistan, Oxford University Press, Karachi, 1998.
5. J.M. Kenoyer, Ancient Cities of the Indus Valley Civilization, Oxford University Press, Karachi, 1998.
6. L.A. Sherwani (Editor), Speeches, Writings and Statements of Iqbal, Iqbal Academy, Lahore, 1995.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-301	Software Engineering	3	Advanced Core	Major Courses

Software life-cycle, Planning a software project, Software cost estimation, Software Specification, requirement definition, system modelling, prototyping, formal, Algebraic and Model based Specification, Software Design, Object-Oriented Design, Function Oriented Design, Real-Time Design, user interface design, Programming Techniques and Tools, Reliability and Reusability, Computer Aided Software Engineering (CASE) tools, Software Verification and Validation, Software Management.

References

1. Waman S. Jawadekar, Software Engineering: Principles and Practice, McGraw Hill, 2004. ISBN 0070583714
2. Alain Abran, James W. Moore, Pierre Bourque, Robert Dupuis, Leonard L. Tripp, Guide to the Software Engineering Body of Knowledge, 2004 Version IEEE, 2004. ISBN 0-7695-2330-7
3. Carlo Ghezzi, Mehdi Jazayeri and Dino Mandrioli, Fundamentals of Software Engineering, 2/E, 2003, Pearson Education (Addison Wesley), ISBN 0-13-099183-X
4. Hans Van Vliet, Software Engineering: Principles and Practice, 2/E, John Wiley and Sons, 2002. ISBN 0-471-97508-7

5. Eric J. Braude, Software Engineering: An Object-Oriented Perspective, John Wiley and Sons, 2001. ISBN 0-471-32208-3
6. D. L. Parnas and D. M. Weiss and D. M. Hoffman, Software Fundamentals: Collected Papers by David L. Parnas, Addison-Wesley, 2001. ISBN 0-201-70369-6
7. Roger S. Pressman, Software Engineering: A Practitioner's Approach, 5/E, McGraw Hill, 2001. ISBN 0-07-365578-3
8. Ian Sommerville. Software Engineering, 6/E, Pearson Education (Addison Wesley), 2001. ISBN 0-201-39815-X
9. Shari Lawrence Pfleeger, Software Engineering: Theory and Practice, Prentice Hall, 1998. ISBN 0-13-624842-X

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-302	Operating Systems	3	Advanced Core	Major Courses

Introduction: Overview of Operating Systems, UNIX System V Architecture, File Systems: File Systems organization and management, Case Study: UNIX System V, Process Management: Process description and control, Interrupt handling through context switching, Case Study: UNIX System V, Concurrency and Synchronization, Deadlocks, Case Study: UNIX System V, Process Scheduling: Scheduling levels, Objectives and policies, Multiprocessing Systems, Device management: Basic functions and techniques for device management, I/O Buffering, Disk Scheduling, concepts of network operating systems and distributed operating systems.

References

1. Silberschatz, Galvin and Gagne, Operating Systems Concepts, 7/E, 2005, John Wiley & Sons, Inc.
2. Andrew S. Tanenbaum and Albert S. Woodhull, Operating Systems: Design and Implementation, 2/E, 1997, Prentice Hall

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-303	Database Systems	3	Advanced Core	Major Courses

Database concepts: File systems and models for conceptual and logical design of databases, Data models and integrity: Organisation, storage, search and retrieval methods in hierarchical, network and relational data models, Introduction to SQL, Query optimisation, security, and integrity and concurrency protocols.

References

1. Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, 3/E, McGraw-Hill
2. Abraham Silberschatz, Sudarshan Korth, Database System Concepts, 4/E - McGraw-Hill
3. C. J. Date, An Introduction to Database Systems, 8/E, Addison-Wesley

Code	Course Title	Credits	Dept. Category	HEC Classification
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CIS-311	Computer Networking	3+1*	Advanced Core	Major Courses
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Computer Networks: Their Goals, Classification and Topologies, A communication system and devices, Channel characteristics, Transmission modes, Modulation and Modems Synchronization, Network Architecture and layered protocols, The seven layered ISO/OSI Reference Model, Analogue interfaces, RS-232-C and RS-449, Digital interface, X,21, Error detection and correction, Local Area Networks, IEEE 802 LAN standards and their relationship to ISO/OSI Model, Data-link controls, BSC, HDLC etc, Packet Switching, Segmentation and Reassembly, Virtual Circuits and Datagrams, X,25 Network, The PAD, Frame relay, ATM, Example Networks, ARPANET, BITNET etc, Public Data Networks, Flow and congestion control, Packet Routing, Internet working, Electronic mail and virtual terminals.

