

North Carolina Agricultural & Technical State University



College of Engineering

Computer Science Department

Master of Science in Computer Science

Graduate Student Handbook

(Last Updated July 2006)

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North Carolina A&T State University is committed to equality of educational opportunity and does not discriminate against applications, students, or employees based on race, color, national origin, religion, gender, sexual orientation, age or disability. Moreover, North Carolina A&T State University is open to people of all races and actively seeks to promote racial integration by recruiting and enrolling a larger number of white students.
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1. Introduction

This handbook serves as both a source of information on the graduate program in the Computer Science Department for prospective students and as a manual on current policies, procedures, and guidelines for current students. This handbook should always be used in conjunction with other official publications of the University, of the Graduate School, and of the College of Engineering Graduate Office.

The current edition of the North Carolina Agricultural & Technical State University (NC A&T SU) Graduate Catalog contains the university procedures and requirements. Those procedures and requirements pertain to all graduate work undertaken at NC A&T SU. It is the responsibility of each graduate student to ensure that their graduate program conforms to these requirements. Additional information or clarification about the Graduate School requirements can be obtained from the Office of Graduate Studies (122 Gibbs Hall), 336-334-7920 (<http://www.ncat.edu/~gradsch/>)

Any changes in this catalog will be disseminated in writing. It is the student's obligation to obtain the most current information from their advisor before designing a course of study. The policies stipulated in this document are the only basis for designing a program of study for each MS student.

2. Masters Program General Description

The Department of Computer Science offers an innovative graduate program, combining computer science fundamentals with practical knowledge and technical excellence in the most advanced technologies. The Computer Science Department performs research funded by agencies including the National Aeronautics and Space Administration, the U.S. Air Force, the National Security Agency, the National Imagery and Mapping Agency, the Naval Oceanographic Office, National Science Foundation and among others.

The research interests of faculty members cover many areas of computer science. The department's strengths are in the areas of software engineering, computer security, computational science, distributed systems, visualization, multiagent systems, multimedia input and high performance computing, artificial intelligence, and algorithms.

The Department offers an MS Computer Science degree with option of a "General Track", and four specialization tracks "Software Engineering Track", "Computational Science and Engineering Track", "Information Assurance" and "Artificial Intelligence Track". Students interested in Software Engineering, Computational Science and Engineering, Information Assurance and Artificial Intelligence can choose one of these specialization tracks, whereas students interested in other areas may select General Track, and design their curriculum in consultation with their advisor to satisfy all graduation requirements of MS in CS. Detailed description of the program appear in Section 5 on Degree requirements.

3. Ph.D Program General Description

The Computer Science Department is committed to cooperate with the Electrical Engineering Department and the Industrial Engineering Department to offer Ph.D program. Students interested in the Human-Interface field can pursue Industrial Engineering. Students interested in Networks, Artificial Intelligence, Software Engineering, and information System can pursue the Electrical Engineering Ph.D. program.

4. Admission Requirements

It is assumed that all entering students have completed undergraduate courses in programming in a high-level language (such as C, C++, Java, or Smalltalk), in data structures, and in computer architecture, as well as mathematical maturity (for example Calculus I & II, and Discrete Mathematics or Switching Theory). Students who have not had such courses or their equivalent may be required to take undergraduate courses to remedy deficiencies, with no credit towards the degree. A 3.0 GPA and an undergraduate degree in Computer Science or a related discipline are required for unconditional admission.

Detailed information on admissions procedures, along with the appropriate forms, are available from the Graduate School and College of Engineering graduate office. You may directly contact:

College of Engineering

Assistant Dean for Student Development: Mr. Leotis Parrish, McNair, 336-334-7589

The Graduate School

Admissions Director: Ms. Young, Gibbs Hall, 336-334-7920

The Graduate School Admission Information booklet from the College of Engineering details admission procedure, unconditional admission, provisional admission, and special student status.

5. Degree Requirements

The Masters of Science in Computer Science at NC A&T SU can be earned with one of three options: *Project, Thesis, or course*. The Thesis option requires thirty credit hours consisting of twenty-four credit hours of course work and six credit hours for the thesis. The Project option requires thirty-three credit hours consisting of thirty credit hours of course work and three credit hours for the project. The course option is the default option for all students, and requires thirty-three credit hours of course work. Graduate credit hours are earned only on courses numbered 600 and above, and at least half of the credit hours must be in courses numbered 700 and above.

As stated before, students may specialize in one of four tracks (Software Engineering Track, Computational Science and Engineering Track, Information Assurance, and Artificial Intelligence Track), or select the General Track and design their own program in consultation of their advisor such that all requirements for MS in CS at NC A&T SU are satisfied. Students choosing Software Engineering, or Computational Science and Engineering, or Information Assurance, or Artificial Intelligence may benefit from the following description of the four areas:

SOFTWARE ENGINEERING(SE): Software engineering can be defined as the systematic approach to the development, operation, maintenance, and retirement of software. Software is not only program code, but includes the various documents needed for the development, installation, utilization, and maintenance of a system. Engineering refers to the application of a systems approach to the production of large software systems. Methodologies for analysis and design are evolving, and being automated through the use of CASE (computer aided software engineering) tools. The methods of software engineering seek to produce high quality systems, on time, at the lowest possible cost. Research projects include object oriented methodologies, software production cost modeling, software reliability engineering, software reuse, and the social implications of computer technology. In accordance with our historical mission, the program also provides students with knowledge of organizational theory, management practices, information economics, and societal and policy frameworks.

COMPUTATIONAL SCIENCE AND ENGINEERING(CSE): Computational science is a relatively new branch of science and has emerged as a powerful and indispensable method of analyzing a variety of problems in research, production and process development, and manufacturing. Computational modeling and simulation is being accepted as a third methodology in scientific research, complementing the traditional approaches of theory and experiment. Computational modeling, simulation, and visualization are immensely useful for studying things that are otherwise too big, too small, too expensive, too scarce, or too inaccessible to study. The rapid growth of information technology and its applications in the job market created a need for multi-skilled workers at all levels, including the master's.

INFORMATION ASSURANCE (IA): With wide spread use of the Internet, Information Assurance has become a dominant issue in the Information Technology (IT) industry. Information Assurance has significantly influenced priorities for IT education, research, and development. To defend our homeland and stay at the forefront of scientific discovery, federal and local governments recognize the need for a well-trained workforce in emerging and advanced tools of information security. The rapid growth of Information Assurance in the job market created a need for well-trained workers at all levels, including the master's. Research topics include network security, Web security, wireless security, intrusion detection, information privacy and security, and software development security.

ARTIFICIAL INTELLIGENCE (AI): Artificial intelligence uses symbolic computation and complex interrelations of variables to produce "intelligent" responses to problem situations. The responses are intelligent

in the sense that unforeseen situations are accommodated. Problems of interest are frequently ill-structured: that is, they cannot be stated in the forms required by commonly used deterministic and sequential algorithms. Artificial intelligence often involves search and inference, and frequently supports human decision making. It is thus natural to view artificial intelligence software as tackling problems as humans would tackle them. Research topics include mobile robots motion planning, computer vision, automated reasoning, the acquisition and representation of knowledge, and the analysis of decision making in realistic business settings. Artificial intelligence uses a multitude of paradigms, willingly collaborates with other areas of computer science, and pursues real-world applications.

GENERAL TRACK: There are several other research areas in the Department of Computer Science. Students can select a research topic from these areas as the project/thesis. Students must consult their advisor to design their curriculum and project/thesis.

The course-work requirements for MS in Computer Science at NC A&T SU must be satisfied by:

1. Two three credit hours courses in core area required of all students in the program,
2. Required courses specific to the student's track (Students selecting General Track design their curriculum in consultation with their advisor, and with approval of Director of Graduate Studies),
3. Approved elective courses in the student's track for students pursuing a specialty track in Software Engineering, or Computational Science and Engineering Track, Information Assurance or Artificial Intelligence,
4. Elective courses chosen with the prior written approval of the student's advisor and the Director of Graduate Studies, and
5. With permission of a student's advisor and the Director of Graduate Studies, the student may take up to a maximum of two electives outside the Computer Science Department.

