National Academic Reference Standards (NARS)

For

Computing and Information

March 2015

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Preface

Based on the Presidential Decree number (82) for the year 2006, the National Authority for Quality Assurance and Accreditation of Education (NAQAAE) was founded to enhance the quality of education in Egypt.

In the light of NAQAAE's mandates, developing National Academic Reference Standards (NARS) for higher education comes on the top of its priorities. NARS are intended to set out clearly the graduate attributes and academic characteristics expected to be achieved in the academic programs of different disciplines.

The natural resources are no longer the backbone for development and prosperity; instead knowledge economy has become the main base for inducing tremendous and progressive breakthroughs in the resources of nations. In this regard, knowledge economy requires high quality education based on well defined reference standards.

The international changes and the concomitant alterations in the socio-economic conceptions obliged quality education as the main gate for human resources development. The latter, in turn, is counted as one of the most important determinants of national sustainable development.

Good practice in education should encourage students to improve their innovative and creative capabilities, employ appropriate technologies and pursue independent and life-long learning. This would necessitate setting out plans to develop the institutional capabilities and educational efficiency. Accordingly, educational institutions have to reform their programs and courses to meet the demands of the labor market. In addition, graduates should acquire the flexibility that enables them to adapt to the future needs of the labor market.

In alignment with its functions, NAQAAE, in collaboration with the stakeholders, has developed an integrated system to assure education quality. One of the system's outcomes is a series of guides for NARS in different academic disciplines to help higher education institutions in designing their programs to meet the accreditation requirements.

National Authority for Quality Assurance and
Accreditation of Education (NAQAAE)

Acknowledgements

The National Authority for Quality Assurance in Education (NAQAAE) would like to thank all the stakeholders involved in this work. The stakeholders included are representatives from the Ministry of Higher Education, National Syndicates, the Academic university staff members and the Private Sector. All of them were committed to make this work possible through their knowledge and experience.

The President of the National Authority for Quality Assurance in Education, Professor Magdy Kassem and Board members would like to acknowledge the efforts done by the task force group assigned to prepare this guideline for their hard work to ensure high quality graduates and to be comparable to the international standards.

Professor Magdy Kassem
NAQAAE, President

Methodology

NAQAAE has invited a group of education experts, in different academic disciplines, from state, private and Al-Azhar Universities to develop a general framework of the guide for the national academic reference standards (NARS) in the different sectors of higher education. The steps proceeded as follows:

1. **Brain Storming**
   The authority held several workshops for expert groups to discuss the general framework and elements/contents of the NARS guide and Standardization of concepts and terms used in the NARS within a definite time table.
2. **Reviewing of the International Academic Standard**
   Experts groups have reviewed the academic standards of some World accreditation institutions and standard applied in the corresponding faculties at universities from different countries in the world to have access to the global level, taking into account the need to preserve the Egyptian identity.
3. **Reviewing the Available Academic Standards in Egypt**
   The working groups have reviewed the academic standards which have been developed by the sectors of the Supreme Council of Universities - Ministry of Higher Education and Scientific Research. In accordance with the required amendments to NAQAAE, groups developed the guidelines to meet the needs of higher education institutions.
4. **Reviewing by Technical Committee**

   Standard first drafts were reviewed by technical committees formed by NAQAAE board, to insure that standards meet the agreed essential elements as well as the technical editing of the draft.

5. **Stakeholders Approval**
   After the completion of the draft of national academic reference standards, it was presented to representatives from stakeholders, faculty members from different universities and Al-Azhar institutions and representatives from the Ministry of Higher Education and the State for Scientific Research, to take appropriate action.
6. **Dissemination**
   The Authority posted academic standards on its website (naqaae.org.eg), to receive feedback from students, faculty members and stakeholders.
7. **Endorsement of Standards**
   The draft was revised according to the feedback received and introduced to NAQAAE's Board for approval.

Computing and Information

1. Introduction to Computing and Information

Computing and Information is concerned with the understanding, design, programming, and exploitation of computation, and computer technology - one of the most significant advances of the twentieth century. It is a discipline that blends theories (including those derived from a range of other disciplines such as mathematics, engineering, Cybernetics, graphical design or well-founded experimental insight) with the solution of immediate practical problems; it combines the ethos of the scholar with that of the professional; it supports the development of both small scale and large scale systems that support organizational goals; it helps individuals in their everyday lives; it is everywhere and diversely applied to a range of applications, and yet important components are invisible to the eye.

Computing and Information Specialists are more in demand today than ever before. In fact, more and more fields, from the arts and humanities to music, medicine, linguistics and communication, architecture, and the natural sciences rely on computing to advance their inventions and powers of discovery. And where we are today is just the beginning.

The information is that what computer systems can provide to aid a company, non-profit or governmental organization in defining and achieving its goals. Information system is concerned with the processes that an enterprise can implement and improve using information technology. IS professionals must understand both technical and organizational factors, and must be able to help an organization determine how information and technology-enabled business processes can provide a foundation for superior organizational performance. They serve as a bridge between the technical and management communities within an organization.

The computing and information discipline is important for the community because:

1. In the 21st century, computing and information is part of everything we do.
2. Skills in computing and information enables the graduates to solve complex, challenging problems.
3. Computing and Information drives innovation in the sciences and also in engineering, business, entertainment and education.
4. Computing and Information offers many types of profitable careers.
5. Computing and Information jobs are among the highest paid and have the highest job satisfaction. IT jobs are high added value driven with minimum capital investment.

6. IT can generate jobs easily on massive scale with limited time training.
7. IT can generate national revenues through the technique of body shopping and outsourcing since it focuses on brain power.
8. The opportunities for innovation and creativity in software are unlimited specially with the rapid development in the hardware.
9. Computing and Information has a space for both collaborative work and individual effort.

2. Aims of the Study of Computing and Information

The reasons for studying computing and information are as diverse as its domains of application. Some students are attracted by the depth and intellectual richness of the theory, others by the possibility of engineering large and complex systems; many study computing and Information because it gives them the opportunity to use a creative and dynamic technology. Besides being everywhere and diversely applied, computing and Information promotes innovation and creativity assisted by rapid technological change; it requires a disciplined approach to problem solving that brings with it an expectation of high quality; it approaches design and development through selection from a wide range of alternative possibilities justified by carefully crafted arguments based on insight; it controls complexity first through abstraction and simplification, and then by the integration of components. Above all, it is a product of human ingenuity, and provides major intellectual challenges; yet this limits neither the scope of computing and Information, nor the complexity of the application domains addressed.

A traditional description of computing and Information presents a spectrum of activity ranging from theory at one end to practice at the other. It also describes aspects ranging from hardware through to software and from the study of computers and computation through to applications-oriented studies. The following headings give a high-level characterization of the whole area of computing and Information:

Hardware

- Computer architecture and construction
- Processor architecture
- Device-level issues and fabrication technology
- Peripherals and attachments.
- Computer networks, distributed systems, technologies

Software

- Programming languages
- Software tools and packages

- Computer applications
- Structuring of data and information
- Operating systems: the control of computers, resources and interactions

Theory

- Mathematics and Algorithms design and analysis
- Formal methods and description techniques
- Modeling and frameworks
- Analysis, prediction and generalization
- Human behavior and performance

Practice

- Problem identification and analysis
- Design, development, testing and evaluation
- Management and organization
- Professionalism and ethics
- Commercial and industrial exploitation

Communication and Interaction

- Human-computer interaction, involving communication between computers and people

It is difficult to define computing and information with any degree of precision given the dynamic change that is happening within it. Certain areas within the field such as Artificial Intelligence, Computer Science, Information Systems, Software Engineering, Multi-media, and Networks form familiar domains of activity which are represented strongly within computing and information. The overall field is wide ranging and it is important that those working in unusual and innovative areas recognize that they also reside within the field of computing and information.

Faculties and Institutions will produce aims and objectives that characterize their programs and indicate that their curricula are at degree level. Degree programs in computing and information can take various forms, each of which could prepare their students for different but valid careers.

At one extreme a degree program might provide opportunities for its students to attend modules on a wide range of topics spanning the entire area of computing and information. Graduates from such courses would have great flexibility, and might be of especial value either in emerging areas where specialist courses may not be established or in contexts where their ability to span the field would be useful.

At another extreme there can be programs that take one very specific aspect of computing and information and cover it in great depth. The graduates from such programs will

typically tend to seek opportunities in the specialist area which they studied, whether it be the development of multimedia systems, network design, the formal verification for safety-critical systems, electronic commerce or whatever other specialties emerge and become important. Program designers, students and stakeholders will need to be aware of this spectrum of program identity, and the balance of practice and theory are appropriate to the aims of the particular degree program, such that practical activity can be supported by an understanding of underlying principles.

3. Computing and Information Programs

The scope of what we call computing and information has broadened to the point that it is difficult to define it as a single program. Recent curriculum approaches divide such program into: **computer science, information systems, information technology, and software engineering**. These address major sub-programs, but additional possibilities still exist. Some **Mixed Disciplinary Majors** are introduced in this NARS for computing and information programs. This introduction has been produced in an attempt to characterize these sub-programs and also to characterize graduates from such degree programs. There is no question that computing and information in the 21st century will encompass many vital programs with their own integrity and educational practices.

It is hardly surprising that the diversity of computing and information is reflected in the varied titles and curricula that institutions have given to their computing and information - related degree courses. While this benchmarking standards, NARS, aims to capture the nature of computing and information as a discipline, individual institutions may need to draw on a wider range of materials and resources including other benchmarking standards to capture fully the specific character of their particular degree programs.

The common computing and information subprograms are listed in the following:

1. **Computer Science**
   Tends to be relatively broad and with an emphasis on the underlying science aspects.

2. **Information Technology**
   Involves different related fields such as: computer networks infra-structure, multimedia, Image processing, pattern recognition, computer vision , information and network security , robotics, etc….

3. **Information Systems**
   Essentially, this is computing and information in an organizational context, typically in businesses.