References

1. Computer Networking; A Top Down Approach Featuring the Internet, 2/E, James F. Kurose, Keith W. Ross Pearson Education 2003.
2. Computer Networks, Andrew S. Tanenbaum 4/E, Pearson Education, 2003, ISBN-10: 0130661023, ISBN-13: 9780130661029,
3. Data and Computer Communication, William Stallings 7/E, Prentice-Hall (Pearson Education), 2004, ISBN-81-203-2355-6

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-321	Microprocessors and Interfacing	2+2*	Advanced Core	Discipline Specific

Review of basic logic circuits & technology, Description of bus, timing analysis, serial and parallel interfacing, polling and interrupts, counters and interval timers, A/D and D/A conversion, interfacing to magnetic devices, Direct Memory Access (DMA) techniques, Laboratory Experiments: Design of a memory board, Parallel I/O & keyboard design, Interrupts & interrupt vector, Serial communication between computers, Use of DMA Controller.

References

1. Douglas V Hall, Microprocessors and Interfacing, Rev. 2nd Ed., McGraw Hill, 2006.
2. Barry B. Brey, The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, and Pentium Pro Processor Architecture, Programming, and Interfacing, Prentice Hall, 2000.

Code	Course Title	Credits	Dept. Category	HEC Classification
CMS-207	Professional Ethics	2	Institutional Reqt.	Courses from other Depts.

Ethical Concepts and Principles; Understanding the Codes of Conduct; Caring for Company Assets; Avoiding Conflicts of Interest; Confidential Information and Intellectual Property; Business Gifts and Hospitality; Electronic Communications; Antitrust and Fair Competition; Ethics in Research, Documentation and Treatment of Research Data; Reporting and Assistance, Deception; Harassment and Bullying; Privacy and Confidentiality; Cultural Conflicts; Misunderstanding and misusing Jokes, Innuendos, and Banter at work; Lack of Stewardship of Company Assets (funds, physical property, intellectual property); Cheating and Plagiarism by Students and Researchers, Identifying and Resolving Ethical Dilemmas; Need for and Characteristics of a Corporate-level Ethics Program; Best Practices in the Development of Code of Ethics; Embedding an Ethics Policy (and Code) into the day to day working

of an Organization; Training Methods; Characteristics of an Effective Corporate Ethics Program; Corporate Social Responsibilities.

References

1. M. W. Martin, M. Martin and R. Schinzinger, Ethics in Engineering, McGraw-Hill, 2004.
2. Charles Mitchell, A Short Course in International Business Ethics: Combining Ethics and Profits in Global Business, World Trade Press, 2003.
3. Joan C. Callahan, Ethical Issues in Professional Life, New York: Oxford University Press, 1988.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-XXX	Parallel and Distributed Computing	3	Advanced Core	Major Courses

A selection of topics from the following: the challenges faced in constructing parallel and distributed applications, including testing, debugging and performance evaluation. Various implementation techniques, paradigms, architectures and programming languages including: Flynn's taxonomy, MPI, MapReduce, OpenMP, GPGPU, concurrency and multi-threading.

On successful completion of this course students will be able to:

- 1 Develop and apply knowledge of parallel and distributed computing techniques and methodologies.
- 2 Apply design, development, and performance analysis of parallel and distributed applications.
- 3 Use the application of fundamental Computer Science methods and algorithms in the development of parallel applications.
- 4 Explain the design, testing, and performance analysis of a software system, and to be able to communicate that design to others.

References

1. An Introduction to Parallel Programming by Peter Pacheco (Elsevier 2011)
2. Designing and Building Parallel Programs, by Ian Foster (Addison-Wesley, 1995)
3. Parallel Programming for Multicore and Cluster Systems - T. Rauber, G. Runger, Springer 2009
4. Principles of Parallel Programming - C. Lin, L. Snyder, Addison-Wesley, 2009.
5. The Art of Computer Systems Performance Analysis - R. Jain, 1997

Code	Course Title	Credits	Dept. Category	HEC Classification
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CIS-XXX	Introduction to ICT	2+1	Advanced Core	Major Courses
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This course focuses on a breadth-first coverage of the use of computing and communication technologies to solve real life problems; including computing environments, general application software like word processing, visual presentation applications, tabular data manipulation, DBMS, WWW, Email management systems, Virus, Anti-Virus and Spam Protection; Introduction to the basic computing hardware (main building blocks), operating systems, data networks; software engineering and communication technology along with social and ethical issues. An introduction of the program of study in computing for which this course is being taught (CS, IT, SE etc.). The course attempts to provide every student a set of productivity tools that they will be able to use for the rest of their lives. Course Outline: Number Systems, Binary numbers, Boolean logic, History computer system, basic machine organization, Von Neumann Architecture, Algorithm definition, design, and implementation, Programming paradigms and languages, Graphical programming, Overview of Software Engineering and Information Communication Technology, Operating system, Compiler, DBMS, Computer networks and internet, WWW, web mail applications, Computer graphics, AI, Viruses and Anti-Viruses, Use of office productivity tools, such as word processors, spreadsheets, presentation applications, etc., Social, Ethical, Professional and Legal Issues, and overview of the complete program of studies in computing and its structure.

