Texas Higher Education Coordinating Board

Making Opportunity Affordable in Texas:

A Student-Centered Approach

Tuning of Computer Information Systems and Sciences

Texas Higher Education Coordinating Board

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Tuning Oversight Council for Mathematics, Business, and Information Systems

Computer Information System Committee

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Definition of Tuning

"Tuning" is a faculty-led pilot project designed to define what students should know, understand, and be able to demonstrate after completing a degree in a specific field, and to provide an indication of the knowledge, skills, and abilities students should achieve prior to graduation at different levels along the educational pipeline – in other words, a body of knowledge and skills for an academic discipline in terms of outcomes and levels of achievement of its graduates.

Tuning provides an expected level of competency achievement at each step along the process of becoming a professional: expectations at the beginning of pre-professional study, at the beginning of professional study, and at the transition to practice. It involves seeking input from students, recent graduates, and employers to establish criterion-referenced learning outcomes and competencies by degree level and subject area. Through Tuning, students have a clear "picture" of what is expected and can efficiently plan their educational experience to achieve those expectations. The objective is not to standardize programs offered by different institutions, but to better establish the quality and relevance of degrees in various academic disciplines.

An overview of Lumina Foundation for Education's "Tuning USA" Initiative is available at: http://www.tuningusa.org/; an overview of Tuning work to date in Texas is available at: http://www.thecb.state.tx.us/tuningtexas.

Definition of Computer Information Systems and Sciences

A Computer Information Systems and Sciences (CIS) degree program is a broad-based study of computer and information sciences with a focus on the development and application of systems and technology to support organizations. The program is designed such that students gain competence in both information technology and business practices and processes, preparing them for careers in areas such as application and web development, database and information management, systems integration, and support. The curriculum teaches students to analyze, design, and implement solutions to information technology problems by focusing on the fundamentals of system analysis and design as well as problem-solving strategies. Courses of study typically include programming, web and mobile development, database systems, IT infrastructure, systems analysis and design, and enterprise architecture; additionally, depending on the institution and department offering the degree, it may include project management as well as core business courses.

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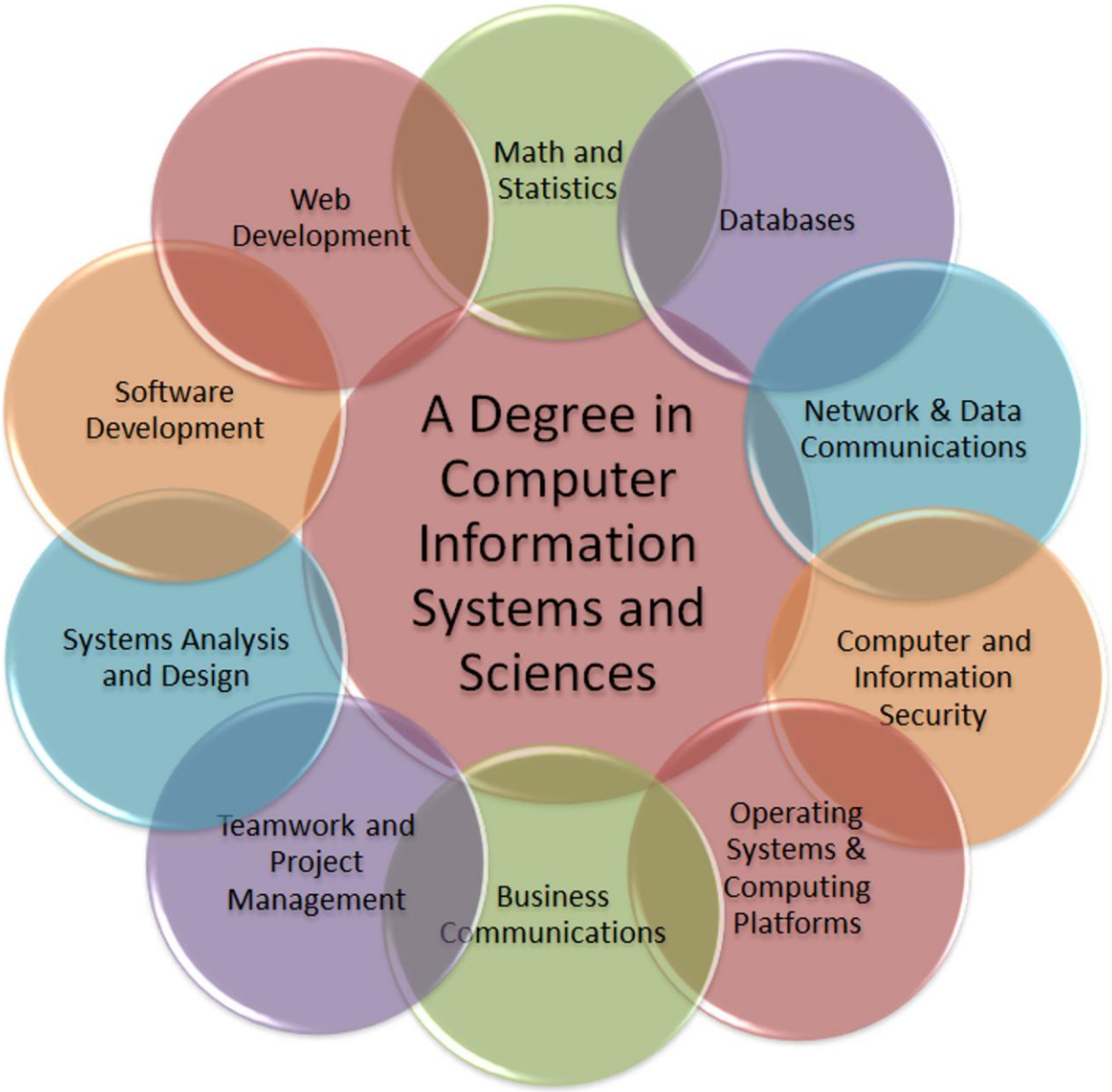
Computer Information Systems and Sciences Expertise Profile

The expertise profile lists types of course topics included in typical baccalaureate degrees in Computer Information Systems and Sciences (CIS). Note: General undergraduate degree requirements (e.g., the core curriculum) are not considered for the purpose of tuning Computer Information Systems and Sciences and this report.