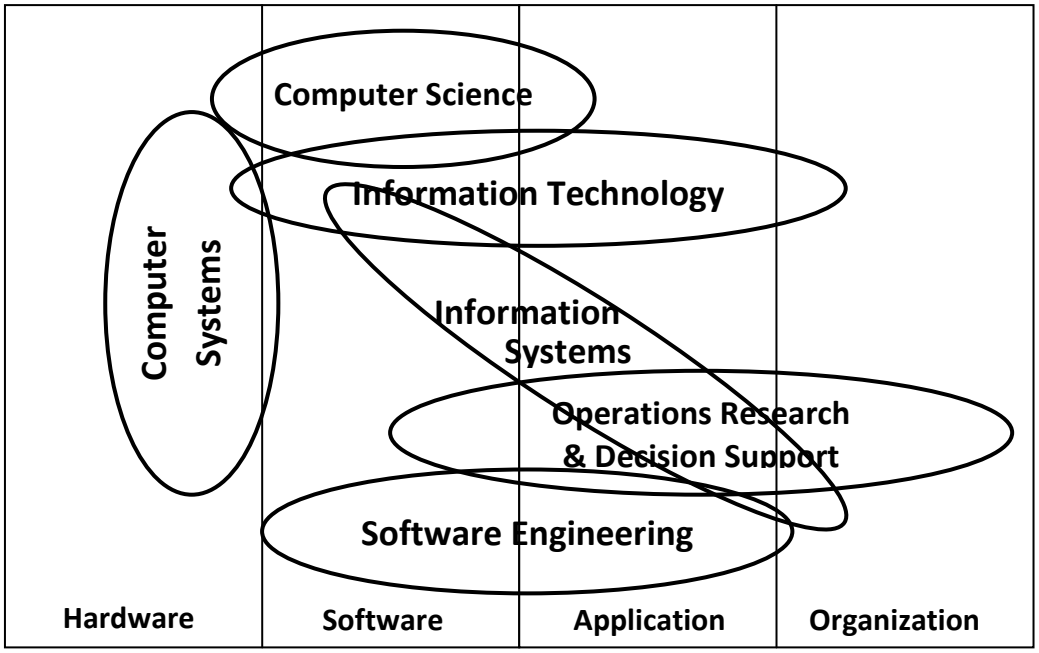
4. **Software Engineering**

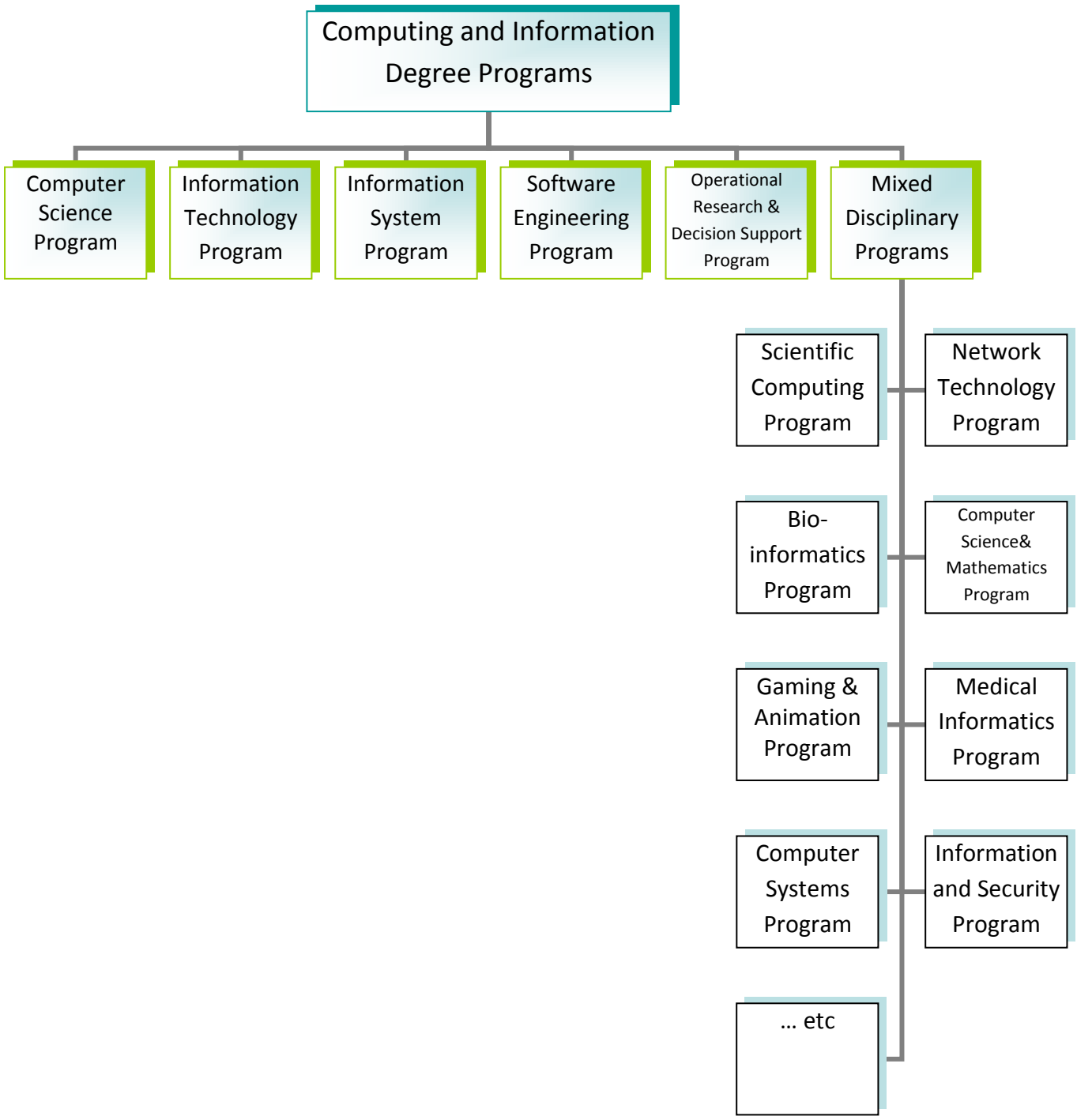
   Focuses on large-scale software systems; employs certain ideas from the world of engineering in building reliable software systems.

5. **Operation Research and Decision Support.**

   Operations Research (OR) and Decision Support (DS) emphasize optimizing organizational and system performance using advanced analytical methods to help make better decisions. Operations Research is used in many different industry segments in different business functions; from health care to logistics to financial services. In deploying its techniques, Operations Research relies on high-performance computing capabilities and, accordingly, technology, computing, and information sciences all leverage OR's historical and current intellectual thought to enhance practical application.

   The ORDS program aims to produce a graduate capable of analyzing and developing models, as well as supporting complex decisions in different systems and operations at all managerial levels. The program graduates should be able to play an effective role when it comes to decision formulation in the corporate as well as in the wider societal setting, identify the salient parameters that are necessary for decision making, and utilizing information and techniques from diverse fields. The program aims to produce a problem solver with a sufficient grasp of the fundamental decision support techniques and approaches and with a broad intellectual outlook that would enable him/her to effectively contribute in a wide variety of settings.





6. **Mixed Disciplinary Majors**

Because computing and information is such an important and dynamic field, many interdisciplinary majors, some are very recent developments, exist at some faculties. Here are just a few examples of these opportunities.

a. **Scientific Computing**. Scientific Computing (SC) is the focal point of computational science activities at the sector of computing. Computational science involves the invention, implementation, testing, and application of algorithms and software used to solve large-scale scientific and engineering problems.
Scientific computing is now widely accepted, along with theory and experiment, as a crucial third mode of scientific investigation and engineering design. Aerospace, automotive, biological, chemical, semiconductor, and other industrial sectors now rely on simulation for technical decision support. For government agencies also, scientific computing has become an essential support for decisions on resources, transportation, and defense. Finally, in many new areas such as medicine, the life sciences, management and marketing, and finance, techniques and algorithms from computational science are of growing importance.
The field of scientific computing combines simulation, visualization, mathematical modeling, programming, data structures, networking, database design, symbolic computation, and high performance computing with various scientific programs. Hence, scientific computing may be defined as a broad multidisciplinary area that encompasses applications in science/engineering, numerical analysis, and computer science. Computer models and computer simulations have become an important part of the research repertoire, supplementing (and in some cases replacing) experimentation. Going from application area to computational results requires domain expertise, mathematical modeling, numerical analysis, algorithm development, software implementation, program execution, analysis, validation and visualization of results. Scientific computing involves all of this. Although it includes elements from computer science, engineering and science, scientific computing focuses on the integration of knowledge and methodologies from all of these programs, and as such is a subject which is (in some sense) distinct from any of them.

b. **Bioinformatics** combines elements from at least biology, biochemistry, and computer science, and prepares students for careers in the biotechnology and pharmaceutical industries, or for graduate school in informatics. Some programs may also include elements from information systems, chemistry, mathematics, and statistics. In the newer interdisciplinary areas, different faculties use different names for the same subject. For example, one faculty' "bioinformatics" may be another faculty "computational biology."

c. **Computational Science (or Scientific Computing)** means science done computationally, and serves as a bridge between computing technology and basic sciences. It blends several fields including computer science, applied mathematics, and one or more application sciences (such as physics, chemistry, biology,

engineering, earth sciences, business and others). Some programs also include information systems.

d. **Computer Science and Mathematics** combines computer science with mathematics of course. Some of these programs are found at faculties that do not have a full major in computer science; some are found at universities with very large computer science departments.

e. **Gaming and Animation**. Majors for students interested in creating computer games and computer animations are being developed at a number of faculties. These majors have various flavors and may combine either or both of computer science and information technology work with either or both of art and (digital) media studies.

f. **Medical (or health) Informatics** programs are for students interested in students who want to work in a medical environment. Some students will work as technology experts for hospitals; some in public health; some students may be premed or pre-dental. Coursework may be drawn from any or all of computer science, information systems, or information technology in combination with biology, chemistry, and courses unique to this interdisciplinary field.

g. **Computer Systems.** Computer systems program is concerned with the design and construction of computers and computer-based systems. It involves the study of hardware, software, communications, and the interaction among them. Its curriculum focuses on the theories, principles, and practices of traditional electrical engineering and mathematics and applies them to the problems of designing computers and computer-based devices.

Computer systems students study the design of digital hardware systems including communications systems, computers, and devices that contain computers, software development, focusing on software for digital devices and their interfaces with users and other devices. Computer System study may emphasize hardware more than software or there may be a balanced emphasis.

Computer System has a strong engineering flavor, and currently, a dominant area within computing engineering systems is embedded systems, the development of devices that have software and hardware embedded in them. This program is very similar in every aspect with the computer engineering program presented before.

h. Network Technology: Networks technology is the knowledge of the technologies involved in network management and operating, network & information security, embedded networks systems, and internet and web technology, gained by study, experience and practice, applied with judgment to develop ways to utilize, ethically and economically, the advances in modern technology and communication for the

benefit of mankind. It is the ability to initiate and conduct activity associated with networking processes, systems, problems, opportunities, future, impacts, ethics and consequences. It involves knowledge, ways of thinking and acting, and theoretical and practical networking skills. It helps preparing individuals to make well-informed choices in their means of communication as consumers, workers, citizens and members of the global community.

4. Career Paths

- **Career Path 1: Designing and Implementing Software.**
  This refers to the work of software development which has grown to include aspects of web development, interface design, security issues, mobile computing, and so on. This is the career path that the majority of computer science graduates follow. Career opportunities occur in a wide variety of settings including large or small software companies, large or small computer services companies, and large organizations of all kinds (industry, government, banking, healthcare, etc.).

- **Career Path 2: Developing Effective Ways to Solve Computing and Scientific Problems.**
  This path involves modeling and simulation of scientific and industrial problems such as economic systems and predictions, population studies, parallel computing, cloud computing, and optimization.

- **Career Path 3: Planning and Managing Organizational Technology Infrastructure.**
  This path involves Information systems, information management, risk analysis, e-commerce, e-government, etc.

- **Career Path 4: Applications.**
  This career path involves utilizing IT technology in existing applications as well as devising new ones such as mobile applications, web development, remote sensing, GIS, Information security, data mining, robotics, etc……

- **Career Path 5: R&D**
  This path ends up with career positions involving research work in academia or industry, by keeping up with the state of the art in all related subjects in computing and information.

- **Career Path 6: Data Scientist.**
  A person taking that career path will be focused on the monetization of organizational data. This can be achieved by applying methods from statistics, data

modeling, and machine learning. The job would also require the ability to deal with Big Data and its close disciplinary cousin of Cloud Computing.

- **Career Path 7: Systems Engineer**.
  Applying problems solving skills with computational thinking to deal with complex systems. A system's engineer designs and optimizes work flows, and manages project risk. The job deals with identifying required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem.

- **Career Path 8: Technical Analyst.**
  This career requires the ability to extract meaningful knowledge out of data to facilitate decision making. It draws upon the ability to apply computational techniques to model data, and effectively employing mathematical, probabilistic, and statistical approaches to the problem at hand.

- **Career Path 9: Optimization Specialist.**
  Dealing with challenge find optimal solutions or strategies to wide range of problems by applying computational and mathematical tools and devising new techniques when necessary. Optimization can be applied to incerbly broad range of disciplines from computer design to political campaigning strategy.

- **Career Path 9: Operations Research and Decision Support Specialist.**
  In all economic sectors, and on various organizational levels and functions, an ORDS specialist is a high-level problem-solver who provides the necessary insights for decision makers through the use of advanced quantitative techniques, such as mathematical modeling, statistical analysis, optimization, and simulation. Such analysis and insights will help businesses and organizations operate more effectively and efficiently. The specialist is able to recognize problems, select the most appropriate methodology/method/technique, develop models, reach alternative solutions, and examine the impact of such solutions to the particular problems in hand and the system as a whole.

5. General National Academic Reference Standards (NARS) for Computing and Information Disciplines

5.1 Attributes of Computing and Information Programs Graduates

The graduates of the computing and Information programs should be able to:

1. Apply the fundamental theories and principles of computing and information applications.
2. Integrate and evaluate the computing tools and facilities.
3. Apply knowledge of mathematics and science.
4. Design a computing system, component and process to meet the required needs within realistic constraints
5. Exploit the techniques, skills and up-to-date computing tools, necessary for computing and information practice.
6. Display professional responsibilities and ethical, societal and cultural concerns
7. Use, compare and evaluate a range of formal and informal techniques, theories and methods to develop computing and information applications.
8. Consider and deal with the individual, social, environmental, organizational and economic implications of the application of computing and information.
9. Carry out a work plan with minimal supervision.
10. Communicate effectively.
11. Hold knowledge and skills required by the computing and information industry.
12. Engage in self and life-long learning and research in computing and information.
13. Fulfill requirements of potential employers.