References

1. Introduction to Computers by Peter Norton, 6th Edition, McGraw-Hill SiE, ISBN 0-07-059374-4.
2. Computers: Information Technology in Perspective, 9/e by Larry Long and Nancy Long, Prentice Hall.
3. An Invitation to Computer Science, Schneider and Gersting, Brooks/Cole Thomson Learning, 2000.
4. Information System Today by Leonard Jessup, Joseph Valacich.
5. Computers Today by Suresh K. Basandra.
6. Computer Science: An overview of Computer Science, Sherer.

Code	Course Title	Credits	Dept. Category	HEC Classification
CMS-305	Internet Application Development	3+1*	Advanced Core	Major Courses

Survey of contemporary Internet technologies, Programmer-oriented survey of authoring, distributing and browsing technologies, The role, use and implementation of current internet tools, TCP/IP namespaces, connections, protocols, Client-server structures, World Wide Web/ HTTP/ HTML techniques for text, images, links and forms, Indexing and search technologies, Server-side programming, Scripting, Dynamic contents with Java, Security and privacy issues, Programming projects on clients and server side, May include UNIX scripts, C, PERL and Java.

References

1. Matthew MacDonald, Beginning ASP.NET 2.0 in VB 2005: From Novice to Professional, APress, 2006.
2. Matthew MacDonald, ASP.NET: The Complete Reference, McGrawHill/Osborne, 2002.
3. Imar Spaanjaars, Paul Wilton, ASP.NET 2.0 Projects, Wrox, 2006.
4. Microsoft .NET Framework Software Development Kit Documentation, Available: [On DVD] and on Microsoft's Web Site.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-315	Introduction to Artificial Intelligence	3	Advanced Core	Discipline Specific

Introduction, Intelligent Agents, 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, Uncertain Knowledge and Reasoning, Probabilistic Reasoning, Probabilistic Reasoning Over Time, Making Simple Decisions, Making Complex Decisions, Learning from Observations, Knowledge in Learning, Strong-method Problem Solving, Automated Reasoning, Role of Knowledge in Language Understanding, Stochastic Tools for Language Analysis

References

1. G. F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, 5th Edition, Addison-Wesley, 2005.
2. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 2nd Edition, Prentice-Hall, 2003.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-317	Theory of Automata	3	Advanced Core	Major Courses

Introduction to Automata, Review of proof techniques, Finite Automata, Deterministic/Non Deterministic Automata, Equivalence, Epsilon NFA, Regular Expressions & Languages, Regular expressions, Regular Grammars, Finite Automata and Regular Expressions, Properties of Regular Languages, Algorithms for Regular Languages, Context-free Languages (CFL), Context-free grammars (CFG), Parse Trees, Derivations and ambiguity, Push down automata (PDA), PDA/CFG Equivalence, Deterministic PDA's, Properties of Context-free Languages, Chomsky-normal-form grammars, Pumping Lemma, Closure Properties, Algorithms for CFL's, Turing Machines, Types of Turing Machines, Decidability, Recursive & recursively enumerable languages, Some real un-decidable problems, Intractable Problems, P, NP Classes, NP-complete problems.

References

1. J. E. Hopcroft, R. Motwani, J. D. Ullman, Introduction to Automata Theory, Languages, and Computation, 2/E, Addison-Wesley, 2001.
2. P. Linz, An Introduction to Formal Languages and Automata, 4th Edition, J and B Publishers, 2006.
3. D. I. A. Cohen, Introduction to Computer Theory, 2/E John Wiley & Sons, 1996.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-318	Data Structures and Algorithms	3+1	Advanced Core	Major Courses

A brief introduction to object-based approach, basic class syntax, important constructs in C++ class design; Abstract data types; Asymptotic analysis, efficiency of algorithms, estimation of the running time of algorithms, best, average and worst case; Introduction to direct and indirect recursion and iterative programs; Link lists, doubly linked lists, circular linked lists, stacks, queues, priority queues, binary heaps; Trees terminology, traversals, infix, postfix, prefix notations, with an emphasis on search trees, insertion, search, deletion of nodes, imbalance problem, balanced AVL trees, left and right rotations; Hashing, hash

tables, hash function, collisions and their solutions; General-purpose sorting algorithms and their comparison, internal and external sorting; Graph algorithms, directed and undirected graphs, graph operations, adjacency matrix and list representations, searching graphs, graph traversals, shortest path; Algorithm design by examining common problem-solving techniques, greedy algorithms, divide and conquer approach.

