

Revised Graduate Curriculum (including New Graduate Courses) Proposal from

The Department of Computer Science

Revision of the Computer Science MS Program Curriculum

A. PROPOSAL SUMMARY AND CATALOG COPY.

1. SUMMARY.

The Computer Science Department has added two new strategic development areas in research and education - data visualization and computer gaming. The Department has hired 8 new graduate faculty members in the past two years to support this effort. The Charlotte Visualization Center has been established under the leadership of Bank of America Endowed Professor Ribarsky. Computer Game Design and Development Certificate Programs at graduate and undergraduate levels are in the final stage of preparation. The formal proposals for the certificate programs will appear in front of the Graduate Council and Undergraduate Course and Curriculum Committee in the near future. This MS program revision proposal includes 16 new course sub-proposals, most of them are in the areas of data visualization and computer gaming:

- a. ITCS 5121/4121 Information Visualization
- b. ITCS 5122/4122 Visual Analytics
- c. ITCS 5123/4123 Visualization and Visual Communication
- d. ITCS 5133/4133 Numerical Computation Methods and Analysis
- e. ITCS 5146/4146 Grid Computing
- f. ITCS 5232/4232 Game Design and Development Studio
- g. ITCS 5235/4235 Game Engine Construction
- h. ITCS 5236/4236 Artificial Intelligence for Computer Games
- i. ITCS 5237/4237 Audio Processing for Entertainment Computing
- j. ITCS 6124/8124 Illustrative Visualization
- k. ITCS 6126/8126 Large Scale Information Visualization
- l. ITCS 6127/8127 Real-time Rendering Engines
- m. ITCS 6128/8128 3D Display and Advanced Interfaces
- n. ITCS 6159/8159 Intelligent Tutoring Systems
- o. ITCS 6167/8167 Advanced Networking Protocols
- p. ITCS/ITIS 6228/8228 Medical Informatics

This proposal revises the core and breadth requirements to reflect the additional faculty expertise and new course offerings. A revised course rotation schedule is attached in Appendix 17. This proposal also revises minimum background requirements for admission to the MS program.

2. PROPOSED CATALOG COPY.

MS Degree Requirements

The Master of Science program in Computer Science requires 30 graduate credit hours, which may optionally include 6 hours of thesis. At least 21 hours of the courses applied to the degree must be from the Department of Computer Science. At least 15 hours must be 6000 level or above courses. No more than 6 hours may be in Individual Study. A maximum of 6 hours of graduate credit may be transferred from other institutions.

I. Core Requirement

All students must take two courses from the Core Category:

ITCS 5102 Survey of Programming Languages
ITCS 5141 Computer Organization and Architecture or ITCS 6182 Advanced Computer
Architecture
ITCS 6112 Software System Design and Implementation
ITCS 6114 Algorithms & Data Structures

II. Breadth Requirements

All students must take three courses, each from a different Course Category, to satisfy the breadth requirements.

Course Categories are:

- Data Management

ITCS 6155 Knowledge Based Systems
ITCS 6157 Visual Databases
ITCS 6160 Database Systems
ITCS 6161 Advanced Topics in Database Systems
ITCS 6162 Knowledge Discovery in Databases
ITCS 6163 Data Warehousing

- Networked Systems

ITCS 5145 Parallel Computing
ITCS 5146 Grid Computing
ITCS 6132 Modeling & Analysis of Communication Networks
ITCS 6166 Computer Networks
ITCS 6167 Advanced Networking Protocols
ITCS 6168 Wireless Communications

- Visualization and Computer Graphics

ITCS 5120 Introduction to Computer Graphics
ITCS 5121 Information Visualization
ITCS 5122 Visual Analytics
ITCS 5123 Visualization and Visual Communication

ITCS 6124 Illustrative Visualization
ITCS 6126 Large Scale Information Visualization
ITCS 6127 Real-time Rendering Engines
ITCS 6128 3D Display and Advanced Interfaces
ITCS 6140 Data Visualization

- Intelligent & Interactive Systems

ITCS 5152 Computer Vision
ITCS 6050 Topics in Intelligent Systems
ITCS 6111 Evolutionary Computation
ITCS 6125 Virtual Environments
ITCS 6134 Digital Image Processing
ITCS 6150 Intelligent Systems
ITCS 6151 Intelligent Robotics
ITCS 6156 Machine Learning
ITCS 6158 Natural Language Processing
ITCS 6267 Intelligent Information Retrieval

- Applications (includes all application area specific courses such as Medical Informatics, and Game Design)

ITCS 5133 Numerical Computation Methods and Analysis
ITCS 5230 Introduction to Game Design and development
ITCS 5231 Advanced Game Design and Development
ITCS 5232 Game Design and Development Studio
ITCS 5235 Game Engine Construction
ITCS 5236 Artificial Intelligence for Computer Games
ITCS 5237 Audio Processing for Entertainment Computing
ITCS 6153 Neural Networks
ITCS 6159 Intelligent Tutoring Systems
ITCS 6165 Coding and Information Theory
ITCS 6222 Biomedical Signal Processing
ITCS 6224 Biomedical Image Processing
ITCS 6226 Bioinformatics
ITCS 6228 Medical Informatics

III. Area of Concentration

Each student must take at least three related courses (9 hours) to form an area of concentration. The area of concentration may differ from the Course Categories; students are encouraged to have their areas of concentration aligned with faculty research areas. The three courses forming the student's area of concentration must have the written approval of the student's academic advisor. Only one breadth course can be included in the area of concentration courses. Core courses can not be used in area of concentration. At least two of the three courses forming an area of concentration should be from the Department of Computer Science.

Minimum Background Requirements for Admission

Applicants to MS program in Computer Science must have had a computing background equivalent to two years of undergraduate training in Computer Science, including at least an introductory course on programming, a course on data structures, and a course either in operating systems or computer architecture. In addition, background in Mathematics to include courses in Linear Algebra or Statistics, Discrete Mathematics, and at least one year of Calculus is also required. Students without sufficient background in Computer Science or Mathematics may be admitted to the Program but must complete background courses determined by the MS Program Director in the first year.

New Courses:

ITCS 4121. Information Visualization. (3) Prerequisites: ITCS 1215 or approval of the instructor. Information visualization concepts, theories, design principles, popular techniques, evaluation methods, and information visualization applications. (Spring) (Evenings)

ITCS 5121. Information Visualization. (3) Prerequisites: graduate standing. Information visualization concepts, theories, design principles, popular techniques, evaluation methods, and information visualization applications. (Spring) (Evenings)

ITCS 4122. Visual Analytics. (3) Prerequisites: any of STAT 1220, 1221, 1222, 2122, or 2223, or approval of the instructor. This course introduces the new field of visual analytics, which integrates interactive analytical methods and visualization.. Topics include: critical thinking, visual reasoning, perception/cognition, statistical and other analysis techniques, principles of interaction, and applications. (Fall) (Evenings)

ITCS 5122. Visual Analytics. (3) Prerequisites: any of STAT 1220, 1221, 1222, 2122, or 2223, or approval of the instructor. This course introduces the new field of visual analytics, which integrates interactive analytical methods and visualization.. Topics include: critical thinking, visual reasoning, perception/cognition, statistical and other analysis techniques, principles of interaction, and applications. (Fall) (Evenings)

ITCS 4123. Visualization and Visual Communication. (3) Prerequisites: none. Understanding the relatively technical field of visualization from the point of view of visual communication, this course draws connections with photography, design, illustration, aesthetics, and art. Both technical and theoretical aspects of the various fields are covered, and the connections between them are investigated. (Spring) (Evenings)

ITCS 5123. Visualization and Visual Communication. (3) Prerequisites: none. Understanding the relatively technical field of visualization from the point of view of visual communication, this course draws connections with photography, design, illustration, aesthetics, and art. Both technical and theoretical aspects of the various fields are covered, and the connections between them are investigated. (Spring) (Evenings)

ITCS 4133. Numerical Computation Methods and Analysis.(3) Prerequisites: ITCS 2214 and either MATH 1120 or MATH 1241. Introduction to principles and techniques behind numerical methods and algorithms that underlie modern scientific and engineering applications. Roots of equations; linear systems (direct methods, LU/QR factorization, iterative methods); Eigen values and vectors; Interpolation, Approximation; Numerical Differentiation/Integration, ODEs and PDEs. (On Demand).

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ITCS 4146 Grid Computing. (3) Prerequisite: ITCS 1215.

Grid computing software components, standards, web services, security mechanisms, schedulers and resource brokers, workflow editors, grid portals, grid computing applications. (Spring)

ITCS 5146 Grid Computing. (3) Prerequisite: ITCS 1215 or Graduate Standing.

Grid computing software components, standards, web services, security mechanisms, schedulers and resource brokers, workflow editors, grid portals, grid computing applications. (Spring)

ITCS 4232. Game Design and Development Studio. (3) Prerequisite: ITCS

4120, ITCS 4231, and consent of instructor. Application of advanced concepts and techniques for electronic game design and development.

Teams will use engineering techniques to incorporate game programming and scripting, networking, graphics, physics, audio, game data structures and algorithms, and artificial intelligence into an electronic game. Individuals will develop a complete portfolio of prior work and the class project. (Spring) (Evenings)

ITCS 5232. Game Design and Development Studio. (3) Prerequisite: ITCS

5120, ITCS 5231, and consent of instructor. Application of advanced concepts and techniques for electronic game design and development.

Teams will use engineering techniques to incorporate game programming and scripting, networking, graphics, physics, audio, game data structures and algorithms, and artificial intelligence into an electronic game. Individuals will develop a complete portfolio of prior work and the class project. (Spring) (Evenings)

ITCS 4235. Game Engine Construction. (3) Prerequisite: ITCS 4120 or Permission of

Department. Introduction to principles and techniques behind modern computer and console game engines. Graphics Rendering Pipeline (transformations, lighting, shading); 2D/3D Texture Mapping; Image Based Rendering; Spatial Structures and Acceleration Algorithms; Level of Detail; Collision Detection, Culling and Intersection Methods; Vertex/Pixel Shaders; Pipeline Optimization; Rendering Hardware.(Spring, Alternate Years) (Evenings)

ITCS 5235. Game Engine Construction. (3) Prerequisite: ITCS 5120 or Permission of

Department. Introduction to principles and techniques behind modern computer and console game engines. Graphics Rendering Pipeline (transformations, lighting ,shading); 2D/3D Texture Mapping; Image Based Rendering; Spatial Data Structures and Acceleration Algorithms; Level of Detail; Collision Detection, Culling and Intersection Methods; Vertex/Pixel Shaders; Pipeline Optimization; Rendering Hardware. (Spring, Alternate Years) (Evenings)

ITCS 4236. Artificial Intelligence for Computer Games. (3) Prerequisite: ITCS 3153.

Application of advanced concepts and techniques in artificial intelligence for electronic game design and development. An investigation of the artificial intelligence techniques necessary for an agent to act, or appear to act, intelligently in interactive virtual worlds. Topics include uncertainty reasoning, machine learning, perception, knowledge representation, search, and

planning. Emphasis will be on implementation and experimentation with the goal of building robust intelligent agents in interactive entertainment domains. Elements of multi-agent collaboration and the use of cognitive architectures in interactive computer games will also be discussed. (On demand)

ITCS 5236. Artificial Intelligence for Computer Games. (3) Prerequisite: ITCS 6150 or permission of instructor. Application of advanced concepts and techniques in artificial intelligence for electronic game design and development. An investigation of the artificial intelligence techniques necessary for an agent to act, or appear to act, intelligently in interactive virtual worlds. Topics include uncertainty reasoning, machine learning, perception, knowledge representation, search, and planning. Emphasis will be on implementation and experimentation with the goal of building robust intelligent agents in interactive entertainment domains. Elements of multi-agent collaboration and the use of cognitive architectures in interactive computer games will also be discussed. (On demand)

ITCS 4237. Audio Processing for Entertainment Computing. (3) Prerequisite: MATH 1242, MATH 2164, and ITCS 2215 or equivalents. Introduction to the principles and applications of audio (digital signal) processing focusing on entertainment domains. Topics include: analysis of signals, transforms, digital filter design techniques, audio engine development, file encoding/decoding, spatial sound rendering, optimization, and advanced audio techniques. (On demand)

ITCS 5237. Audio Processing for Entertainment Computing. (3) Prerequisite: MATH 1242, MATH 2164, and ITCS 6114 or equivalents. Introduction to the principles and applications of audio (digital signal) processing focusing on entertainment domains. Topics include: analysis of signals, transforms, digital filter design techniques, audio engine development, file encoding/decoding, spatial sound rendering, optimization, and advanced audio techniques. (On demand)

ITCS 6124. Illustrative Visualization. (3) Prerequisites: ITCS 4120 or ITCS 5120. This course focuses on advanced concepts and techniques related to the design, implementation, integration, and management of illustrative visualization and computer graphics. Topics include various advanced visualization topics: feature extraction, non-photorealistic rendering, point-based rendering, hardware-accelerated rendering, segmentation, image generation, animation, evaluation, design, and interaction. (Spring) (Evenings)

ITCS 8124. Illustrative Visualization. (3) Prerequisites: ITCS 4120 or ITCS 5120. This course focuses on advanced concepts and techniques related to the design, implementation, integration, and management of illustrative visualization and computer graphics. Topics include various advanced visualization topics: feature extraction, non-photorealistic rendering, point-based rendering, hardware-accelerated rendering, segmentation, image generation, animation, evaluation, design, and interaction. (Spring) (Evenings)

ITCS 6126. Large Scale Information Visualization. (3) Prerequisites: ITCS 4121 or ITCS 5121 Information Visualization. Concept, theory, design principles, data processing techniques, and visual metaphors and interaction techniques for massive, multi-dimensional, multi-source, time-varying information exploration. (Fall) (Evenings)

ITCS 8126. Large Scale Information Visualization.(3) Prerequisites: ITCS 4121 or ITCS 5121 Information Visualization. Concept, theory, design principles, data processing techniques, and

visual metaphors and interaction techniques for massive, multi-dimensional, multi-source, time-varying information exploration. (Fall) (Evenings)

ITCS 6127. Real-Time Rendering Engines. (3G). Prerequisites: ITCS 5120 or ITCS 6120. This course focuses on advanced concepts and techniques employed in building real-time rendering systems that support a high level of realism as well as handle large geometric models. Topics include: modern graphics hardware, programmable shaders, shadow and environment mapping, image-based modeling and rendering, large data models (simplification, level of detail), high quality interactive rendering. (On Demand).

ITCS 8127. Real-Time Rendering Engines. (3G). Prerequisites: ITCS 5120 or ITCS 6120. This course focuses on advanced concepts and techniques employed in building real-time rendering systems that support a high level of realism as well as handle large geometric models. Topics include: modern graphics hardware, programmable shaders, shadow and environment mapping, image-based modeling and rendering, large data models (simplification, level of detail), high quality interactive rendering. (On Demand).

ITCS 6128. 3D Display and Advanced Interfaces. (3G). Prerequisites: ITCS 4120 or ITCS 6120. The course covers the fundamentals of 3D display hardware and software technology. Topics include: human visual spatial perception of natural and synthetic 3D images, 3D display hardware, human computer interface algorithms for effective stereoscopic display, 3D display rendering techniques. (On Demand).

ITCS 8128. 3D Display and Advanced Interfaces. (3G). Prerequisites: ITCS 4120 or ITCS 6120. The course covers the fundamentals of 3D display hardware and software technology. Topics include: human visual spatial perception of natural and synthetic 3D images, 3D display hardware, human computer interface algorithms for effective stereoscopic display, 3D display rendering techniques. (On Demand).

ITCS 6159. Intelligent Tutoring Systems. (3) Prerequisite: Graduate standing or permission of the instructor. This course introduces the issues relevant to creating adaptive learning systems using artificial intelligence and includes a project to build a small Intelligent Tutoring System (ITS). Topics include: representation of knowledge and cognition, ITS design, adaptive user interfaces, design and evaluation of feedback, experimental methods, educational data mining, history of intelligent tutoring, tutor authoring, and issues for implementation. (Fall, alternate years) (Evenings)

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ITCS 6167. Advanced Networking Protocols. (3) Prerequisites: ITCS 6166 or ITCS 6168. This course focuses on advanced networking concepts and protocols related to the design, implementation, integration, and management of networking and communication systems. Topics include: topology control protocols, ad hoc routing protocols, power management protocols, distributed data processing protocols for various networking systems (Internet,

wireless mesh networks, ad hoc networks, sensor networks, peer-to-peer networks). (Spring) (Evenings)

ITCS 8167. Advanced Networking Protocols. (3) Prerequisites: ITCS 6166 or ITCS 8166 or ITCS 6168 or ITCS 8168. This course focuses on advanced networking concepts and protocols related to the design, implementation, integration, and management of networking and communication systems. Topics include: topology control protocols, ad hoc routing protocols, power management protocols, distributed data processing protocols for various networking systems (Internet, wireless mesh networks, ad hoc networks, sensor networks, peer-to-peer networks). (Spring) (Evenings)

ITCS 6228. Medical Informatics (3) Prerequisites: Graduate Standing. This course focuses on methods and techniques used in storage, communication, processing, analysis, integration, management, and distribution of medical information. The course emphasizes the applications of telemedicine and intelligent computer-aided decision making systems in different medical and surgical systems. The course also discusses the computational methods to accept or reject a new drug or a new treatment for a given disease. (Fall, Alternate years) (Evenings)

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ITIS 6228. Medical Informatics (3) Prerequisites: Graduate Standing. This course focuses on methods and techniques used in storage, communication, processing, analysis, integration, management, and distribution of medical information. The course emphasizes the applications of telemedicine and intelligent computer-aided decision making systems in different medical and surgical systems. The course also discusses the computational methods to accept or reject a new drug or a new treatment for a given disease. (Fall, Alternate years) (Evenings)

ITIS 8228. Medical Informatics (3) Prerequisites: Graduate Standing. This course focuses on methods and techniques used in storage, communication, processing, analysis, integration, management, and distribution of medical information. The course emphasizes the applications of telemedicine and intelligent computer-aided decision making systems in different medical and surgical systems. The course also discusses the computational methods to accept or reject a new drug or a new treatment for a given disease. (Fall, Alternate years) (Evenings)

B. JUSTIFICATION.

1. Need Addressed

The proposed course category structure and degree requirements force an MS student in Computer Science to attempt courses in at least three different areas in addition to the core. When a student decides on an area of concentration, the courses available in that area will be clearly listed. And the Department can offer more graduate courses in faculty research areas, which also benefit student learning.

2. Prerequisites/Co-requisites

In addition to the standard GRE & TOEFL (for foreign students) test scores and undergraduate GPA requirements, the specific Computer Science and Mathematics background requirements can ensure that the students in the program are ready for a graduate level study in computer science.

3. Course Numbering

16 proposed new courses are at the 5000 and 6000 level for MS students. The second digits are all 1 or 2 for regular lecture courses. The companion 8000 level courses to the corresponding 6000 level courses are for PhD students. The companion 4000 level courses to the corresponding 5000 level courses are for advanced undergraduate students.

4. Improvements

The course offerings will better match faculty expertise. Students will get better guidance on area of concentration selection. Also the new rotation schedule will be posted in the web for students to plan ahead on their graduate study. In the past, the Department had to offer many temporary topic courses for those subjects in the new course proposals.

C. IMPACT.

1. Students Served.

This proposal mainly serves Computer Science MS students. SIS MS IT students can also be benefited from the availability of these new courses. The 8000 level courses will serve IT PhD students in CS, SIS, & BI tracks. And the companion 4000 level courses to the proposed 5000 level courses can benefit advanced undergraduate CS & SIS students.

2. Effect on Existing Courses and Curricula

a. Offering

The Department has worked out a 2-year rotation schedule, see Attachment 17, to cover all ITCS graduate courses including both the new courses in this proposal and the existing courses.

b. Other Courses

The offering of all graduate courses by the Computer Science Department have been reviewed. The new rotation schedule takes care of all courses.

c. Anticipated Enrollment

The MS program in CS currently has 104 students, each takes about 2.5 courses a semester on the average. The CS track of IT PhD program has 42 students, each takes about 1.5 courses a semester in addition to their research hours. Dividing 323 student-courses by 21 courses per semester offering in the rotation schedule, the average enrollment of a graduate CS class will be about 15 graduate students (for both new and existing courses), which is about right class size for graduate courses.

d. Enrollment Impacts

The average enrollment of a graduate CS class will be about 15 graduate students (for both new and existing courses).

e. Previous Topic Courses

Some of the proposed new courses have been offered before as topics courses ITCS 6010/8010 Topics in Computer Science or ITCS 5010/4010 Topics in Computer Science. For details, see attached individual new course sub-proposals.

f. Other Areas of Catalog Copy That Would Be Affected

The proposed catalog copy covers all areas of catalog that are affected.

D. RESOURCES

1. Personnel

No additional faculty is required to implement the changes being proposed. All CS graduate faculty members will be involved in the revised program.

2. Physical Facility

No additional facilities are required as a result of this program revision.

3. Equipment and Supplies

No new equipment or supplies are required to deliver this revised program.

4. Computer

No new computer equipment is required to deliver the revised program.

5. Audio-Visual

No new audio-visual equipment is required to deliver the revised program.

6. Other Resources

No other new resources are required to deliver this revised program.

7. Funding Sources

Not applicable, as no new resources are required.

E. CONSULTATION WITH THE LIBRARY AND OTHER DEPARTMENTS OR UNITS

1. Library Consultation

The Library consultation letters are attached to individual new course sub-proposals.

2. Consultation with Other Departments or Units

The letter of support from SIS department is attached as Attachment 20.

F. INITIATION AND CONSIDERATION OF THE PROPOSAL

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

G. ATTACHMENTS

- 1. Proposal for ITCS 5121/4121 Information Visualization**
- 2. Proposal for ITCS 5122/4122 Visual Analytics**
- 3. Proposal for ITCS 5123/4123 Visualization and Visual Communication**
- 4. Proposal for ITCS 5133/4133 Numerical Computation Methods and Analysis**
- 5. Proposal for ITCS 5146/4146 Grid Computing**
- 6. Proposal for ITCS 5232/4232 Game Design and Development Studio**
- 7. Proposal for ITCS 5235/4235 Game Engine Construction**
- 8. Proposal for ITCS 5236/4236 Artificial Intelligence for Computer Games**
- 9. Proposal for ITCS 5237/4237 Audio Processing for Entertainment Computing**
- 10. Proposal for ITCS 6124/8124 Illustrative Visualization**
- 11. Proposal for ITCS 6126/8126 Large Scale Information Visualization**
- 12. Proposal for ITCS 6127/8127 Real-time Rendering Engines**
- 13. Proposal for ITCS 6128/8128 3D Display and Advanced Interfaces**
- 14. Proposal for ITCS 6159/8159 Intelligent Tutoring Systems**
- 15. Proposal for ITCS 6167/8167 Advanced Networking Protocols**
- 16. Proposal for ITCS/ITIS 6228/8228 Medical Informatics**
- 17. Two-Year Rotation Schedule** for Computer Science graduate courses
- 18. Current degree requirements** of MS program in Computer Science
- 19. Consultation letters from the Library** are attached to individual new course sub-proposals
- 20. Consultation letter from Software and Information Systems Department**

Attachment 1. Proposal for ITCS 5121/4121 Information Visualization

The University of North Carolina at Charlotte

New Undergraduate and Graduate Course Proposal
from the Department of Computer Science

No. CSCI-11-14-2006a

Title: Addition of new undergraduate course ITCS 4121 and graduate course ITCS 5121:
Information Visualization

A. Proposal Summary and Catalog Copy

1. Summary

The Computer Science Department proposes to add one new undergraduate and one new graduate course to the respective curricula, ITCS 4121 and ITCS 5121: Information Visualization

2. Proposed Catalog Copy

ITCS 4121. Information Visualization (3) Prerequisites: ITCS 1215 or approval of the instructor. Information visualization concepts, theories, design principles, popular techniques, evaluation methods, and information visualization applications. (Spring) (Evenings)

ITCS 5121. Information Visualization (3) Prerequisites: graduate standing. Information visualization concepts, theories, design principles, popular techniques, evaluation methods, and information visualization applications. (Spring) (Evenings)

B. Justification

1. Need:

Information visualization is a research area that focuses on the use of visualization techniques to help people understand and analyze abstract data. Information visualization techniques have been widely used in applications where abstract data are collected, analyzed, and presented, such as financial analysis, digital libraries and bioinformatics. Information visualization is also one of the major research areas in the blooming field of visual analytics.

2. Prerequisites/Corequisites:

Prerequisites: Students are expected to have basic programming skills preferably in Java or C++. Necessary prerequisites are ITCS 1214 and ITCS 1215, which covers basic programming skills. Students who have not taken ITCS 1214 and ITCS 1215 can be accepted by admission of the instructor.

3. Course numbering:

The course is positioned as suitable for both advanced undergraduate and graduate students.

4. Effect on scope, quality, and efficiency:

Information visualization considerably broadens the scope of courses taught in the computer science department. It provides useful concepts and techniques to many research fields where abstract data are collected, analyzed, and presented. It also provides students necessary background for learning visual analytics

C. Impact

1. Students Served:

The course will serve CS majors as well as students from such diverse fields as finance, engineering and bioinformatics. It is positioned as an accessible outreach course to show the CS students one of the major visualization fields, and to teach students from other departments techniques that can be applied to their own fields.

2. Effect on existing courses and curricula:

- a. The course will be offered each Spring.
- b. The content of other courses will not be affected. The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.
- c. The anticipated enrollment is 30 students/Spring semester.
- d. This new course is part of the CS MS program revision.
- e. Affected areas of catalog copy: In curriculum outlines, and requirements for the degree, the proposed courses should be listed as elective options.

D. Resources Required to Support Proposal

1. Personnel:

- a. *Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty.*
No requirements for new faculty or increased load on present faculty.
- b. *List by name qualified faculty members interested in teaching the course(s).*
Jing Yang is interested and qualified to teach the course.

2. Physical Facility:

No new physical facilities are needed, beyond a regular classroom to teach the class.

3. Equipment and Supplies:

No new equipment and supplies are needed to teach the courses.

4. Computer:

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use their own computers or those in the Woodward 335 for course assignments and projects. Faculty will use their own existing computers for course preparation. Computing resources are adequate for the proposed course.

5. Audio-Visual:

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources:

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None needed.

E. Consultation with Library and Other Departments or Units

1. Library Consultation: Attached

2. Consultation with other Departments or Units: SIS Department

F. Initiation and Consideration of Proposal

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

G. Attachments

1. Consultation with Library memo

2. Syllabus for the proposed graduate course



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 1, 2006

Subject: ITCS 4121/5121: Information Visualization

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/01/06

Check One:

1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
3. Holdings are adequate only if Dept. purchases additional items.
4. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Information Visualization and related subjects retrieved 6745 pertinent items. Of this total, 1804 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 54 journals and 923 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 01, 2006

Date

Atkins Library Holdings in Areas Related to

Information Visualization

11/01/06

Subject Heading	All Books	After 2000	Journals	Electronic Resources
Animation	262	82	2	34
Cognition	2117	359	20	155
Data analysis	3127	975	16	632
Data visualization	78	40	1	14
Graphic design	273	79	7	8
Graphic visualization	72	25	1	18
Information visualization	58	33	1	18
Multidimensional visualization	4	3	0	1
Multimedia visualization	12	5	0	2
Scatterplot*	4	3	0	1
Visual analysis	147	99	1	11
Visual perception	591	101	5	29
Totals	6745	1804	54	923

ITCS 4121/5121: Information Visualization - Syllabus

Course Description (catalog description):

Information visualization concepts, theories, design principles, popular techniques, evaluation methods, and information visualization applications. (Spring)

General Information:

Information visualization is the science that unveils the underlying structure of abstract data sets using visual representations that utilize the powerful processing capabilities of the human visual perceptual system.

Topics of this course include a) visual perception, cognitive issues, as well as other theory and design principles behind information visualization; b) popular multidimensional visualization techniques such as parallel coordinates, scatterplot matrixes and glyphs; popular hierarchy and graph visualization techniques such as the treemap; c) basic interaction techniques such as selection and distortion; evaluation; and d) examples of information visualization applications and systems, such as bio-information visualization, document visualization and multimedia library visualization.

The exact selection of topics is driven by three criteria: (1) essentials that must be covered, (2) advances in research, and (3) the interests of the participants.

Pre- or co-requisites:

ITCS1214 and ITCS1215

Objectives of the course:

This course will help students build basic concepts and learn popular techniques and applications of information visualization.

Instructional method

The course is offered as a regular class, combining lecture and discussion.

Means of student evaluation

Critiques:30%, Presentations: 30%, Projects: 20%, Class Participation: 20%..

1) Critiques: This course is reading intensive. The instructor will assign reading tasks to the students in the following approaches: a. The teacher will distributes papers to students each week and ask the students to write critiques on the papers and turn the critiques in the next weeks. The teacher will grade the critiques and give feedbacks on them in the weeks followed. The grades on the critiques will greatly affect the final grades. Regarding to the critiques, the teacher will give several questions related to the papers for students to answer in the critiques. Students are encouraged put their own thinking about the paper into the critiques. b. The teacher will give some topics and ask students to find papers on those topics. Students will be asked to write critiques and sometimes give presentations on the papers they find.

b) Presentations: Each student will give an in-class 10-minute presentation every three weeks. Students are required to send the presentation topics to the teacher one day before their presentation. Students will get the teacher's feedback on their slides if they send the slides to the teacher one day before the presentation.

c) Project: The students will be required to implement one information visualization prototype to practice what they learn in class. The students are not required to know OpenGL before they take this course since all the basic drawing elements will be provided to them (they can do the projects from scratch though). The students will be asked to present their projects in class.

Here is a list of sample projects: Build simple a file browser; Implement a parallel coordinate display; Implement a glyph display.

d) Class participation: There will be lots of in-class discussions in the classes. Students' performance in the discussions will also greatly affect their final grade.

GRADUATE STUDNETS (ITCS 5121): Graduate students will have additional work in reading and critique writing. The project has an additional challenge part to be done by graduate students. This part is available to undergraduate students for extra credit.

The basic undergraduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
60 -69.9	D
Below 60	F

The basic graduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Attendance Policy

Attendance of all scheduled classes is mandatory. 5% of total grade will be deducted for every class that you are absent, unless a good reason is given.

Late policy

Critiques: The full score of each critique assignment is 100 points. You will be deducted 10 points for each day delayed.

Academic Integrity

Unless otherwise specified, the UNC Charlotte guidelines on Academic Integrity fully apply to all work in this course. This includes critique and programming assignments.

Textbook

Recommended textbook: Spence, Robert. Information Visualization. Addison-Wesley.

In addition, many recent papers in the field will be read in the class. The papers will be provided by the teacher.

Also, the teacher will circulate a set of useful reference books within the class. Here is a list of the books:

1. Ware, Colin. Information Visualization: Perception for Design (2nd Edition). Morgan-Kaufmann, 2004.
2. Tufte, Edward. The Visual Display of Quantitative Information (2nd Edition). Graphics Press, 2001.
3. Tufte, Edward. Envisioning Information. Graphics Press, 1990.
4. Tufte, Edward. Visual Explanations: Images and Quantities, Evidence and Narrative. Graphics Press, 1997.

Outline of Course Content

- a) visual perception, cognitive issues, as well as other theory and design principles behind information visualization;
- b) popular multidimensional visualization techniques such as parallel coordinates, scatterplot matrixes and glyphs; popular hierarchy and graph visualization techniques such as the treemap;
- c) basic interaction techniques such as selection and distortion; evaluation; and
- d) examples of information visualization applications and systems, such as bio-information visualization, document visualization and multimedia library visualization

Useful Resources

1. Dr. Daniel Keim's tutorials

http://dbvis.inf.uni-konstanz.de/group/get_tutorials.php?name=keim

2. Dr. George Robertson's tutorials

<http://research.microsoft.com/~ggr/pubs.htm>

3. Dr. John Stasko's Information Visualization course materials

http://www-static.cc.gatech.edu/classes/AY2006/cs7450_spring/index.html

4. XmdvTool homepage

<http://davis.wpi.edu/~xmdv/>

Software

Two existing information visualization prototypes will be provided to the students for developing their projects. One was written in java and another was written in C++. Basic input, output and drawing functions are provided in them. Students can select one of them and build their projects on it. They can also build their project from scratch using any C++ or Java environment.

Attachment 2. Proposal for ITCS 5122/4122 Visual Analytics

The University of North Carolina at Charlotte

New Undergraduate and Graduate Course Proposal **No. CSCI-11-14-2006b**
from the Department of Computer Science

Title: Addition of new undergraduate course ITCS 4122 and graduate course ITCS 5122: **Visual Analytics**

A. Proposal Summary and Catalog Copy

1. Summary

The Computer Science Department proposes to add two new courses to the undergraduate and graduate curricula, ITCS 4122 and ITCS 5122: Visual Analytics

2. Proposed Catalog Copy

ITCS 4122. Visual Analytics. (3) Prerequisites: any of STAT 1220, 1221, 1222, 2122, or 2223, or approval of the instructor. This course introduces the new field of visual analytics, which integrates interactive analytical methods and visualization.. Topics include: critical thinking, visual reasoning, perception/cognition, statistical and other analysis techniques, principles of interaction, and applications. (Fall) (Evenings)

ITCS 5122. Visual Analytics. (3) Prerequisites: any of STAT 1220, 1221, 1222, 2122, or 2223, or approval of the instructor. This course introduces the new field of visual analytics, which integrates interactive analytical methods and visualization.. Topics include: critical thinking, visual reasoning, perception/cognition, statistical and other analysis techniques, principles of interaction, and applications. (Fall) (Evenings)

B. Justification

1. Need:

Visual Analytics (VA) is a new field of research that has grown out of visualization, and is a natural and much needed extension of the field. There is considerable funding available, and there is also a lot of interest from industry in the field, making it likely that students experienced in VA will be sought after very soon.

Visual Analytics also aims to expand the students' horizons both in terms of visualization, and in terms of more general critical thinking (which is naturally tied to intelligence analysis, the main application area for VA right now).

The VA course also provides a good starting point for students to get an introduction to visualization and then pursue the more specialized courses that are offered.

The course is being taught as a special topics course right now (Fall 2006), and has received a lot of interest from students with a background in the financial sector – an audience we are especially interested in here in Charlotte.

2. Prerequisites/Corequisites:

The course requires a basic understanding of statistics, so any one of STAT 1220, 1223, or 2122, are required. Students who have taken courses elsewhere, or can demonstrate sufficient knowledge of statistics will also be admitted.

3. Course numbering:

The course numbers position this course as an advanced undergraduate or basic graduate course. The goal is to give a broad audience access to the course, and spur interest in advanced visualization courses.

4. Effect on scope, quality, and efficiency:

Visual Analytics is the core of the visualization courses offered by members of the Charlotte Visualization Center, and will also be the basis for the Visual Analytics concentration and certificate we are working on. The course lays the foundations for advanced visualization courses, while demonstrating the practical relevance of the materials taught.

C. Impact

1. Students Served:

The course will serve the needs of undergraduate and graduate students in Computer Science as well as in other departments. In reaching out to students of other subjects, we will provide useful skills to those students, and also enrich the experience of CS students by bringing in people with application-oriented interests.

2. Effect on existing courses and curricula:

- f. The course will be offered each fall.
- g. The content of other courses will not be affected. The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.
- h. The anticipated enrollment is 15-20 students/fall semester.
- i. This new course is part of the CS MS program revision.
- j. This course has been offered once as a special topic course (ITCS 4010/5010) in Fall 2006. The enrollment for the course was 10 students.
- k. Affected areas of catalog copy: In curriculum outlines, and requirements for the degree, the proposed courses should be listed as elective options.

D. Resources Required to Support Proposal

1. Personnel:

- c. *Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty.*

No requirements for new faculty or increased load on present faculty. A student assistant will be needed when the course enrollment exceeds 10 students.

- d. *List by name qualified faculty members interested in teaching the course(s).*

Both Robert Kosara and William Ribarsky are interested and qualified to teach this course.

2. Physical Facility:

No new physical facilities are needed, beyond a regular classroom to teach the class.

3. Equipment and Supplies:

No new equipment and supplies are needed to teach the courses.

4. Computer:

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use their own computers or those in the Woodward 335 for course assignments and projects. Faculty will use their own existing computers for course preparation. Computing resources are adequate for the proposed course.

5. Audio-Visual:

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources:

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None needed.

E. Consultation with Library and Other Departments or Units

1. **Library Consultation:** Attached

2. **Consultation with other Departments or Units:** SIS Department

F. Initiation and Consideration of Proposal

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

G. Attachments

1. Consultation with Library memo

2. Syllabus for the proposed graduate course



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 2, 2006

Subject: ITCS 4122/5122: Visual Analytics

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/02/06

Check One:

1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
5. Holdings are adequate only if Dept. purchases additional items.
6. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Visual Analytics and related subjects retrieved 2155 pertinent items. Of this total, 821 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 15 journals and 250 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 02, 2006

Date

Atkins Library Holdings in Areas Related to

Visual Analytics

11/02/06

Subject Heading	All Books	After 2000	Journals	Electronic Resources
Critical thinking	488	215	0	16
Data mining	316	122	4	102
Data representation	119	54	3	9
Data transformation	95	73	0	15
Data visualization	78	40	1	14
Glyph*	21	6	0	1
Graphics program*	213	58	0	31
Histogram*	25	17	0	3
Information visualization	58	33	1	18
Scatterplot*	4	3	0	1
Visual analysis	147	99	1	11
Visual perception	591	101	5	29
Totals	2155	821	15	250

ITCS 4122/5122: Visual Analytics - Syllabus

Course Catalog Description

ITCS 4122/5122 Visual Analytics. (3) Prerequisites: any of STAT 1220, 1221, 1222, 2122, or 2223, or approval of the instructor. This course introduces the new field of visual analytics, which integrates interactive analytical methods and visualization.. Topics include: critical thinking, visual reasoning, perception/cognition, statistical and other analysis techniques, principles of interaction, and applications. (Fall) (Evenings)

Prerequisites

any of STAT 1220, 1223, or 2122, or approval of the instructor.

Objectives of the course

Providing students with knowledge about visualization, interaction, and analysis of data. Students will learn about existing techniques, and will use their skills for a practical visualization example of real-world data.

Instructional Method

This course incorporates lectures, guest lectures, in-class exercises and discussions, a project, smaller assignments, and student presentations.

Method of Student Evaluation

Students will be evaluated based on: 2 exams, assignments, a class project, and presentations. They will count toward the grade as follows:

Assignments:	30%
Project:	15%
Presentations:	20%
Midterm/Final:	35%

Undergraduates (4122) will only give one presentation (at the end), and their class projects will be done in small groups (2-3 students). They can give a paper presentation for additional credit.

Graduates (5122) will give two presentations (a paper presentation and a final one), and will each complete a project on their own.

The basic undergraduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
60 -69.9	D
Below 60	F

The basic graduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, and fully cite any sources used. Assignments or projects that are not appropriate in an academic setting, subject to the instructor's discretion, will not be accepted for a grade.

Attendance: Class attendance is a responsibility of each individual. If a student chooses not to attend class, he/she is responsible for any handouts, announcement, and contents of missed lectures.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

There is no official textbook for this course. Copies of the slides used in class will be provided to the students, along with a selection of relevant papers from conferences and journals. The booklet *Critical Thinking: Concepts and Tools* (Richard Paul and Linda Elder) will also be used.

Software: Java, any development environment, optionally using OpenGL

Topics

1. Introduction, overview, [What is visual analytics?](#)
2. Visual representation
 - a) History: London cholera/Broad Street water pump, Napoleon's March, use of charts by Playfair/Nightingale, etc.
 - b) Visualization of unstructured data
 - Scatterplots, scatterplot matrices
 - Parallel coordinates
 - Glyphs
 - Histograms
3. [Visualization/Visual Analytics Applications](#)
 - a) Various [application areas](#)
 - b) [Success stories](#)
4. The Analytic Process
 - a) Basics, Intelligence culture
 - b) Analytic reasoning and discourse
 - c) Sense-making
 - d) Ontologies
5. Perception
 - a) Basics of visual perception, the eye, perception and cognition
 - b) Pre-attentive processing
 - c) Gestalt laws
6. Visualization of structured data
 - a) Treemaps, Node-link-diagrams, etc.
 - b) Graphs as node-link and matrix
7. Color
 - a) Meaning of color
 - b) Good/bad choices of color
 - c) How to choose good colors (Which Blair Project, etc.)
8. Text visualization
 - a) Topic islands, Theme river, IN-SPIRE, etc.

- b) Text and visual interfaces
 - c) Text in visualization (labels, captions)
9. Data
- a) Data types (numerical, categorical, text, etc.)
 - b) Data representation/structures
 - c) Large and high-dimensional data
 - d) Types of structures that are interesting (what are we looking for?)
 - e) Data transformations (projections, clustering)
 - f) Data mining
10. Interaction
- a) Principles of interaction
 - b) Linking and Brushing
 - c) Focus and Context
 - d) Mixed initiative interaction
11. Technology and devices
- a) Large displays
 - b) High-density displays
 - c) Small displays
 - d) Input devices

Attachment 3. Proposal for ITCS 5123/4123 Visualization and Visual Communication

The University of North Carolina at Charlotte

New Undergraduate and Graduate Course Proposal
from the Department of Computer Science

No. CSCI-11-14-2006c

Title: Addition of new undergraduate course ITCS 4123 and graduate course ITCS 5123:
Visualization and Visual Communication

A. Proposal Summary and Catalog Copy

1. Summary

The Computer Science Department proposes to add one new undergraduate and one new graduate course to the respective curricula, ITCS 4123 and ITCS 5123: Visual Communication in Computer Graphics and Art

2. Proposed Catalog Copy

ITCS 4123. Visualization and Visual Communication (3) Prerequisites: none. Understanding the relatively technical field of visualization from the point of view of visual communication, this course draws connections with photography, design, illustration, aesthetics, and art. Both technical and theoretical aspects of the various fields are covered, and the connections between them are investigated. (Spring) (Evenings)

ITCS 5123. Visualization and Visual Communication (3) Prerequisites: none. Understanding the relatively technical field of visualization from the point of view of visual communication, this course draws connections with photography, design, illustration, aesthetics, and art. Both technical and theoretical aspects of the various fields are covered, and the connections between them are investigated. (Spring) (Evenings)

B. Justification

1. Need:

The CS department has considerable expertise and a large number of students working in fields that are inherently visual: visualization, virtual reality, computer games, real-time graphics. Few of the students get exposed to any aspects of visual communication other than their own field, however, and their overall visual literacy is rather limited.

Robert Kosara has taught the course twice at UNCC, with a total of 11 students. The course was also taught twice at Vienna University of Technology in Vienna, Austria, in cooperation with the artist Georg Russegger, and was taken by a total of almost 100 students there.

2. Prerequisites/Corequisites:

None.

3. Course numbering:

The course is positioned as suitable for both undergraduate and graduate students, from both computer science and art. Since the art department currently has no graduate program, all art students will be undergraduates.

4. Effect on scope, quality, and efficiency:

Visual Communication considerably broadens the scope of courses taught in the computer science department. It provides useful context to many concepts that play a role in visualization and computer graphics, and shows their practical relevance in many real-world situations.

The course also increases the students' visual literacy, thus enhancing their work in all visual areas, like visualization, computer games, virtual reality, etc.

C. Impact

1. Students Served:

The course will serve CS majors as well as students from such diverse fields as art, architecture, communication, English, etc. It is positioned as an accessible outreach course to show both the CS students the relevance of their work, and to teach other students about interesting topics in computer science.

In light of current efforts to establish programs in media art and related fields, the course could also serve as a model, and a possible candidate for these programs.

2. Effect on existing courses and curricula:

- l. The course will be offered each spring.
- m. The content of other courses will not be affected. The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.
- n. The anticipated enrollment is 10-15 students/spring semester.
- o. This new course is part of the CS MS program revision.
- p. This course has been offered twice as a special topic course (ITCS 4010/5010) in Fall 2005 and Spring 2006. The enrollment for the course in spring 2006 was six graduate and four undergraduate students (all CS or SIS).
- q. Affected areas of catalog copy: In curriculum outlines, and requirements for the degree, the proposed courses should be listed as elective options.

D. Resources Required to Support Proposal

1. Personnel:

- e. *Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty.*

No requirements for new faculty or increased load on present faculty.

- f. *List by name qualified faculty members interested in teaching the course(s).*

Robert Kosara is currently the only faculty member who is interested and qualified to teach the course.

2. Physical Facility:

No new physical facilities are needed, beyond a regular classroom to teach the class.

3. Equipment and Supplies:

No new equipment and supplies are needed to teach the courses.

4. Computer:

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use their own computers or those in the Woodward 335 for course assignments and projects. Faculty will use their own existing computers for course preparation. Computing resources are adequate for the proposed course.

5. Audio-Visual:

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources:

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None needed.

E. Consultation with Library and Other Departments or Units

1. Library Consultation: Attached.

2. Consultation with other Departments or Units: SIS Department and Art Department

F. Initiation and Consideration of Proposal

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

G. Attachments

1. Consultation with Library memo

2. Consultation with Department of Art

2. Syllabus for the proposed graduate course



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 2, 2006

Subject: ITCS 4123/5123: Visual Communication in Computer Graphics and Art

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/02/06

Check One:

1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
7. Holdings are adequate only if Dept. purchases additional items.
8. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Visual Communication in Computer Graphics and Art and related subjects retrieved 9657 pertinent items. Of this total, 2373 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 67 journals and 667 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 02, 2006

Date

**Atkins Library Holdings in Areas Related to
Visual Communication in Computer Graphics and Art
11/02/06**

Subject Heading	All Books	After 2000	Journals	Electronic Resources
Aesthetics	2737	618	10	111
Animation	262	82	2	34
Computer art	272	91	0	35
Computer game*	252	130	0	74
Computer graphic*	650	133	14	152
Graphic visualization	72	25	1	18
Photography	3532	661	25	80
Virtual reality	201	81	2	36
Visual art	769	229	3	18
Visual communication	270	99	2	16
Visual design*	239	95	4	26
Visual literacy	62	27	0	3
Visualization	339	102	4	64
Totals	9657	2373	67	667

From: Strassberg, Roy
Sent: Monday, December 18, 2006 1:11 PM
To: Chen, Ken
Cc: Ribarsky, William
Subject: RE: Consultation for a new CS course proposal

Ken,

I have received only the response below. Per Dr. Kosara's agreement to change the course title, the art unit approves of this course.

Thanks for the opportunity to respond.

Roy

From: Chen, Ken
Sent: Monday, December 11, 2006 5:26 PM
To: Strassberg, Roy
Cc: Wilson, David; Ribarsky, William; Hodges, Larry; Wang, Yu
Subject: RE: Consultation for a new CS course proposal

Roy:

Dr. Kosara has decided to change his new course title to
ITCS 5123/4123 Visualization and Visual Communication
from the original title
ITCS 5123/4123 Visual Communication in Computer Graphics and Art
Thank you for the input.
Ken

Keh-Hsun Chen (Ken), Ph.D.
Professor and Associate Chair
Department of Computer Science
410D Woodward Hall
704-687-8545
chen@uncc.edu

From: Strassberg, Roy
Sent: Monday, December 11, 2006 4:07 PM
To: Chen, Ken
Subject: FW: Consultation for a new CS course proposal

Ken,

I just received this response, among others.

Roy

From: Tweedy, Joan
Sent: Monday, December 11, 2006 4:04 PM
To: Strassberg, Roy
Subject: RE: Consultation for a new CS course proposal

To Whom it May Concern,

I recommend that the title be changed to Visual Communications and Graphic Images. Something that doesn't include the word art. I don't think they are proposing to teach how to make art as much as how to make effective images. Art is such a loaded word, and in this context I believe it is being misused, even though some of the images used may indeed be art.

Joan Tweedy, Assistant Professor of Art

Coordinator of Ceramics,

Department of Art

From: Art Department Faculty [<mailto:ART-F@LISTSERV.UNCC.EDU>] **On Behalf Of** Strassberg, Roy
Sent: Saturday, December 09, 2006 5:54 PM
To: list-ART-F
Subject: FW: Consultation for a new CS course proposal

Please review the enclosed proposed course and let me know if you support this as a new offering in the Computer Science department.

Absent a response, I will send the required letter.

Thanks,

Roy

-----Original Message-----

From: Chen, Ken

Sent: Sat 12/9/2006 4:50 PM

To: Strassberg, Roy

Cc: Kosara, Robert; Wilson, David; Hodges, Larry

Subject: Consultation for a new CS course proposal

Dear Prof. Strassberg:

Dr. Kosara of Computer Science is proposing a new course ITCS 4123/5123 Visual Communications. The Graduate Committee of College of Computing and Informatics believes a consultation with Dept. of Art is in order, which I agree. Please review the attached proposal and provide us a consultation letter at your earliest convenience. Thank you and wish you

Happy Holidays!

Regards,
Ken Chen

<<Proposal for ITCS 4123-5123.doc>>

Keh-Hsun Chen (Ken), Ph.D.
Professor and Associate Chair
Department of Computer Science
410D Woodward Hall
704-687-8545
chen@uncc.edu

CICS 4123/5123: Visualization and Visual Communication - Syllabus

Course Catalog Description

CICS 4123/5123. Visualization and Visual Communication (3) Prerequisites: none. Understanding the relatively technical field of visualization from the point of view of visual communication, this course draws connections with photography, design, illustration, aesthetics, and art. Both technical and theoretical aspects of the various fields are covered, and the connections between them are investigated. Students from computer science, architecture, art, and any other field are welcome. (Spring).

Prerequisites

None

Objectives of the course

To provide CS students with a broader understanding of visual communication and visualization, and to encourage them to apply ideas from art and design in their work. Another intention is to achieve a higher level of self-awareness and self-criticism in students' work, and thus increasing the quality of their projects.

Instructional Method

This course incorporates lectures, guest lectures, in-class exercises and discussions, a group project, individual assignments, and student presentations. In addition to completing projects and assignments, students will also critique each others' work. This way, they will practice the self-reflective and iterative way students in art usually work.

In addition, student work will be shown in a gallery setting on campus, to push the idea of exposure and awareness of the impact of one's work even further – and also to increase the reach of the class. A similar exhibit in Vienna proved very successful and very motivating for the students.

Method of Student Evaluation

Students will be evaluated based on: 2 exams, a group project, smaller individual assignments, and presentations. They will count toward the grade as follows:

Homework:	25%
Project:	20%
Presentations:	20%
Midterm/Final:	35%

The project consists of the design and implementation of a visualization method for a data set. Students from CS and other areas will work together on the design and interactive aspects of the project. Attendance and participation are required in class.

Undergraduate students (4123) will only do one presentation (the final presentation), and also work in larger groups (3-5 students). Graduate students (5123) will have to present a paper in addition to the final project, and will work on the final project in smaller groups (two students, one CS one from a different field).

The basic undergraduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
60 -69.9	D
Below 60	F

The basic graduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, and fully cite any sources used. Assignments or projects that are not appropriate in an academic setting, subject to the instructor's discretion, will not be accepted for a grade.

Attendance: Class attendance is a responsibility of each individual. If a student chooses not to attend class, he/she is responsible for any handouts, announcement, and contents of missed lectures.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

There is no official textbook for this course. Reading materials will be put together from books and conference and journal articles. Copies of the slides used in class will also be provided.

Software: Students' choice, but Java using OpenGL will be recommended. It is also likely that art students will be familiar with Adobe Flash.

Topics

12.Introduction

- a) Basics of visualization
- b) Visualization as visual communication
- c) History of visualization

13.Photography

- a) Pinhole camera
- b) Lens camera
- c) Use of aperture and exposure time
- d) Shutter types and effects
- e) Extended photography: tx-transform, generalized lens models

14.Visualization

- a) Visualization overview
- b) Structured and unstructured data, continuous and categorical data
- c) Interaction
- d) Color in visualization

15.Representation in Visualization

- a) Spatial metaphors
- b) Continuous and discrete metaphors
- c) Representation theory (Goodman)

16.Illustration and Design

- a) Design principles
- b) Illustration principles
- c) Differences design, illustration, visualization

17.Art

- a) Short historical overview
- b) Modern and postmodern theory
- c) Selected artists
- d) Aesthetics
- e) Visualization in art
- f) Artistic principles in visualization
- g) Unifying principles

Attachment 4. Proposal for ITCS 5133/4133 Numerical Computation Methods and Analysis

The University of North Carolina at Charlotte

New Undergraduate and Graduate Course Proposal
from the Department of Computer Science

No. CSCI-11-14-2006d

Title: Addition of a new undergraduate course ITCS 4133: **Numerical Computation Methods and Analysis** and a new graduate course ITCS 5133: **Numerical Computation Methods and Analysis**

A. Proposal Summary and Catalog Copy

1. Summary

The Computer Science Department proposes to add two new courses to the undergraduate and graduate curricula, **ITCS 4133/5133 Numerical Computation Methods and Analysis** and delete ITCS 3123 Introduction to Numerical Methods

2. Proposed Catalog Copy

ITCS 4133. Numerical Computation Methods and Analysis.(3) Prerequisite: ITCS 2214 and either MATH 1120 or MATH 1241. Introduction to principles and techniques behind numerical methods and algorithms that underly modern scientific and engineering applications. Roots of equations; linear systems (direct methods, LU/QR factorization, iterative methods); Eigen values and vectors; Interpolation, Approximation; Numerical Differentiation/Integration, ODEs and PDEs. (On Demand).

ITCS 5133. Numerical Computation Methods and Analysis.(3) Prerequisite: ITCS 2214 and either MATH 1120 or MATH 1241. Introduction to principles and techniques behind numerical methods and algorithms that underly modern scientific and engineering applications. Roots of equations; linear systems (direct methods, LU/QR factorization, iterative methods); Eigen values and vectors; Interpolation, Approximation; Numerical Differentiation/Integration, ODEs and PDEs. (On Demand).

B. Justification

1. Need:

This proposal seeks to restructure and renumber the existing course, ITCS 3123: Introduction to Numerical Methods, to a more appropriate number that reflects the level of the course. It also seeks to introduce Masters level students to this course by adding ITCS 5133. This topic is of considerable interest to the areas of scientific and engineering computing and crucial to graduates working in real-world applications. We also believe this will be a useful elective to the new programs in bioinformatics that are in development in the college of computing and informatics.

2. Prerequisites/Corequisites:

This course is targeted at senior level students, as well as Masters students. Students should have knowledge of basic data structures , such as ITCS 2214, as well as some calculus, such as Math 1241 or Math 1120. In addition, they should have reasonable software skills in a high level language such as C++ or Java.

3. Course numbering:

The course numbers position this as senior level or Masters level course.

4. Effect on scope, quality, and efficiency:

The proposed course will be of interest to students with interests in scientific and engineering computing applications. The topics covered in this course are essential to the research programs in computer science and bioinformatics

C. Impact

1. Students Served:

The course will serve the curricular needs of undergraduate and MS graduate students in the Computer Science Department, as well as students with interests in biomedical and bioinformatics related computing. This course can potentially also be of interest to students in the college of engineering.

2. Effect on existing courses and curricula:

- a. The course will be offered approximately on demand. We expect it to be offered at least once every 2 years.
- b. The content and frequency of offering of other courses will not be affected.
- c. The anticipated enrollment is about 10-15 students.
- d. Enrollment in other elective courses will not be affected.
- e. The computer science department has offered ITCS 3123: Introduction to Numerical Methods for many years. This proposal rennumbers this course and places it a more appropriate level, as well as add a section for MS level students. The content of the course has also been updated.
- f. Affected areas of catalog copy: In curriculum outlines, and requirements for the degree, the proposed courses should be listed as elective options.

D. Resources Required to Support Proposal

1. Personnel:

- a. *Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty.*

No requirements for new faculty or increased load on present faculty. A student assistant will be needed when the course enrollment exceeds 15 students.

- b. List by name qualified faculty members interested in teaching the course(s).

Possible instructors include Drs Kalpathi Subramanian, Gyorgy Revesz, Bill Ribarsky, Larry Hodges.

2. Physical Facility:

No new physical facilities are needed.

3. Equipment and Supplies:

No new equipment or supplies are needed to teach the courses.

4. Computer:

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use the Woodward 335 computer lab for course assignments and projects.. Existing computing resources in CCI are adequate for the proposed course.

5. Audio-Visual:

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources:

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None needed.

E. Consultation with Library and Other Departments or Units

1. Library Consultation: Attached

2. Consultation with other Departments or Units: SIS Department

F. Initiation and Consideration of Proposal

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

G. Attachments

1. Consultation with Library memo
2. Consultation with Department of Mathematics and Statistics
3. Syllabus for the proposed graduate course



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 2, 2006

Subject: ITCS 4133/5133: Numerical Computation Methods and Analysis

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/02/06

Check One:

1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
9. Holdings are adequate only if Dept. purchases additional items.
10. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Numerical Computation Methods and Analysis and related subjects retrieved 6765 pertinent items. Of this total, 1764 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 67 journals and 560 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 02, 2006

Date

**Atkins Library Holdings in Areas Related to
Numerical Computation Methods and Analysis
11/02/06**

Subject Heading	All Books	After 2000	Journals	Electronic Resources
Eigenvalue*	108	46	0	17
Gaussian elimination	10	9	0	3
Least squares	126	50	0	14
Linear algebra	199	50	2	12
Linear system*	465	200	2	56
Mathematical algorithm*	273	85	2	30
Mathematical approximation*	273	71	0	19
Mathematical computation*	651	158	16	80
Mathematical interpolation*	55	23	1	5
Mathematical iteration*	17	9	2	2
Mathematical method*	1921	349	23	118
Numeric* algorithm*	113	44	1	14
Numeric* approximation*	129	51	0	13
Numeric* computation*	103	33	3	12
Numeric* differentiation*	17	15	0	4
Numeric* equation*	564	124	1	36
Numeric* interpolation*	22	18	0	6
Numeric* iteration*	12	7	0	2
Numeric* method*	635	167	7	47
Partial differential equation*	475	61	3	23
Vector*	597	194	4	47
Totals	6765	1764	67	560

Dear Professor Chen

Thank you for your e-mail of December 9 informing the department of the proposal to create the course

ITCS 4133/5133 Numerical Computation Methods and Analysis.

The Math department does note some overlap with our existing courses Math 5165 and Math 5171 but are satisfied that the computational emphasis of the ITCS course as opposed to the analysis emphasis of the Math courses will result in quite different courses which will meet the legitimate needs of differing groups of students. Our department would not accept completion of ITCS 4133/5133 as a substitute for our courses and we would allow students who have completed ITCS 4133/5133 to take any of our graduate courses for full credit. I leave it for your committee to decide if students who have completed the Math courses should receive credit for subsequently taking ITCS 4133/5133 but I suspect that it would be such a rare occurrence that it may be pretty much a moot point. I have no objection to leaving the courses completely independent.

In summary, thank you for consulting with our department and, on behalf of the department, we do not have any objections to the creation and offering of the course.

Sincerely
Alan Dow

--
Alan Dow
Chair
Mathematics and Statistics
UNC Charlotte, NC 28223

ITCS 4133/5133: Numerical Computation Methods and Analysis

ITCS 4133. Numerical Computation Methods and Analysis.(3) Prerequisite ITCS 2214 and either MATH 1120 or MATH 1241. Introduction to principles and techniques behind numerical methods and algorithms that underly modern scientific and engineering applications. Roots of equations; linear systems (direct methods, LU/QR factorization, iterative methods); Eigen values and vectors; Interpolation, Approximation; Numerical Differentiation/Integration, ODEs and PDEs. (On Demand).

ITCS 5133. Numerical Computation Methods and Analysis.(3) Prerequisite: ITCS 2214 and either MATH 1120 or MATH 1241. Introduction to principles and techniques behind numerical methods and algorithms that underly modern scientific and engineering applications. Roots of equations; linear systems (direct methods, LU/QR factorization, iterative methods); Eigen values and vectors; Interpolation, Approximation; Numerical Differentiation/Integration, ODEs and PDEs. (On Demand).

Prerequisites

ITCS 2214 and either MATH 1241 or MATH 1120.

Objectives of the course

Providing computer science students with the basic knowledge of numerical techniques, algorithms and the means to analyze such techniques. The content of this course will be integral to scientific and engineering computing applications.

Instructional Method

This course will be taught primarily through lectures.

Method of Student Evaluation

Students will be evaluated based on: individual programming projects, 2 quizzes and a final exam.

Projects:	40%
Quizzes	30%
Final:	30%

Final grade will be assigned based on the projects, 2 quizzes and final exam. A normal 90-80-70-60 scheme will be employed for the final grade. For students in ITCS 5133, additional requirements will be part of course projects, as well as the final exam, with more emphasis on the analytical aspects of the course.

The basic undergraduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
60 -69.9	D
Below 60	F

The basic graduate grading scale is

90 – 100	A
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80-89.9	B
70 – 79.9	C
Below 70	U

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, except when working as part of a team.

Attendance: Class attendance is mandatory. If a student misses a class, he/she is responsible for any handouts, announcement, and contents of missed lectures.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

Suggested References:

- Numerical Methods: Algorithms and Applications, Laurene Fausett, Prentice Hall, 2003.
- Numerical Methods for Engineers, B.M. Ayyub, R.H. McCuen, Prentice Hall, 1996.
- Numerical Analysis, Richard Burden, Douglas Faires, 7th edition, Brooks/Cole, 2001.

Software:

All needed software tools are either available or are open-source.

Topics

1. Foundations
 - a. Sample problems, numerical methods
 - b. Linear algebra background
 - c. Numerical precision
 - d. Algorithms: performance, complexity
2. Roots of Equations
 - a. Bisection Method
 - b. Regula Falsi, Secant Methods
 - c. Newton's , Muller's methods
 - d. Analysis
3. Linear Systems
 - a. Direct Methods(Gaussian Elimination, Pivoting, Tridiagonal Systems)
 - b. LU/QR Factorization
 - c. Iterative Methods (Jacobi, Gauss-Seidel Methods, Successive Over-Relaxation)
4. Interpolation, Approximation

- a. Polynomial Interpolation
 - b. Spline Interpolation(Linear, quadratic, Cubic)
 - c. Least Squares Approximation (Linear, Quadratic)
 - d. Continuous Least Squares Approximation
5. Numerical Differentiation and Approximation
- a. Differentiation
 - b. Numerical Integration (Trapezoidal, Simpson Rules)
 - c. Gaussian Quadrature
6. Ordinary Differential Equations
- a. Taylor Methods
 - b. Runge-Kutta Methods
 - c. Multi-Step Methods
 - d. Stability
7. Partial Differential Equations
- a. Classification of PDEs
 - b. Heat Equation (Parabolic)
 - c. Wave Equation (Hyperbolic)
 - d. Poisson Equation (Elliptic)

Attachment 5. Proposal for ITCS 5146/4146 Grid Computing

University of North Carolina at Charlotte

New Undergraduate and Graduate Course Proposal

No. CSCI-11-14-2006e

From Department of Computer Science

“Establishment of a course in Grid Computing”

A. PROPOSAL SUMMARY AND CATALOG COPY.

1. SUMMARY.

The purpose of this proposal is to establish an elective course in Grid computing for senior undergraduates (ITCS 4146) and an elective course in grid computing for first year graduate students (ITCS 5146).

2. PROPOSED CATALOG COPY.

ITCS 4146 Grid Computing

3 Credit hours

Prerequisite: ITCS 1215

Grid computing software components, standards, web services, security mechanisms, schedulers and resource brokers, workflow editors, grid portals, grid computing applications. (Spring)

ITCS 5146 Grid Computing

3 Credit hours

Prerequisite: ITCS 1215 or Graduate Standing

Grid computing software components, standards, web services, security mechanisms, schedulers and resource brokers, workflow editors, grid portals, grid computing applications. (Spring)

B. JUSTIFICATION.

1. Need Addressed Grid computing uses geographically distributed and interconnected computers collectively for computing and resource sharing. Grid computing usually involves teams working together on a common goal, sharing computers and resources and possibly experimental equipment. The concept of Grid computing was first demonstrated in the mid-1990's and since then has grown in importance both in the scientific community, and more recently in the business community, as a way of sharing resources and computing power.

The proposed course was taught in Fall 2004 as a topics course on NCREN (North Carolina Research and Education Network) after receiving funding from the National Science Foundation and the University of North Carolina Office of the President. Seven North Carolina universities received the course providing students, or both students and computing equipment to form the Grid for the course. Thirty-four students enrolled in the course from the seven universities. The course was taught again in Fall 2005 on NCREN and that case twelve North Carolina universities were involved. Forty-three students enrolled in the course from nine universities. Most students in the course were senior undergraduates although there were about four graduate

students (who were given additional coursework). Several faculty elected to be in attendance. The institutions that received the course in 2004 and 2005 included:

- Appalachian State University
- Elon University
- Lenoir Rhyne College
- NC Central University
- NC State University
- University of North Carolina at Asheville
- University of North Carolina Chapel Hill
- University of North Carolina at Charlotte
- University of North Carolina at Greensboro
- University of North Carolina at Pembroke
- University of North Carolina at Wilmington
- Western Carolina University
- Winston-Salem State University
- Wake Technical Community College (faculty only)

Clearly there is a statewide interest in this course. It is perhaps one of the first such courses, nationally and internationally (see http://www.cs.uncc.edu/~abw/gridarticles/gridcourse_more.html).

2. Prerequisites The course is a programming course with several detailed programming assignments. To take the course, students are expected already to have basic programming skills preferably in Java and C and also are able to learn how to do Linux command-line programming actions. A necessary undergraduate prerequisite is ITCS 1215 (with ITCS 1214), which covers basic programming skills.

3. Course Numbering It is proposed to target senior undergraduate and first year graduate students in Computer Science and Engineering, as was done with the NCREN grid computing topics courses. Such courses are numbered ITCS 4xxx/5xxx.

4. Improvement to Programs There are currently only eight 4000/5000 level courses offered in Computer Science, yet at least forty-two 6000 level courses for graduate students, not including special topics courses. The proposed courses provide additional state-of-the-art electives for both undergraduates and graduate students.

C. IMPACT.

1. Groups of Students The BS program in Computer Science require students to take at least 9 hours at the 3000 level or above and 6 hours at the 4000 or above level or above. The proposed ITCS 4146 course can be used to satisfy this requirement partially. With departmental approval, undergraduate Computer Science students in the early entry MS program can take the proposed course at the 5000 level (ITCS 5146) for both their BS and MS degrees.

The 5000 level version of the proposed course is primarily for MS graduate students in Computer Science and related areas, and satisfies one of the courses students can take towards their 30 hours (although at least 15 hours must be at the 6000 level for CS MS graduate students). The MS program in Computer Science also requires three courses to be selected as a concentration. The proposed course is a suitable course, which together with the existing courses ITCS 5145 Parallel Computing and ITCS 6182 Advanced Computer Architecture could form a concentration focusing on high performance computing. It could be used with ITCS 5145 and ITCS 6166 Computer Communications and Networks for a concentration focusing on distributed computing. It could be used simply as a free elective.

2. Affect on Existing Courses Any new course affects the existing course enrollments to some extent but the current limited offerings at the 4000/5000 level in Computer Science suggests that there will not be any significant adverse affect adding another one.

(a) Course frequency: The course will be offered every Spring.

(b) Affect on other courses: The Grid computing course does not affect the contents of any other Computer Science course. The subject matter is not covered in any other Computer Science course (apart from a small overlap on grid security that may appear in the context of Internet security). The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.

(c) Anticipated enrollment: When the course was offered as a topics course on NCREN in Fall 2005, six Charlotte students enrolled in the course (43 students overall). The small number of Charlotte students can be partly attributed to the instructor (B. Wilkinson) only just returning from leave of absence and being unknown to students. It is expected that perhaps 10-20 students would registers in subsequent years.

No changes are needed to curriculum outlines, requirements for the degree, etc., other than listing ITCS 4146/ITCS5146 as a Computer Science elective.

D. RESOURCES REQUIRED TO SUPPORT PROPOSAL.

1. Personal.

(a) None. Existing faculty would teach the course.

(b) B. Wilkinson, Professor of Computer Science, is qualified to teach the course.

2. Physical Facility

No new facilities required.

3. Equipment and Supplies

No new equipment. Existing computers to be used, see below.

4. Computer

Four dual Xeon Blade servers were purchased from a grant to teach the course as a topics course. The same computer systems will be used to teach the course as a catalog course.

5. Audio-Visual

If the course is taught on NCREN as done previously, NCREN facilities will be needed. The course may also be taught in-house and not on NCREN.

6. Other Resources

None

7. Funding

None required

E. CONSULTATION WITH THE LIBRARY AND OTHER DEPARTMENTS OR UNITS

1. Library Consultation Attached

2. Consultation with Other departments of units SIS Department

F. INITIATION AND CONSIDERATION OF THE PROPOSAL.

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

G. ATTACHMENTS

1. Consultation with Library memo

2. Syllabus for the proposed graduate course



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 2, 2006

Subject: ITCS 4146/5156: Grid Computing

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/02/06

Check One: 1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
11. Holdings are adequate only if Dept. purchases additional items.
12. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Grid Computing and related subjects retrieved 2778 pertinent items. Of this total, 1319 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 32 journals and 910 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 02, 2006

Date

Atkins Library Holdings in Areas Related to
Grid Computing
11/02/06

Subject Heading	All Books	After 2000	Journals	Electronic Resources
Computational grid*	21	15	2	8
Computer network architecture	79	36	0	14
Computer resource manage*	463	236	0	357
Computer schedul*	97	41	0	16
Computing infrastructure*	202	138	1	64
Computing network*	287	113	9	102
Grid architecture	13	10	0	2
Grid comput*	23	16	2	14
Grid infrastructure*	7	6	1	2
Grid security	12	11	0	3
High performance comput*	208	71	10	67
Internet network*	1214	507	7	249
Service oriented architecture	14	11	0	1
Virtual organization*	138	108	0	15
Totals	2778	1319	32	914

TO ADD WHEN DONE

ITCS 4146/5146 Grid Computing

ITCS 4146 Grid Computing. (3) Prerequisite: ITCS 1215.

Grid computing software components, standards, web services, security mechanisms, schedulers and resource brokers, workflow editors, grid portals, grid computing applications. (Spring)

ITCS 5146 Grid Computing. (3) Prerequisite: ITCS 1215 or Graduate Standing.

Grid computing software components, standards, web services, security mechanisms, schedulers and resource brokers, workflow editors, grid portals, grid computing applications. (Spring)

Course Objectives:

This course will introduce students to grid computing. Upon completion of this course, students will learn:

- How to program web services and clients that interact with web services (as web services are the basis of modern grid infrastructure).
- How to program grid services (the form of web services used in grid computing) and clients that interact with grid services.
- The security mechanisms used in grid computing including personally requesting certificates from a certificate authority and handling the signed certificate.
- How to submit grid computing jobs, including RSL job specification.
- How to interact with a job schedule and submit jobs with resource requirements.
- How to use a grid computing workflow editor to submit complex intercommunicating web and grid services.
- The technical internal structure of grid portals and portlets.

Detailed list of topics:

Grid computing, Virtual organizations, computational grid projects, grid computing networks, TeraGrid, grid projects in the US and around the world, grid challenges
Internet Technologies, IP addresses, HTTP, URL, HTTP, XML, Telnet, FTP, SSL
Web Services, Service-Oriented Architecture (SOA), service registry, XML documents, XML schema, namespaces, SOAP, XML/SOAP examples, AxisWSDL, portType, message definition, WSDL to/from code
Grid Computing Standards, Open Grid Services Architecture (OGSA), Web Services Resource Framework (WSRF), Globus 4.0, components, creating a GT 4 service and clients.
Security, Secure connection, authorization requirements, symmetric and asymmetric (public/private) key cryptography, non-repudiation, digital signatures, certificates, certificate authorities, X509 certificate
Information Directory Services, LDAP, resource discovery
GT 4 Job submission, Basic structure (version 4.0), service container, service browser, Globus Resource Allocation Manager (GRAM), job submission with globusrun-ws, Grid Security Infrastructure (GSI), Globus certificates, simpleCA, proxies, creating a proxy, Resource management, resource Specification Language, syntax and examples in RSL and RSI-2.
Schedulers and resource brokers, Condor, submit description file, DAGMan, Checkpointing, ClassAd, Condor-G, Sun Grid Engine
High Performance computing (HPC) techniques suitable for grid computing, Techniques for high performance computing, brief introduction to MPI.

Workflow editors, GridNexus, JXPL
Grid portals, Examples and design using JSP 168
Grid computing Applications, Scientific, business

Instructional Method:

The course will be presented as a lecture course, possibly but not necessarily, broadcast on NCREN across the State of North Carolina. Students will access the computers used for the course remotely for programming assignments. WebCT will be used for assignment submission, quizzes, and grade reporting to students (to include feedback). Guest lecturers were invited at the end of the Fall 2004 and Fall 2005 courses and this practice will be continued for NCREN courses. Extensive slides (600+) and other details of the Fall 2005 grid computing topics course can be found at <http://www.cs.uncc.edu/~abw/ITCS4010F05/>.

Means of student evaluation:

Students will be evaluated through programming assignments, class tests and multiple-choice WebCT reality-check quizzes, a presentation, and final test. For each assignment, a 6-10 page Word document is required that shows how the assignment instructions were followed and all tasks were performed. Screen shots are required in the document and submitted through WebCT. The number of screen shots is up to the student but it should demonstrate that the programs worked.

Each assignment will have three dates posted on the course home page:

- Date set
- Date to report systems problems (typically 3-5 days after the date set)
- Date due

which are *very* firm.

- Students **MUST** report any system problems that are preventing them from completing an assignment by the date to report systems problems so that students can be given an account elsewhere on the grid if necessary.
- No extensions will be allowed if problems are not reported by the system reporting date unless there are documented unresolved system problems.

Grading

Several programming assignments:	45%
Assignment 1 Web service Java programming assignment. Tomcat	
Assignment 2 GT4 service programming assignment. Globus 4.0 environment.	
Assignment 2a “Sticky Note” tutorial.	
Assignment 3 Submitting a Job to the Grid, GT4 globusrun-ws, job specified in RSL-2	
Assignment 4 Submitting an SGE Job	
Assignment 5 Using GridNexus	
Additional assignments/presentations/quizzes	15%
Class tests (2)	25%
Final test	15%

Graduate students (ITCS 5146): Graduate students will have additional work including a term paper to write and present on a grid computing topic. Also each assignment has an additional challenge part to be done by graduate students. These parts are available to undergraduate students for extra credit.

The basic undergraduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
60 -69.9	D
Below 60	F

The basic graduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Policies that apply to the course:

Attendance Policy

Attendance is expected. Attendance will be recorded. If a student misses classes, it can have a deleterious effect on their grade. After 4 missed classes without good reason: 2 marks are taken off the overall accumulated marks (out of 100) for each additional class missed. If a student must miss class, he/she must see the instructor beforehand to avoid losing marks.

University integrity

All submitted assignments must be the student's own work. Copied work or work done by more than one person (unless specifically instructed) will not be accepted - at the very minimum, zero credit. The *UNC-C Code of Student Academic Integrity* applies to both assignments and tests. No work will be accepted after the due date without good reason. Each assignment has

Class Expectations

- Print out slides before class, read them, and annotate them during class.
- Read key papers and other materials provided.
- Ask questions during class and participate in class discussion.

Grading policies

The basic undergraduate grading is

90 – 100	A
80-89.9	B
70 – 79.9	C
60 -69.9	D
Below 60	F

The basic graduate grading is

90 – 100	A
----------	---

80-89.9	B
70 – 79.9	C
Below 70	U

Additional requirements - Instructions for site interaction when NCREN facility used:

Each site will be using their NCREN facility, which provides microphones for individuals to speak. The following announcement will be made:

- Please feel free to speak at suitable times but remember that the NCREN needs to be able to recognize the site and speaker, so first announce your institution.
- Since most microphones are turned on all the time, any sound will be heard across all sites unless a site turns their microphones off, so try to avoid unnecessary sounds.
- Fans from laptop can be especially disturbing, so move laptop away from a microphone.

Textbooks

There is no assigned course textbook. A suitable book does not exist. Materials and links are provided on the course home page. For more information see <http://www.cs.uncc.edu/~abw/ITCS4010F05>. The following books are listed as additional reading:

- “The Grid Core Technologies,” M. Li and M. Baker, Wiley, 2005, ISBN 0-470-09417-6.
- “Grid Computing Making the Global Infrastructure a Reality,” F. Berman, G. C. Fox and A. J. G. Hey editors, Wiley, 2003, ISBN 0-470-85319-0.
- “The Grid 2, Blueprint for a New Computing Infrastructure,” I. Foster and C. Kesselman editors, Morgan Kaufmann, 2004, ISBN 1-55860-933-4.
- “Grid Computing,” J. Joseph and C. Fellenstein, Prentice Hall/IBM Press, 2004, ISBN 0-13-145660-1.
- “Grid Computing: A Practical Guide to Technology and Applications,” by A. Abbas, Charles River Media, Inc., 2004, ISBN 1-58450-276-2.

Attachment 6. Proposal for ITCS 5232/4232 Game Design and Development Studio

University of North Carolina at Charlotte

New Undergraduate and Graduate Course Proposal
From: Department of Computer Science

No. CSCI-11-14-2006f

TITLE: ESTABLISHMENT OF A CAPSTONE UNDERGRADUATE AND GRADUATE COURSE IN GAME DESIGN & DEVELOPMENT

A. PROPOSAL SUMMARY AND CATALOG COPY:

1. SUMMARY:

The Computer Science Department proposes to add two new courses in the area of Game Design and Development: a capstone course to the undergraduate and graduate curriculums in gaming. These courses should be considered electives in general.

2. PROPOSED CATALOG COPY:

ITCS 4232. Game Design and Development Studio. (3) Prerequisite: ((ITCS-4120 OR ITCS-4130) AND ITCS-4231 AND one approved game elective) OR consent of instructor. Application of advanced concepts and techniques for electronic game design and development. Teams will use engineering techniques to incorporate game programming and scripting, networking, graphics, physics, audio, game data structures and algorithms, and artificial intelligence into an electronic game. Individuals will develop a complete portfolio of prior work and the class project. (Spring) (Evenings)

ITCS 5232. Game Design and Development Studio. (3) Prerequisite: (ITCS-5120 AND ITCS-5231 AND one approved game elective) OR consent of instructor. Application of advanced concepts and techniques for electronic game design and development. Teams will use engineering techniques to incorporate game programming and scripting, networking, graphics, physics, audio, game data structures and algorithms, and artificial intelligence into an electronic game. Individuals will develop a complete portfolio of prior work and the class project. (Spring) (Evenings)

B. JUSTIFICATION

1. Need:

The proposed courses address several needs for the Computer Science Department, the College of Computing and Informatics, UNC Charlotte, and the state of North Carolina. First, enrollments into computer science and related fields are dropping across the nation even though, according to the Bureau of Labor Statistics, demand for jobs in IT-related fields will be higher than demand in most other sectors of the economy. If these projections are correct and current enrollment trends continue, we may face a shortage of IT workers in the US. Game courses are very attractive to students, and gaming has surpassed film and movies in the economy. There are few game-related curricular programs at universities in the country. Providing this service will make UNC Charlotte and the College of Computing and Informatics unique.

A key component for a rounded technical education is the ability to apply classroom theory and knowledge in practice. This polishing creates better game developers for industry and scientists in this field, solidifies the knowledge learned by the student, and aids in developing a portfolio of work which is essential for gaining employment in the games industry.

North Carolina is particularly well situated to become a leader in attracting and producing game designers and developers. Two of the three main game engine companies are in North Carolina, Epic Software and Numeric Design Limited. The North Carolina Serious Games Initiative, a pioneering organization, supports the development of game technologies in business, education, training, and medical applications. Several companies, including 3DSolve and Virtual Heroes, that develop serious games technologies, reside in North Carolina. Other game companies, such as Red Storm Entertainment, are also located here in NC. These companies have already sent representatives to the Game Design course to give talks, have expressed interest in hiring student interns in the future, and are excited to see universities in NC offering courses that will prepare students to work in the game industry.

Given the size and state of the gaming and interactive media industries, supporting focused curricula is needed at universities, and can be particularly valuable for such companies here in NC. More importantly, games are becoming recognized as one avenue for increasing enrollments in computer science, as evidenced by Microsoft Research's Game Curriculum Request for Proposals in 2004-2005. Computer Science and the College of Computing and Informatics can benefit from providing this service by recruiting more students and rejuvenating interest in computing related fields.

2. Prerequisites/corequisites:

ITCS 4120/5120 Introduction to Computer Graphics, ITCS 4231/5231 Advanced Game Design and Development, and (1) approved game elective in the following areas are required as prerequisites. The elective areas are artificial intelligence, networks, audio processing, computational geometry, computational physics, computer graphics, and specialized game design (e.g., massively multiplayer online game design). This class is intended as a capstone for the game certificate sequence. The game certificate requires two electives. The purpose of requiring all of the graphics and gaming classes plus one elective is to ensure that students are at or near the end of the certificate classes. The development of a portfolio element and the skills needed to create balanced project teams require the prerequisites and the specialization class (elective) of the students. Prerequisites can be waived for advanced students with permission of the Game Design and Development Program Directors or the Department Chair.

3. Course numbering:

ITCS 4232 is intended as a senior-level course, so that students have had exposure to a broad range of computer science courses and experience in more complex group assignments and/or projects. ITCS 5232 is intended to be an intermediate level graduate course. ITCS 4232/5232 are each intended as a second-semester, major team project extension of ITCS 4231/5231.

4. Effect on scope, quality, and efficiency:

These proposed courses will broaden the scope of the computer science curriculum to include the application of a host of computing skills in designing and implementing games. The use of games, and the connection between the university and the games industry will motivate students to excel in computer science, and thus improve the quality of our graduates and hence the quality of our program.

C. IMPACT

1. Students served:

Undergraduate and graduate majors in computer science will have an additional pair of courses as electives for the major, which integrate their computing skills. This is the capstone class for the Certificate in Computer Game Design and Development.

2. Effect on existing courses and curricula:

- a. ITCS 4232/5232 will be offered each spring.
- b. The content of other courses will not be affected. The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.
- c. The anticipated enrollment is ITCS 4232: 20 students/ spring semester, ITCS5232: 15 students/ spring semester
- d. This new course is part of the CS MS program revision.
- e. ITCS 4230/5230 has been offered twice as a special topic course (ITCS 4010/5010) in Spring 2005 and Fall 2005. The enrollment for the course in Spring 2005 was approximately 38 undergraduates in ITCS 4010 and 5 graduate students in ITCS 5010. The enrollment for the course in Fall 2005 was 2 undergraduates and 4 graduate students. This low enrollment was probably due to the fact that the course was taught in two consecutive semesters, so those seniors interested in the course had already taken it, and due to the lack of its being labeled as a game course in the catalog. Students are very enthusiastic about the course. Two students in fall 2005 have been in contact with the game industry and may have a game they are developing purchased. Games created in the course have demonstrated complex programming and software engineering techniques, as well as creativity in design and gameplay. Students have also created game design documents, reports, demonstrations, and presentations of professional quality, which will help them in their future careers.
- f. Affected areas of catalog copy: In curriculum outlines, and requirements for the degree, the proposed courses should be listed as elective options.

H. RESOURCES REQUIRED TO SUPPORT PROPOSAL.

1. Personnel

- a. Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty.

No requirements for new faculty or increased load on present faculty.

- b. List by name qualified faculty members interested in teaching the course(s).

Drs. Tiffany Barnes and Michael Youngblood are qualified to teach the course. Dr. Barnes has taught ITCS 5220 and 5231. Dr. Youngblood has taught “AI for Computer Games” at UNCC and “Software Engineering for Computer Games” at The University of Texas at Arlington.

2. Physical Facility

No new physical facilities are needed, beyond a regular classroom to teach the class.

3. Equipment and Supplies

No new equipment and supplies are needed to teach the courses.

4. Computer

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use their own computers or those in the Woodward 335 for course assignments and projects. Faculty will use their own existing computers for course preparation. Computing resources are adequate for both courses.

5. Audio-Visual

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None needed.

I. CONSULTATION WITH THE LIBRARY AND OTHER DEPARTMENTS OR UNITS

1. Library Consultation

Attached

2. Consultation with other departments or units

SIS Department.

J. INITIATION AND CONSIDERATION OF THE PROPOSAL

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

K. ATTACHMENTS

1. Consultation with Library memo

2. ITCS4232 course outline including basic topics to be covered and suggested textbooks and reference materials with dates of publication.

3. Syllabi for graduate courses ITCS 5232



J. Murrey Atkins Library

Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 2, 2006

Subject: ITCS 4232/5232: Game Design and Development Studio

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/02/06

Check One: 1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
13. Holdings are adequate only if Dept. purchases additional items.
14. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Game Design and Development Studio and related subjects retrieved 2846 pertinent items. Of this total, 761 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 38 journals and 815 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 02, 2006

Date

Atkins Library Holdings in Areas Related to

Game Design and Development Studio

11/02/06

Subject Heading	All Books	After 2000	Journals	Electronic Resources
Artificial intelligence	1121	93	20	155
Audio programming	16	9	0	1
C (Computer programming language)	124	42	0	45
Computer game*	252	130	0	74
Computer graphics	650	133	14	152
DirectX	21	19	0	19
Electronic game*	382	152	1	263
Game design*	9	5	0	3
Game programming	88	66	0	42
Interactive media	23	7	0	3
Video game*	50	26	0	8
Virtual reality	73	59	2	34
Visual programming	25	10	1	12
“Visual Studio”	12	10	0	4
Totals	2846	761	38	815

ITCS 4232 Game Design and Development Studio - Outline

Course Catalog Description

ITCS 4232. Game Design and Development Studio. (3) Prerequisite: ((ITCS-4120 OR ITCS-4130) AND ITCS-4231 AND one approved game elective) OR consent of instructor. Application of advanced concepts and techniques for electronic game design and development. This course is a major capstone project course where students apply knowledge from ITCS 4230, 4231, and game development related electives as part of a team project to develop an electronic game. All phases of the engineering process will be explored from requirements through design, implementation, testing, distribution, and maintenance. Advanced game programming and scripting, networking, graphics, physics, audio, game data structures and algorithms, and artificial intelligence will be incorporated into a single integrated electronic game. The requirements of and a complete portfolio of prior work and the class project will be developed. (Spring)

Prerequisites

ITCS 4120, ITCS 4231, and (1) Approved Game Elective

Objectives of the course

At the end of this course, students should be able to:

1. Learn to apply prior knowledge to develop from concept-to-delivery a complete interactive computer game
2. Demonstrate software engineering principles as applied to game development
3. Demonstrate advanced skills as a team in all areas of game development, including: graphics, physics, audio, networking, performance optimization, artificial intelligence, user interface design, interactivity, and procedurally-generated content
4. Design and implement a complex electronic game as part of a team through all phases of development which shall include the idea pitch, requirements, high-level design, low-level design, user documentation, implementation, testing, delivery, and maintenance
5. Learn to critically evaluate and test computer games
6. Communicate game design and development ideas effectively with both technical and non-technical audiences

Instructional Method

This course incorporates lectures, guest lectures, in-class exercises and discussions, a team project, and many student demonstrations and presentations.

Method of Student Evaluation

Students will be evaluated based on a team project with several stages of deliverables (pitch, requirements, design, implementation, testing, delivery, and maintenance feature patch). The project, a team implementation of a complete computer game, includes evaluation of the game as well as presentations at each development stage throughout the course of the game design and development. Attendance and participation are required in class. For each absence beyond the third absence, 5 points may be deducted from a student's overall grade.

A standard 10-point grading scale will be used for the class (A: 90-100, B: 80-90, ...).

The basic undergraduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C

60 -69.9	D
Below 60	F

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, and fully cite any sources used. Assignments or projects that are not appropriate in an academic setting, subject to the instructor's discretion, will not be accepted for a grade.

Attendance: Attendance is mandatory. For each absence beyond the third absence, 5 points may be deducted from a student's overall grade.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

Title: *Introduction to Game Development*
 Edited by: Steve Rabin
 ISBN: 1-58450-377-7
 Charles River Media, May 2005

Title: *The Mythical Man-month*
 Author: Fred Brooks
 ISBN: 0-20100-650-2
 Addison-Wesley, January 1975 (This is a seminal book on Software Engineering teams)

Title: *Peopleware: Productive Projects and Teams*
 Authors: Tom DeMarco and Timothy Lister
 ISBN: 0-93263-343-9
 Dorset House Publishing Company, Incorporated; 2nd edition (February 1, 1999)

Additional Optional Texts:

- *3D Games - Real-Time Rendering and Software Technology* by Alan Watt and Fabio Policarpo, 2000.
- *Game Programming Gems Series*, edited by Mark DeLoura and others, editions 1-6, pub. Dates 2000-2006.
- *AI Game Programming Wisdom Series*, edited by Steve Rabin, 2002, 2003, 2004
- *Chris Crawford on Game Design* by Chris Crawford, 2003.
- *Rules of Play: Game Design Fundamentals* by Katie Salen and Eric Zimmerman, 2003.

Software:

- DirectX
 - This software is available for free download at www.microsoft.com
- C/C++/C#
 - Any development environment (Visual Studio available on campus and through www.msdn.com)
- Microsoft XNA Game Studio Express
 - Freely downloadable.

Topics

1. Developing the Game Idea – Concept & Beginning Preproduction Phases
 - a. Building the team
 - b. Establishing ground rules, processes, and a creative environment
 - c. Rough Cost and Time Estimations
 - d. Elements of the Pitch
 - e. The Pitch
 - f. Evaluating the Pitch
 - g. Development Agreement
2. Game Design & Requirements – Preproduction Phase
 - a. Game Design Document (GDD)
 - b. Cost and Time Estimations
 - c. Milestones
 - d. Intellectual Property
3. Game Detailed Design – Preproduction Phase
 - a. Technical Design Document (TDD)
 - b. Risk Management
 - c. Profit and Loss Analysis
4. Game Implementation – Production Phase
 - a. Profiling for efficient code
 - b. Real-time demands
 - c. Multi-processing
 - d. Early Demos
 - e. Asset Management
 - f. Team Dynamics
 - g. Overcoming obstacles (time, money, resources, technical, and personal)
 - h. Promotion
5. Game Testing and Delivery – Postproduction Phase
 - a. Play Testing and the Test Plan
 - b. Quality Assurance
 - c. Localization
 - d. ESRB Rating
 - e. Box & Docs
 - f. Release
6. Game Maintenance
 - a. Post-release fixes
 - b. Add-on packs
 - c. Post Mortem evaluations
 - d. Legal issues

ITCS 5232 Game Design and Development Studio - Syllabus

Course Catalog Description

ITCS 5232. Game Design and Development Studio. (3) Prerequisite: (ITCS-5120 AND ITCS-5231 AND one approved game elective) OR consent of instructor. Application of advanced concepts and techniques for electronic game design and development. This course is a major capstone project course where students apply knowledge from ITCS 5230, 5231, and game development related electives as part of a team project to develop an electronic game. All phases of the engineering process will be explored from requirements through design, implementation, testing, distribution, and maintenance. Advanced game programming and scripting, networking, graphics, physics, audio, game data structures and algorithms, and artificial intelligence will be incorporated into a single integrated electronic game. The requirements of and a complete portfolio of prior work and the class project will be developed. (Spring)

Prerequisites

ITCS 5120, ITCS 5231, and (1) Approved Game Elective

Objectives of the course

At the end of this course, students should be able to:

1. Learn to apply prior knowledge to develop from concept-to-delivery a complete interactive computer game
2. Demonstrate software engineering principles as applied to game development
3. Demonstrate advanced skills as a team in all areas of game development, including: graphics, physics, audio, networking, performance optimization, artificial intelligence, user interface design, interactivity, and procedurally-generated content
4. Design and implement a complex electronic game as part of a team through all phases of development which shall include the idea pitch, requirements, high-level design, low-level design, user documentation, implementation, testing, delivery, and maintenance
5. Learn to critically evaluate and test computer games
6. Communicate game design and development ideas effectively with both technical and non-technical audiences

Instructional Method

This course incorporates lectures, guest lectures, in-class exercises and discussions, a team project, and many student demonstrations and presentations.

Method of Student Evaluation

Students will be evaluated based on: a team project with several stages of deliverables (pitch, requirements, design, implementation, testing, delivery, and maintenance feature patch). The project, a team implementation of a complete computer game, includes evaluation of the game as well as presentations at each development stage throughout the course of the game design and development. Attendance and participation are required in class. For each absence beyond the third absence, 5 points may be deducted from a student's overall grade.

A standard 10-point grading scale will be used for the class (A: 90-100, B: 80-90, ...).

The basic graduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, and fully cite any sources used. Assignments or projects that are not appropriate in an academic setting, subject to the instructor's discretion, will not be accepted for a grade.

Attendance: Attendance is mandatory. For each absence beyond the third absence, 5 points may be deducted from a student's overall grade.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

Title: *Introduction to Game Development*
Edited by: Steve Rabin
ISBN: 1-58450-377-7
Charles River Media, May 2005

Title: *The Mythical Man-month*
Author: Fred Brooks
ISBN: 0-20100-650-2
Addison-Wesley, January 1975 (This is a seminal book on Software Engineering teams)

Title: *Peopleware: Productive Projects and Teams*
Authors: Tom DeMarco and Timothy Lister
ISBN: 0-93263-343-9
Dorset House Publishing Company, Incorporated; 2nd edition (February 1, 1999)

Additional Optional Texts:

- *3D Games - Real-Time Rendering and Software Technology* by Alan Watt and Fabio Policarpo, 2000.
- *Game Programming Gems Series*, edited by Mark DeLoura and others, editions 1-6, pub. Dates 2000-2006.
- *AI Game Programming Wisdom Series*, edited by Steve Rabin, 2002, 2003, 2004
- *Chris Crawford on Game Design* by Chris Crawford, 2003.
- *Rules of Play: Game Design Fundamentals* by Katie Salen and Eric Zimmerman, 2003.

Software:

- DirectX
 - This software is available for free download at www.microsoft.com
- C/C++/C#
 - Any development environment (Visual Studio available on campus and through www.msdn.com)
- Microsoft XNA Game Studio Express
 - Freely downloadable.

Topics

1. Developing the Game Idea – Concept & Beginning Preproduction Phases
 - a. Building the team
 - b. Establishing ground rules, processes, and a creative environment
 - c. Rough Cost and Time Estimations
 - d. Elements of the Pitch
 - e. The Pitch
 - f. