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A Practical Information Technology Program

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ABSTRACT

This paper discusses the challenges facing business in the 21st century and the dramatic changes in the use of computers and application development process. These challenges, as well as the increase of global economy, coupled with the demand for the business technology workers indicate the need for redesigning the Information System Curriculum. The proposed framework for an Information Technology (IT) Program in this paper offers a pragmatic curriculum model to accommodate the needs and challenges of the 21st century. The framework provides a fundamental IT education for the graduates of such a curriculum, as well as allowing an area of specialization. In addition, the program can be implemented easily with existing resources.

INTRODUCTION

The business challenges of the 21st century are different than those of the 1960s or 1970s, as are the needs of employers. For many years, the Information Systems and Computer Science programs in the United States have been viewed as a model for the rest of the world. However, dramatic technological advancements, growth of technological awareness, as well as program innovations in other countries may impact both the quality and the popularity of the American model. The dramatic changes and expansion in computer application as well as the changes in the nature of the work requirement for American companies indicate a need for redesigning computer education curriculum in higher education.

In designing the curriculum, the needs of the organizations which hire graduates to solve their work force problems should be carefully considered. There have been significant trends in the use of technology, application development process, and the employment of IT professionals. Digital technology, telecommunication, globalization and outsourcing have shifted employment and industry infrastructure. Technology has even created a new sector of industry– the Information Service industry.

CHALLENGES FOR THE 21ST CENTURY

Successful development of curriculum must include provisions for adapting and adjusting to changes while being responsive to needs for future updating. One of the challenges in the process and development of curriculum is the provision for the detection of changes and trends while providing the safeguards necessary for detection and inclusion in the programs. The most important challenge that influences curriculum development involves business challenges of the 21st century.

The Trends of Applications in Business

The development of applications in static form, using console interface and the legacy languages with the lengthy System Life Cycle methodology are not economically feasible anymore. Actually, the maintenance of legacy systems is becoming very expensive (News Briefs, 2007). A survey of IT decision makers in 2006 indicated that the majority of them (75%) were planning to migrate away, if they can, from their legacy system within three years (Robb, 2007.) Anthes (2006) reports that out of 352 companies, 62% indicated that they are using COBOL; but 77% of them said they will replace it and gradually migrate away from it "every chance we get" (Anthes, 2006). Eventually, all the legacy systems have to be replaced with the web-intermingled, attractive window oriented interface. Already the demand is high for such integrated systems with an enterprise database that can handle all functions of business. The use of a database management system is critical to all projects (Post, 2005.) As organizational data are abundant, and decisions are becoming more complex to handle exclusively by human beings, managers need intelligent applications that use AI for converting mass data into useful decision support systems to facilitate decision making (News Briefs, 2007).

Globalization and Outsourcing

Expanding operations, outsourcing, and off-shoring, are part of globalization's optimization forces. Companies are expanding operations to any part of the world where they can be operated more economically. IBM, a U.S. based company, is reducing its workforce in the U.S. while expanding its operations elsewhere. An unofficial report indicates that IBM will increase operations in India from 20,000 employees to 100,000 in the next few years (NewsBrief, 2007). Regardless of the firms' locations, outsourcing has been and will be the norm, particularly in the specialized areas such as IT -- services and infrastructure. Per IBM's Global Business report of 2008, Bharti Airtel, a major Indian leading mobile telecom service provider, has outsourced its IT and network management for greater operational efficiencies (IBM Global Business, 2008). Fraihat's study has identified the critical success factors for outsourcing the information Technology services (Fraihat, 2006.)

The Information Service Industry

In the 19th century, technological disciplines and processes revolutionized manufacturing. In the 20th century, technology further reformed the service sector. There is general agreement in the literature, and the data supports that the service sector expansion is the direct result of computer technology, digital and telecommunications innovations. Studies have shown a positive relationship between IT infrastructure and service-sector growth (Datta, 2006).

Managing Projects

The growth of computer usage and applications is not limited to web technology or business practice. Computer systems usage operates now as an integral part of almost any business organization. Organizations use information technology strategies to gain competitive advantages (Lea, 2005). Alignment of the information system plans is a predictive of the use of information technology for competitive advantage (Sasidharan, Wu, Pearce, Kearns, & Lederer, 2006.) However, there was a time when the Strategic Information System (SIS) could be used to

gain competitive business advantage. Today, not using a modern information system is deemed a competitive disadvantage. Businesses need professionals for developing, expanding, and managing their computer applications to stay competitive. For this purpose, organizations need IT professionals who know how to manage the projects. Of course, project management software is an important tool to manage complex projects, and using automated tools such as OPNET IT Guru is becoming common for modeling, designing, and developing applications (Chen, 2004.)