References

1. Cormen, Thomas H. *Introduction to algorithms*. MIT press, 2009.
2. Allen, Weiss Mark. *Data Structures and Algorithm Analysis in C++*. Pearson Education India, 2007.

Lafore, Robert. *Sams Teach Yourself Data Structures and Algorithms in 24 Hours with Cdrom*. Sams, 1999

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-499	Seminar Project Proposal	1	Advanced Core	Major Courses

The student will undertake an in-depth study of some Computer and Information Sciences related problem in their 6th to 8th semesters (Seminar Project). The research proposal will be for this seminar project.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-308	Modeling and Simulation	3	Advanced Core	Discipline Specific

Introduction to systems, models and simulators, Deterministic and Stochastic Models, Analog and Numerical Models, Discrete and Continuous Simulation, Computational techniques for numerical simulation of physical systems, Finite Difference based Simulators, Simulations using Finite Element Methods, Monte Carlo Simulation, Simulation of Micro-, Macro- and Super-macro Systems, Advanced Topics.

References

1. F.L. Severance, System Modeling and Simulation: An Introduction, Wiley, 2001.
2. K. Ogata, Modern Control Engineering, 4th Edition, Prentice Hall, 2003.
3. Hugh Jack, Dynamic System Modeling and Control, 2005. (Free Online Book)

http://claymore.engineer.gvsu.edu/~jackh/books/model/pdf/model2_6.pdf

4. R.L. Woods and K.L. Lawrence, Modeling and Simulation of Dynamic Systems, Prentice Hall, 1997.

Code	Course Title	Credits	Dept. Category	HEC Classification
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CIS-316	Fundamentals of Image Processing	3	Foundation	Discipline Specific
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Image processing system, CCD cameras, Perspective transformations and camera calibration, Performance and signal to noise considerations, Image noise reduction via filtering, Image enhancement, Linear contrast stretching, Histogram equalization, Color image formats, Color correction, Image compression via run-length and Huffman coding, Edge detection, Detection of change or movement via image subtraction, Image segmentation via thresholding, Histogram aided thresholding, Region growing, Edge detection via Hough transform and contour-based segmentation, Point, line and region measurements.

References

1. Gonzalez and Woods, Digital Image Processing, 3rd Edition (DIP/3e), Prentice Hall, 2008.
2. Gonzalez, Woods and Eddins, Digital Image Processing Using MATLAB (DIPUM), Prentice Hall, 2004.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-304	Computer Security	3	Advanced Core	Major Courses

Introduction to computer security, Information and its Control, Computer System Security and Access Controls, System Access: Logging Into Your System, Identification and Authentication, Protecting Passwords, Data Access: Protecting Your Data, Viruses and its remedies, Secure System Planning and Administration, Communications and Network Security, Encryption, Cryptography: tools and techniques, Cryptographic Keys: Private and Public, The Data Encryption Standard, Public Key Algorithms, Digital Signatures and Notaries, Communications Vulnerabilities, Communications Threats, Encrypted Communications, Risk Analysis and Disaster Planning, Firewalls: introduction, protocol stacks, packet filters.

References

1. William Stallings, Cryptography and Network Security: Principles and Practices, 4th Edition, Prentice Hall 2006.
2. Behrouz A. Forouzan, Cryptography and Network Security, 1st Edition, McGraw-Hill, 2007.
3. Man Young Rhee, Internet Security: Cryptographic Principles, Algorithms and Protocols, 1st Edition, John Wiley & Sons, 2003.
4. Bruce Schneier, Applied Cryptography: 2nd Edition, John Wiley & Sons, 1996.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-499	Seminar Project	3+6	Advanced Core	Major Courses

The student will undertake an in-depth study of some Computer and Information Sciences related problem, This will be done either by joining an on-going research program, or by initiating a new program under the guidance of a PIEAS faculty member, The nature of the project may be research, development or design and may involve experimental, theoretical, or computational work or a combination of these, The Project Supervisor will be responsible for reporting the grade of the student based on the evaluation of a comprehensive report and seminar, Normally, this project is to be completed by the end of eighth semester, However, if the supervisor(s) feel that more time is needed for the satisfactory completion of the project, the duration may be extended.

Code	Course Title	Credits	Dept. Category	HEC Classification
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CMS-301	Principles of Management	3	Advanced Core	Univ. Common Courses
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Introduction to Management and Organizations; Organizational Vision, Mission and Strategies; Organizational Culture; Socially Responsible Organizations; Foundations of Planning; Planning Tools and Techniques; Organizational Structure and Design; Human Resource Management; Foundations of Behavior; Leadership and Motivation; Operations and Value Chain Management; Performance Management; Project Portfolio Management System; Project Networks; Scheduling; Resource Allocation and Resource Leveling; Project Execution and Controlling; Introduction to PMBOK.