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Computer Information Systems and Sciences Employment Profile

The employment profile lists the employment pathways available for graduates of Computer Information Systems and Sciences (CIS) programs. CIS employment opportunities are listed by industry.

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The Spectrum of Business-Related Computing Degrees

There are a variety of degrees offered in the area of computing which cover diverse areas of study. On one end of the spectrum is Business Management, where the focus is on business modeling and processes. On the other end is Computer Engineering, which focuses on hardware and system software engineering. In between those disciplines are the fields of Computer Science, Computer Information Systems and Sciences, and Management Information Systems. These fields of study are served by a spectrum of degrees, which have variable emphases on either technology or business competencies. See page 8 for a tabulation of the fields and their degrees. See also Appendix A, by Dr. Wierschem, Texas State University-San Marcos: "*Technology Degrees: What's the Difference*?" for a discussion of the fields' characteristics.

The study of Computer Information Systems and Sciences involves a significant software component; however, the CIS major will study both business and technical aspects of information systems. The study of CIS provides the knowledge required for the design and implementation of all aspects of an organization's information system.

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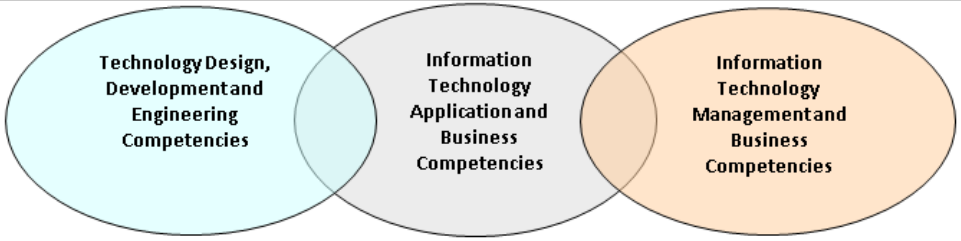
The Spectrum of Business Related Computing Degrees

CE (BS)	CS (BS)	CIS (BS or BBA)	MIS (BBA)	Management (BBA)
Computer Engineering	Computer Science	Computer Information Systems	Management Information Systems	Business Management
Typically, business courses are not required.	Business courses may be required.	Technology courses are dominant over business courses.	Business courses are dominant over technology courses.	Entirely business courses.
Concerned with the creation of new hardware and systems, software designs, and tools resulting in new technologies that may be applied throughout the information technology spectrum.	Concerned with the creation of software technologies and tools that may be applied in many different problem domains, both commonplace and specialized.	Concerned with the synthesis and application of information technologies that improve business processes in the functional areas.	Concerned with analysis of organizational information, technology needs, and the management of technology in the business functional areas.	Concerned with the business functional areas: accounting, finance, marketing, management, etc.
Emphasis is on computer hardware and system software engineering.	Emphasis is on software engineering.	Emphasis is on developing solutions that serve business interests.	Emphasis is on the business value of data made available through the application of information technology.	Emphasis is on business data collection, analysis, synthesis, and modeling.



CIS programs may be part of an institution's School of Business, School of Arts and Sciences, School of Technology, or School of Engineering. Many times, Business Management and Management Information Systems degrees are in the School of Business and CIS and CS are located in other schools, but there are exceptions.

Programs may or may not be accredited. Business Management, Management Information Systems, and Computer Information Systems programs could be accredited by AACSB or ACBSP. Computer Science and Computer Information Systems programs could be accredited by ABET. However, overlap exists in which agency may be used for MIS and CIS program accreditation.

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Computer Information Systems and Sciences Key Competencies Profile

The key competencies profile is a schematic diagram that is derived from the competency table. It illustrates, for each learning outcome (columns), the required competency levels according to Bloom's taxonomy (rows) that should be gained at each of four educational levels:

1. secondary education competencies, marked "HS";
2. lower-division competencies, marked "CC";
3. baccalaureate-level competencies, marked "BS"; and,
4. graduatelevel competencies, marked "G."

The level of response for each of Bloom's taxonomy levels is described through active verbs; examples of verbs for each level can be found at:

http://www.teach-nology.com/worksheets/time_savers/bloom/

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Computer Information Systems and Sciences Key Competencies Diagram

	Software Development	Web Development	Math Computations and Statistics	Databases	Network and Data Communications	System Analysis and Design	Operating Systems	Computer and Information Security	Project Management	Team Work	Business Communication	Professional Practices	Application Environments and Business Core
Evaluation	G	G	G	G	G	G	G	G	G	G	G	G	G
Synthesis	BS	BS	BS	BS	BS	BS	G	BS	BS	BS	BS	BS	BS
Analysis	BS	BS	BS	BS	BS	BS	BS	BS	BS	BS	BS	BS	BS
Application	CC	BS	CC	BS	BS	BS	BS	BS	BS	BS	CC	CC	CC
Comprehension	CC	CC	CC	CC	BS	CC	CC	CC	BS	CC	CC	CC	CC
Knowledge	HS	HS	HS	HS	CC	HS	CC	CC	CC	HS	HS	CC	CC

G	graduate-level competencies
BS	baccalaureate-level competencies
CC	lower-division competencies
HS	secondary education competencies

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Computer Information Systems and Sciences Key Competency Tables and Learning Outcome Descriptions

The Computer Information System and Sciences (CIS) competency table has 13 learning outcome titles, with a learning outcome description for each:

1. Software Development
2. Web Development
3. Math Computations and Statistics
4. Databases
5. Network and Data Communications
6. System Analysis and Design
7. Operating Systems
8. Computer and Information Security
9. Project Management
10. Teamwork
11. Business Communication
12. Professional Practices
13. Application Environments and Business Core

The competency table has four learning outcome categories (columns from left to right):

1. core competencies needed to enter higher education in Computer Information Systems and Sciences (HS);
2. lower-division competencies gained during first two years of study (CC);
3. baccalaureate-level CIS competencies (BS); and,
4. graduate-level CIS competencies (G).