Sections 5.1 through 5.5 describe different aspects of the program in detail.

5.1. Required Core Courses

The following core courses are required for all students for the MS in CS at NC A&T SU.

COMP 755	Advanced Operating Systems
COMP 785	Advanced Design and Analysis of Algorithms

5.2. Required Courses for Tracks

The Department offers specialty tracks in Software Engineering, Computational Science and Engineering, Information Assurance, and Artificial Intelligence for students interested in these areas. The student has the option of choosing one of these tracks, or opting for the General Track. Each track has its own required courses and required electives, in addition to the common core courses. Every student must formulate a curriculum that fulfills all graduation requirements, in consultation with their advisor, and with approval of Director of Graduate Studies.

The required course for the five tracks are listed below:

Software Engineering

COMP 710	3	Software Specification, Analysis, & Design
COMP 711	3	Software System Design, Implementation, Verification, & Validation
COMP 712	3	Software Project Management
COMP xxx	3	Software Engineering Elective (see list in the next section)

Computational science and Engineering

COMP 770	3	Computer Organization and Programming for Scientific Computing
COMP 732	3	Advanced Software Tools
MATH 731	3	Advanced Numerical Methods
COMP xxx	3	Computational Science and Engineering elective

Information Assurance

COMP 620	3	Information, Privacy, and Security
COMP 621	3	Web Security
COMP 790	3	Network Security
COMP xxx	3	Information Assurance elective

Artificial Intelligence

COMP 645	3	Artificial Intelligence
COMP 740	3	Advanced Artificial Intelligence
COMP xxx	3	AI Elective (see list in the next section)
COMP xxx	3	AI Elective (see list in the next section)

General Track

COMP 681	3	Formal Methods
COMP 710	3	Software Specification, Analysis, & Design

5.3. Thesis, Project, and Course Option

Each student has the option of completing the final degree requirements with the completion of a Master's Thesis, a Master's Project, or by means of courses work. The particulars of each option are discussed under their respective titles in this handbook. The following tables summarize the requirements for each available option in the five tracks.

<i>SE Track</i>	Required Core	Specialty Required	Specialty Electives	Approved Electives	Project/Thesis	Total Credits
SE Course Option	6 credits COMP 755 COMP 785	9 credits COMP 710 COMP 711 COMP 712	3 credits with approval (see list)	15 credits with approval (see list)	.	33
SE Project Option	6 credits COMP 755 COMP 785	9 credits COMP 710 COMP 711 COMP 712	3 credits with approval (see list)	12 credits with approval (see list)	COMP 796 MSCS Project: 3 credits.	33
SE Thesis Option	6 credits COMP 755 COMP 785	9 credits COMP 710 COMP 711 COMP 712	3 credits with approval (see list)	6 credits with approval (see list)	COMP 797 MS Thesis Research: 6 credits.	30

<i>CSE Track</i>	Required Core	Specialty Required	Interdisciplinary Electives	Approved Electives	Project/Thesis	Total Credits
CSE Course Option	6 credits COMP 755 COMP 785	9 credits COMP 770 COMP 732 MATH 731	6 credits with approval	12 credits with approval		33
CSE Project Option	6 credits COMP 755 COMP 785	9 credits COMP 770 COMP 732 MATH 731	6 credits with approval	9 credits with approval	COMP 796 MSCS Project: 3 credits.	33
CSE Thesis Option	6 credits COMP 755 COMP 785	9 credits COMP 770 COMP 732 MATH 731	6 credits with approval	3 credits with approval	COMP 797 MS Thesis Research: 6 credits.	30

<i>IA Track</i>	Required Core	Specialty Required	Interdisciplinary Electives	Approved Electives	Project/Thesis	Total Credits
IA Course Option	6 credits COMP 755 COMP 785	9 credits COMP 620 COMP 621 COMP 790	6 credits with approval	12 credits with approval		33
IA Project Option	6 credits COMP 755 COMP 785	9 credits COMP 620 COMP 621 COMP 790	6 credits with approval	9 credits with approval	COMP 796 MSCS Project: 3 credits.	33
IA Thesis Option	6 credits COMP 755 COMP 785	9 credits COMP 620 COMP 621 COMP 790	6 credits with approval	3 credits with approval	COMP 797 MS Thesis Research: 6 credits.	30

<i>AI Track</i>	Required Core	Specialty Required	Specialty Electives	Approved Electives	Project/Thesis	Total Credits
AI Course Option	6 credits COMP 755 COMP 785	6 credits COMP 645 COMP 740	6 credits with approval (see list)	15 credits with approval (see list)		33
AI Project Option	6 credits COMP 755 COMP 785	6 credits COMP 645 COMP 740	6 credits with approval (see list)	12 credits with approval (see list)	COMP 796 MSCS Project: 3 credits.	33
AI Thesis Option	6 credits COMP 755 COMP 785	6 credits COMP 645 COMP 740	6 credits with approval (see list)	6 credits with approval (see list)	COMP 797 MS Thesis Research: 6 credits.	30

<i>General Track</i>	Required Core	Specialty Required	Specialty Electives	Approved Electives	Project/Thesis	Total Credits
General Course Option	6 credits COMP 755 COMP 785	6 credits COMP 681 COMP 710		21 credits with approval (see list)		33
General Project Option	6 credits COMP 755 COMP 785	6 credits COMP 681 COMP 710		18 credits with approval (see list)	COMP 796 MScS Project: 3 credits.	33
General Thesis Option	6 credits COMP 755 COMP 785	6 credits COMP 681 COMP 710		15 credits with approval (see list)	COMP 797 MS Thesis Research: 6 credits.	30

5.4. Summary List of Graduate Courses in Computer Science

Course		SE Track		CSE Track		IA Track		AI Track		General	
		Req	Elec	Req	Elec	Req	Elec	Req	Elec	Req	Elec
COMP 611	System Testing and Evaluation		√		√		√		√		√
COMP 620	Information, Privacy, and Security		√		√	√			√		√
COMP 621	Web Security		√		√	√			√		√
COMP 627	Wireless Network Security		√		√		√				√
COMP 645	Artificial Intelligence							√			√
COMP 653	Computer Graphics		√		√		√		√		√
COMP 662	Computer Aided Instruction								√		√
COMP 663	Compiler Construction		√						√		√
COMP 670	Advanced Computer Architecture		√		√		√		√		√
COMP 681	Formal Methods		√		√				√	√	
COMP 700	Independent Study		√		√		√		√		√
COMP 710	Software Specification, Analysis, & Design	√			√		√		√	√	
COMP 711	SW System Design., Imptn., Veriftn., &	√									√
COMP 712	Software Project Management	√			√		√		√		√
COMP 713	Social Impacts of Software Systems		√		√		√		√		√
COMP 714	CASE, Automated Development, & Info.								√		√
COMP 716	Object-Oriented Program and Software Reuse		√		√		√		√		√
COMP 717	Software Fault Tolerance		√				√				√
COMP 718	Object Oriented Software Engineering		√		√		√		√		√
COMP 722	E-Commerce		√		√		√		√		√
COMP 723	Intrusion Detection		√		√		√				√
COMP 732	Advanced Software Tools		√	√			√				√
COMP 733	Parallel Computing Applications		√		√		√		√		√
COMP 740	Advanced Artificial Intelligence				√			√			√
COMP 741	Knowledge Representation and Acquisition		√		√		√		√		√
COMP 742	Automated Reasoning								√		√
COMP 745	Computational Linguistics								√		√
COMP 747	Computer Vision Methodologies		√				√		√		√
COMP 749	Intelligent Robot								√		√
COMP 750	Distributed Systems		√		√		√		√		√
COMP 753	Performance Modeling and Evaluation		√		√		√		√		√
COMP 755	Advanced Operating Systems	√		√		√		√		√	
COMP 767	Computer Network Architecture		√		√		√		√		√
COMP 770	Computer Org. and Prog. for Sci.		√	√			√				√
COMP 780	Semantics of Programming Languages		√		√				√		√
COMP 785	Advanced Analysis of Algorithms	√		√		√		√		√	
COMP 786	Multiagent Systems		√		√		√		√		√
COMP 790	Special Topics in Computer Science		√		√	√			√		√
COMP 793	Masters Supervised Teaching		√		√		√		√		√
COMP 796	MSCS Project		√		√		√		√		√
COMP 797	MS Thesis Research		√		√		√		√		√

COMP 999	Continuation Research		√		√		√		√	
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5.5. Approved Elective Courses from other Departments

The following list indicates which courses from departments other than Computer Science can be taken as elective courses.

ELEN 602 Semiconductor theory and devices
ELEN 614 Integrated Circuit Fabrication Methods
ELEN 615 Silicon Device Fabrication laboratory
ELEN 616 Microprocessor Software Design
ELEN 617 Microprocessor Hardware Design
ELEN 627 Switching Theory
ELEN 629 VLSI Design
ELEN 633 Digital Electronics
ELEN 649 Modulation theory and Communication systems
ELEN 650 Digital Signal Processing I
ELEN 656 Probability and Random Processing
ELEN 668 Automatic Control Theory
ELEN 674 Network Synthesis
ELEN 705 Solid State Devices
ELEN 727 Switching and Finite Automata Theory
ELEN 729 Digital Systems
ELEN 748 Statistical Communication Theory
ELEN 756 Optical Electronics
ELEN 760 Theory of Linear Systems
ELEN 762 Network Matrices and Graphs
GEEN 601 Industrial Automation
GEEN 602 Advanced Manufacturing
INEN 600 Survey of Industrial Engineering Topics
INEN 615 Industrial Simulation
INEN 670 Principles of Ergonomics
INEN 675 Design and Analysis of Experiments
INEN 735 Human-Computer Interface
MATH 607 Theory of Numbers
MATH 620 Elements of Set Theory and Topology
MATH 623 Advanced Probability and Statistics
MATH 624 Methods of Applied Statistics
MATH 632 Games and Queue Theory
MATH 700 Theory of Functions of a Real Variable I
MATH 701 Theory of Functions of a Real Variable II
MATH 710 Theory of Functions of a Complex Variable I
MATH 711 Theory of Functions of a Complex Variable II
MATH 715 Projective Geometry
MFG 651 Principles of Robotics
MFG 674 Advanced Automation and Control
MFG 770 Managing a Total Quality System

6. Advisor

Upon receipt of admission from the Dean of the Graduate School, the student should meet with the Computer Science Director of Graduate Studies for the assignment of a temporary advisor. The advisor will assist the student

in registration until the student selects a permanent advisor by mutual agreement between the student and the graduate faculty member.

All students *must* select a permanent advisor by the first month of their second semester of full time study. (Thesis and project students must form their Thesis or Project Committee by the end of the first month of their second semester). It is the responsibility of **the student** to meet all deadlines.

7. Transfer Credits

No more than six hours of transfer credits may be applied to the MS degree. Written approval of the Department Chair or the Director of Graduate Studies is required. The courses transferred must be equivalent to NC A&T SU listed courses at the 600 level or above, and may not have been counted towards any degree requirements at another institution.

8. Residency

A minimum of three-fourths (75%) of the hours required for the MSCS degree must be earned in residence study at NC A&T SU. Refer to the Graduate School bulletin for details.

9. Time Limit

The MSCS program must be completed within six consecutive calendar years. The program is designed to be completed in three semesters of full-time study, which is also the limit on departmental financial support.

10. Course Option

The Course Option is the default option for all students. Thesis and Project credits cannot be counted towards the Course Option. Suggested programs of study for full time students selecting the Course Option are listed below.

**Suggested Schedule for a MS in Computer Science
Course Option, Total Credits: 33**

Software Engineering Track - Course Option

Fall - Semester 1

COMP 755	3	Advanced Operating Systems
COMP 710	3	Software Specification, Analysis & Design
COMP 712	3	Software Project Management
COMP xxx	3	Software Engineering Elective

Spring - Semester 2

COMP 785	3	Advanced Design and Analysis of Algorithms
COMP 711	3	Software System Design, Implementation, Verification & Validation
COMP xxx	3	Software Engineering Elective
COMP xxx	3	Elective

Fall - Semester 3

COMP xxx	6	Software Engineering Elective
COMP xxx	3	Elective

Computational Science and Engineering Track - Course Option

Fall - Semester 1

COMP 755	3	Advanced Operating Systems
COMP 732	3	Parallel Computing Applications
MATH 731	3	Advanced Numerical Methods
COMP xxx	3	Computational Science and Engineering Elective

Spring - Semester 2

COMP 785	3	Advanced Design and Analysis of Algorithms
COMP 770	3	Computer Organization and Programming for Scientific Computing
COMP xxx	3	Computational Science and Engineering Elective
COMP xxx	3	Elective

Fall - Semester 3

COMP xxx	6	Computational Science and Engineering Elective
COMP xxx	3	Elective

Information Assurance Track - Course Option

Fall - Semester 1

COMP 620	3	Information, Privacy and Security
COMP 755	3	Advanced Operating Systems
COMP 790	3	Network Security
COMP xxx	3	Elective

Spring - Semester 2
 COMP 785 3 Advanced Design and Analysis of Algorithms
 COMP 621 3 Web Security
 COMP xxx 3 Information Assurance Elective
 COMP xxx 3 Elective

Fall - Semester 3
 COMP xxx 6 Information Assurance Elective
 COMP xxx 3 Elective

Artificial Intelligence Track - Course Option

Fall - Semester 1
 COMP 645 3 Artificial Intelligence
 COMP 755 3 Advanced Operating Systems
 COMP xxx 3 Artificial Intelligence Elective
 COMP xxx 3 Elective

Spring - Semester 2
 COMP 785 3 Advanced Design and Analysis of Algorithms
 COMP 740 3 Advanced Artificial Intelligence
 COMP xxx 3 Artificial Intelligence Elective
 COMP xxx 3 Elective

Fall - Semester 3
 COMP xxx 6 Artificial Intelligence Elective
 COMP xxx 3 Elective

General Track - Course Option

Fall - Semester 1
 COMP 755 3 Advanced Operating Systems
 COMP 710 3 Software Specification, Analysis & Design
 COMP xxx 6 Elective

Spring - Semester 2
 COMP 785 3 Advanced Design and Analysis of Algorithms
 COMP 681 3 Formal Methods
 COMP xxx 3 Elective
 COMP xxx 3 Elective

Fall - Semester 3
 COMP xxx 6 Elective
 COMP xxx 3 Elective

11. Project Option

The Project Option should be considered by students who seek to demonstrate that they have mastery of a computer science specialty that can be demonstrated by the completion of a substantial implementation project. This option provides excellent preparation for development of the professional skills of the students already working as a computer professional, as well as those students who seek substantive work experiences after graduation, or who may plan to pursue doctoral studies.

To select the Project Option, the student must find a member of the graduate faculty willing to serve as the Project Advisor. Acceptance to the MS program does NOT guarantee that the student will be able to find a graduate faculty member willing to serve as their Project Advisor. If no faculty member is willing to serve, the student will select either the Thesis Option or the Course Option, as explained under the respective headings in this document.

With the Project Advisor, the student will select a committee of 3 to 5 faculty members as the MS Project Committee. This committee serves in the capacity of an impartial second source of professional review of the quality of the student's work and, in conjunction with the academic advisor, assists the student in the research work

required for the Project. A majority of the members of this committee must be from within the Computer Science Department. The composition of the committee must be approved by the departmental Director of Graduate Studies. Both the departmental Director of Graduate Studies and the Department Chair are “ex-officio” members of every Project Committee, although they may also be selected as regular committee members.

An oral defense of the Project is required, scheduled by the student. An affirmative vote by a majority of the committee after the oral examination is necessary for the student to pass.

Note that MS Thesis credits cannot be counted towards the Project Option. Suggested programs of study for full time students selecting the Project Option are listed below.

Suggested Schedule for a MS in Computer Science Project Option, Total Credits: 33

Software Engineering Track - Project Option

Fall - Semester 1

COMP 755	3	Advanced Operating Systems
COMP 710	3	Software Specification, Analysis & Design
COMP 712	3	Software Project Management
COMP xxx	3	Software Engineering Elective

Spring - Semester 2/

COMP 785	3	Advanced Design and Analysis of Algorithms
COMP 711	3	Software System Design, Implementation, Verification & Validation
COMP xxx	3	Software Engineering Elective
COMP xxx	3	Elective

Fall - Semester 3

COMP xxx	3	Software Engineering Elective
COMP xxx	3	Elective
COMP 796	3	MSCS Project

Computational Science and Engineering Track - Project Option

Fall - Semester 1

COMP 755	3	Advanced Operating Systems
COMP 732	3	Parallel Computing Applications
MATH 731	3	Advanced Numerical Methods
COMP xxx	3	Computational Science and Engineering Elective

Spring - Semester 2

COMP 785	3	Advanced Design and Analysis of Algorithms
COMP 770	3	Computer Organization and Programming for Scientific Computing
COMP xxx	3	Computational Science and Engineering Elective
COMP xxx	3	Elective

Fall - Semester 3

COMP xxx	3	Computational Science and Engineering Elective
COMP xxx	3	Elective
COMP 796	3	MSCS Project

Information Assurance Track - Project Option

Fall - Semester 1

COMP 620	3	Information, Privacy and Security
COMP 755	3	Advanced Operating Systems
COMP 790	3	Network Security
COMP xxx	3	Elective

Spring - Semester 2		
COMP 785	3	Advanced Design and Analysis of Algorithms
COMP 621	3	Web Security
COMP xxx	3	Information Assurance Elective
COMP xxx	3	Elective

Fall - Semester 3		
COMP xxx	3	Information Assurance Elective
COMP xxx	3	Elective
COMP 796	3	MSCS Project

Artificial Intelligence Track - Project Option

Fall - Semester 1		
COMP 645	3	Artificial Intelligence
COMP 755	3	Advanced Operating Systems
COMP xxx	3	Artificial Intelligence Elective
COMP xxx	3	Elective

Spring - Semester 2		
COMP 785	3	Advanced Design and Analysis of Algorithms
COMP 740	3	Advanced Artificial Intelligence
COMP xxx	3	Artificial Intelligence Elective
COMP xxx	3	Elective

Fall - Semester 3		
COMP xxx	3	Artificial Intelligence Elective
COMP xxx	3	Elective
COMP 791	1	Current Topics in Computer Science
COMP 796	3	MSCS Project

General Track - Project Option

Fall - Semester 1		
COMP 755	3	Advanced Operating Systems
COMP 710	3	Software Specification, Analysis & Design
COMP xxx	6	Elective

Spring - Semester 2		
COMP 785	3	Advanced Design and Analysis of Algorithms
COMP 681	3	Formal Methods
COMP xxx	3	Elective
COMP xxx	3	Elective

Fall - Semester 3		
COMP xxx	3	Elective
COMP xxx	3	Elective
COMP 796	3	MSCS Project

12. Thesis Option

The thesis option requires twenty-four credit hours of course work and a written thesis acceptable to the student's thesis committee. This option provides the greatest theoretical depth in a research area. This is the most challenging route to the MS degree, and is suggested for those students who show self motivated and are capable of independent work.

To select the Thesis Option, the student must find a member of the graduate faculty willing to serve as the Thesis Advisor. Acceptance to the MS program does **not** guarantee that the student will be able to find a graduate faculty member willing to serve as their Thesis Advisor. If no faculty member is willing to serve, the student will select either the Project Option or the Course Option, as explained under the respective headings in this document.

With the Advisor aid, the student will select a committee of 3 to 5 faculty members as the MS Thesis Committee. This committee serves in the capacity of an impartial second source of professional review of the quality of the student's work and, in conjunction with the academic advisor, assists the student in the research work required for the Thesis. A majority of the members of this committee must be from within the Computer Science Department. The composition of the thesis committee must be approved by the departmental Director of Graduate Studies. Both the departmental Director of Graduate Studies and the Department Chair are "ex-officio" members of every Thesis Committee, although they may also be selected as regular committee members.

An oral defense of the Thesis is required, and its scheduling is the student's responsibility. An affirmative vote by a majority of the committee after the oral examination is necessary for the student to pass.

The suggested schedule for thesis option of MS in CS is listed below.

Suggested Schedule for a MS in Computer Science Thesis Option, Total Credits: 30

Software Engineering Track- Thesis Option

Fall - Semester 1

COMP 755	3	Advanced Operating Systems
COMP 710	3	Software Specification, Analysis & Design
COMP 712	3	Software Project Management
COMP xxx	3	Software Engineering Elective

Spring - Semester 2

COMP 785	3	Advanced Design and Analysis of Algorithms
COMP 711	3	Software System Design, Implementation, Verification ,& Validation
COMP 797	3	MS Thesis Research

Fall - Semester 3

COMP xxx	3	Elective
COMP xxx	3	Elective
COMP 797	3	MS Thesis Research

Computational Science and Engineering Track - Thesis Option

Fall - Semester 1

COMP 755	3	Advanced Operating Systems
COMP 732	3	Parallel Computing Applications
MATH 731	3	Advanced Numerical Methods
COMP xxx	3	Computational Science and Engineering Elective

Spring - Semester 2

COMP 785	3	Advanced Design and Analysis of Algorithms
COMP 770	3	Computer Organization and Programming for Scientific Computing
COMP 797	3	MS Thesis Research

Fall - Semester 3

COMP xxx	3	Elective
COMP xxx	3	Elective
COMP 797	3	MS Thesis Research

Information Assurance Track - Thesis Option

Fall - Semester 1

COMP 620	3	Information, Privacy and Security
COMP 755	3	Advanced Operating Systems
COMP 790	3	Network Security
COMP xxx	3	Elective

Spring - Semester 2
 COMP 785 3 Advanced Design and Analysis of Algorithms
 COMP 621 3 Web Security
 COMP 797 3 MS Thesis Research

Fall - Semester 3
 COMP xxx 3 Information Assurance Elective
 COMP xxx 3 Elective
 COMP 797 3 MS Thesis Research

Artificial Intelligence Track - Thesis Option

Fall - Semester 1
 COMP 645 3 Artificial Intelligence
 COMP 755 3 Advanced Operating Systems
 COMP xxx 3 Artificial Intelligence Elective
 COMP xxx 3 Elective

Spring - Semester 2
 COMP 785 3 Advanced Design and Analysis of Algorithms
 COMP 740 3 Advanced Artificial Intelligence
 COMP 797 3 MS Thesis Research

Fall - Semester 3
 COMP xxx 3 Artificial Intelligence Elective
 COMP xxx 3 Elective
 COMP 797 3 MS Thesis Research

General Track - Thesis Option

Fall - Semester 1
 COMP 755 3 Advanced Operating Systems
 COMP 710 3 Software Specification, Analysis & Design
 COMP xxx 6 Elective

Spring - Semester 2
 COMP 785 3 Advanced Design and Analysis of Algorithms
 COMP 681 3 Formal Methods
 COMP 797 3 MS Thesis Research

Fall - Semester 3
 COMP xxx 3 Elective
 COMP xxx 3 Elective
 COMP 797 3 MS Thesis Research

13. Ph.D Program

The Computer Science Department is committed to cooperate with the Electrical Engineering Department and the Industrial Engineering Department to offer Ph.D programs.

The suggested schedule for Computer Science students planning on pursuing an Industrial Engineering Ph.D in the Human-Interface field after graduation from the CS MS program is listed below.

Fall –Semester 1		
COMP 755	3	Advanced Operating Systems
COMP xxx	3	Required course for corresponding track
INEN 600	3	Survey of Industrial Engineering Topics
COMP xxx	3	Elective for corresponding track
Spring - Semester 2		
COMP 785	3	Advanced Design and Analysis of Algorithms
COMP xxx	3	Required course for corresponding track
INEN 615	3	Industrial Simulation
COMP xxx	3	Elective for corresponding track
Fall - Semester 3		
COMP xxx	6	Elective
INEN 735	3	Human-Computer Interface

The suggested schedule for Computer Science students planning on pursuing an Electrical Engineering Ph.D after graduation from the CS MS program is listed below.

Fall –Semester 1		
COMP 755	3	Advanced Operating Systems
COMP xxx	3	Required course
COMP xxx	3	Elective
ELEN 624	3	Computer Organization and Architecture Design
Spring - Semester 2		
COMP 785	3	Advanced Design and Analysis of Algorithms
COMP 681	3	Formal Methods
ELEN 621	3	Embedded Systems Design
COMP xxx	3	Elective
Fall - Semester 3		
COMP xxx	3	Required course
COMP xxx	6	Elective
ELEN 720	3	Theoretical Issues in Computer Engineering

ELEN 720, 624, 621 all have the prerequisite ELEN 427 (Introduction to Microprocessors) which is virtually identical to our COMP 370 (Intro. to Computer Architecture) course.

14. Financial Support

The Computer Science Department is committed to financial support of worthy full-time students on a merit basis. Awards offer a monthly stipend of up to \$1,350 for students engaged in teaching assistantships or research assistantships, and may include tuition remission. All awards are made on competitive basis, and every applicant may not receive an offer. Support is limited to a maximum of three semesters of full time study. The student must indicate interest in these programs in relevant section of the application package, and submitting the assistantship application directly to the department along with the admissions application and letters of recommendation.

15. Critical Steps

1. Apply for admission:
 - a. complete the Graduate school application form, which can be obtained from the Graduate School at 336-334-7920, or Web site.
 - b. pay the required application fee,
 - c. request or present the necessary transcripts, and
 - d. complete financial aid or fellowship requests.

2. Receive admission status letter from Graduate School.
3. See departmental Director of Graduate Studies for appointment of temporary advisor.
4. Prepare course schedule for first term, obtain advisor approval, submit to departmental Director of Graduate Studies. [*File The Graduate School Master and Doctoral Plan of Graduate Work Form*]
5. Complete any and all course deficiencies.
6. Select permanent advisor before the first month of the second semester. Obtain approval of departmental Director of Graduate Studies.
7. Consult with permanent advisor to complete degree plan.
8. Consult with permanent advisor to select thesis or project committee if applicable.
9. Have degree plan approved by all concerned and placed on file with the departmental Director of Graduate Studies.
10. Schedule thesis/project proposal defense by the start of the second semester.
11. Present thesis/project proposal, pass by the start of the second semester, and place on file with the departmental Director of Graduate Studies. [*File Acceptance of Proposal for Thesis/Project Form*]
12. Complete course work.
13. Schedule and complete as applicable the Course Option, Project, or Thesis defense. [*File Defense Results Form*]
14. Obtain written approvals for completion of all work.
15. Transmit completion information as necessary with the departmental Director of Graduate Studies and the Graduate School. [*File Graduation Request Form*]
16. Graduate!

16. Thesis and Project Selection Guidelines

When the student decides to pursue working on a Project or Thesis, the student must consider the area of Computer Science. All courses the student has taken, or is taking, offer possibilities for further exploration. The student should select a topic that the student finds interesting and pleasant to work on.

The student should check the journals and conferences of the particular area of interest. The student should pick specific subject matter in the area. For example, in Operating Systems the student might choose to examine process scheduling or virtual paged memory management. The student should read the journal and conference articles to gain a sense of the current state-of-the-art and to seek possible avenues of research. Often, authors point out unanswered questions in their articles. The student might be able to work on extending the concepts in the article. If the author makes restrictive assumptions, the student may be able to relax those assumptions.

After completing the above process, the student will schedule an extended visit with a professor who teaches in the selected area of interest. The student should bring to the meeting a list of the literature that the student reviewed and the research/project ideas. The professor may already have a topic in mind for a thesis or project, and is waiting for a graduate student to express an interest. However, the student should not expect this to be so. The student has the responsibility to identify a topic and the professor's job is to provide advice while the student is deciding.

During the process, the student should keep the following mind:

- The student is responsible for finding the topic.
- No professor is required to direct your thesis or project. It is solely the professor's individual decision. Often, a professor may already have commitments that will not allow the addition of another thesis/project advisee.

- The student is responsible for the progress of the thesis or project. The professor will not (and should not) do the research, will not write the thesis or project report, will not take responsibility for the student's mistakes, and is not responsible for seeing that the student finishes by the date the student's desire. Each of those tasks is solely the responsibility of the student!
- The date of completion is a function of how many hours the student works on the thesis or project, the quality of work performed, how well the research progresses, and the like. Research has unknowns, and the advisor cannot determine how long it will take to finish.

17. Thesis & Project Requirements and Oral Examination

All MS program students selecting the Thesis and Project options must complete a thesis or a project, as described in this document. The procedure for preparation of the thesis/project and the Master's oral examination follows:

1. With the consent and advice of the thesis/project advisor, the student selects a tentative thesis/project topic.
2. In consultation with the thesis/project advisor, the student selects committee members.
3. The student prepares a typed proposal outlining the proposed work. A thesis proposal is expected to review the state of the art, and should clearly indicate that a substantial literature search has been completed. A thesis proposal will not be considered complete without a list of all relevant references that must have been read by the student.
4. The thesis/project advisor approves the proposal draft, and the student submits it to the committee members at least 5 days before the proposal meeting.
5. A proposal meeting is held with the committee. A proposal meeting is required for students working on a thesis and optional for students working on a project. If a student working on a project chooses to not hold a proposal meeting, they must get written approval of their project from all committee members. The student must present the proposal (approximately 20 minute) and answers questions from committee members. The committee decides if the topic is or is not suitable and makes suggestions on scope, solutions, etc. If the decision is favorable, the committee becomes the thesis/project committee. The student must submit a Proposal Acceptance form to the departmental Director of Graduate Studies upon successful completion of the proposal meeting. This form is available from the departmental secretary. **THE PROPOSAL DEFENSE SHOULD BE COMPLETED BY THE START OF THE SECOND SEMESTER.**
6. The thesis/project advisor is consulted during research and initial writing. Other committee members are also available for guidance and advice. The thesis/project advisor may schedule a committee meeting for progress review.
7. The thesis/project advisor approves the draft of the thesis/project. The draft is then circulated to committee members at least two weeks before the oral examination.
8. Committee members read the draft and submit suggestions for changes or additions to the student.
9. In consultation with the thesis/project advisor, the student makes the changes and/or additions.
10. The student must schedule the oral examination with the departmental Director of Graduate Studies, after arranging acceptable times with all committee members. The time should be during normal working hours. The student must advertise the meeting to the general public (for example, by placing announcements on bulletin boards). Copies of the thesis or project, including all necessary media (disks, printouts, etc.), must be submitted to the departmental Director of Graduate Studies at least **one week prior to the scheduled oral date**. If this is not done, the departmental Director of Graduate Studies will cancel the scheduled oral examination and it must be rescheduled.
11. The oral examination begins with a 30-40 minute presentation by the student, followed by questions on the thesis/project topic.

12. The student leaves the room. The committee decides on a pass or fail, and the student is so informed. It is the firm policy of this department that students who do not perform well on the oral will not pass. In the case of a re-test, the student must appear again for an oral examination no sooner than four weeks following the original oral. This procedure may be repeated at the option of the committee.
13. Bound copies of the thesis/project report will be supplied to each committee member and to the CS Department. The department copy must be hard bound. As specified in the Graduate School Bulletin, three copies must also be deposited with the Dean of the Graduate School. Please consult the College of Graduate Studies for details.

18. Student Life

Graduate students are an integral part of the daily workings of the Computer Science Department. They help set the tone of hard work, strong character, commitment, good communications, joint collaboration, and cooperative service. Undergraduates often turn to graduate students for help in course work, and guidance in personal and career matters. Our department motto is “It’s how we put it together that sets us apart,” and we mean it! We sincerely ask, and expect, the help of all graduate students on helping our department grow and strive for excellence. Full time students are particularly crucial in this matter. Graduate life can be challenging and enjoyable. All the challenges can be conquered by responsible and mature approach. Parking spaces are limited, and it is recommended that you obtain parking permit if you want to park on campus. However, the students should know that the parking lots close to the Computer Science Department fill up early in the morning. Graduate students who are granted financial compensation need to complete the required paperwork, and they are advised to see the departmental secretary to complete the necessary formalities for getting paid. The Computer Science Department is a dynamic and growing environment as we are in the process of garnering additional facilities to enhance the department. The faculty requests students to assist them in understanding their concerns.

Please feel free to speak with your advisor, with the Director of Graduate Studies, or with the Department Chairperson, at any time and about any matter. Your expressed desire for confidentiality will be respected. The campus office of student services may also be able to assist in meeting your needs during times of duress.

19. Initiation of Your MSCS Program

This section identifies opportunities for the student to get a head start on the MSCS Program at North Carolina Agricultural and Technical State University (NC A&T SU) by highlighting certain areas. This section can serve multiple objectives:

1. acclimate the student to the MSCS program,
2. help remove any deficiencies in the student’s undergraduate preparation for MSCS, and
3. offer opportunities to place out of courses that cover subject material in which the student has extensive background.

19.1. Self Study Books and Preparatory Courses

It is assumed that all entering students have completed undergraduate courses in programming in a high level language (such as C, C++, Java or Smalltalk), data structures, and computer architecture as well as mathematical maturity (for example Calculus I & II, and Discrete Mathematics or Switching Theory). Students who have not had such courses or their equivalent may be required to take undergraduate courses to remedy deficiencies, with no credit towards the degree. The extent of this familiarity is described in the following sections.

Programming

Incoming students are expected to be able to design and implement a simple object-oriented or structured program to solve problems with the level of difficulty at par with a second semester programming course. Students who are not familiar enough with a programming language should study the following book:

Stevens, *Teach Yourself C++*, MIS Press, ISBN 0-55828-250-5.

Operating Systems

Incoming students are expected to be sufficiently familiar with an operating system to perform elementary file operations such as creating files using editor, deleting files, making directories, deleting directories, copying files/directories, etc. Familiarity with an editor and/or word processor is also assumed. Students deeming themselves deficient in this area should consult the following book:

Silberschatz, Peterson, and Galvin, *Operating System Concepts*, Addison-Wesley, ISBN 0-201-58021-7.

Computer Architecture

Elementary knowledge of computer architecture (hardware) is assumed to the degree of identifying the characteristics and functions of the four basic hardware components of a computer (central processing unit, memory, input/output [I/O] devices, and buses). A basic understanding of fundamental concepts is sufficient. Students finding themselves deficient in this area should consult the following book:

Stallings, *Computer Organization & Architecture*, 3d Edition, MacMillan, ISBN Number 002-415495-4.

Data Structures and Algorithms

Data structures and algorithms are the foundations of good systems. Students should be familiar with the elementary algorithms to solve recurring problems (such as sorting) and have a good understanding of fundamental data types (stacks, queues, trees, etc.). Students finding themselves deficient in this area should consult the following book:

Sedgwick, *Algorithms in C*, Addison-Wesley, ISBN 0-201-51425-7.

Mathematical Maturity

Students should be comfortable with fundamental college mathematics (two semesters calculus and one semester discrete mathematics). Courses in linear algebra, probability, and logic are very helpful. Mathematical maturity can substitute for these courses. Students finding themselves deficient in this area should consult the following book:

Graham, Knuth, Patashnik, *Concrete Mathematics: A Foundation for Computer Science*, Addison-Wesley, ISBN 0-201-15236.

19.2. Exemption by Examination

Students who have previous knowledge of computer science background material may request credit by examination for that course. All such requests should be addressed in writing to the Graduate Director, who will arrange a combination of oral and written examinations.

20. Special Welcome to International Students

International students may have particular concerns about acclimating to NC A&T SU's environment. Students are expected to be fluent in English, since it is the medium of instruction in all courses. TOEFL scores of above 550 are required. Students with TOEFL scores under 550 will be required to take ENGL 331: Technical Writing. Additionally, international students will have to adjust to cultural differences. Various campus offices offer special support services and activities directed at international students. International students should also be aware that a number of research grants restrict financial aid to US citizens. As a result, financial assistance to foreign students is limited.

21. Computer Science Faculty Listing

Sharon A. Brown, B.S., M.S., North Carolina A&T State University; M.S., University of Illinois; Adjunct Associate Professor and Director of Undergraduate Studies; Artificial Intelligence.

Edmundson Effort, BS and M.S., North Carolina A&T State University; Adjunct Assistant Professor and System Administrator in College of Engineering.

Edward C. Carr, B.S., Wingate University; M.S., North Carolina A&T State University; M.S., Western Carolina University; Adjunct Assistant Professor; Graph Theory, Concurrency, AI.

Dent Gelonia, B.S., University of Georgia; M.S., Clark Atlanta University; Ph.D. Brown University; Visiting Assistant Professor; Applied mathematics.

Albert C. Esterline, B.A., Lawrence University; M.Litt., Ph.D., University of St. Andrews; M.S., Ph.D., University of Minnesota; Associate Professor; Multiagent Systems, Formal Methods, Concurrency, AI.

Jung Hee Kim, B.S., Korea University; M.S., Ph.D., Illinois Institute of Technology; Associate Professor; Analysis of Tutorial Dialogues and Synthesis of Language.

Yaohang Li, B.S., South China University of Technology; M.S., Florida State University; Ph.D., Florida State University; Assistant Professor; Parallel/Distributed/Grid Computing, Computational Science, Bioinformatics.

Kenneth A. Williams, B.S., M.S., Michigan Technological University; Ph.D., University of Minnesota; Associate Professor and Chairperson; Distributed Operating Systems, Optical Communications, Computer Architecture.

Jinsheng Xu, B.S., Nanjing University; M.S., Beijing University; Ph.D., Michigan State University; Assistant Professor; Parallel and Distributed Simulation, Network Simulation, Parallel Algorithms, Performance Evaluation.

Sung Yoon, B.S., Seoul Nation University; M.S., North Carolina A&T State University, Ph.D., North Carolina State University; Associate Professor; Image/Video Coding, Computer Vision, Computer Graphics, Wireless Communication.

Xiaohong Yuan, B.S., Hua Zhong University of Science and Technology; Ph.D., Institute of Automation, Chinese Academy of Sciences; Ph.D., Florida Atlantic University; Associate Professor; Wireless Communication Networks, Artificial Intelligence, Software Engineering.

Huiming Yu, B.S., Xiamen University; M.S., Hefei Polytechnic University; Ph.D., Stevens Institute of Technology; Professor and Director of Graduate Studies; Visualization, Web-Based Applications, Software Reuse, Motion Planning.

22. Course Listings and Descriptions

COMP-611. System Testing and Evaluation

Credit 3 (3-0)

This course will focus on the methods, techniques, procedures for system testing and evaluation. The main topics include reliability measurement, testing small and large systems, black box software testing, white box software testing, testing of concurrent and real-time systems, client-server testing, test case design methods, and automated testing tools.

COMP-620. Information, Privacy and Security

Credit 3 (3-0)

This course examines the security and privacy issues associated with information systems. There are cost/risk tradeoffs to be made. Discussed are topics such as technical, physical, and administrative methods of providing security, access control, identification, and authentication. Encryption is examined, including Data Encryption Standards (DES) and public key crypto-systems. Management considerations such as key protection and distribution, orange book requirements, and OSI data security standards are covered. Privacy legislation is covered, as is current cryptographic research.

COMP-621. Web Security

Credit 3 (3-0)

This course focuses on the technologies that provide security services for the World Wide Web. It introduces a set of procedures, practices, and technologies for protecting web servers, web users, and their surrounding organizations. We discuss, understand and use various security technologies for the World Wide Web (WWW). How to use these technologies to secure WWW applications will be addressed.

COMP-627. Wireless Network Security

Credit 3 (3-0)

This course covers the security issues associated with wireless networks. Emerging wireless technologies, standards and protocols are explored. The course will define and demonstrate various threats to wireless security. Topics include security service, security protocol, and security architecture for wireless. Details of wireless encryption techniques are examined.

COMP-645. Artificial Intelligence

Credit 3 (3-0)

This course presents the theory of artificial intelligence, and application of the principles of artificial intelligence to problems that cannot be solved, or cannot be solved efficiently, by standard algorithmic techniques. Knowledge representation, and Knowledge-based systems. Topics include search strategies, production systems, heuristic search, expert systems, inference rules, computational logic, natural language processing. Predicate calculus is discussed. An artificial intelligence language is presented as a vehicle for implementing concepts of artificial intelligence. Prerequisite: COMP 285.

COMP-653. Computer Graphics

Credit 3 (3-0)

This is a course in fundamental principles and methods in the design, use, and understanding of computer graphic systems. Topics include coordinate representations, graphics functions, and software standards. Hardware and software components of computer graphics are discussed. The course presents graphics algorithms. It also introduces basic two-dimensional transformations, reflection, shear, windowing concepts, clipping algorithms, window-to-

viewport transformations, segment concept, files, attributes and multiple workstation, and interactive picture-construction techniques. Prerequisite: COMP 285 and Math 350.

COMP-662. Computer Aided Instruction

Credit 3 (3-0)

This course provides a conceptual foundation for the development of instructional tools based on a variety of learning theories. Students will learn how to design and implement Computer Aided Instruction (CAI) projects using authoring software. As part of the implementation process, a multimedia programming language will be studied and practiced. The concept of Intelligent Computer Aided Instruction (ICAI) will be introduced.

COMP-663. Compiler Construction

Credit 3 (3-0)

This course emphasizes the theoretical and practical aspects of constructing compilers for computer programming languages. The course covers principles, models, and techniques used in the design and implementation of compilers, interpreters, and assemblers. Topics include lexical analysis, parsing arithmetic expressions and simple statements, syntax specification, algorithms for syntax analysis, object code generation, and code optimization. Each student will develop and implement a compiler. Prerequisite: COMP 375 and COMP 385.

COMP-670. Advanced Computer Architecture

Credit 3 (3-0)

This is a course that examines the control and storage structures that facilitate the execution and management of logically segmented programs and data. Of special focus are input-output mechanisms, performance tuning, and microprogramming.

COMP-681. Formal Methods

Credit 3 (3-0)

In this course formal methods that model the software development process will be studied. Fundamental and practical methodologies and theories, including set theory and the foundations of software engineering will be emphasized. Applications to formal specifications, object-oriented programming and data modeling will be examined. Topics include: set theory, relations and functions, induction and recursion, symbolic logic, complex models, and application case studies.

GRADUATE STUDENTS ONLY

COMP-700. Independent Study

Credit 3 (3-0)

This course can be used for study of advanced topics in computer science pertinent to the student's interest under supervision of a faculty member. Prerequisite: Permission of Instructor

COMP-710. Software Specification, Analysis and Design

Credit 3 (3-0)

This course examines the formalization of software requirements and the analysis of the flow of data through a proposed large software system. Methodologies covered include Structured Analysis (data flow diagramming), hierarchy charts, entity-relationship data diagrams, procedure specifications, and Information Engineering. Additional methodologies addressed include Jackson Structured Diagrams, Harlan Black Boxes, and Object-Oriented Analysis techniques. Prerequisite: Graduate standing.

COMP-711. Software System Design, Implementation, Verification and Validation

Credit 3 (3-0)

This course proceeds from the evaluation of a completed system design for completeness, correctness, information engineering, and functionality. Accepted industry and academic standards for such reviews will be used, for example leveling of data flow diagrams, measures of module cohesion, control structures, and function point estimation. As part of the implementation process, verification and validation methodologies will be studied and practiced. An actual system will be implemented by the end of the semester. Prerequisite: COMP-710.

COMP-712. Software Project Management

Credit 3 (3-0)

This course examines the nature of data processing projects, definitions of purpose, scope, objectives, deliverable dates, and quality standards. Interpersonal interaction and people-oriented management techniques are studied, along with team member measurement and assessment methods. Project management tools such as PERT (Project Evaluation and Review Technique), and CPM (Critical Path Method) are covered. Managerial styles in motivating, innovating, and organizing will be examined, along with techniques for improving these skills. Equipment and software selection and installation guidelines, and the proper use of outside consulting services will be examined. Prerequisite: Graduate standing.

COMP-713. Social Impacts of Software Systems

Credit 3 (3-0)

This course examines the increasing importance of computer technology in the functionality of our economy, our government, and our industry. Potential impacts upon personal privacy and autonomy are examined in relation to the public policy and social impacts of computer technology. The role and opportunity for historically under-represented technical professionals will be explored. Interdisciplinary readings, written and oral presentations, and in class

debates are required. Outside speakers from related disciplines are invited to participate. Prerequisite: Graduate standing.

COMP-714. CASE, Automated Development and Information Engineering **Credit 3 (3-0)**

Beginning with the concepts of automated development, various models are reviewed in detail, especially Information Engineering, Methodology assessment approaches are covered, especially the Software Engineering Institute Process Maturity model, and a variety of organizational impacts of technology are examined. Computer Aided Software Engineering (CASE) is covered through tutorial laboratory sessions and a problem assignment. Topics include fundamentals of data analysis, diagramming tools for data modeling process analysis, presentation architecture, communications architecture, data architecture, process architecture, and application construction. Techniques and tools for defining menu structures, screens and screen dialogues, and user interface management systems are studied, as are the general principles of physical design. Prerequisite: Graduate standing.

COMP-716. Object-Oriented Programming and Software Reuse **Credit 3 (3-0)**

Introduce software reuse principles and reuse driven software development. Reuse techniques will be addressed that include reuse readiness assessment, corporate reuse plan creation and organizing for reuse. Discuss application package selection, selecting reusable components and identifying candidate reusable components. Teach and use the object-oriented programming language Java, emphasize its object-oriented features and how to use Java to develop reusable components, subsystems and frameworks. Prerequisite: Graduate standing.

COMP-717. Software Fault Tolerance **Credit 3 (3-0)**

The principles, techniques and current practices in the area of fault tolerant computing with an emphasis on system structure and dependability are examined in this course. Major topics include system models, software/hardware interaction, failure and reliability, fault tolerance principles, redundancy, rollback and recovery strategies, and N-version programming. Redundancy in data structures and the validation of fault tolerant software are studied. Prerequisite: Graduate standing.

COMP-718. Object Oriented Software Engineering **Credit 3 (3-0)**

This course covers the concept of the "object-oriented life cycle", demonstrating a practical methodology for the application of object oriented methods to large projects. The specific problems and solutions for large software systems are discussed. Object Oriented Requirements Analysis (OORA), Object-Oriented Requirements Specification (OORS), Object Oriented Analysis (OOA), Object Oriented Design (OOD), and Object Oriented Domain Analysis (OODA) are covered. Existing and upcoming object oriented Computer Aided Software Engineering (CASE) tools are examined and object oriented database design issues are discussed with analysis of specific systems currently in practice or under development. Prerequisite: Graduate standing.

COMP 722 E-Commerce **Credit 3 (3-0)**

This course covers the computer science and technology that enable e-commerce and the business concepts needed to understand e-commerce. Topics reviewed include HTML and CSS as well as client-side scripting. Topics introduced include e-commerce features, business models, and marketing concepts. Topics emphasized include the HTTP protocol, server-side scripting, the XML family of specifications, web services, the Semantic Web, and security in an e-commerce context.

COMP-723. Intrusion Detection **Credit 3 (3-0)**

This course introduces the concepts, techniques, tools, and the state of the art in the area of network intrusion detection systems. Topics to be covered include: network and computer system security fundamentals, network security models and approaches, attack classification and analysis, intrusions detection techniques and tools (vulnerability scanners, network sniffer, system monitoring and logging, etc), firewall, as well as the tools and techniques for intrusion signature analysis, such as TCPdump and Snort, etc. Prerequisite: Graduate standing.

COMP-732. Advanced Software Tools **Credit 3 (3-0)**

The software tools utilized in the high performance and massively parallel computing environments are indispensable to the practicing computer scientist. Message passing, profiling, languages, compilers, porting, system library usage, cache optimization, and in-lining are the topics of this course. Prerequisite: Graduate standing.

COMP-733. Parallel Computing Applications **Credit 3 (3-0)**

Many problems in computing can be solved more efficiently on a parallel computer. The parallel computing paradigm is the main focus of this course. The applicability of Amdahl's law, PRAM models, matrix by vector transforms, matrix by matrix graphics and visualization computations will be discussed. Prerequisite: Graduate standing.

COMP-740. Advanced Artificial Intelligence **Credit 3 (3-0)**

This course is a further study of artificial intelligence principles, with a focus on knowledge-based systems. The course examines planning, belief revision, control, and system evaluation and implementation. Advanced topics include automated theorem proving, learning and robotics, neural nets, and the adequacy of existing theoretical treatments. Prerequisite: COMP-645.

COMP-741. Knowledge Representation and Acquisition **Credit 3 (3-0)**

The representation formalisms used in artificial intelligence are explained, along with representation selection and implementation in common Artificial Intelligence languages and shells. Formalisms include first order logic and its extensions, semantic nets, frames and scripts, and KL-ONE-like languages. Knowledge acquisition is introduced as eliciting knowledge, interpreting elicited data within a conceptual framework, and the formalizing of conceptualizations prior to software implementation. Knowledge acquisition techniques such as protocol analysis, repertory grids, and laddering are examined. Prerequisite: Graduate standing.

COMP-742. Automated Reasoning **Credit 3 (3-0)**

This course studies the computational aspects of logic via propositional and predicate calculi, as well as the theory underlying their automation through logic programming languages. Various forms of resolution and their soundness and completeness are examined along with unification and its properties. Proof procedures and their search characteristics, term rewriting, and techniques such as narrowing are researched as a means of theory resolution. The relationship of formal specification techniques such as cut elimination, efficiency, and implementation issues are addressed. Prerequisite: COMP-645.

COMP-745. Computational Linguistics **Credit 3 (3-0)**

A presentation of computational linguistics theory and practice. Advanced readings that emphasize theories of dialogue and research methodologies are examined. Technical writing for journals and conferences is stressed as a goal of research output. Prerequisite: COMP-645.

COMP-747. Computer Vision Methodologies **Credit 3 (3-0)**

This course researches techniques for image understanding, both low-level and high-level image processing, mathematical morphology, neighborhood operators, labeling and segmentation. Vision methods covered include perspective transformation, motion, the consistent-labeling problem, matching, object models, and knowledge-based vision. Prerequisite: COMP-645.

COMP-749. Intelligent Robots **Credit 3 (3-0)**

This course examines intelligent robot systems as inclusive of knowledge representations, path finders, inference systems of rules and logic, and image understanding and spatial reasoning systems. Problems of navigation, algorithm development, robot programming languages and multiple robot co-operation are explored. Prerequisite: Graduate standing.

COMP-750. Distributed Systems **Credit 3 (3-0)**

This course examines the operating system concepts necessary for the design and effective use of networked computer systems. Such concepts include communication models and standards, remote procedure calls, name resolution, distributed file systems, security, mutual exclusion, and distributed databases. Students are required to construct an advanced implementation of distributed operating system facilities or a simulation of same. Prerequisite: COMP-755.

COMP-753. Performance Modeling and Evaluation **Credit 3 (3-0)**

Common techniques and current results in the performance evaluation of computer systems are studied in this course. Background material in probability theory, queuing theory, simulation, and discrete mathematics is reviewed so that a performance evaluation of resource management algorithms for operating systems and database management systems in parallel and distributed environments may be developed. Prerequisite: COMP-755.

COMP-755. Advanced Operating Systems **Credit 3 (3-0)**

This course centers on operating systems for multi-processing environments: concurrent processes, mutual exclusion, job scheduling, memory, storage hierarchy, file systems, security, and distributed processing. Also discussed are virtual resource management strategies. A design project involving the construction of operating facilities is produced. Prerequisite: Graduate standing.

COMP-767. Computer Network Architecture **Credit 3 (3-0)**

This is a course in the architecture of computer communication networks and the hardware and software required to implement the protocols that define the architecture. Basic communication theory, transmission technology, private and common carrier facilities, international standards, satellite communications, and local area networks are examined. Methods of performance analysis and communication network modeling are discussed. Prerequisite: Graduate standing.

COMP-770. Computer Organization and Programming for Scientific Computing **Credit 3 (3-0)**

Computer programming in the High Performance Computing environment is unlike that of the common workstation or desktop computing platform. Programming parallel computers with regard to data transfer (MPI), data storage and process execution are the main focus of this course. The architecture and organization of various parallel computing platforms are examined. Prerequisite: Graduate standing.

COMP-780. Semantics of Programming Languages

Credit 3 (3-0)

This course examines the formal treatment of the specification, meaning, and correctness of programs. Required mathematical results are examined, in areas such as universal algebra and category theory. Major course topics include the lambda calculus, type systems for programming languages, polymorphism, algebraic specification, rewrite systems, and semantic domains. The denotational semantics of programming languages, program logics, and program verification are discussed. Prerequisite: Graduate standing.

COMP-785. Advanced Analysis of Algorithms

Credit 3 (3-0)

This course discusses the design and analysis of efficient algorithms and algorithmic paradigms. Applications include sorting, searching dynamic structures, graph algorithms, computationally hard problems, and NP completeness. Prerequisite: Graduate standing.

COMP-786. Multiagent Systems

Credit 3 (3-0)

This course primarily addresses multiagent systems, emphasizing collaboration and group attributes. Topics include planning for multiagent tasks and distributed planning, distributed problem solving, agent communication languages (involving speech acts), negotiation, ontologies and knowledge sharing, distributed rational decision making (involving techniques from economics), societal theories (from philosophy), and computational organization theory. Formalisms (including modal logics, process algebras, Petri nets, and Statecharts) are presented and applied to the specification and modeling of multiagent systems. Prerequisite: Graduate standing.

COMP-790. Special Topics in Computer Science

Credit 3 (3-0)

This course permits research in advanced topics pertinent to the student's program of study. Prerequisite: Permission of advisor.

COMP-793. Masters Supervised Teaching

Credit 3 (3-0)

Students will gain teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment. Prerequisite: Graduate standing.

COMP-796. Masters Project

Credit 3 (3-0)

The student will conduct advanced research of interest to the student and the instructor. A written proposal, which outlines the nature of the project and the deliverables, must be submitted for approval. This course is only available to project option students. Prerequisite: Graduate standing.

COMP-797. Masters Thesis

Credit 3 (3-0)

Master of science thesis research will be conducted under the supervision of the thesis committee chairperson leading to the completion of the master's thesis. This course is only available to thesis option students. Prerequisite: Permission of advisor.

COMP-999. Continuation of Research

Credit 1 (1-0)

Continue incomplete thesis or project work.

23. Forms

Important forms to ensure program requirements are available on the Computer Science Department's web site.

<http://www.comp.ncat.edu/>

School of Graduate Studies web site provides study plan forms, application forms and other materials.

<http://www.ncat.edu/~gradsch/>

Defense Results of Thesis/ Project

Last Name: _____ **First Name:** _____
Student ID: _____ **Date:** _____

The thesis/project entitled:

It was:

_____ **Accepted**

_____ **Rejected**

Student Signature: _____ **Date:** _____

Advisor Approval: _____ **Date:** _____

Committee Member Signature:

_____ **Date:** _____

_____ **Date:** _____

_____ **Date:** _____

_____ **Date:** _____

Graduate Director Approval: _____ **Date:** _____

Acceptance of Proposal for Thesis/ Project

Last Name: _____ First Name: _____

Student ID: _____ Date: _____

The thesis/project proposal entitled:

It was:

_____ Accepted

_____ Rejected

Student Signature: _____ Date: _____

Advisor Approval: _____ Date: _____

Committee Member Signature:

_____ Date: _____

_____ Date: _____

_____ Date: _____

_____ Date: _____

Graduate Director Approval: _____ Date: _____