References

1. C. F. Gray, E. W. Larson, Project Management: The Managerial Process, Boston: McGraw-Hill/Irwin, 2008.
2. S. P. Robbins, M. Coulter, Management, 9/E, Prentice Hall, 2007.
3. A Guide to the Project Management Body of Knowledge (PMBOK Guide), 3/E, Project Management Institute.

Code	Course Title	Credits	Dept. Category	HEC Classification
CMS-301	Entrepreneurship	2+1	University Elective	Univ. Common Courses

Conceptual definition of entrepreneurs and entrepreneurship. Entrepreneurship in economic theory. Historical development of entrepreneurship. Entrepreneurial practice. The importance of small business. Entrepreneurial economy. Entrepreneurship and Economic Development. Type of Entrepreneurship. Entrepreneur and small business. Features and types of businesses and entrepreneurs. Sources of business ideas. The role of entrepreneurship in economic development. Terms of entrepreneurship. Innovation and entrepreneurship. Entrepreneurship and small business. The life cycle of a small company. Small business sector in Pakistan. Forms of entrepreneurial organization. Sources of capital. Entrepreneurial process. Entrepreneurial strategies. Starting a new company. Buying an existing business. Franchising. Family business. Entrepreneurial project: an entrepreneurial venture and entrepreneurial development chain. Defining the business concept. Writing a business plan. Basics of Venture Marketing. Fundamentals of entrepreneurial management. Small business enterprises. Business process: product design, operational art, stock management. Technical and technological analysis of entrepreneurial projects. Designing a business investment. Knowledge Economy. Entrepreneur biographies - the actual successes and failures. Business results in SMEs.

References

1. Essentials of Entrepreneurship Second Edition: Changing the World, One Idea at a Time 2nd Edition by Robert A. Baron (Author), Keith M. Hmieleski (Author)
2. Advanced Introduction to Entrepreneurship, 2014, Robert D. Hisrich.

Code	Course Title	Credits	Dept. Category	HEC Classification
NE-404	Basic Nuclear Engineering	3	Advanced Core	Courses from other Depts.

Natural and artificial radioactivity; Radioactive decay; Half life; α , β and γ decay mechanisms; Nuclear Reactions; Fission; Fusion; Role and importance of nuclear energy; Nuclear cross sections; Reaction rates; Nuclear fission and chain Reaction; Reactor Control Requirements; Criticality conditions; Conversion and breeding; Reactor components and their characteristics; Classification and design features of research, production, and power reactors; Introduction to fast and fusion reactor systems. Different Types of nuclear fuel cycles; Front end and back end fuel cycle operations; Fuel burnup; In-core fuel management principles. Radiation units; Radiation sources; Biological effects of radiation; Radiation protection standards; Radiation dose calculations; Radiation shielding; Radiation protection principles; Safety aspects of nuclear power plants.

References

1. J. K. Shultis, D. S. McGregor, R. E. Faw, Fundamentals of Nuclear Science and Engineering, 3/E, CRC Press, 2007.
2. S. Glasstone and A. Sesonske, Nuclear Reactor Engineering, Chapman and Hall, 1994.
3. J. R. Lamarsh Introduction to Nuclear Engineering, 3/E, Prentice Hall, 2001.
4. I. U. Rahman and P.S. Sheih, Introduction to Nuclear Engineering, Krieger Pub. Co., 1981.

Electives

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-307	Computer Graphics	3+1*	Advanced Elective	Major Courses

Introduction to computer graphics, fundamentals of input and display devices, Geometrical Transformations, Homogeneous co-ordinates, Representing Curves and Surfaces, Solid Modelling, 2D transformations, translation, rotation, scaling, shear etc, Clipping, windowing techniques, Modelling hierarchies, 3D transformations, Viewing in 3D, planar projections, 3D curves and surfaces, Perspective viewing, 3D clipping, Geometric algorithms for graphics problems, with applications to ray tracing, hidden surface elimination, etc.

References

1. Hill, F.S. Jr., Kelly, S.M, Computer Graphics using OpenGL, Prentice Hall, 2007
2. Peter Shirley, Michael Ashikhmin, Michael Gleicher, Stephen R. Marschner, Erik Reinhard, Kelvin Sung, William B. Thompson, Peter Willemsen, Fundamentals of Computer Graphics, 2/E, 2005, A K Peters Ltd, 978-1-56881-269-4
3. Foley J.D., van Dam A., Feiner S.K., Hughes J.F., Phillips R.L, Introduction to Computer Graphics, Addison Wesley, 2003,
4. A. Watt, 3D Computer Graphics, Addison Wesley, 2000
5. Foley J.D., van Dam A., Feiner S.K., Hughes J.F., Computer Graphics: Principles and Practice, 2/E, Addison Wesley, 1999
6. James D. Foley, Andries van Dam, Steven K. Feiner, John F. Hughes, Computer Graphics, Principles and Practice, 2/E, Addison- Wesley, 1990.