Learning outcome descriptions for each of the outcome titles of the competency table explain the foundational knowledge, skills, and attitudes that should be achieved by the graduates. Institutions may add further learning outcomes according to the mission and goals of the department and the students.

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Software Development

Software Development is the process of creating computer programs to handle specific tasks. It involves designing, writing, testing, and maintaining program source code. Usually, software development involves a set of related programs that address a specific application.

Lower-division work focuses on learning the basic concepts of programming and the ability to develop simple programs that demonstrate the application of fundamental programming constructs and data types. Additional lower-division work focuses on building the level of competence in the fundamental concepts.

Upper-division students develop more complex programs and suites of programs which require increasing amounts of analysis and design work, such as collecting and understanding user requirements. Implementation of solutions will likely involve small development teams.

Students will be competent at reading and writing in multiple programming languages. Students will be able to design and analyze algorithms, select appropriate paradigms, and utilize modern development and testing tools. This competency provides a foundation for other competencies such as programming languages, algorithms and complexity, and software engineering.

(Derived from ACM/IEEE-CS Computer Science Curricula 2013, p.138)

SOFTWARE DEVELOPMENT			
Core Competencies Needed to Enter Higher Education in CIS	**Lower-Division CIS Competencies Gained During First Two Years of Study**	**Baccalaureate-Level CIS Competencies**	**Post-Graduate/ Work Experience CIS Competencies**
Knowledge	**Comprehension Application**	**Analysis Synthesis**	**Evaluation**
Understand and apply fundamentals of logic to problem solving.	Describe how data is represented, manipulated, and stored in a computer. Demonstrate the ability to create, modify, code, and test programs that use fundamental concepts such as: basic computation, simple file I/O processing, typical conditional and iterative structures, definition of functions, array processing, searching and sorting, classes, inheritance, and interfaces. Construct, execute, and debug programs using contemporary integrated software (visual) development environments. Understand programming methodologies, including object-oriented, structured, and procedural programming. Describe the phases of program translation from source code to executable code. [Adapted from ACGM.]	Analyze user needs and develop programs using the appropriate language(s) and concepts of structure and object-oriented design methodologies. Design algorithms to utilize system resources efficiently. Combine tools and techniques. Develop a minimal set of software development documents as a team member. Apply consistent documentation and program-style standards that contribute to code readability and maintainability. Contribute to a small-team code review. Assess the need to build custom software or configure an existing software package.	Compare currently available programming languages, software development methodologies, and development environments, and select and use those appropriate for a particular project. Evaluate code for reusability and library development. Assess configuration versus customization impacts when working with third party software packages.

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Web Development

Web development refers to building, creating, and maintaining websites, including all aspects such as web design, web publishing, web programming, and database management. In addition, a web developer needs to maintain currency in skills that allow for programming, design, and database access to enhance the customer's experience of the web.

Upon completion of the Bachelor's degree, the student will be able to design webpages according to an organization's standards and best practices to meet the needs and expectations of the users of the website. Students will be skilled in design and typographic principles enabling them to design creative web pages that maximize color, type, and contrast to develop attractive webpages. Students will demonstrate competency in current technologies for web design and programming.

WEB DEVELOPMENT			
Core Competencies Needed to Enter Higher Education in CIS	**Lower-Division CIS Competencies Gained During First Two Years of Study**	**Baccalaureate-Level CIS Competencies**	**Post-Graduate/ Work Experience CIS Competencies**
Knowledge	**Comprehension**	**Application Analysis Synthesis**	**Evaluation**
Identify how the internet functions with specific attention to the world wide web and identify basic structural and functional aspects of files, file systems, and interconnectivity between devices.	Implement a basic connection between a database and a website or web application.	Build webpages with dynamic capabilities. Apply design techniques in the creation and optimization of graphics and other embedded elements. Create sites using World Wide Web Consortium formatting and layout standards. Integrate multiple components to create a web-based application, including internet protocols, web server controls, authentication of users, SQL data sources, and website management. Utilize design strategies to increase the success of locating the site via search engines and meet the needs of clients.	Design, create, evaluate, and maintain an enterprise website. Assess effectiveness of web content delivery and recommend technical and design improvements.

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Math Computations and Statistics

Mathematics deals with the science of structure, order, and relation that has evolved from counting, measuring, and describing the shapes of objects. It uses logical reasoning and quantitative calculation, and is considered the underlying language of science. The principal branches of mathematics relevant to Computer Information Sciences are algebra, analysis, arithmetic, applied calculus, linear programming, computing theory, probability, set theory, and statistics.

The knowledge and problem-solving tools derived from the study of mathematics enables the Computer Information Systems and Sciences graduate to provide logical, efficient, and precise technical solutions to complex problems for organizations.

MATH COMPUTATIONS AND STATISTICS			
Core Competencies Needed to Enter Higher Education in CIS	**Lower-Division CIS Competencies Gained During First Two Years of Study**	**Baccalaureate-Level CIS Competencies**	**Post-Graduate/ Work Experience CIS Competencies**
Knowledge	**Comprehension Application**	**Analysis Synthesis**	**Evaluation**
Translate and evaluate algebraic expressions. Solve science and technology problems using algebra.	Use data collection and statistics as tools to reach reasonable conclusions. Compute or solve theoretical probabilities, confidence intervals, linear regressions, and correlation problems. Apply logical and mathematical concepts to computing, including proofs, set theory, matrix theory, and Boolean algebra. Apply calculus of algebraic, trigonometric, exponential, and logarithmic functions.	Formulate and design solutions to technical, business, and economic problems applying the theories of finite math, applied calculus, discrete math, analysis, and probability and statistics.	Model and evaluate information systems utilizing appropriate mathematical and statistical techniques.

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Databases

A database is a major component in an information system providing business applications a means for efficient storage and retrieval of information. Database management and administration encompasses the design, development, operations, and management of information as well as the implementation of policies to ensure information availability, integrity, and security.

CIS graduates will coordinate with various units within an organization to determine the most effective means to represent their data for efficient information retrieval. To do so, they must understand how business processes and procedures relate to database systems. They will use their logical skills to design and create databases using relational and other data models. The demand for database professionals will continue as data analytics play a larger role in business strategies and decision making.

DATABASES			
Core Competencies Needed to Enter Higher Education in CIS	**Lower-Division CIS Competencies Gained During First Two Years of Study**	**Baccalaureate-Level CIS Competencies**	**Post-Graduate/ Work Experience CIS Competencies**
Knowledge	**Comprehension**	**Application Analysis Synthesis**	**Evaluation**
Identify sentence structure. Identify and describe various problem-solving methodologies. Identify sets, unions, and intersection.	Describe various data entry and storage applications on the web or productivity software. Define database management systems and explain how they relate to other areas of information systems. Demonstrate the ability to use a database management system by creating and modifying tables and using queries to create reports.	Analyze organizational requirements and create logical and physical database models. Design and implement databases using relational theory and/or other data structures to ensure system scalability, security, data integrity, performance, and reliability. Maintain data integrity while migrating data into the database. Develop and implement complex queries for business analysis and decision making. Differentiate roles of database administrator versus data analyst. Understand the differences between a database and a data warehouse in relation to their application to business intelligence, data analytics, and data mining.	Compare and contrast new advances in database models and languages and apply them in the enterprise. Integrate distribution strategies, concurrency mechanisms, query optimization techniques, recovery, and security procedures in database design. Evaluate data warehousing and mining processes to centralize data and data-mining software and other tools to support business intelligence and data analytics.

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Network and Data Communications

Networking and Data Communication is the study of the components and processes comprising computer network infrastructures and the movement of data through the networks from one endpoint to another. The implementation details and capabilities of networks are changing rapidly. Consequently, the study of networking must be considered a starting point for a career-long learning process.

Graduates in CIS will need to possess the knowledge of networking principles. In most cases, one of the chief resources of an organization is its computer network, and its efficient and reliable operation is a prerequisite to supporting the business. It is a resource that must be understood, utilized, and maintained. In situations where the IT staff develop client-server or other networked applications, an even more in-depth knowledge of networks and data communications is required to allow the benefits of wired and wireless networking to contribute to the profitability and efficiency of the organization.

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NETWORK AND DATA COMMUNICATIONS			
Core Competencies Needed to Enter Higher Education in CIS	**Lower- Division CIS Competencies Gained During First Two Years of Study**	**Baccalaureate-Level CIS Competencies**	**Post-Graduate/ Work Experience CIS Competencies**
None	**Knowledge**	**Comprehension Application, Analysis Synthesis**	**Evaluation**
Intentionally left blank	List and define appropriate networking terminology. Describe data communication and networking models, protocols, topologies, standards, and applications. Articulate the organization of the Internet. Explain how different types of IT applications depend on the Internet.	Describe the layered structure of typical network architecture. Describe the operation of the TCP/IP protocols. Explain the operation of local area networks and their constituent components. Describe different methods of network resource allocation. List factors that affect network performance. Explain the principles of cellular and wireless networks. Describe cloud and/or distributed computing infrastructure. Describe methods of implementing networked mass storage systems. Design and implement a networked application or function. Configure a network to deploy a potential information system. Understand security implications for the development and use of networks.	Plan a new enterprise network with respect to transmission media, configuration, network appliances, etc. Analyze and resolve complex networking and data communication infrastructure for interoperability, scalability, speed, cost, security, performance, or reliability issues. Design a networking infrastructure for a given organization according to its needs. Develop and implement a backup and disaster recovery plan. Evaluate the suitability of an existing network for deploying a potential information system.

System Analysis and Design

Systems Analysis and Design is an interdisciplinary part of science that describes the process or methodology for creating new systems or modifying existing systems in response to changes in business requirements. Analysts consider the organization's mission as well as internal and external factors to identify solutions to business problems and opportunities for organizational growth. Analysts also respond to directives coming either from management, government, or other organizations.

Students may be involved with design projects in conjunction with local business entities or with case studies as a capstone project. They would apply techniques learned in class to real-world issues through, for example, a team project.

The knowledge and problem-solving tools derived from the study of Systems Analysis and Design enables the Computer Information Systems and Sciences graduate to collaborate effectively with clients, users, and project leaders professionally and ethically to support the development, operation, and maintenance of an organization's system.

SYSTEM ANALYSIS AND DESIGN			
Core Competencies Needed to Enter Higher Education in CIS	**Lower-Division CIS Competencies Gained During First Two Years of Study**	**Baccalaureate-Level CIS Competencies**	**Post-Graduate/ Work Experience CIS Competencies**
Knowledge	**Comprehension**	**Application Analysis Synthesis**	**Evaluation**
Identify and apply fundamentals of logic to problem solving. Collect and structure information recognizing that components can be combined to make a whole. Recognize that a problem may have multiple solutions by listing pros and cons for each alternative.	Demonstrate the ability to use computer systems by creating and modifying programs, by identifying hardware and software components, and discussing internet technologies. Explain general systems theory, primarily by breaking down a system or process into its individual components, so that each component can be analyzed as an independent entity, and the components can be added to describe the totality of the system.	Demonstrate use of design and development tools and industry-relevant methodologies throughout the analysis/design cycle. Analyze and document requirements and work with users to categorize and prioritize requirements in order to present alternatives. Analyze organizational systems in order to determine how current systems might be improved. Develop a logical design involving various implementation approaches. Determine risk, feasibility, and performance when presenting systems alternatives. Implement and document a physical system that is scalable, secure, and reliable.	Evaluate customer satisfaction at all phases of a system's development life cycle. Assess software development and project controls through application of quality metrics and recommend process improvements. Incorporate new methodologies, tools, and industry best practices. Mentor and coach new hires on organizational best practices regarding system analysis and design.

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Operating Systems

An Operating System (OS) is a specialized collection of programs that collectively serve as an intermediary between the hardware architecture and the user applications. The OS facilitates the efficient allocation of hardware resources to the user applications and allows the user applications to request specialized services and gain access to the underlying hardware.