The Demand for IT Professionals

Information Technology related fields will be one of the fastest growing occupations in the United States (Horrigan, 2004; Kung, Yang, & Zhang, 2006). The research shows that the salaries of the IT workers will rise even in an economic downturn (Koong, Liu & Fowler, 2003). According to the Department of Labor projections through 2012, the IT Job growth is noticeable, and the most growth is in IT type of jobs including Network Telecommunications analysts, at 55%; Applications Software Engineers at 48%, and Systems Software engineers at 43%. The least growing area are the programming jobs at 2%, see Table 1.

Table 1: The Growth Rate for the Areas of the IT jobs (Source: U.S. Department of Labor).

Type of Specialty	**% growth Rate**
Network systems and data communications analysts	55%
Software engineers, applications	48%
Software engineers, systems software	43%
Network and systems administrators	38%
Database administrators	38%
Systems analysts	31%
Information scientists, research	26%
Support specialists	23%
Computer specialists, all other	19%
Programmers	2%

THE CURRICULUM IN HIGHER EDUCATION

Several studies have compared and evaluated current curriculum in the United States. In 1996, Gill and Hu compared curriculum models to see how the undergraduate information systems education was evolving (Gill & Hu, 1999). Most recently, Kung, Yang and Zhang (2006), have studied the core courses taught in undergraduate IS programs within business schools, and the researchers have attempted to identify the base of knowledge that all IS graduates possess. Their survey was limited to undergraduate programs in the United States. They considered both the accreditation criteria as well as the model set by ABET 2004 and the IS 2002. They also compared the results with a comparable study from ten years earlier by Maier and Gambill (1996). Kung, Yang and Zhang (2006) study concluded that the undergraduate IS programs in the United States have experienced a gradual change in the past ten years. Some of the courses, such as database, are common in all curricula, while other courses, such as systems analysis and design, have become more important in some institutions of higher learning. The study indicated that the requirements for some important subjects, such as telecommunications, have been

dropped, and some of the course requirements and offerings, such as programming (particularly COBOL) and operating systems, have been cut. However, surprisingly, COBOL has remained as a course requirement in some of the curriculum. Still, most of the IS programs (88%) have required more than one programming course. And, COBOL is offered by 20% of the universities surveyed. The majority of schools have either a capstone course or an internship requirement to acquire the technical and organizational skills. Overall, although there has been some gradual modifications, the structure and course combination have not changed dramatically since the 1970's.

The Need for a New Approach to Curriculum

The advancements of technology, applications, and methods of developing applications, as well as the service focus of business, must influence the updating of the curriculum in computer science or Information Systems (Gill & Hu, 1999; Lee, Koh, Yen &Tang, 2002; Lee, Trauth & Farwell, 1995; Maier & Gambill, 1996). Tatnall & Davey (2004) studied the success of IT curriculum innovation and concluded that the information system is still in its evolution, so IS programs ought to be assessed regularly in terms of curriculum and teaching methods. However, the basic requirements, the teaching of the old technology, and the methods of teaching, have not undergone a dramatic change. With the current curriculum, a student, upon completion of his/her education, can solve a well-defined small problem, and implement it with some technology. But, if the small task is defined, it is much cheaper to let other programmers in a low-wage environment do the implementation. Businesses no longer rely on custom applications using old technology such as COBOL (Babcock, 2003; Hayers, 2002; Laudon & Laudon, 2004; Ruby, 2005).

In order to maintain the leadership in higher education programs in computer related fields in the United States, the curriculum need to be updated to accentuate on the trends; otherwise, they may be considered obsolete. Holmes (2007) indicated that the computing discipline is losing respect and needs to be reformed. Computing professionals deal with people and data, while computers are only tools. Therefore, it is appropriate to view computing professions alongside other disciplines such as teaching and research functions (Holmes, 2007). For example, programming jobs should be separated from computing professions in the same way that engineers are separated from technician jobs.