Cod e	Course Title	Credits	Dept. Category	HEC Classification
CIS-310	Programming in Java	3	Advanced Elective	Major Courses

Introduction to Java, primitive data types and operations, control statements, methods, programming with objects and classes, class inheritance, arrays and vectors, graphics programming, creating user interfaces, applets and advanced graphics.

References

1. Ivon Horton, Beginning Java2, Wrox Press, 2000. ISBN: 81-7366-1545.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-341	Operations Research	3	Advanced Elective	Major Courses

Introduction to Linear Programming, The Simplex Algorithm, Sensitivity Analysis and Duality, Goal Programming, Transportation, Assignment and Transshipment Problems, Game Theory, Queuing Theory.

References

1. Frederick S. Hillier, Gerald J. Lieberman, Introduction to operations research, 2005, McGraw-Hill, ISBN:0073017795
2. P.A. Jensen and J.F. Bard, Operations Research: Models and Methods, John Wiley & Sons, Inc., ISBN 0-471-38004-0
3. Wayne L. Winston, Operations Research: Applications and Algorithms/Book and Disk (Business Statistics), 3/E, 1994, Duxbury Pr, ISBN-10: 0534209718, ISBN-13: 978-0534209711

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-411	Microsoft Windows Programming	3	Advanced Elective	Major Courses

Overview of Windows Programming, Introduction to Resources, Introduction to the API Programming, Programming with Resources and Response Tables, Window Controls Understanding controls and messages, Events, Static controls, List boxes, Check boxes, Edit controls, The Control Message AP1, Working with GDI (Graphics Device Interface) and Metafiles, A Tour of Visual Programming, Writing MDI (Multiple Document Interface) Applications, Using and Creating DLLs (Dynamic Link Libraries), OLE (Object Linking and Embedding) Programming, OLE Automation, DDE (Dynamic Data Exchange) Programming, Threads and Fibres, Memory Mapped File for memory sharing Handling, ActiveX Controls, Container Applications, COM and DCOM Programming, Reliable and Robust Applications.

References

1. Charles Petzold, Programming Windows, 5/E, 1998, Microsoft Press, ISBN: 1-57231-995-X
2. George Shepherd and Scot Wingo, MFC Internals: Inside the Microsoft(c) Foundation Class Architectur3, 1996, Addison-Wesley Professional, ISBN-10: 0201407213, ISBN-13: 978-0201407211

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-413	Multimedia Applications	3	Advanced Elective	Major Courses

Introduction to multimedia, Image file formats, Video formats and coding, Image transforms, Convolution, Filtering, Graphical models, vector graphics, Audio sampling, Compression methods and standards, Media synchronisation, Implementation technologies, Multimedia document authoring

References

1. D. Lowe and W. Hall, Hypermedia and the Web: An Engineering Approach, J. Wiley and Sons, 1999 (ISBN 0-471-98312-8).
2. J.F.K, Buford, Multimedia Systems, ACM Press, 1994 (ISBN 0-201-53258-1).
3. Fluckiger, Understanding Networked Multimedia, Prentice Hall, (ISBN 0-13-190992-4)
4. Boyle, Design for Multimedia Learning, Prentice Hall, (ISBN 0-13-242215-8)
5. P.W. Agnew and A.S. Kellerman, Distributed Multimedia: Technologies, Applications, and Opportunities in the Digital Information Industry (1st Edition) Addison Wesley, 1996 (ISBN 0-201-76536-5)
6. Sloane, Multimedia Communication, McGraw Hill, (ISBN 0-077092228)

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-413	Computer Aided Design and Manufacturing	3	Advanced Elective	Major Courses

Introduction to CAD, CAD hardware, CAD software, Computer aided drafting, Three dimensional modelling, Use of finite elements as CAD tool, Introduction to CAM, Machine tool control, Robotics in CAM, CAD/CAM systems, Expert CAD systems, Benefits and limitations of CAD/CAM systems, Future of CAD/CAM.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-418	Windows OS and COM+	3	Advanced Elective	Major Courses

General Introduction and survey of the field, Microsoft Architecture, Component object model (COM), Implementing COM, Multi Threading, Active Template Library (ATL), Moving from COM to DCOM.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-420	Web Technologies	3	Advanced Elective	Major Courses

ASP Fundamentals, Handling Requests and Responses, Applications and Sessions, Server Process and ASP Sever Object, Scripting Run-Time Library Objects, Active Server Components, Debugging and Error Handling, ADO Basics, Connections, Commands and Procedures, ASP and Data on Client, Components and Web Application Architecture, ASP and Transacted Web Applications, ASP and Message QUEUE Server, Introducing ADSI and Active Directory, ASP and Collaboration Data Object for NT Server, ASP, ADO and Exchange Server, Dynamic HTML, The DHTML Browser Object Model, The DHTML Document Object, Scripts and Event Handling, Manipulating Contents of the Page, Dialogs, Forms and Data Binding.

Code	Course Title	Credits	Dept. Category	HEC Classification
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CIS-421	Special Topics in Computer and Information Sciences	3	Advanced Elective	Major Courses
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This is a course on advanced topics not already covered in the syllabus; the special paper may be conducted as a lecture course or as an independent study course.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-422	Information Storage and Retrieval	3	Advanced Elective	Major Courses

Information Representation methods, Information versus Data Retrieval, Theory of Information Retrieval for both text and picture materials, Information Retrieval Models: Boolean Model, Vector Model Information, Retrieval Probabilistic Model, Fuzzy Set Model etc, Information Retrieval Language, Retrieval Performance, Efficiency and Effectiveness, Information systems in organizations: relationship, impact on planning and design making, data security.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-430	Mobile Communication Systems	3	Advanced Elective	Major Courses

Introduction to Wireless and Mobile Networks, Basics of Wireless and Mobile Systems, Wireless and Mobile Systems Infrastructure, Fundamentals of Cellular Systems, Channel Utilization Schemes, Frequency planning, Frequency re-use. Propagation Modelling: Interference, co-channel and adjacent channel, channel models, shadowing and multi-path interference, Data over the Mobile Link, Security and Privacy, Overview of present cellular networks: GSM, CDMA, WCDMA .

References

1. C. Smith, D. Collins, 3G Wireless Networks, McGraw-Hill, 2007.
2. G. A. Gow, R. K. Smith, Mobile and Wireless Communications: An Introduction, McGraw-Hill 2006.
3. G. L. Stüber, Principles of Mobile Communication, 2nd Edition, Springer, 2001.
4. U. D. Black, Mobile and Wireless Network, Prentice Hall, 1996.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-441	Software Quality	3	Advanced Elective	Major Courses

Software Quality: Overview and Basics, Fundamentals of Measurement Theory, Software Quality Metrics, Statistical Process Control, Applying Basic Quality Tools in Software Development, Quality in Project Management, Software Quality Assurance, Metrics in Database Design, Defect Removal Effectiveness and Techniques, Metrics for Software Testing, Technical Metrics For Software, Metrics for OO Projects.

References

1. S. H. Kan, Metrics and Models in Software Quality Engineering, 2nd Edition, Pearson Education, 2003.
2. R. S. Pressman, Software Engineering: A Practitioner's Approach, 5th Edition, McGraw Hill, 2001.

Code	Course Title	Credits	Dept. Category	HEC Classification
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CIS-553	Data Warehousing	3	Advanced Elective	Major Courses
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DW Fundamentals, Need for a DW, Decision support vs. transaction processing, Evolution of a DW, Business requirements as the driving force for the DW, Matching information to classes of users, Dimensional modeling, Architecture and Infrastructure, Data extraction, Transformation and loading, Data quality, Selected De-normalizations, Horizontal and vertical partitioning, Materialized views, Physical design, Data mart design, Web data warehousing, Current topics in data warehousing.

References

1. P. Ponniah, Data Warehousing Fundamentals, John Wiley & Sons, 2001.
2. R. Kimball, The Data Warehouse Lifecycle Toolkit: Expert Methods for Designing, Developing and Deploying Data Warehouses, John Wiley & Sons, 1998.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-423	Computational Intelligence	3	Advanced Elective	Major Courses

Introduction to Intelligent Systems, Human Intelligence and Computational Intelligence, Neural Networks (Single and Multi-Layer Feedforward Neural Networks, Associative Memories, Learning Vector Quantization, Self Organizing Maps, Applications to Pattern Recognition), Fuzzy Logic (Introduction, Fuzzy Sets, Fuzzy Classifiers), Evolutionary Computation (Introduction To Genetic Algorithms, Models, Operators, Selection Schemes, Application To Optimization), Hybrid Intelligent Systems.