5.2 Targeted Skills

Graduates are expected to develop a wide range of abilities and skills. These may be divided into four broad categories:

- Knowledge and Understanding
- Computing and Information -related cognitive abilities and skills, i.e. abilities and skills relating to intellectual tasks;
- Computing and Information -related practical skills;
- Additional transferable skills that may be developed in the context of computing and information but which are of a general nature and applicable in many other contexts

Knowledge and Understanding, cognitive, practical and generic skills need to be placed in the context of the program of study as designed by the institution and/or the possible pathways selected by the individual student.

5.2.1 Knowledge and Understanding

The graduates of the computing and information programs should be able to:

K1. Identify the fundamentals of professional communication.
K2. Explain the fundamentals of scientific management, economics, accounting, creative thinking, project management, and decision making.
K3. Express the main concepts of statistics, probability theory, discrete mathematics and numerical analysis and their role in the computing and information discipline.
K4. Recognize programming fundamentals and languages, algorithms complexity analysis, and data structures.
K5. Identify and explain the fundamental concepts, principles, and techniques needed for the analysis, development, validation, verification, deployment, and operations of computer-based systems.
K6. Describe main concept of operating systems, information system, database.
K7. Explain current developments in computing and information research.
K8. Define the mapping of real-world problems to algorithmic solutions
K9. List the professional, moral and ethical issues involved in the exploitation of computer technology and be guided by the appropriate professional, ethical and legal practices relevant to the computing and information industry.
K10. Describe document editing, reviewing, storage, and retrieval systems' fundamentals.

5.2.2 Intellectual Skills

The graduates of the computing and Information programs should be able to:

I1. Analyze a problem as a prelude for identifying, producing, and evaluating creative solutions and sourcing alternatives a creative solution to address it.
I2. Recognize and analyze criteria and specifications appropriate to specific real problems, and outline general strategies for their solution taking time and space complexity into consideration.
I3. Analyze, model, simulate, design and develop ICT-based systems.
I4. Describe the operation and the characteristics of basic data communication and networking.

I5. Identify criteria to measure the efficiency and effectiveness of a computer-based system for its current development and future evolution taking into various limitations and constraints.
I6. Differentiate among best, expected, and worst case behaviors of an algorithm by considering time and space complexity
I7. Evaluate research papers in a range of knowledge areas

5.2.3 Professional / Practical

The graduates of the computing and information programs should be able to:

P1. Study and improve organizational processes from an ICT perspective.
P2. Negotiate effectively with clients, other stakeholders and peers.
P3. Recognize the professional, economic, social, environmental, moral and ethical issues involved in the sustainable exploitation of computer technology and be guided by the adoption of appropriate professional, ethical and legal practices.
P4. Outline basic designs for data storage conceptual schemes.
P5. Analyze simple and complicated electrical circuits and using electrical laws in solving problems and/or formal electrical analysis methods
P6. Employ the statistical, probabilistic and mathematical techniques in analyzing data and interpreting experimental results.
P7. Plan, schedule, control, and lead ICT projects.
P8. Deploy appropriate tools for the construction and documentation of computer-based systems that are used to solve practical problems
P9. Deploy different modeling techniques to model and analyze real life computing problems.
P10. Evaluate computer-based systems from various perspectives.
P11. Develop a range of fundamental research skills that enable the graduate to continuously increase his knowledge, advance his career and pursue graduate studies.
P12. Design, implement, maintain, and manage software systems. Assess the implications, risks or safety aspects involved in the operation of computing equipment within a specific context.
P13. Handle a mass of diverse data, assess risk and draw conclusions.
P14. Write concise, comprehensible and cognitively efficient business communications' media.

5.2.4 Transferable Skills

Graduates of the computing and information programs should be able:

G1. Edit and review a professional report or document and design its storage, distribution and retention standards.
G2. Effective information-retrieval skills (including the use of browsers, search engines and catalogues) and general IT facilities.
G3. The ability to work as a member of a development team, recognizing the different roles within a team and different ways of organizing teams.
G4. Demonstrate independent critical thinking and problem solving skills.
G5. Communicate effectively through oral, written, and visual means. Prepare technical reports to a professional standard
G6. Demonstrate skills in team work, team management, time management and organizational skills.

6. Curricula Contents for Computing and Information Disciplines

Table 1: Indicative curricula content by subject area

	Subject Area	Tolerance %
A	Humanities, ethical and Social Sciences (Univ. Req.)	8-10
B	Mathematics and Basic Sciences	16-18
C	Basic Computing Sciences (institution req.)	26-28
D	Applied Computing Sciences (specialisation)	28-30
E	Training	3-5
F	Projects	3-5
	Subtotal	84-96
G	Optional (Institution character-identifying subjects)	16-4
	Total	100

National Academic Reference Standards

1- NARS CHARACTERIZATION OF COMPUTER SCIENCE

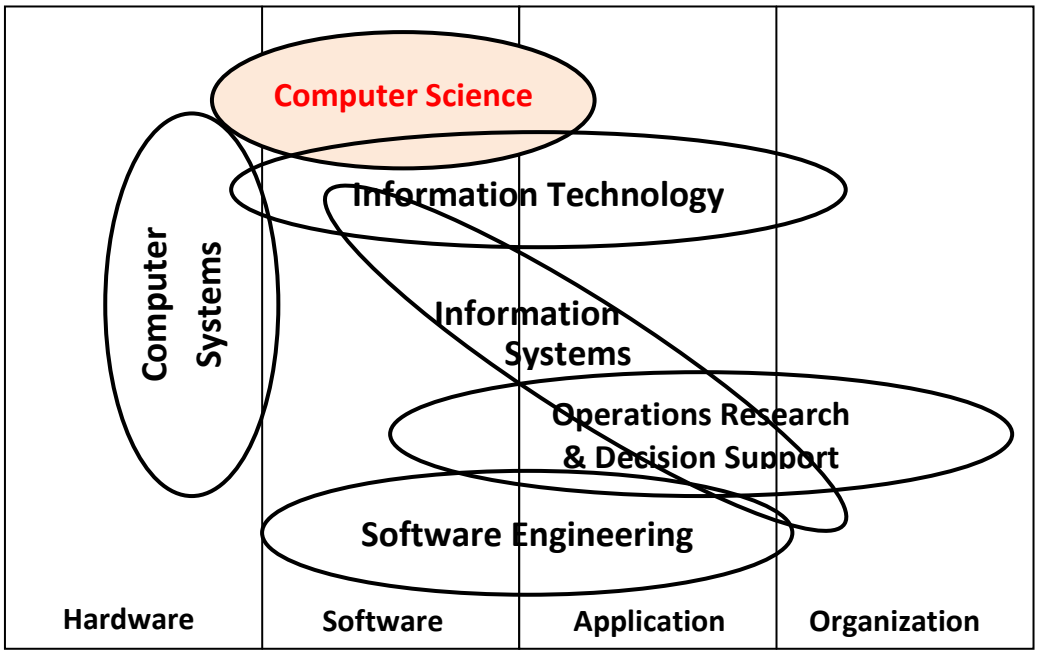
1.1 Introduction

Computer science spans a wide range, from its theoretical and algorithmic foundations to World Wide Web and its applications, computer vision, intelligent systems, bioinformatics, high performance computing, distributed systems, Object-oriented programming, grid and cloud computing and other exciting areas.

The work of computer scientists could be fallen into three categories.

- Design and implement software. Computer scientists take on challenging programming jobs.
- Supervise other programs by keeping them aware of new approaches.
- Devise new ways to use computers. Progress in the CS areas of networking, database, and human-computer-interface enabled the development of the World Wide Web.

Now CS researchers are working with scientists from other fields to make robots become practical and intelligent aides, to use databases to create new knowledge, and to use computers to help decipher the secrets of our DNA. They develop effective ways to solve computing problems. For example, computer scientists develop the best possible ways to store information in databases, send data over networks, and display complex images. Their theoretical background allows them to determine the best performance possible, and their study of algorithms helps them to develop new approaches that provide better performance.



1.2 The Attributes of Computer Science Graduate

The Computer Science program is designed to provide the student with the foundations of the discipline as well as the opportunity for specialization. After successfully completing the Computer Science program, the graduate should be able to:

1. Demonstrate knowledge and competence in fundamental areas of computer science such as: algorithms, design and analysis, computational theory, computer architecture and software based systems.
2. Apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design, implementation, evaluation and evolution of computer-based systems.
3. Apply knowledge of mathematics and science to real world problems; as well as to analyze and interpret data.
4. Demonstrate the analytic skills necessary to effectively evaluate the relative merits of software and computer systems, and algorithmic approaches.
5. Understand and apply a wide range of principles and tools of software engineering, such as design methodologies, choice of algorithm, language, software libraries and user interface technique.
6. Understand and apply a wide range of principles and tools of natural language processing and data mining

7. Have a solid understanding of the used concepts in computer science to be able to pursue further learning, whether as graduate students or on their own.
8. Demonstrate an understanding of algorithms and data structures, computer organization and architecture, programming language concepts, compilers, networks, artificial intelligence, graphics, human computer interfaces, and databases, and identify and define the computing requirements for its solution.
9. Design, implement, and evaluate a computer-based systems, process, component or program.
10. Use knowledge and understanding in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoff involved in design choices.

1.3 National Academic Reference Standards for Computer Science

1.3.1 Knowledge and Understanding

In addition to **Knowledge and Understanding** of computing and information graduate, the Computer Science graduate should be able to:

K11. Identify quality criteria that enable future development of computer-based systems.
K12. List the Fundamental topics in Computer Science related to software engineering principles.
K13. List the Fundamental topics in Computer Science related to artificial intelligence principles
K14. List the Fundamental topics in Computer Science related parallel and distributed processing principles
K15. Recognize and explain essential concepts, principles, and theories related to computer science such as operating system.
K16. Recognize and explain essential concepts, principles, and theories related to computer science such as computer graphics, and pattern recognition.
K17. Recognize and explain essential concepts, principles, and theories related to computer-application development such as: databases, information systems development, and human computer interface.

1.3.2 Intellectual Skills

In addition to **Intellectual Skills** of computing and information graduate, the Computer Science graduate should be able to:

I8. Define real problems, identify appropriate problem solving methods that satisfy commercial or industrial constraints and analyze results

I9. Identify different computer- system application attributes, components, relationships, patterns, architecture, and source of errors.
I10. Generate and evaluate a range of innovative design patterns and solutions to solve a computer science problem containing a range of commercial and industrial constraints.
I11. Apply solutions to a computer science problem, follow-up on solution to verify it, and if necessary restrict the solution methodologies upon the results.
I12. Discuss factors other than computational efficiency that influence the choice of algorithms, such as programming time, maintainability, and the use of application-specific patterns in the input data.
I13. Analyze the extent to which a computer-based system meets the criteria defined for its current use and future development.

1.3.3 Professional and Practical Skills

In addition to **Professional and Practical Skills** of computing and information graduate, the Computer Science graduate should be able to:

P15. Apply the principles of human-computer interaction to the construction and evaluation of a wide range of application including web-application, mobile application, and multimedia systems
P16. Apply the principles of parallel and distributed processing using appropriate techniques, tools.
P17. Apply the principles of artificial intelligence using appropriate techniques, tools.
P18. Evaluate the systems in terms of general quality attributes and possible tradeoffs presented within the given problem
P19. Use a common, non-formal method to model and specify, in the form of a requirements specification (design) document, the requirements (design) for a medium-size software system, and conduct a review of a these documents using best practices to determine their quality.

2- NARS CHARACTERIZATION OF INFORMATION TECHNOLOGY

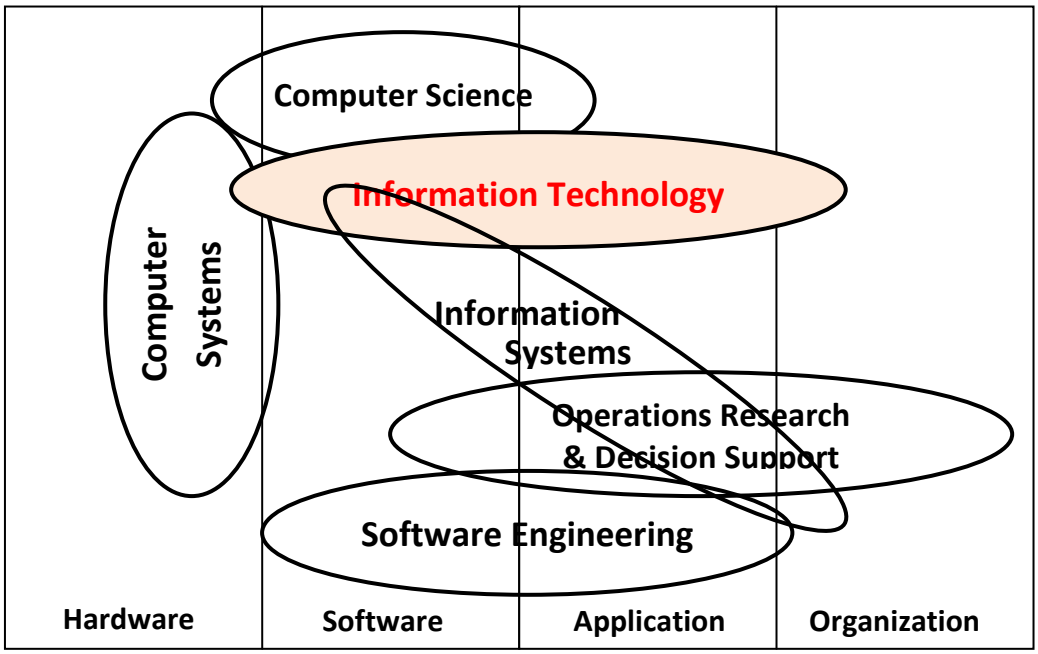
2.1 Introduction

Today, organizations of every kind are dependent on information technology. They need to have appropriate systems in place. These systems must work properly, be secure, and upgraded, maintained, and replaced as appropriate. Disciplines are established to reflect these needs. While the Information Technology and Information Systems disciplines both include a focus on software and hardware, they use technology as critical instruments for addressing organizational needs. Information Technology can be seen as the complement of Information Systems: its emphasis is on the technology itself more than on the information it conveys. IT is a new and rapidly growing field that started as a grassroots response to the practical, everyday needs of business and other organizations.

Information Technology focuses on ensuring that the organization's infrastructure is appropriate and reliable and using computing to meet the needs of technology-dependent organizations. Information technology refers to undergraduate degree programs that prepare students to meet the computer technology needs of business, government, healthcare, faculties, and other kinds of organizations. In some nations, other names are used for such degree programs.

IT programs exist to produce graduates, who possess the right combination of knowledge and practical expertise to take care of both an organization's information technology infrastructure and the people who use it, planning and management of the technology lifecycle by which an organization's technology is maintained, upgraded, and replaced. Graduates of information technology programs address these needs. Information Technology (IT) in its broadest sense encompasses all aspects of computing technology. IT, as an academic discipline, focuses on meeting the needs of users within an organizational and societal context through the selection, creation, application, integration and administration of computing technologies.

IT programs aim to provide IT graduates with the skills and knowledge to take on appropriate professional positions in Information Technology upon graduation and grow into leadership positions or pursue research or graduate studies in the field.



2.2 The Attributes of The Information Technology Graduates

According to the ACM, and the IEEE Computer Society – for four-year programs in Information Technology, Computing Curricula, Information Technology Volume, Version: Aug 22, 2008, an IT graduate must therefore acquire a skill set that enables him or her to successfully perform integrative tasks, including the ability to:

1. Knowledge of computing and mathematics appropriate to the discipline
2. Analyze a problem, and identify and define the computing requirements appropriate to its solution
3. Design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
4. Demonstrate independent critical thinking and problem solving skills and function effectively on a team to accomplish a common goal.
5. An understanding of professional, ethical, legal, security and social issues and responsibilities
6. Communicate effectively with a range of audiences
7. Analyze the local and global impact of computing on individuals, organizations, and society
8. Recognition of the need for and an ability to engage in continuing professional development
9. Use current techniques, skills, and tools necessary for Information technology practice and in the creation of an effective project plan

10. Use and apply current technical concepts and practices in the core information technologies subjects.
11. Identify and analyze user needs and take them into account in the selection, creation, evaluation and administration of computer-based systems.
12. Address information technologies problems of organizations or individuals.
13. Effectively integrate IT-based solutions into the user environment
14. Understand the best practices and standards and their application

2.3 National Academic Reference Standards for Information Technology Graduates

2.3.1 Knowledge and Understanding

In addition to **Knowledge and Understanding** of computing and information graduate, the Information Technology graduate should be able to

K11. Know the role of human factors in the design of Information Technology systems.
K12. Provide a deeper understanding of some aspects of the subject, such as multimedia, computer and communication network, mobile communication systems, pattern recognition, cryptography and network security.
K13. Demonstrate an in-depth understanding of the fundamental concepts and issues (e.g., quality and security) related to the design of computer and communication networks (e.g. mobile, wireless, and optical).
K14. Demonstrate an understanding of the fundamental concepts related to the design and development of web-based and internet-based systems.
K15. Demonstrate an understanding of the fundamental concepts, tools, and techniques for the design, development, and management of information-related systems (e.g., databases and information retrieval systems).
K16. Understand the various issues (e.g., quality, reliability, and human factors) related to the broad context of IT systems and their use in various domains (e.g., accounting and healthcare).
K17. Identify key challenges inherent in the maintenance and evolution of IT-based systems and describe various techniques and technologies used to confront these challenges.
K18. Demonstrate an understanding of the fundamental concepts, tools, and techniques used for processing various multimedia information including signal processing, pattern recognition, and speech and processing.

2.3.2 Intellectual Skills

In addition to **Intellectual** of computing and information graduate, the Information Technology graduate should be able to

I8. Develop innovative, effective and practical designs to solve real-life IT-related problems with identified specifications and constrained.
I9. Identify and analyze pressing and practical problems and challenges in IT-based systems and develop and express practical solutions to solve and confront identified problems and challenges.
I10. Identify a range of solutions and critically evaluate and justify proposed design solutions.
I11. Define real problems, identify appropriate problem solving methods that satisfy commercial or industrial constraints and analyze results
I12. Develop effective and efficient designs for practical IT problems by exploiting knowledge and skills gained on various IT areas.
I13. Analyze the extent to which a computer-based system meets the criteria defined for its current use and future development.
I14. Apply validation and verification techniques for IT-based solutions.
I15. Recognize the professional, moral and ethical issues of involved in the exploitation of Information Technology and be guided by their adoption, reflect on issues of professional practice within the discipline.

6.3.3 Professional and Practical Skills

In addition to **Professional and Practical** Skills of computing and information graduate, the Information Technology graduate should be able to

P15. Develop and analyze IT solutions using appropriate tools and techniques.
P16. Design, implement and modify efficient software and hardware systems.
P17. Implement different tools for visualizing and presenting data and information on the different platforms.
P18. Evaluate the efficiency and effectiveness of IT solutions using appropriate techniques.
P19. Develop good understanding of various information technologies and the trend of their use in various real-life systems.
P20. Recognize risks or safety aspects involved in the operation of computer-network-based systems.
P21. Evaluate the systems in terms of general quality attributes and possible tradeoffs presented within the given problem
P22. Make effective use of general IT facilities, plan and manage a project to complete within budget and schedule

3- NARS CHARACTERIZATION OF INFORMATION SYSTEMS

3.1 Introduction

Information systems focus on integrating information technology solutions and business processes to meet the information needs of businesses and other enterprises, enabling them to achieve their objectives in an effective, efficient way. This discipline's perspective on information technology emphasizes information, and views technology as an instrument for generating, processing, and distributing information.

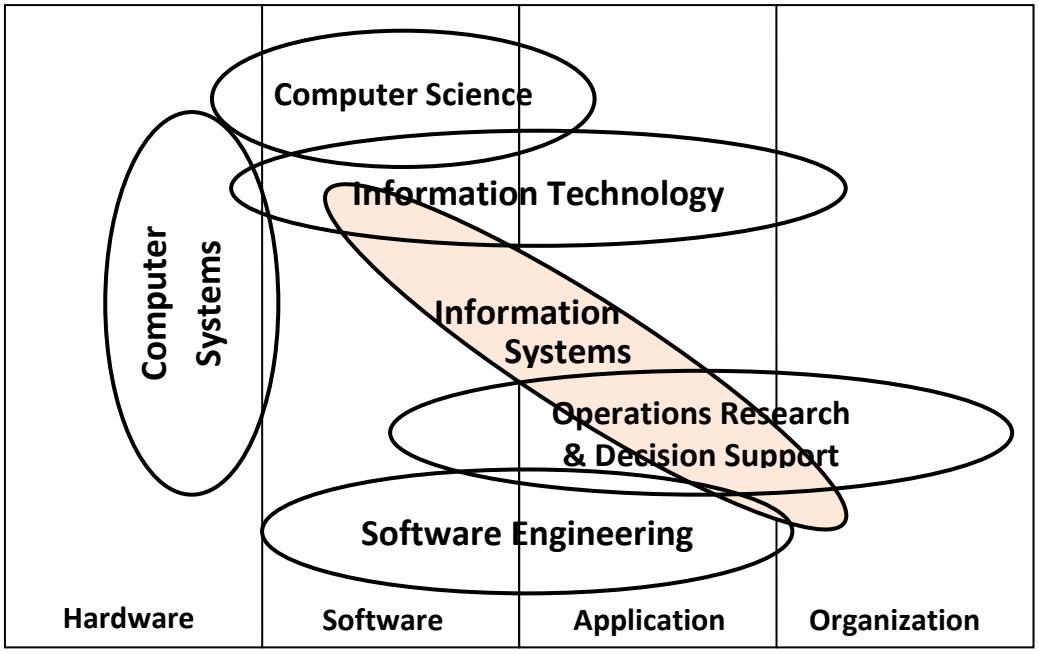
In conceptualizing the role of information systems in the future and the requirements for IS curricula, several elements remain important and characteristic of the discipline. These characteristics evolve around four major areas of the IS profession:

1. IS professionals must have a broad business and real world perspective. Students must therefore understand that:
   - IS are enablers of successful performance in organizations
   - IS span and integrate all organizational levels and business functions
   - IS are increasingly of strategic significance because of the scope of the organizational systems involved and the role systems play in enabling organizational strategy
2. IS professionals must have strong analytical and critical thinking skills. Students must therefore:
   - Be problem solvers and critical thinkers
   - Use systems concepts for understanding and framing problems
   - Be capable of applying both traditional and new concepts and skills
   - Understand that a system consists of people, procedures, hardware, software, and data
3. IS professionals must exhibit strong ethical principles and have good interpersonal communication and team skills. Students must understand that:
   - IS require the application of professional codes of conduct
   - IS require collaboration as well as successful individual effort
   - IS design and management demand excellent communication skills (oral, written, and listening)
   - IS require persistence, curiosity, creativity, risk taking, and a tolerance of these abilities in others

4. IS professionals must design and implement information technology solutions that enhance organizational performance. Students must therefore:
   - Possess skills in understanding and modeling organizational processes and data,
   - defining and implementing technical and process solutions, managing projects, and integrating systems
   - Be fluent in techniques for acquiring, converting, transmitting, and storing data and information
   - Focus on the application of information technology in helping individuals, groups, and organizations achieve their goals

The information systems specialist plays a key role in determining the requirements for an organization's information systems and is active in their specification, design, and implementation.

A majority of Information Systems (IS) programs are located in business faculties. All IS degrees combine business and computing coursework. A variety of IS programs exist under various labels which often reflect the nature of the program. For example, programs in Computer Information Systems usually have the strongest technology focus, while programs in Management Information Systems emphasize the organizational and behavioral aspects of IS. Degree program names are not always consistent.



3.2 The Attributes of Information Systems Graduate

The Information Systems program is designed to provide the student with the foundations of the discipline as well as the opportunity for specialization. After successfully completing the Information systems program, the graduate should be able to:

1. Recognize problems that are amenable to computer information systems, and knowledge of the tools necessary for solving such problems.
2. Understand fundamentals of systems development life cycle (SDLC), information networks, information security, data mining, e-commerce, geographical information systems, and crisis management.
3. Managing and exploiting organizational data and information; designing data and information models, Managing information systems development resources and projects
4. Implement solutions, including use of appropriate programming languages, web-based systems and tools, design methodologies, and database systems.
5. Apply the principles of effective information management, information organization, information mining, and information-retrieval skills to information of various kinds, including text, images, sound, and video.
6. Know the fundamentals of intelligent information systems technologies.
7. Specify, design, and implement computer-based information systems, and evaluate them in terms of general quality attributes and possible tradeoffs presented within the given problem.
8. Apply IS solutions to functional, inter-organizational, operational, managerial, and executive problems and opportunities.
9. Describe characteristics of various components of information systems, use the appropriate tools and techniques to analyze, design, and construct information systems.
10. Communicate effectively by oral, written and visual means.
11. Work effectively as an individual and as a member of a team.
12. Perform independent and efficient time management.
13. Aware of key ethical issues affecting information systems and their responsibilities as information science professionals.