Computing professionals need education and curriculum that are different than the skills and knowledge required by professionals who use computing power as a tool. Wu, Chen and Chang (2007) investigated the professional activities and the perceived skills/knowledge needed by different levels of management. Their findings confirmed that the critical professional activities and skills/knowledge required by the various levels of managers were significantly different among the management levels. Organizations always need qualified IT workers to carry out the business operations. However, managers are cautious of the knowledge and skills needed for their operations, particularly during an economic downturn (Galup, Dattero & Quan, 2004).

Necessary Course Content

Employers are still looking for a qualified work force in computer technology. But the type of the IT professional needed in the 21st century is different than the type of professional that was typical in the 1980's or 1990's. Organizations must hire IT professionals who understand business and are able to manage their projects. Businesses prefer to outsource or offshore the technical details (Abraham, Beath, Bullen, Gallagher, Goles, Kaiser, & Simon, 2006). The major challenge in staying competitive is to design, develop and deliver systems that can meet the modern requirements.

What type of IT workers should Higher Education prepare for in the future? The answer relies on understanding the work force requirements for the particular area, and the stages of the segments of the economy that employ this type of professional. For example, in the United States, where the shift of the segment of the economy is moving towards the service sector, and economic performance is of some concern, business organizations prefer to offshore the type of jobs which have economic benefits. Therefore, employers need IT professionals who have a deep knowledge in computer technology, understand their respective businesses, communicate effectively, and can manage projects. This is confirmed by Mashaw (2009) and the findings that show that even though technical skills are needed to start employment, employers value business and project management knowledge and prefer to outsource technical assignments. The proper use of project management techniques can improve the success rate of the projects (Tesch, Ireland, & Liu, 2008.) However, employers still need up-to-date qualified IT technical professionals to fulfill their in-house work requirements. The recent growth of technical schools (such as the University of Phoenix) could indicate that the employers still need an up to date technical workforce. Technical schools are market driven, and can adopt technological changes more rapidly than legacy schools.

Necessary Technical Courses – The Research

In the United States, community colleges have programs for preparing students for technical skills, while universities have programs in computer science, computer engineering, and information systems within the colleges of business. Some of the information system programs in the business schools are only an option, with a limited number of information system courses. The problem with this kind of option is that students' technical skills are very limited, yet students, as well as employers, expecting technical knowledge for productive employment. These programs do highlight business knowledge in their curriculum, but they do not emphasize the technology elements. Therefore, these option programs inadequately prepare students for the expectation to be qualified professionals in Information Technology.

In a midsize university (about 14,000 students) in Northern California, we have been offering a CIS option in the Business Major. The requirements for the information technology courses were very limited. The majority of the course requirements were for either business or general education. Only 12% of the courses (6 courses) were information systems related, see Table 2.

Tale 2: The composition of the current program.

	Area Requirements	%
1	The General Education-breadth requirements courses	38 %
2	Business courses	50%
3	Information Systems courses	12%

There were some concerns that the option was too limited in scope and did not offer enough technical knowledge and specialization. A proposal was being evaluated for a Major in Information Technology that would place more emphasis on information systems course work than business-related courses. In preparation, marketing research was conducted to identify the demand for such a major in the area, and to explore the perception of respondents for course work. A survey was prepared and distributed to gather information regarding the following points:

- the quality of the currently offered CIS-option program versus a more technical IT program
- the need for a Major in Computer Information Technology in the area
- the balance of technical courses and business courses
- the likelihood of enrollment for the new major
- the computer languages to be offered in the program
- the necessary business-related courses needed for such a program

The participants were familiar with the current program, but had expressed concern that the current program was not "technical enough." The research objective was indicated in the survey's introduction. Approximately 466 individuals responded to the survey-interview questionnaire. The participants in the survey were students from surrounding colleges, university alumni, and potential employers for the major. The respondents' pool and status are shown in Table 3.

Table 3: The Composition of the Respondents.

Status	Number of Respondents	Percent
Existing students	195	42.5%
East-Bay Junior College students	135	29.5%
Alumni	69	15.1%
Potential Employer, for CIS Major	52	11.4%
Other	7	1.5%

The results were interesting, though unsurprising. The following is a summary of the results (See Table 4).

- The majority of the respondents (80.8%) indicated that there is a need for a major in Computer Information Technology.

- The majority of the respondents (62.8%) indicated that the quality of the current CIS-option program would be improved if there was such a major.
- The majority of the respondents (85.7%) expressed that in order for such a major to be successful, more than 50% of the courses should be technical in Computer Information Technology. (This was in response to a question about the balance between Business and CIS related courses.)
- Many respondents (44.6%) indicated that they would likely enroll in such a major. However, a considerable number of remaining respondents (35.7%) indicated that they had not made decisions about enrolling in computer related fields.
- The popular programming languages among the respondents were C++ (63.1%), Web-Based Applications Programming (60.2%), JAVA (55.5%), Windows Programming (52.4%), and Visual-Basic (45.4%).
- The majority of respondents (71%) indicated that the business disciplines' offerings for such a major should be limited. (Compared to the existing option, in which the majority of the requirements were in business).

The respondents indicated that the business course offerings should be limited to courses in Management, Economics, Marketing, Accounting, and Finance. Admittedly, the purpose of this research was for identifying the market in the area for such a major, and the result is limited to its use and purpose.

Table 4: Responses to the Marketing Survey for a Computer Technology Major.

Responses to Questions regarding a New Major in IT *	Respondents Reaction
Is there is a need for a Technical major in this area?	80.8% Yes
Does the proposed Major improve the quality of the existing CIS-option?	62.8% Yes
Should 50% or more of the courses be technical?	85.7% Yes
What is the likelihood for enrollment in such a major?	Very Likely: 10.5% Likely: 44.6% Less likely 9.2 Indecisive 35.7%
What programming languages should be taught?	C++: 63.1% JAVA: 60.2% Windows: 52.4% Visual-Basic: 45.4%.
Should the business courses be limited?	71% Yes

A FRAMEWORK FOR AN IT PROGRAM

An ideal framework for an undergraduate degree in Computer Information Technology (CIT) should provide the opportunity to obtain the necessary general education, the fundamental knowledge of computer technology, and a focus on the emerging applications of IT, yet it must be flexible enough to accommodate the trends and future evolution of the CIT field. The program should provide opportunity for specialized work, not only in the computer field, but also in other areas such as Biology, Statistics, engineering, etc. Specialization in a specific area should be based on students' needs or interests, which, of course, would be demand driven.

The Composition of a Suggested Program

This proposal is for a Baccalaureate of Science Degree in Computer Information Technology. The program recognizes the interdisciplinary nature of an information technology program and recommends courses from a variety of disciplines. Specifically, the proposed program is designed with the following objectives:

- To ensure that the knowledge taught in information technology is in harmony with the advancing technology and to prepare students for successful employment in a specialized area in information technology.

- To prepare graduates so that they can participate in solving business problems with consideration given to business performance, global operations, and particularly customer care.

- To provide educational opportunities to individuals who bridge the business-technology gap, and make sure that both business and technology components are optimal for the intended educational process.

- To provide a quality education that will prepare a student to contribute positively to society and to excel in professional careers in technology-related positions.

The specific objectives of the proposed B.S. in the Computer Information Technology program are to educate students so that the graduate will:

- Have skills for effective written and oral communication with both technical and non-technical people in information technology and in the specialized area of interest, as well as skills and strategies for facilitating group projects and activities.
- Have the fundamental knowledge regarding concepts, tools, methods and methodologies of IT, including the opportunity to learn appropriate conceptual and computational tools essential for a successful career.
- Have a solid foundation in a chosen interest area, while enabling the student to achieve depth of knowledge of IT associated with this chosen interest area and direct interaction with industry through cooperative education experience.
- Have an appreciation for the global impact of information technology on society and an understanding of the ethical and social responsibilities of IT professionals.
- Have a clear understanding of problem solving, reasoned decision making, and ethics.

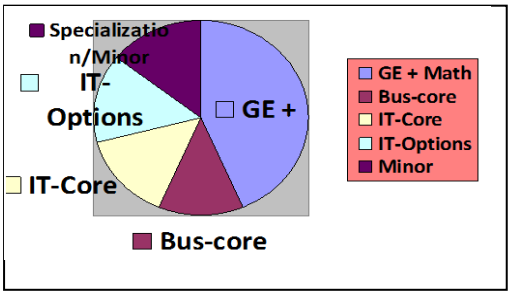
The program has the following components:

1. The General Educational Requirements

A well designed general and global education program for such a major should develop students' understanding of themselves, society, the world community, and the physical universe. However, the existing general educational requirements of the university should be fortified to emphasize

analytical thinking and problem solving, communication abilities, and a strong background in math/statistics, science, economics, and computer literacy, see Figure 1.

Figure 1: Business Core and IT Core.



2. Business core courses

Environments and fundamental tools of business equip students with essentials and context for modern business, and tools to understand business functions. Appendix A shows possible suggested courses to fulfill this objective.

3. Information Technology core courses

The foundation and general information for technology core courses provide students with the knowledge and opportunity to explore the area of Information Technology. Tier 1 of Appendix A shows some examples of suggested courses.

4. Information Technology Concentration courses

The follow up, more advanced information technology courses, would prepare students with the necessary knowledge, technology background, and essential tools necessary to excel in an area of Information Technology in depth and have a solid foundation in a chosen interest area. For implementation purposes, there would be a pool of intermediate courses available to the students so that a student can choose selected courses based on her/his own career goals. This category prepares a student for a specialized area in the IT field. The Tier 2 pool of courses in Appendix A shows examples of courses for this purpose.

5. A specialization or a "Minor"

This category enables a student to achieve in depth knowledge of IT associated concentration in a chosen career interest. The specialization can be either in the area of IT, or any area outside of the IT, which would allow students to "minor" in a field of their choice. Examples of specialization are Statistics, Microbiology, Engineering, or a specialization in IT such as security, networking, and digital animation, to name a few. Tier 3 of Appendix A shows examples of courses that could be taken for a specialized area in IT, such as processor design and network security, or again, the student could choose a minor area outside of the IT.

6. The capstone or integration

One or two capstone or cooperative education courses allow the integration of areas and

direct interaction with industry through the cooperative education experience, or specially designed project or case oriented courses.

The suggestions of the units of course requirements and the proportions for each tier are shown in Table 5.

Table 5: Course Composition for an IT Curriculum.

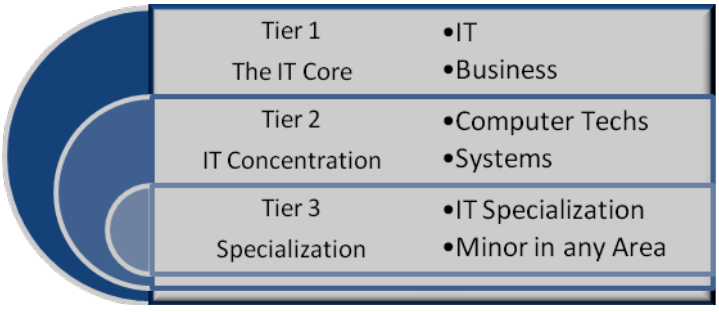
	Area Requirements	%	Approx Units	No of Courses
1	The General Education-breadth requirements, fortified	40 -50%	45-54	15-18
2	Business Core	10-15%	12-20	4-6
3	Information Technology core	10-15%	12-20	4-6
4	Technology Concentration	10-15%	12-20	4-6
5	Minor, in any field of interest	10-15%	10-20	4-6
6	The capstone or integration	5-10%	6-12	2-4

Implementation and Typical Courses

Implementing such a program is feasible with existing resources by pooling the courses from different disciplines and designing a package to fit the specific needs of local employers and the interests of students. Ideally, this program should be offered through the cooperation between the Computer Science and Information Systems Department.

The typical courses in the program would consist of existing university courses for general education, business, information systems and computer information systems and computer science courses. A major portion of the program could come from the existing university General Education (GE) requirements. But it should be fortified to accommodate the requirements for this major - - a strong math and statistical ability, written and oral communication, and computer literacy skills. Other recommended areas or courses to be included in the GE could include economics, philosophy and/or logic. The business courses could include quantitative analysis, financial analysis, management, marketing, and project management. To implement the IT portion, the courses from information systems and computer science could be pooled together to create a planned program. Appendix A provides examples of courses for different levels or tiers. The IT courses consist of 4 tiers, see Table 6.

Table 6: The Core.



Tier 1 – The Core

The IT core covers two important sections for an IT education:

a. The IT Core --The IT Core should be designed to include fundamentals of problems, data, computer, test, algorithm, process, system, information, language, telecommunication, and software. In practice, the typical courses are introduction to programming methods, systems analysis and design, software engineering, computer organization, database management systems, telecommunications, and web languages. All these courses are already offered in the computer Science Department or the Information Systems department.

b. The Business Core --The core courses for business contain the tool kit for the essentials and the context of modern business functions. The typical courses could be financial analysis, management, marketing, quantitative-decision making, business policies and strategies, and project management.