Students must have a working knowledge especially of the user side of the OS-to-user interface (the API) to successfully implement application programs. While application developers may not deal directly with the hardware-to-OS side of the system, some knowledge of the interaction is still required to develop efficient applications.

The topic of Operating Systems may not be covered in a required course for a CIS program, but may be covered in an elective course or in other places. The level of knowledge needed is appropriate for a good application developer, but not for a person who maintains an operating system.

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OPERATING SYSTEMS			
Core Competencies Needed to Enter Higher Education in CIS	**Lower-Division CIS Competencies Gained During First Two Years of Study**	**Baccalaureate-Level CIS Competencies**	**Post-Graduate/ Work Experience CIS Competencies**
None	**Knowledge Comprehension**	**Application Analysis**	**Synthesis Evaluation**
Intentionally left blank	Identify the types of systems software. Describe the functions of a contemporary operating systems. Explain the purpose of utilities included with most operating systems. Demonstrate an understanding of the concepts of computer hardware architectures. Explain hierarchy of computer memory. Explain the concept of virtual memory and how it is realized in hardware and software. Explain the concepts of operating system virtualization. Demonstrate an understanding of the concepts of computer hardware architectures.	Discuss networked, client-server, and other distributed operating systems and tell how they differ from single-user operating systems. Explain the purpose of application program interfaces (APIs) and middleware. Explain how computing resources are used by application software and managed by system software. Compare the functions of operating systems with respect to convenience, efficiency, and the ability to evolve. Discuss ways that operating systems can help administrators control a network and administer security. Explore the effect of operating systems patches to ensure system reliability and security. Apply virtualization tools to run multiple, simultaneous operating systems for testing, development, and/or production systems.	Implement changes to an enterprise computing environment necessitated by changes to operating systems or improvements to hardware. Collect and analyze performance measurements and use the results to improve system performance. Configure virtualization tools in testing and development environments.

Computer and Information Security

Security ensures the confidentiality, integrity, and availability of paper and electronically stored data. The risk of disclosure or loss of data is even more critical as companies, governments, and individuals move their information and computing services to third parties and/or the cloud. An increased national commitment to computer security requires education and training for people in the field, as well as education for the public.

Security measures enable authorized users to accomplish their tasks while protecting the computer applications, networks, and stored data from misuse, disclosure, destruction, modification, or disruption. While one must preserve privacy and security through implementation of best practices, security is much more encompassing. Security must also be addressed when analyzing, designing, modifying, implementing, and using computer systems. Computing security involves keeping networked and other critical computer systems secure, protected against anticipated threats, monitored for possible threats and intrusions (from within and without), physically protected, and access-controlled. There must be both individual and corporate accountability for security and analysis of failures.

COMPUTER AND INFORMATION SECURITY			
Core Competencies Needed to Enter Higher Education in CIS	**Lower-Division CIS Competencies Gained During First Two Years of Study**	**Baccalaureate-Level CIS Competencies**	**Post-Graduate/ Work Experience CIS Competencies**
None	**Knowledge Comprehension**	**Application Analysis Synthesis**	**Evaluation**
Intentionally left blank	Describe chronology of communications systems and development. Define terms and functions performed in the automation of Information Systems. List and describe elements of an AIS as well as the relationship among AIS components (hardware, software, firmware components). Understand the principles of computer security together with the ethical, legal, and compliance implications.	Safeguard data by ensuring individuals development of secure software that prevents security issues, such as buffer overflows. Identify proper software tests that should be used in developing systems. Examine the National Information Assurance Training Standard for Senior Systems Managers. Describe methods of computer security management. Explain elements of cyber law and its relationship to computer security. Describe components of security as they relate to national policy, threats, vulnerabilities, countermeasures, risk-management, systems lifecycle management, trust, modes of operation, roles of organizational units, and facets of NSTISS. Identify and analyze the risk related to new and/or emerging security threats caused by emerging technologies, such as for cloud and mobile environments.	Develop, implement, and assess a security policy for a networked information system. Develop and evaluate an enterprise-wide security program, and provide training on employee roles and expectations on information security expectations. Manage security-related systems administration functions. Identify and analyze the risk related to new and/or emerging security threats caused by emerging technologies.

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Project Management

Project management involves defining project standards, targets, benchmarks, and performance measures. Successful project management ensures delivering projects on time and within the set budget using an automated scheduling tool. Projects require an effective plan for controlling and tracking the project's scope, cost, schedule, communication, and risk-management.

Project Managers must be prepared to work with a variety of project management tools and software development methodologies to utilize the appropriate tools for any given project. Project Managers within an IT department will develop detailed project schedules, estimates, and resource plans to achieve project objectives. Project managers must have effective communication skills to negotiate and mediate any issues that may potentially put the project at risk. Communication also involves reporting of project changes, status updates, and financial reporting to stakeholders and project members. Evaluation may be conducted at the conclusion of a project to determine if improved processes need to be implemented for a project environment.

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PROJECT MANAGEMENT			
Core Competencies Needed to Enter Higher Education in CIS	**Lower-Division CIS Competencies Gained During First Two Years of Study**	**Baccalaureate-Level CIS Competencies**	**Post-Graduate/Work Experience CIS Competencies**
None	**Knowledge**	**Comprehension, Application, Analysis, and Synthesis**	**Evaluation**
Intentionally left blank	Recognize the functions of planning and tracking projects. Explain factors of project success and project failure.	Develop skills in formulating, planning, and tracking of projects using an automated scheduling tool utilizing multiple estimating techniques and understanding Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM) theory. Conduct a basic cost benefit analysis that covers the total cost of ownership for the project and its outcomes. Formulate clear and concise, measurable Project Objective(s). Develop a Work Breakdown Structure that considers all of the applicable project requirements as defined by the project's scope by applying the appropriate Project Control activities necessary to keep a project on task. Identify project risk factors and the mitigation actions that will reduce these possible risks and their potential impact. Develop an initial project plan and all of its components as dictated by the project's size and complexity.	Evaluate and implement a continuous improvement of teams. Integrate processes and tools used in positioning, planning, developing, and implementing project teams across organizational boundaries. Effectively estimate a project's effort and associated costs and translate this into a project budget. Justify the proposed project to key stakeholders. Facilitate a project's resources and allocate the appropriate resources to tasks. Monitor actual progress and calculate true Earned Value (EV). Revise schedule changes and constraints throughout the project's life cycle while managing the project's critical path. Appraise and prioritize appropriate risk-management processes, assess risk probability and its potential impact.

Teamwork

Teamwork is the process of working in partnership and cooperation with others to achieve a common goal. Team members bring individual skills, traits, and personalities to a team, providing unique knowledge and diverse backgrounds to the table. The collective efforts of the members and their ability to come to consensus, respecting differing viewpoints, determine the effectiveness and efficiency in teamwork.

Teamwork is essential in many aspects of business and information technology. A cohesive and cooperative team can facilitate innovative ideas, decisions, and solutions within an institution. A team may utilize individual skillsets and bodies of knowledge to accomplish goals faster using a "divide and conquer" methodology.

TEAMWORK			
Core Competencies Needed to Enter Higher Education in CIS	**Lower-Division CIS Competencies Gained During First Two Years of Study**	**Baccalaureate-Level CIS Competencies**	**Post-Graduate/ Work Experience CIS Competencies**
Knowledge	**Comprehension**	**Application Analysis Synthesis**	**Evaluation**
Be exposed to teamwork and paired activities.	Recognize roles embedded within teams and their values. Identify and discuss functions of leadership. Identify and discuss basic forms of motivation. Demonstrate the ability to learn and problem-solve in a team environment.	Align team goals with business objectives. Demonstrate the ability to deal with conflict in teams. Conduct team meetings by utilizing effective time management. Effectively identify and document roles and responsibilities of team members. Recognize how different personalities influence the team environment positively or negatively. Evaluate the extent of cooperation within team projects.	Use project team assessment and evaluation techniques and tools to improve team performance. Effectively communicate within a group to achieve consensus by using collaborative tools. Use best practices in contracting and engaging team members as well as project team sponsors and stakeholders.

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Business Communication

Business Communication is the sharing of information within an organization. Businesses may use communication between a business and employees, or interdepartmentally as needed to promote relationships internally as well as externally to build relationships with other businesses and the public.

It is essential for CIS professionals to be able to communicate effectively with their peers, project team members, management, and customers. Written, oral, and visual communications must be competently applied.

BUSINESS COMMUNICATION			
Core Competencies Needed to Enter Higher Education in CIS	**Lower-Division CIS Competencies Gained During First Two Years of Study**	**Baccalaureate-Level CIS Competencies**	**Post-Graduate/ Work Experience CIS Competencies**
Knowledge	**Comprehension Application**	**Analysis Synthesis**	**Evaluation**
Utilize word processing, presentation, and email software to communicate. Write with proper sentence structure, grammar, and composition. Compose text by means of outline, logic structure, and through use of typical essay components.	Demonstrate communication competence and critical thinking through an understanding of the foundational communication models. Demonstrate the principles of appropriate and effective public speaking skills in professional presentations by effective use of software and design. Demonstrate written and oral competencies as they relate to employment and business communication. Utilize various technologies as they relate to competent communication. Demonstrate effective cross-cultural communication. Distinguish ideas by others separately from original thought. Apply appropriate formatting in citing sourced references.	Report on a project's status using appropriate content and detail for different levels within the organization. Implement critical thinking components, appropriate technologies, and professional practices in delivery of oral, written, virtual, and graphical communication.	Evaluate both technical and business issues within an organization and use appropriate communication to achieve organizational objectives.

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Professional Practices

CIS students must have a broad understanding of technical, organizational, legal, and ethical issues and how these issues may affect their immediate work and their careers. Students should understand how technology impacts society in many aspects, and should be aware of the ethical questions that exist in the field.

Upon entering the workforce, students must be able to understand the impact of technology and the consequences of unethical behavior. Learning at the baccalaureate level should prepare students to recognize these potential problems and provide a framework for students to model their actions. Emphasis on codes of conduct from professional organizations, such as ACM or IEEE, encourages students to conduct themselves according to ethical standards in the industry. An emphasis on lifelong learning provides guidance to students on how to remain current in a field that changes quickly and its importance to the student's performance and career.

PROFESSIONAL PRACTICES			
Core Competencies Needed to Enter Higher Education in CIS	**Lower-Division CIS Competencies Gained During First Two Years of Study**	**Baccalaureate-Level CIS Competencies**	**Post-Graduate/ Work Experience CIS Competencies**
None	**Knowledge Comprehension Application**	**Analysis Synthesis**	**Evaluation**
Intentionally left blank	Identify academic and professional codes of ethics in CIS and describe the societal impact of computers and technology. Explain the impact of continuous education on longevity, productivity, and career trajectories. Recognize the ethical implications involving current events and technology.	Analyze case studies in ethical issues and societal issues to provide possible solutions. Explain the necessity of lifelong learning within the profession. Explain the implication of complying with federal and state regulations regarding professional practices. Compare various organizations involved in international professional practices standards, such as ISSO and International Professional Practice Partnership.	Self-assess behavior when confronting ethical dilemmas in professional work. Practice lifelong learning as a professional and ethical responsibility to ensure competence and protect public welfare. Analyze and implement new regulations in order to comply.

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Application Environments and Business Core

Computer Information Systems and Sciences' primary purpose is to assist an organization in the attainment of stated goals/objectives. It is imperative that the CIS major understand the fundamentals of that organization.

Typically, the application environment is a business or non-profit organization; therefore, a CIS major in this environment must understand the basic fundamentals of business. However, educational institutions may include their own specialized application environment to teach its students based on businesses within the local area[1]. This could include a variety of environments, such as bioinformatics, manufacturing, law, education, entertainment, or health care. The application environment may apply to where the Computer Information Systems and Sciences program is housed (Business, Technology, Engineering, Arts and Sciences). Business and application environments will complement the Computer Information Systems and Sciences body of knowledge.

APPLICATION ENVIRONMENTS AND BUSINESS CORE			
Core Competencies Needed to Enter Higher Education in CIS	**Lower-Division CIS Competencies Gained During First Two Years of Study**	**Baccalaureate-Level CIS Competencies**	**Post-Graduate/ Work Experience CIS Competencies**
None	**Knowledge Comprehension Application**	**Analysis Synthesis**	**Evaluation**
Intentionally left blank	Demonstrate an understanding of economic systems and concepts related to economic theories. Apply economic concepts to the evolving global economy, especially in the areas of international trade, labor markets, and distribution of income. Demonstrate an understanding of generally accepted accounting principles and their impact on financial and managerial reports. Demonstrate an understanding of basic concepts within the application environment.	Illustrate contemporary organizational concepts, principles, and practices that explain how organizations are formed and operated. Analyze how interpersonal issues, such as conflict, change, and leadership may be applied to management concepts. Relate concepts within the application environment to current processes and technologies.	Recommend continuous improvement plans that implement innovative solutions to address the unique management or organizational issues within IT. Evaluate current practices within the application environment.

[1]ABET, an accrediting agency for Information Systems requires that the curriculum include the following "One-half year of course work that must include varied topics that provide background in an environment in which the information systems will be applied professionally".

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Community College Program of Study for Transfer Leading to a Computer Information Systems and Sciences Program

FRESHMAN YEAR

First Semester (Fall)		SCH	Second Semester (Spring)		SCH
BCIS 1305/1405	Business Computer Applications	3 or 4	COSC 1337/1437	Programming Fundamentals II	3 or 4
COSC 1336/1436	Programming Fundamentals I	3 or 4	MATH 1325/1425	Math for Business and Social Sciences II**	3 or 4
MATH 1324/1424 or 1314/1414	Math for Business and Social Sciences I** College Algebra	3 or 4	SPCH 1315 or SPCH 1321	Public Speaking* or Business & Professional Communication*	3
XXXX ####	TX Core Curriculum	3	XXXX ####	TX Core Curriculum	3
XXXX ####	TX Core Curriculum	3	XXXX ####	TX Core Curriculum	3
		15-18			**15-17**

SOPHOMORE YEAR

First Semester (Fall)		SCH	Second Semester (Spring)		SCH
ACCT 2401	Principles of Financial Accounting	3 or 4	COSC 2325/2425	Computer Organization	3 or 4
MATH 1342/1442 or 2342/2442	Elementary Statistical Methods	3	XXXX ####	Application Environment Course***	3
ECON 1301 or 2301 or 2302	Economics* or Macro- or Microeconomics*	3	XXXX ####	TX Core Curriculum	3
XXXX ####	Application Environment Course***	3	XXXX ####	TX Core Curriculum	3
XXXX ####	TX Core Curriculum	3	XXXX ####	TX Core Curriculum	3
		15-16			**15-16**

* Courses may apply towards TX Core Curriculum.

** ABET accredited programs may require Calculus I. Please check with your terminal institution.

*** Please check with your terminal institution for applicable courses.

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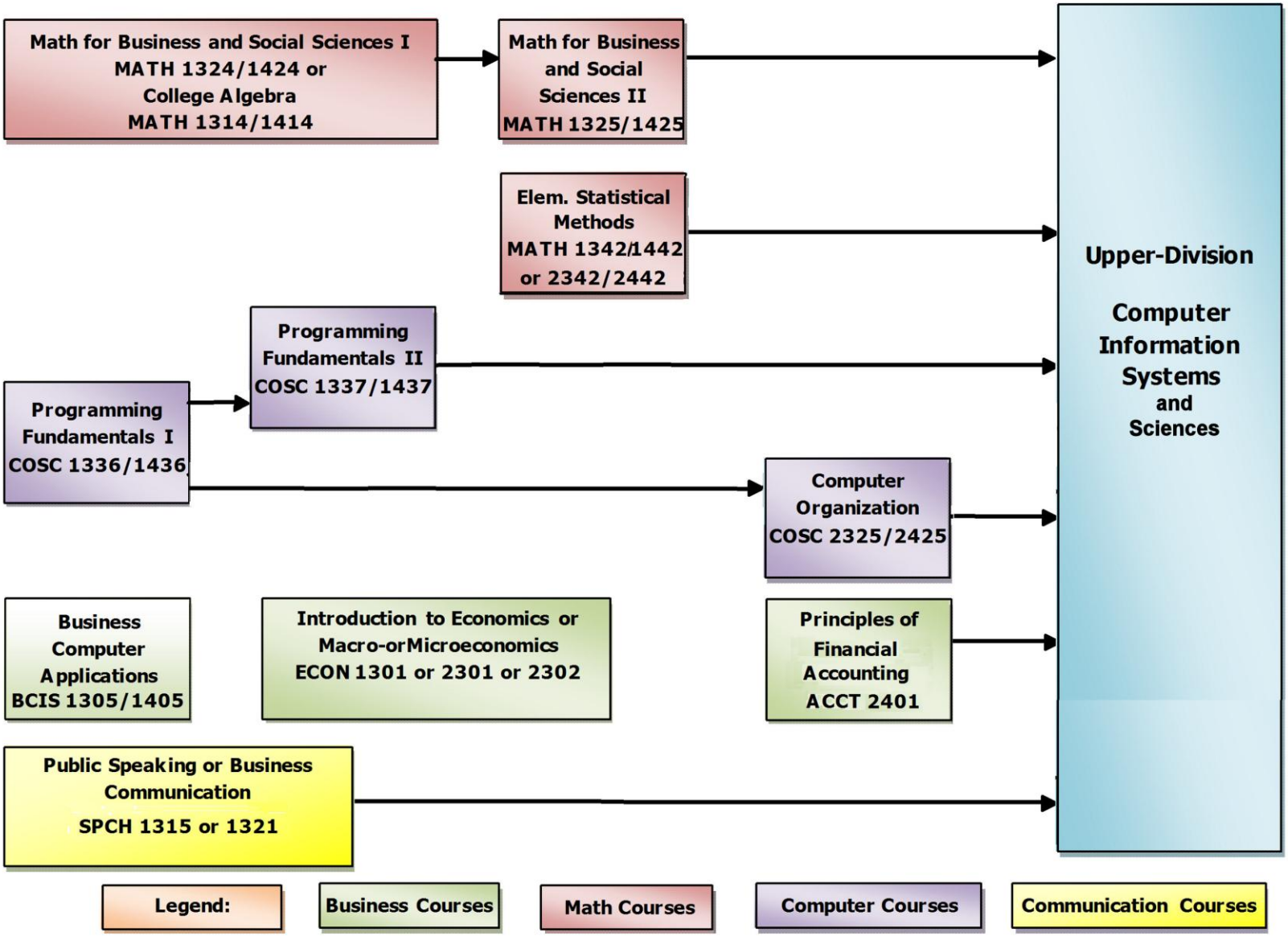
Prerequisite Flowchart for Computer Information Systems and Sciences



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Appendix A:

Technology Degrees - What is the difference?