References

1. Konar A., Computational Intelligence: Principles, Techniques and Applications, Springer, 2005.
2. Fausett L., Fundamentals of Neural Networks, Pearson Education, 3rd Ed. 2005.
3. Jang J. S. R., Sun C. T., and Mizutani E., Neuro-Fuzzy and Soft Computing, Pearson Education, 2004.
4. Vose M. D., The Simple Genetic Algorithm, Prentice Hall, 1999.
5. Pedrycz W., Computational Intelligence: An Introduction, CRC Press Inc., 1997.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-424	Formal Specification Methods in Software Development	3	Advanced Elective	Major Courses

Introduction to Formal Specification Approaches, First Order Logic, Substitution, Elimination, Satisfactions, Validity, Extensions, Modeling with Relations and Functions, Lambda Notation, Overriding, Modeling with Sequences and Bags, Structural Induction, The one-point rule, Uniqueness, Proof by Induction, Primitive Induction, Consistency, Generic abbreviations, Axiomatic definitions, Schema, Renaming, Schemas Operators, The Elements of Formal Model, Constructors, Record Types, Distributed Operators, Functional Refinement, Abstraction, Recursion, Modeling with Mappings, Validation and Verification Techniques, Internal Consistency, Completeness, Visualization, Systematic Testing, Defining Relationships between Z and VDM.

References

1. Fitzgerald J., Larsen P. G., Mukherjee P., Plat N., and Verhoef M., Validated Designs for Object-oriented Systems, Springer Verlag, New York, 2005.
2. Smith G., The Object-Z Specification Language, Advances in Formal Methods, Kluwer Academic Publishers, 2000.

3. Fitzgerald J., and Larsen P. G., *Modeling Systems: Practice Tools and Techniques in Software Development*, Cambridge University Press, 1998.
4. Diller A., Z: *Introduction to Formal Methods*, 2/E, John Wiley & Sons, 1994.

Code	Course Title	Credits	HEC Classification
CIS-xxx	Mobile Application Development	2+1*	University Elective
Introduction, about mobile applications, mobile devices, platforms, mobile devices operating systems. Mobile app design and issues, frame works and tools (Android SDK, eclipse), types of mobile apps. Making your first app. Android navigation and interface design (layouts and intents). File and database handing, displaying information (list and adapters), handling maps and locations (location sensors, maps and fragments), accessing hardware and sensors. Web applications over mobile devices, developing smart applications. Testing and debugging mobile apps, introduction to iOS app development. Business issues, publishing mobile apps. References The course cannot be taught from one or two text books. The course requires use of SDKs and API documentation, Books for Java and android. Following are some recommended books. 1. Gargenta, Marko, and Masumi Nakamura. <i>Learning Android</i>. O'reilly, 2014. 2. McWherter, Jeff, and Scott Gowell. <i>Professional mobile application development</i>. John Wiley & Sons, 2012 3. Schwarz, Ronan. <i>The Android developer's cookbook</i>. Pearson Education, 2013.			

Code	Course Title	Credits	Dept. Category
CIS-xxx	Human Computer Interaction	3	Advanced Elective
The Human, Computer and Interaction, Usability paradigm and principles, Introduction to design basics, HCI in software process, Design rules, prototyping, evaluation techniques, task analysis, Universal design and User support and Computer Supported Cooperative Work; Introduction to specialized topics such as Groupware, pervasive and ubiquitous applications References 1. Dix, Alan. <i>Human-Computer Interaction</i>. Pearson Prentice-Hall, 2011 2. Shneiderman, Ben. <i>Designing the User Interface: Strategies for Effective Human-Computer Interaction</i>. Pearson Addison Wesley, 2014.			

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-425	Introduction to Mobile Robots	3+1*	Advanced Elective	Major Courses

Introduction and applications of robots, Robot architectures, Mechanics & locomotion, Sensors and their types, Sensor data fusion, Robot vision and perception in mobile robotics, Robot localization, Different localization techniques, Robot control, Navigation, Path planning methods, Obstacle avoidance techniques, Introduction to multi agent systems, Human robot interaction.

References

1. Roland Siegwart and Illah R. Nourbakhsh, Introduction to Autonomous Mobile Robots. MIT Press, 2004.
2. Saeed B. Niku, Introduction to Robotics, Analysis, Systems, Applications, Prentice Hall, 2001.
3. Robin R. Murphy, Introduction to AI Robots. MIT Press, 2000.

Code	Course Title	Credits	Dept. Category	HEC Classification
CIS-426	Introduction to Parallel Algorithms	3	Advanced Elective	Major Courses

Principals of parallel algorithms, Analysis of computation, communication and synchronization, Introductory Dense/sparse matrix algorithms, Sorting algorithms, Graph algorithms, Search and Optimization algorithms, Iterative methods for linear systems, Introduction to Parallel numerical libraries

References

1. Wilkinson B., Michael A., "Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers ", 2nd ed., Prentice Hall, 2003.
2. Foster I., "Designing and Building Parallel Programs", Addison-Wesley, 1995.
3. Grama A., Gupta A., Karypis G., and Kumar V., "Introduction to Parallel Computing", 2nd ed., Addison-Wesley, 2003.
4. Roosta S. H., Parallel Processing and Parallel Algorithms: Theory and Computation, Springer-verlag, 2000.