Tier 2– The IT Concentration

This tier of IT courses contains a pool of intermediate IT courses allowing a student to concentrate on an area of interest. Of course, the tier 1 –IT-Core should be the prerequisite for this tier of courses. Examples of courses in this tier include data communications and networking, digital processing, operating systems, data structures and algorithms, software engineering, software quality and assurance, and network security (See Appendix A). A student can take, with the advisor's assistance, say five or six of these courses per his/her career objectives. For example, if a student desires to major in Computer Science, then the student can take Digital Processing, Data Structures and Algorithms, and Software Engineering. Appendix A shows some examples of suggested courses.

Tier 3– The Specialization

The proposed framework allows a student to specialize in an area of his/her choice for the chosen career. This flexibility allows two kinds of concentration or specialization: 1) within the IT, or 2) in another field such as science, medicine, etc. A student can concentrate on:

a. A specialized area in IT such as in Security, Web Technology, etc. In this case, a student can choose five or six courses from the pool of advanced IT courses. Appendix A shows a sample of courses and area of specialization see. For more examples of the specialized area see Table 5.

b. An area for specialization based on interest and career objectives; such as Computer Science, Information Services, Biology, Statistics, Supply Chain Management, and ERP, etc. In this case, a student can take five to seven courses, either from the IT pools, or from an outside area as a minor.

Table 5: For examples of the specialized area see the Table in Appendix A.

Specialization or Area of Interest	
Network Systems, Development and Administration Information Systems and Network Security Systems Software Engineers, Applications Development Database Management Systems and Administration Information Systems Development System Integration Web-Application Development and Design E-Business Information Service Systems Technology Supply Chain Management Systems/ERP Ergonomics and Human Factor Engineering	

The capstone allowances could be an integration course, a final project, or a few semesters of co-op field work in the area that would allow students to gain practical experience.

SUMMARY

Employers' needs for manpower in the 21st century are different than employment needs of the 1980s and 1990s. Meanwhile, the computer applications in businesses, the process of developing applications, and tools have gone through fundamental changes since their inception. The economy of service oriented countries does not allow business organizations, particularly in the United States, to focus on the technical details that can be outsourced. It is crucial for tomorrow's workforce that students receive appropriate and innovative curriculum in computer technology.

The curriculum of Computer Information Systems in higher education, though modified slightly, has not kept pace with employers' needs for their workforce. At the same time, there is already a shortage of qualified professionals, and there will be even more demand for qualified professionals in the future.

The proposed framework for an Information Technology Program in this paper offers a pragmatic curriculum model to accommodate the needs and challenges of 21st century businesses. The framework allows a fundamental IT education for graduates as well as an area of specialization. The program can be implemented easily with the existing resources.

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APPENDIX A

The Suggested Structure of the IT Program and Examples of Possible Courses in each Tier

Tiers	Example of IT courses	Example of Business courses
Tier 1 The core	Programming methods Computer Organization, and Architecture Web Languages Security basics Database Management System & admin. Telecommunications Basics Human Computer Interaction Software Engineering Fundamental	Financial Analysis Management Marketing Quantitative-Decision Making Legal Environment of Business Business policies and Strategies Project management Systems Analysis and Design
Tier 2 IT The Concentration	Telecommunication-Networking Server-side Web Languages Systems Programming or OO Languages Database Management Systems & the Web Software Engineering Software Quality and Assurance Graphical User Interface programming Artificial Intelligence & Expert systems Network Operations and Administration High Speed and backbone Design Wireless and Mobile Network Security Human-Computer Interaction Computer Graphics Animation Operating Systems Database Architecture Data Structures and Algorithms Theory of Automata	Data Warehousing and Mining Electronic-Business Customer Relationship Management Enterprise Resource Planning Rapid Application Development and Tools Decision Modeling Supply Management and E-procurement Service Operations Management Enterprise Resource Management Etc  Example of Specialized Area or minor
Tier 3 IT- Specialization And trends (to be updated often)	Security and firewall design Intelligent Net, Security and authentication Digital Design and Microprocessors Digital Signal Processing Game engineering and design Compiler Design VLS Processor Design Digital Signal Processing Software Quality and Assurance High Speed and backbone Design Next Gen Mobile devices Computer Graphics and Animation Game engineering and design	Statistics Bio-Engineering Computer Science Security Business Systems Development Data Warehousing & mining Systems Integration Web-Application Development and Design E-Business Telecommunication and Network Systems Information Systems & Network Security Supply Chain Management Systems/ERP

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