Dr. David Wierschem
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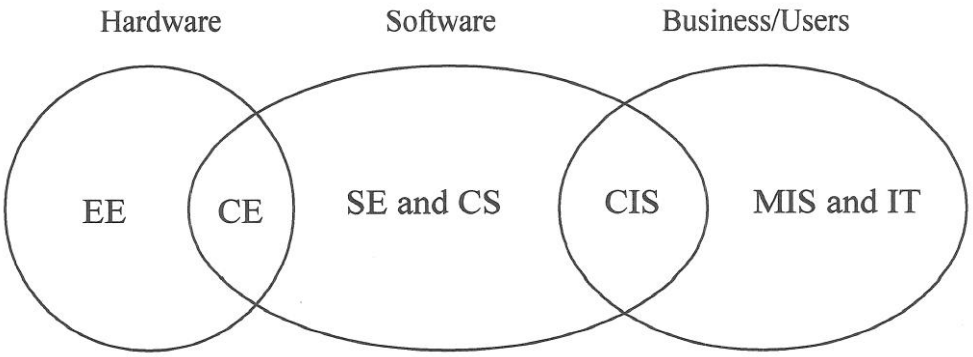
Technology Degrees - What is the difference?

The continued integration of technology into all our lives is undeniable. Desktop computers are giving way to laptops, e-readers, and netbooks. The iPad has taken the world by storm and with it unlocked innumerable new opportunities for technology development. Mobile phones are no longer devices that allow people to talk. In fact, there is a lot less talking and more texting, game playing, and other fun application activity. Technology is no longer tethered with a cord to a wall and is walking around and available anywhere anytime.

All this technology means that there has to be someone out there that is writing software, designing the databases, drawing the graphics, building the networks, designing the systems, and holding a host of other jobs to create and support all this technology. With all of these various job opportunities, if I want to work with computers, what degree should I get? What degrees are available? What degree is right for what I want to do?

What are the available degrees?

The short answer is that there are a variety of degrees offered depending on your interest and aptitude. From a hardware perspective there is electrical engineering (EE) and computer engineering (CE). From a software perspective there is computer engineering (CE), computer science (CS), software engineering (SE), and computer information systems (CIS). From a user of business standpoint there is computer information systems (CIS), management information systems (MIS), and information technology (IT). There are a host of other related degrees also such a computer graphics and informatics. And don't forget the specializations such as geographic information systems and health information systems. The number of degrees offered will continue to grow as computing technology continues to spread across every facet of our lives. That is good news for those interested in working in the area of computing.



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How do these degrees differ from each other?

In general EE and CE focus on the design and manufacture of the hardware components of technology. This includes everything from the hard drive and computer chips to the mouse and flash drives. Those degrees that focus on software (CE, CS, SE and CIS), spend their time primarily writing software code and designing software implementation strategies. CIS, MIS and IT are responsible for identifying and designing the hardware and software devices and applications based on user requirements.

In a sense CIS, MIS and IT act as the liaison between the end users and business professionals and the hardware and software experts.

The variety of degrees is a result of the complexity and broad range of opportunities that technology offers. For students with an aptitude for math and science the EE, CE, SE, CS, or CIS route may be the way to go. For those who like computers but don't want to be a hardcore engineer or programmer than the CIS, MIS or IT options may be more appropriate.

The difference between each of the degrees is a reflection of their emphasis on the specific technology areas they are associated with. For example EE and CE are higher in mathematics requirements and MIS and IT are much less mathematical. EE and CE are much more hardware intensive with CE having some software integration. SE and CS are almost entirely software related and emphasize software programming and associated software development activities. CIS can have a significant software component but also provides opportunities for business and end user development. MIS and IT are almost exclusively associated with business processes and end user support. What this implies is that a successful technology strategy needs all levels of these degrees and there are opportunities for students with all levels of interest in working with computers.

What is the right degree for you?

The answer to this question depends on a person's likes and dislikes, academic aptitudes, and long term goals. No single degree is better than another, they are just different. The best degree is the one that helps you get that job that you enjoy getting up every morning to do.

Each of the specific degrees provides opportunities for working in the more targeted areas of technology including networking, database, systems and many others. The difference is the specific aspect as illustrated below.

If you like math, solving word problems, get good grades in science and math, and like to tinker with physical things then EE or CE may be the route for you. These degrees are very technical and require a high degree of detail. These jobs will focus on the physical aspects of the various technologies. For example they work on the physical components of a database server or network router.

If you like math and like to find ways for things to work faster or better, get good grades in math and science, and like to play with programming computers then CE, SE, CS or CIS might be for you. These degrees while not as technical as EE and CE are still very technical and detail oriented. These jobs focus on the software aspects of the various technologies. For example they work on writing the code that controls the network router, or the database application, or the software application that does your accounting, or even the game you play after school. Other activities may be the design of security software or other applications.

If you are ok at math, want to work with computers but don't want to just program, and like to work with people or business, the CIS, MIS or IT may be the route for you. These degrees are less technical and less detail oriented than the previous degrees and are more targeted on the end users and business needs. Most of these programs work in conjunction with the College of Business and have a significant business curriculum component. These jobs cover a wide variety of opportunities and include the design of networks or the design of databases to meet business needs. They can design and implement security systems and they may provide the technical support for all the computers to keep them running or to provide answers to the users with application questions.