3.3 National Academic Reference Standards for Information Systems

3.3.1 Knowledge and Understanding

In addition to knowledge and understanding of computing and information graduate, the information system graduate should acquire the knowledge and understanding of:

K11. Recall the core concepts related to organizational processes
K12. Describe the basic principles of business process analysis and re-engineering.
K13. Recognize the limitations of what can be achieved with available technology, financial resources and organizational capabilities.
K14. Classify and describe the major information systems development methodologies, tools and techniques.
K15. Explain the different information systems types and architectures.
K16. Identify the data storage alternatives available for information systems.
K17. Discuss the different application platforms (Desktop, Web, Mobile…) available for information systems.

3.3.2 Intellectual Skills

In addition to intellectual of computing and information graduate, the information system graduate should be able to:

I8. Appraise standing processes based on interviewing, observation and documentation analysis.
I9. Tailor proposed processes to address cultural and ethnic needs.
I10. Design data storage schemes.
I11. Develop data-intensive software applications.
I12. Negotiate solutions that fulfill business needs while satisfying political requirements.
I13. Shepherd implementing new processes and automating existing ones.
I14. Employ the principles of human-computer interaction to the evaluation and construction of a wide range of materials including user interfaces, web pages, and multimedia systems.

3.3.3 Professional and Practical Skills

In addition to Professional and Practical Skills of computing and information graduate, the information system graduate should be able to:

P15. Gather requirements using techniques such as interviews, questions and brainstorming sessions.
P16. Express requirements in concise and comprehensive manner.
P17. Represent business processes in formal notations such as BPMN.
P18. Model an information system using formal notations such as UML.
P19. Develop information systems applications using common technologies.
P20. Systematically test information systems applications.
P21. Package and deploy information systems applications.

P22. Apply business intelligence techniques such as data mining and data warehousing.

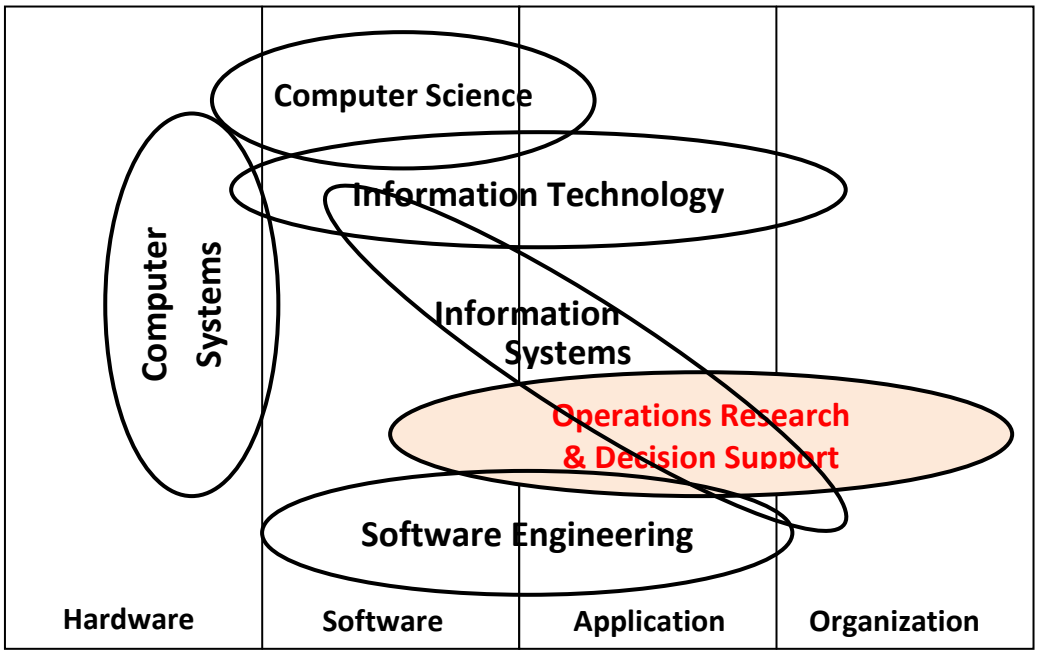
4- NARS CHARACTERIZATION OF OPERATIONS RESEARCH AND DECISION SUPPORT

4.1 Introduction

Operations Research (OR) and Decision Support (DS) is the discipline of applying advanced analytical techniques to enact rational and meaningful decisions by reaching optimal or near-optimal solutions to complex decision-making problems. The solutions aimed for must be applicable, make the best use of available resources, and as effective and efficient as possible. The discipline encompasses a wide range of problem-solving techniques and methods such as mathematical modeling and optimization, simulation, stochastic decision processes, project and operations management, economic methods, data mining and analysis, probabilities and statistics, artificial and computational intelligence, game theory and decision analysis.

OR is distinguished by its interdisciplinary nature and broad applicability as it is used virtually by every organization throughout the globe, along with being an active area of academic research. In various domains, ranging from health care, logistics, marketing, finance, industrial manufacturing to defense and security, OR plays a vital role in addressing numerous business problems such as scheduling, resource management, facility layout planning, forecasting, inventory management, yield management, quality assurance, as well as many others. Technology, computing, and information sciences all leverage OR's historical and current intellectual thought to enhance their practical applications.

This program aims to graduate specialists capable of identifying and analyzing problems, developing models, and supporting complex decisions in different systems and at all managerial levels. Our graduate should be able to play an effective role when it comes to decision formulation in the corporate as well as the wider societal setting, identify the salient parameters that are necessary for decision making, and utilize information and diverse techniques. A world-class problem solver with a grasp of the fundamental OR techniques and approaches in DS and a broad intellectual outlook would be able to effectively contribute in many ways to an improved short and long term decision-making processes in any organization.



4.2 The Attributes of the Operations Research and Decision Support Graduates:

After successfully completing the Operations Research and Decision Support program, the graduate should be able to:

1. Collect and organize data/information from a variety of sources.
2. Investigate the data/information to determine what is relevant to the problem in hand.
3. Deal with complex decision making situations using operations research and systems thinking methodologies.
4. Demonstrate deep knowledge and strong skills in quantitative methods; statistical analysis, mathematical optimization, simulation, and computational intelligence.
5. Analyze and model a given problem or decision situation using appropriate quantitative method.
6. Determine which techniques are most appropriate given the nature of the problem/system, the goals for improvement, and other related constraints.
7. Develop/deploy the needed algorithm(s) and use them to solve the mathematical/simulation model.
8. Design, build, operate and maintain decision support systems.
9. Analyze the results; carry out any required sensitivity/cost-benefit.
10. Advise managers and other decision makers of the various courses of action to take in order to address a problem and their respective consequences/impacts.
11. Continue self-development along the career path.

12. Compile memos, reports, and other documents, summarizing their findings and recommendations for managers and other decision makers.

4.3. National Academic Reference Standards for Operations Research and Decision Support Graduates

4.3.1 Knowledge and Understanding

In addition to Knowledge and Understanding of computing and information graduate, the Operations Research and Decision Support graduate should be able to:

K11. Different types of models and their appropriateness including quantitative and qualitative factors whether deterministic or stochastic.
K12. How different statistical and mathematical disciplines are used to support and facilitate decision-making.
K13. Appropriate technologies used in the planning, design, and operations of organizations and enterprises.
K14. Different types, tools, methods, and application domains of Decision Support Systems, as well as their interactions with a variety of related disciplines.
K15. Various approaches to solve operational managerial problems; Production Management, Operations Management, Inventory Management, Project Management, and Supply Chain Management.
K16. Various approaches to solve strategic managerial problems; game theory, decision theory, crisis management, strategic management, and risk management.
K17. Various simulation approaches; discrete event simulation and system dynamic, and agent based modeling.
K18. Optimization using mathematical programming (linear, non-linear, integer, dynamic, multi-objective), global optimization, network optimization, graph theory, and control theory.
K19. Optimization using computational intelligence techniques such as evolutionary algorithms and meta-heuristics.
K20. Key concepts in data sciences, data mining, data analytics, machine learning, business intelligence, and intelligent computing.
K21. Probabilities, statistical analysis, and stochastic processes such as queuing theory and Markov decision process.

4.3.2 Intellectual Skills

In addition to Intellectual of computing and information graduate, the Operations Research and Decision Support graduate should be able to

I8. Identify, analyze, summarize and visualize real-life problems using system thinking approach.
I9. Examine data/information for relevancy to solve real-life problems.
I10. Select the appropriate model/technique.
I11. Formulate and/or model real-life problems.
I12. Predict the impact of scenarios using what-if analysis, cost-benefit analysis, or sensitivity analysis.
I13. Assess the accuracy and justify the output results.
I14. Design decision support systems, frameworks, and tools.
I15. Design, improve, operate, and maintain processes in an enterprise/organization.

4.3.3 Professional and Practical Skills

In addition to Professional and Practical Skills of computing and information graduate, the Operations Research and Decision Support graduate should be able to

P15. Gather data and information relevant to a specific problem or decision situation.
P16. Develop models/frameworks/tools using different computer modeling and programming languages/software packages.
P17. Deploy appropriate software packages/toolboxes to solve problems.
P18. Analyze, evaluate and improve processes at any stage/level of decision making.
P19. Use advanced computer and information systems technology to serve and support decision-making.
P20. Experiment with the developed models/frameworks/tools to reach practical solutions.
P21. Analyze the results to reach insights, conclusions and provide recommendations.

5- NARS CHARACTERIZATION OF SOFTWARE ENGINEERING

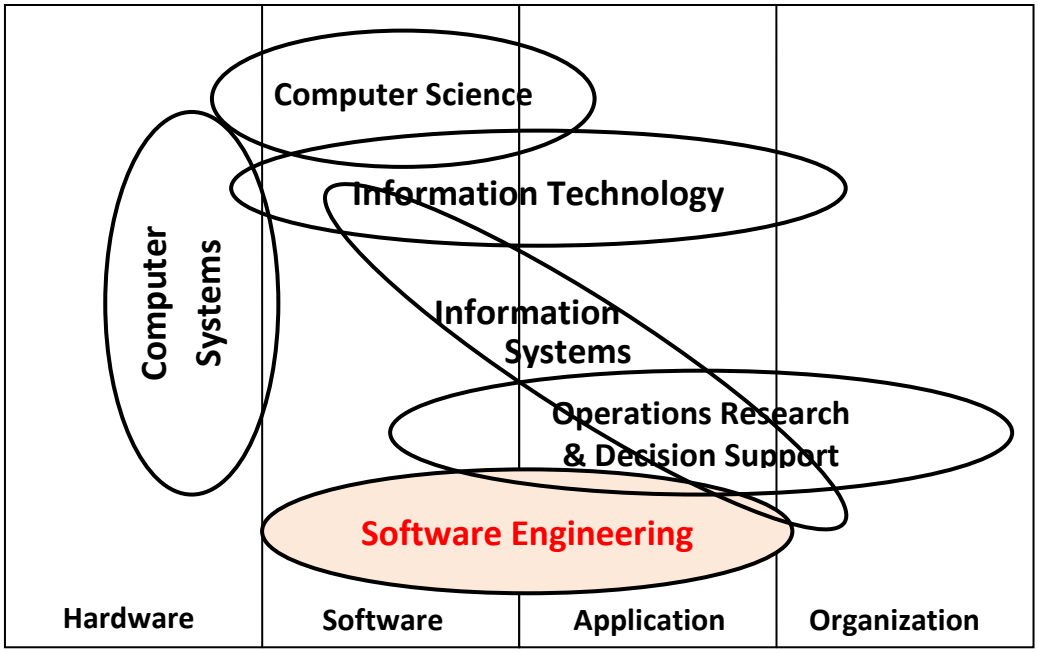
5.1 Introduction

Software Engineering is the application of engineering principles to software development process. It encompasses all the activities involved in developing software from inception to deployment and maintenance.

Software Engineering principles, methodologies and processes should be applied in the production of all kinds of software systems from system software to application software to games to embedded and real time systems to distributed and service-oriented systems to mobile applications to any new platforms that arise in the future.

Software Engineering is one of the major disciplines in computing, with its own body of knowledge that requires an independent study program.

Software Engineers go way beyond mere programming which involves solving problems by developing and implementing algorithms in a programming language. They are the best generalists. They are true and broad professionals. They utilize a wide range of tools to solve clients' problems, satisfy their needs and produce high quality software products. They use disciplined approaches, follow ethics, work in teams both local and global, produce professional technical and user documentation and communicate well.



5.2 The Attributes of the Software Engineering Graduates:

After successfully completing the Software Engineering program, the graduate should be able to:

1- Understand and apply a wide range of mathematical, computing and engineering theories and principles to solve complex problems and develop appropriate software solutions.

2- Analyze, specify, design, and implement software systems, and evaluate them in terms of general quality attributes and possible tradeoffs presented within the given problem.

3- Select and use appropriate programming languages, tools, design methodologies, development processes and database systems to develop software systems.

4- Verify and validate software systems to ensure that they exhibit the expected behavior and posses the desired attributes.

5- Work productively within software development teams locally and globally, and communicate effectively by oral, written and visual means with technical and non-technical personnel.

5.3 National Academic Reference Standards for Software Engineering

5.3.1 Knowledge and Understanding ILOs

In addition to knowledge and understanding skills of Computing and Information graduate, the Software Engineering graduate should be able to:

K12. Recall and explain the essential concepts, principles, and theories related to computer systems, electronics, logic circuits, computer architecture, computer networks, operating systems and parallel and distributed systems.

K13. Recall and explain the main concepts, principles and theories related to discrete mathematics, theory of computation, data storage and retrieval systems, information systems and artificial intelligence.

K14. List and explain the essential concepts, principles, methods, models and theories related to development of various software systems (including desktop, mobile, distributed, web-based, embedded systems and others).

K15. Describe the fundamentals of software systems analysis and design, data and information management, software project and configuration management, and software development models and processes.

K16. Explain the tools, practices and methodologies used in the specification, design, implementation and evaluation of software systems.
K17. Describe the dominant and industry standard modeling and programming paradigms and languages.
K18. State the current and underlying technologies that support all the phases of development of software systems.
K19. Describe the principles of information security and developing secure software.
K20. Identify the principles and methods used for testing and inspecting software systems to evaluate their quality and adherence to specifications.
K21. Give examples of the various software process models and pros and cons of each one.
K22. Recall the management and economics principles relevant to software industry.
K23. List the principles and activities of quality assurance of software systems.
K24. Indicate the code of ethics, professional practices and legal issues related to software engineering.
K25. Define the current and emerging trends in software engineering specifically and information technology at large and their impact on the discipline.
K26. Discuss the challenges inherent in the maintenance and evolution of software systems, and the techniques and best practices currently available for dealing with them.
K27. Recall and explain the engineering foundational skills and techniques especially those that are useful for software engineering, such as measurement, statistical analysis, standards, empirical methods, etc.

5.3.2 Intellectual Skills ILOs

In addition to Intellectual skills of Computing and Information graduate, the Software Engineering graduate should be able to:

I8. Analyze a problem using various sources of information to derive requirements specifications.
I9. Outline client's needs and the constraints and limits on the solution space.
I10. Propose a range of solutions that satisfy the requirements specifications and constraints, and critically evaluate and justify the proposed design solutions.
I11. Evaluate and select suitable tools, languages and methods for modeling, implementing, analyzing and verifying software systems using rational and reasoned technical and business arguments.
I12. Plan, manage and conduct testing activities to investigate the quality of a software system and its ability to provide the expected behavior and analyze and interpret the results.
I13. Review and audit a software artifact to determine its suitability for its intended usage, identify discrepancies from specifications, confirm the technical status of the project or other purposes.

I14. Judge the quality, security, safety, reliability, cost-effectiveness and environmental impact of software systems.
I15. Propose suitable project, process and configuration management methods and techniques for effective production of software systems.
I16. Devise informed technical decisions for the best interest of the business goals of the organization using principles of software engineering economics.
I17. Formulate acceptable, cost-effective and time-efficient problem solutions using essential knowledge and methods of estimating and measuring cost and productivity.
I18. Evaluate different situations arising during software engineering projects in the light of code of ethics and professional practice to make conscious decisions.
I19. Devise suitable engineering techniques and quantitative analysis methods to use in enforcing a systematic disciplined approach for software production.

5.3.3 Professional and Practical Skills ILOs

In addition to professional and practical Skills of Computing and Information graduate, Software Engineering graduate should be able to:

P15. Use appropriate tools and techniques to perform requirements elicitation, analysis, specification and validation.
P16. Apply solid design principles in developing architecture and design of software systems.
P17. Apply the principles of human-computer interaction to design, implement and evaluate user experiences and user interfaces.
P18. Use a broad range of tools and languages to design, implement and debug software systems that fulfill the requirements and adhere to the design.
P19. Perform validation and verification activities on software systems to ensure their correctness and adherence to requirements.
P20. Prepare plans, manage and conduct software maintenance and evolution activities.
P21. Utilize the necessary equipment, models and tools needed for each phase of software development lifecycle and for automation of the development activity when possible.
P22. Schedule and carry out software configuration and change management procedures and release planning and management.
P23. Prepare plans and manage software development projects from inception to final implementation and cut-over.
P24. Prepare and implement quality assurance plans and activities to ensure the quality of software products.
P25. Select and implement suitable software processes to run software development projects according to the circumstances of each project.

P26. Apply engineering principles such as experimental techniques, statistical analysis, risk analysis, measurements, simulation, prototyping, conformance to standards and others to develop and maintain software more efficiently and effectively.
P27. Apply principles of software engineering economics to align software technical decisions with the business goals of the organization.
P28. Analyze, document and compare the feasibility of various options in different phases during software development.
P29. Document software properly according to the applicable standards and produce all necessary technical and non-technical documents.
P30. Apply software code of ethics and professional practice in his/her work and promote its application in his/her work environment.

5.3.4 General and Transferable Skills ILOs

In addition to the General and Transferable Skills of Computing and Information graduate, Software Engineering graduate should be able to:

G7. Effectively conduct information gathering sessions (interviews, questionnaires, etc.) with non-technical personnel.
G8. Function effectively on multidisciplinary, global and virtual teams to accomplish a common goal.
G9. Recognize the need for, and engage in life-long learning of software engineering especially emerging trends and new technologies.
G10. Comment objectively on the performance or work of a peer, identifying strengths and making constructive suggestions for improvement where appropriate.
G11. Display personal responsibility by working to multiple deadlines in complex activities

6- NARS CHARACTERIZATION OF BIOINFORMATICS

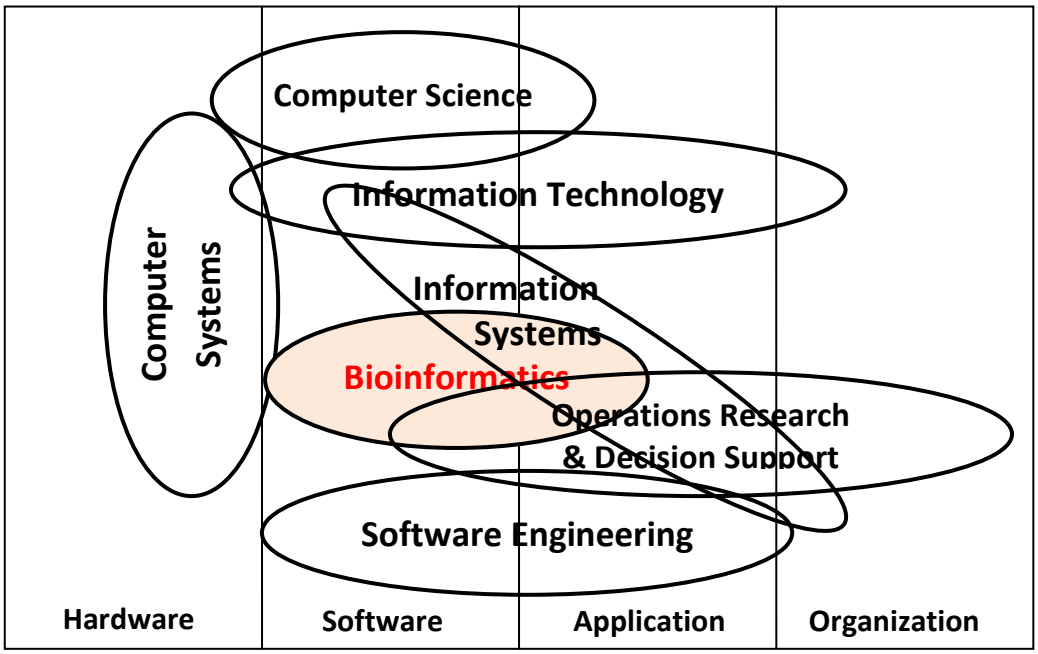
6.1 Introduction

Bioinformatics is an interdisciplinary field joining the field of Biology and Computer Science. Bioinformatics is concerned with the organization and analysis of biological data. For molecular biologists, Bioinformatics is the practice of using software tools to analyze the biological data in order to extract new knowledge, generate new hypothesis, or search for effective molecules. For computer scientists, it is the development of new algorithms and software tools handling biological data. Bioinformatics field attracts researchers from different fields to manipulate with the huge molecular databases so that they can extract useful insights and knowledge.

Bioinformatics is both an umbrella term for the body of biological studies that use computer programming as part of their methodology, as well as a reference to specific analysis "pipelines" that are repeatedly used, particularly in the fields of genetics and genomics. Common uses of Bioinformatics include the identification of candidate genes and nucleotides. Often, such identification is made with the aim of better understanding the genetic basis of disease, unique adaptations, desirable properties, for example agricultural species. Bioinformatics also tries to understand the organizational principles within nucleic acid and protein sequences

The work of Bioinformatics specialist could be fallen into four categories.

- Researcher in pharmacology for discovering new drugs and enhancing the effect of old ones.
- Researcher in agriculture for generating of new strains of plants and understanding its inheritance.
- In medicine field to help in understanding diseases causes and how to trace life cycle of certain disease like cancer.
- Design and implement new algorithms and software that helps physicians in diagnosis and discovering the way for remedy.



6.2 The Attributes of Bioinformatics Graduate

The Bioinformatics program is designed to provide the student with the foundations of the interdisciplinary field of Bioinformatics. After successfully completing the Bioinformatics program, the graduate should be able to:

1. Demonstrate knowledge of a range of specific computational and mathematical techniques in analyzing biological data;
2. Demonstrate a critical understanding of the most common applications in biology, and specifically the power of Bioinformatics in modern bioscience research;
3. Place their existing knowledge of biology, mathematics or computing into a Bioinformatics context.
4. Demonstrate an ability to relate these techniques to computational methods appropriate for the solution of Bioinformatics problems in a professional setting;
5. Be able to specify, test and replicate computational solutions in the analysis of biological data;
6. Develop a multi-disciplinary/inter-disciplinary perspective of Bioinformatics that brings together biological, computational and mathematical skills in application to practical problems in a professional setting;
7. Engage with the essential facts, major concepts, principles and theories associated with Bioinformatics;
8. Be competent users of the basic experimental skills of Bioinformatics;

9. Understand information and data, and their setting within a theoretical framework, accompanied by critical analysis and assessment of the subject area as a coherent whole;
10. Be familiar with the terminology, nomenclature and classification systems, as appropriate;
11. Acquire, interpret and analyze biological information with a critical understanding of the appropriate contexts for their use through the study of the existing primary literature in the field;
12. Be aware of the contribution of their subject to the development of knowledge about the diversity of life and its evolution;
13. Use a range of communication techniques and methodologies relevant to Bioinformatics, including data analysis and the use of statistics;
14. Engage with some of the current developments in Bioinformatics and their applications, and the philosophical and ethical issues involved.

6.3 National Academic Reference Standards for Computer Science

6.3.1 Knowledge and Understanding

In addition to **Knowledge and Understanding** of computing and information graduate, the Bioinformatics graduate should be able to:

K11. Recognize the basic biological terminology and terms of basic Biology and Bioinformatics
K12. List different global Bioinformatics and Systems Biology databases via the WWW
K13. Describe the available modern tools/simulators that help scientists in processing biological data and discovering new scientific discoveries.
K14. Detailed knowledge and understanding of algorithms in Bioinformatics and theoretical systems biology, including their rationality, advantages, and limitations.
K15. Discuss the principles of design and implementation of existing Bioinformatics algorithms and the value of their application to biological data.
K16. Describe the advantages and shortcomings of various Bioinformatics software tools.
K17. Describe new algorithms to manipulate biological data and discover new scientific facts
K18. Describe the application of computing and statistics to Predictive Biology.
K19. Recognize the relevant principles of data mining in Bioinformatics data.

K20. Recognize and describe the principles and advances of various technologies used for studies in modern Biology, such as Microarray and NGS, and the analysis of data generated by such studies.

6.3.2 Intellectual Skills

In addition to **Intellectual Skills** of computing and information graduate, the Bioinformatics graduate should be able to:

I8. Locate and Classify papers written in the field of Bioinformatics
I9. Explain and download biological data from different Bioinformatics databases
I10. Interpret new biological patterns
I11. Analyze DNA, Protein, biological diversity, molecular interaction and e-medical records data.
I12. Describe the key aspects of medical and bio informatics.
I13. Propose data mining solutions in bio informatics data.
I14. Propose efficient solutions for e-medical records management.
I15. Describe the key aspects of DNA replication, molecular biology, cell biology and microarray.
I16. Develop and implement strategies for modeling biological systems.
I17. Make a judgement comparison between different concepts of Computational Biology.

6.3.3 Professional and Practical Skills

In addition to **Professional and Practical Skills** of computing and information graduate, the Bioinformatics graduate should be able to:

P15. Download, analyze, and model data from different Bioinformatics databases
P16. Practice the available computational tools to process biological data
P17. Resolve new tools to help process biological data
P18. Design and implement more efficient algorithms in the field of Bioinformatics to help scientists process their biological Data
P19. Plan, develop, implement, and document various Bioinformatics and modeling software.
P20. Enhance current medical and Bioinformatics applications
P21. Implement data mining techniques over biological and medical data
P22. Design medical records management applications
P23. Use the scientific literature effectively
P24. Apply statistical and modelling skills to the biological data.

P25. Evaluate the existing medical and Bioinformatics applications

6.3.4 General and Transferable Skills

In addition to **General and Transferable Skills** of computing and information graduate, the Bioinformatics graduate should be able to:

G12. Read advanced textbooks in Computational Biology.
G13. Think critically of biological applications and medical records management applications that would benefit from the use of data mining.
G14. Build a solid foundation and acquire the vocabulary needed to supervise or to communicate with others in the fields of Biology and Bioinformatics.

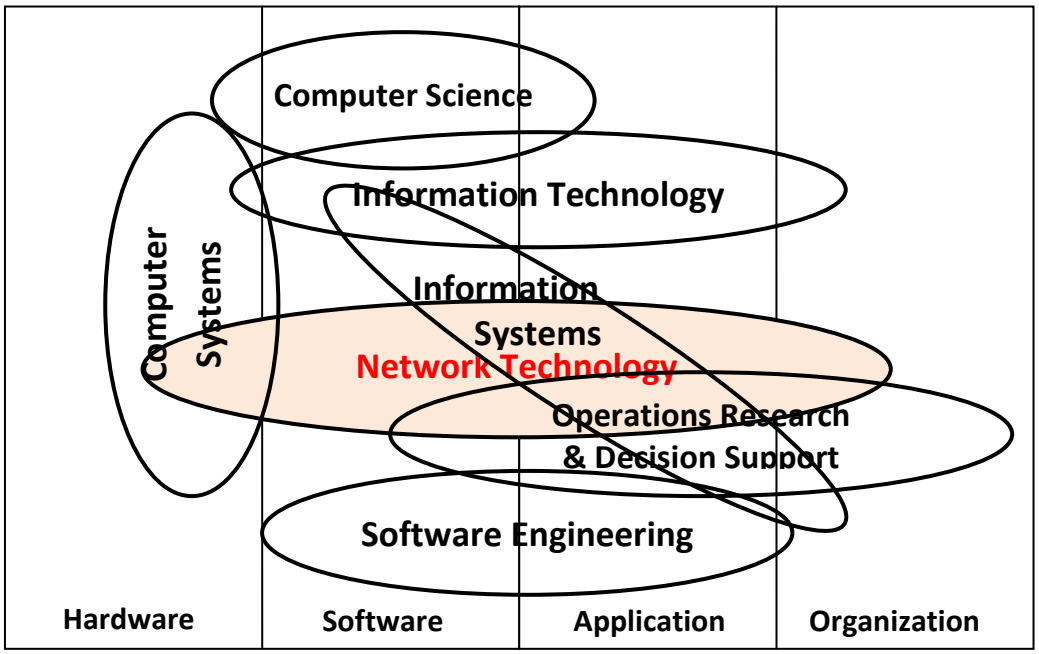
7- NARS CHARACTERIZATION OF NETWORK TECHNOLOGY

7.1 INTRODUCTION

Networks technology is the knowledge of the technologies involved in network management and operating, network and information security, embedded networks systems, and internet and web technology, gained by study, experience and practice, applied with judgment to develop ways to utilize, ethically and economically, the advances in modern technology and communication for the benefit of mankind. It is the ability to initiate and conduct activity associated with networking processes, systems, problems, opportunities, future, impacts, ethics and consequences. It involves knowledge, ways of thinking and acting, and theoretical and practical networking skills. It helps preparing individuals to make well-informed choices in their means of communication as consumers, workers, citizens and members of the global community.

The Networks Technology education should achieve excellence in undergraduate and postgraduate education, research, public service and to advance the state-of-the-art in networks technology. It means to produce talented, broadly educated, highly qualified specialists, useful creative high quality research and technology through academic excellence, and to challenge the students, faculty and staff to learn, to grow, to achieve, and to serve the needs of society, the nation and the world.

It means also to prepare students for a productive and rewarding career in networking or a related profession based on a strong moral and ethical foundation, and to create, integrate, and transfer knowledge of networks technology through the development of citizens and leaders for the society.



7.2 The Attributes of the Network Technology Graduates

Upon completion of the Network Technology program, the graduate student should be able to:

1. Apply knowledge of mathematics, probablities, electornics and logic design.
2. Analyze a problem; write a program using the fundamental concepts of programming; with the ability to document a program and the ability to select a particular computer language for a programming application.
3. Gain comprehensive knowledge of computer architectures, operating systems, information retrieval and database systems, decision support and simulation systems, software development and documentation.
4. Analyze and apply the concepts and techniques of signals processing and pattern recognition with applications in speech and image processing.
5. Know the technology required to build networking systems of all types.
6. Have acquired knowledge of the hardware components that make up computer networks, along with the features and specifications of these components.
7. Have acquired the skills of using modern methodologies and web and networks programming tools in planning, analyzing, designing, building and managing computer networks.
8. Have an integrated understanding of the scientific and practical principles underlying the major fields of networks technology, which include, networks

management and operating, network and information security, embedded networks systems, and internet and web technology.

9. Understand the operation of famous networks' standards.
10. Describe the principles of various types of mobile and wireless networking technologies.
11. Gain a solid understanding of computer graphics and multimedia systems; then evaluate techniques of data compression and transmission concerning the representations of sound, image and video.
12. Get familiar with the terminology and basic principles of Networks.
13. Effectively present ideas in a logical framework in a variety of forms with proper language structure and mechanics.
14. Work effectively in teams in designing and implementing networks' software.

7.3 NATIONAL ACADEMIC REFERENCE STANDARDS FOR NETWORK TECHNOLOGY GRADUATES

7.3.1 Knowledge and Understanding

In addition to Knowledge and Understanding of computing and information graduate, the Network Technology graduate should be able to

K11. Recognize the analytical concepts and algorithmic procedures relevant to computer network technology.
K12. Describe the human and economic sides of modern organizations.
K13. List the principles of computer architecture, operating systems.
K14. State the fundamentals of programming, data structures, algorithms and object orientation.
K15. Recognize the capabilities of design, implementation and evaluation of networking technology and its configuration and management for business.
K16. Describe the characteristics of a computer network system, either wired or wireless.
K17. Classify methods of securing data and networks.
K18. Describe programming computer interfaces and speech production methods.
K19. List the tools and techniques involved in networking applications.
K20. Describe the principles of mobile and wireless networking technologies.
K21. Define significance of the Internet to the global economy.
K22. Specify the software defined for networking and network functions virtualization
K23. Identify different operating systems and different network virtualization techniques.
K24. Describe new network technologies such as wireless sensor networks, higher generations of cellular networks, cognitive radio networks.

7.4.2 Intellectual Skills

In addition to Intellectual of computing and information graduate, the Network Technology graduate should be able to

I8. Analyzing physical problems in mathematical and systematical way.
I9. Design a system, component or process to meet a need.
I10. Identify parameters leading to problem definition and demonstrate problem solving skills.
I11. Construct solutions for a problem, assessing the different alternatives and be creative in the development of designs.
I12. Integrate and evaluate information, techniques, and systems from a variety of sources.
I13. Categorize various communication systems and networks protocols, either wired or wireless.
I14. Analyze, assess and modify the performance of computer network systems, either wired or wireless.
I15. Evaluate and analyze requirements for a computer networking installation and design a suitable system.
I16. Apply solutions to problems associated with the transport of information via a computer network.
I17. Analyze and critically appraise the performance and operation of wireless communication technologies.
I18. Analyze traffic flow in a computer network in order to optimize performance.
I19. Identify and explore options with regard to methods used to identify and secure the required data.
I20. Gain good experience of modern programming languages and frameworks used with networking applications such as Python, JSON, REST and XML.

7.4.3 Professional and Practical Skills

In addition to Professional and Practical Skills of computing and information graduate, the Network Technology graduate should be able to

P15. Prepare a plan to solve problems, perform experiments, then analyze, evaluate and extract conclusions from the experimental results.
P16. Represent information using statistics, diagrams and graphics.
P17. Operate on computer network commercial software systems and measure its feasibility.

P18. Develop computer programs to solve specific problem using various programming language.
P19. Develop programs for networks' operations.
P20. Troubleshoot a network problem.
P21. Implement classical security measures to computer network and data encryption techniques.
P22. Implementation of an effective strategic plan to meet the networking and internetworking requirements of an organization.
P23. Communicate effectively with system administrators in terms of identification of network types, operating systems and data storage areas
P24. Evaluate the technical performance of various networks.
P25. Plan and manage a network project, taking into account commercial and industrial constraints.

7.3.4 General and Transferable Skills

In addition to **General and Transferable Skills** of computing and information graduate, the Network Technology graduate should be able to:

G7. Read advanced textbooks in new Network Technologies that appear every day.
G8. Think critically of biological applications and medical records management applications that would benefit from the use of data mining.
G9. Build a solid foundation and acquire the vocabulary needed to supervise or to communicate with others in the fields of Biology and Bioinformatics.

8- NARS CHARACTERIZATION OF SCIENTIFIC COMPUTING

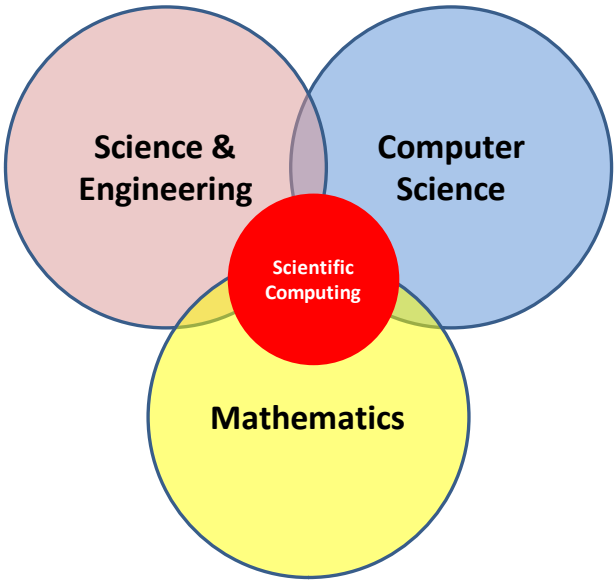
3.1 Introduction

Scientific Computing (SC) is the focal point of computational science activities at the sector of computing and information. Computational science involves the invention, implementation, testing, and application of algorithms and software used to solve large-scale scientific and engineering problems.

Scientific computing is now widely accepted, along with theory and experiment, as a crucial third mode of scientific investigation and engineering design. Aerospace, automotive, biological, chemical, semiconductor, and other industrial sectors now rely on simulation for technical decision support. For government agencies also, scientific computing has become an essential support for decisions on resources, transportation, and defense. Finally, in many new areas such as medicine, the life sciences, management and marketing, and finance, techniques and algorithms from computational science are of growing importance.

The field of scientific computing combines simulation, visualization, mathematical modeling, programming, data structures, networking, database design, symbolic computation, and high performance computing with various scientific disciplines. Hence, scientific computing may be defined as a broad multidisciplinary area that encompasses applications in science/engineering, numerical analysis, and computer science. Computer models and computer simulations have become an important part of the research repertoire, supplementing (and in some cases replacing) experimentation. Going from application area to computational results requires domain expertise, mathematical modeling, numerical analysis, algorithm development, software implementation, program execution, analysis, validation and visualization of results.

Scientific computing involves all of this. Although it includes elements from computer science, engineering and science, scientific computing focuses on the integration of knowledge and methodologies from all of these disciplines, and as such is a subject which is (in some sense) distinct from any of them. The graphical representation of scientific computing, shown in the following figure, is one of several variations on this theme.



Scientific computing includes, but is greater than, the intersection of mathematics, computer science and science and engineering.

3.2 The Attributes of The Computer Science Graduates

After successfully completing the scientific computing and information program, the graduate should be able to :

1. Formulate simple mathematical models of physical systems in terms of algebraic and differential equations, starting from a rough description of the problem.
2. Select or develop a suitable numerical method to obtain quantitative estimates of important parameters in the mathematical models.
3. Implement the numerical method in a programming language and obtain estimates of the parameters of interest.
4. Use high performance computing resources whenever needed to solve large-scale problems.
5. Use symbolic computing tools to develop approximate and closed form solutions.
6. Interpret results and assess the different mathematical models.
7. Deal with scientific databases.
8. Select and use the appropriate visualization technique for visualizing numerical data.
9. Report the results of analysis and the interpretation of those results in a suitable (written text or graphical) form.
10. Continue to learn and be able to read mathematical modeling, computing and numerical methods literature with a view to using new ideas in future scientific computing problems.

3.4. National Academic Reference Standards for Scientific Computing Graduates

3.4.1 Knowledge and Understanding

In addition to Knowledge and Understanding of computing and information graduate, the Scientific Computing graduate should be able to:

1. Use high-level programming languages.
2. Demonstrate basic knowledge and understanding of a core knowledge.
3. Demonstrate strong skills in computational methods, simulation and modeling.
4. Apply effectively computational modeling techniques to an application area fields.
5. Interpret and analyzing data qualitatively and/or quantitatively.
6. Visualize different types of scientific data with different techniques.
7. Deal with high performance computing resources.
8. Communicate the solution process effectively.

3.4.2 Intellectual Skills

In addition to Intellectual of computing and information graduate, the Scientific Computing graduate should be able to:

1. Define problems in precise scientific manner.
2. Set goals towards solving traditional and nontraditional problems.
3. Observe results and attitudes.
4. Formulate clear questions and models for any real-life problems.
5. Perform comparisons between algorithms, methods, and techniques.
6. Perform classifications of (data, results, methods, techniques, algorithms, etc.).
7. Identify attributes and components.
8. Identify relationships and patterns.
9. Identify main ideas.
10. Identify errors.
11. Infer up on the problem conditions.
12. Predict best solution, source of errors, etc...
13. Elaborate.
14. Summarize problems, proposed solutions and their results.
15. Restructure solution methodologies up on their results.
16. Establish criteria.
17. Verify solutions.

3.4.3 Professional and Practical Skills

In addition to Professional and Practical of computing and information graduate, the Scientific Computing graduate should be able to:

1. Explore, and where feasible solve, mathematical problems, by selecting appropriate techniques.
2. Use of standard numerical recipes and mathematical libraries in problem solving.
3. Use symbolic software to develop approximate and closed form solutions.
4. Use scientific visualization packages to visualize complex scientific data sets.
5. Determine the merits of parallelizing a particular scientific code for operation on a shared-memory or a distributed-memory platform.
6. Parallel programming using MPI and OpenMP.
7. Give technical presentations.

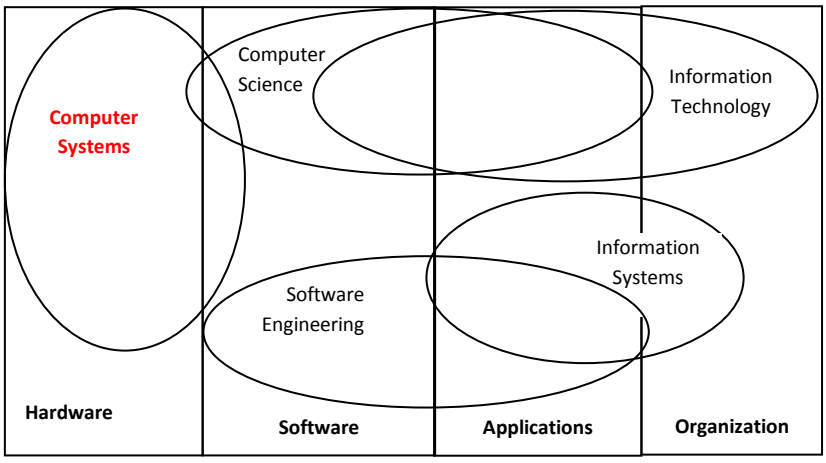
9- NARS CHARACTERIZATION OF COMPUTER SYSTEMS

5.1 Introduction

Computer systems program is concerned with the design and construction of computers and computer-based systems. It involves the study of hardware, software, communications, and the interaction among them. Its curriculum focuses on the theories, principles, and practices of traditional electrical engineering and mathematics and applies them to the problems of designing computers and computer-based devices.

Computer systems students study the design of digital hardware systems including communications systems, computers, and devices that contain computers, software development, focusing on software for digital devices and their interfaces with users and other devices. Computer System study may emphasize hardware more than software or there may be a balanced emphasis.

Computer System has a strong engineering flavor, and currently, a dominant area within computing engineering systems is embedded systems, the development of devices that have software and hardware embedded in them.



5.2 4.2 The Attributes of The Computer Systems Graduates

After successfully completing the Computer Systems program, the graduate should be able to :

1. Recognize problems that are amenable to computer systems, and knowledge of the tools necessary for solving such problems.
2. Have a detailed understanding of the fundamentals of computer programming, networking, computer organization, computer architecture, networks, artificial intelligence, graphics, computer interfacing, databases, embedded applications and computer and network security and operating systems.
3. Analyze real-world problems, and identify and define the computing requirements appropriate to its solution, and. to design systems to meet the desired needs within problem constraints.
4. Apply knowledge of computing to design, implement and evaluate a computer-based solution to a problem to meet desired needs.
5. Demonstrate an understanding of emerging technologies and a working knowledge of currently available software tools, techniques and skills necessary for computing.
6. Identify, formulate, and solve information technology problems.
7. Use the techniques, skills, and modern engineering tools necessary for engineering practice. Graduates will demonstrate the ability to apply knowledge of computing and mathematics.
8. Use and apply current technical concepts and practices in information technology to design effective and usable IT-based solutions and integrate them into the user environment.
9. Work effectively in teams in designing and implementing software systems.
10. Demonstrate the ability to orally communicate ideas and concepts clearly and in an organized manner.

5.3. National Academic Reference Standards for Computer Systems

5.3.1 Knowledge and Understanding

In addition to Knowledge and Understanding of computing and information graduate, the Computer Systems graduate should be able to

1. Demonstrate basic knowledge and understanding of a core of analysis, algebra, applied mathematics and statistics.
2. Understand and apply a wide range of principles and tools of software engineering, such as design methodologies, choice of algorithm, language, software libraries and user interface technique.

3. Demonstrate the principles of computer systems, including architecture, networks and communications.
4. Know and understand the principles and techniques of a number of application areas informed by the research directions of the subject, such as computer interfacing and computer graphics.
5. Show a critical understanding of the physical, electronic, architecture principles underlying hardware design.
6. Understand hardware and/or software designs to provide working solutions, including use of appropriate programming languages, web-based systems and tools, design methodologies, and database systems.
7. Understand the principles computer programming, networking, computer organization, computer architecture, networks, artificial intelligence, graphics, computer interfacing, databases, embedded applications and computer and network security and operating systems.

5.3.2 Intellectual Skills

In addition to Intellectual of computing and information graduate, the Computer Systems graduate should be able to

1. Define traditional and nontraditional information technology problems, set goals towards solving them, and. observe results.
2. Perform comparisons between (algorithms, methods, techniques...etc).
3. Perform classifications of (data, results, methods, techniques, algorithms.. etc.).
4. Identify attributes, components, relationships, patterns, main ideas, and errors.
5. Summarize the proposed solutions ad their results.
6. Restrict solution methodologies upon their results.
7. Establish criteria, and verify solutions.
8. Identify a range of solutions and critically evaluate and justify proposed design solutions.
9. Solve IT problems with pressing commercial or industrial constraints.
10. Generate an innovative design to solve a problem containing a range of commercial and industrial constraints. Design and implement a software or hardware system of significant size.

5.3.3 Professional and Practical Skills

In addition to Professional and Practical Skills of computing and information graduate, the Computer Systems graduate should be able to

1. Use appropriate programming languages, web-based systems and tools, design methodologies, and database systems. Work effectively as an individual and as a member of a team.

2. Perform independent information acquisition and management, using the scientific literature and Web sources.
3. Prepare and present seminars to a professional standard.
4. Communicate effectively by oral, written and visual means.
5. Prepare technical reports, and a dissertation, to a professional standard.
6. Use IT skills and display mature computer literacy.
7. Specify, design, and implement IT and computer-based systems.
8. Evaluate systems in terms of general quality attributes and possible tradeoffs presented within the given problem.
9. Apply the principles of human-computer interaction to the evaluation and construction of a wide range of materials including user interfaces, web pages, and multimedia systems.
10. Identify any risks or safety aspects that may be involved in the operation of computing equipment within a given context.
11. Deploy effectively the tools used for the construction and documentation of software, with particular emphasis on understanding the whole process involved in using computers to solve practical problems.
12. Prepare technical reports, and a dissertation, to a professional standard.
13. Use appropriate computer-based design support tools.

Glossary

1. **Institution**

   A University, faculty or higher institute providing education programs leading to a first university degree or a higher degree (Master's or Doctorate).

2. **Graduate Attributes**

   Competencies expected from the graduate based on the acquired knowledge and skills gained upon completion of a particular program.

3. **National Academic Reference Standards (NARS)**

   Reference points designed by NAQAAE to outline / describe the expected minimum knowledge and skills necessary to fulfill the requirements of a program of study.

4. **Academic Standards**

   Reference points prescribed (defined) by an institution comprising the collective knowledge and skills to be gained by the graduates of a particular program. The academic standards should surpass the NARS, and be approved by NAQAAE.

5. **Subject Benchmark Statements**

   Guideline statements that detail (enumerate) what can be expected of a graduate in terms of the learning outcomes to satisfy the standards set for the program. They enable the outcomes to be compared, reviewed and evaluated against agreed upon standards.

6. **The Program**

   A set of educational courses and activities designed by the institution to determine the systematic learning progress. The program also imparts the intended competencies required for the award of an academic degree.

7. **Intended Learning Outcomes (ILOs)**

   Subject-specific knowledge, understanding and skills intended by the institution to be gained by the learners completing a particular educational activity. The ILOs

emphasize what is expected that learners will be able to do as a result of a learning activity.

8. Knowledge and Understanding

Knowledge is the intended information to be gained from an educational activity including facts, terms, theories and basic concepts. Understanding involves comprehending and grasping the meaning or the underlying explanation of scientific objects.

9. Intellectual Skills

Learning and cognitive capabilities that involve critical thinking and creativity. These include application, analysis, synthesis and evaluation of information.

10. Professional and Practical Skills

Application of specialized knowledge, training and proficiency in a subject or field to attain successful career development and personal advancement.

11. General and Transferable Skills

Skills those are not subject-specific and commonly needed in education, employment, life-long learning and self development. These skills include communication, team work, numeracy, independent learning, interpersonal relationship, and problem solving... etc.

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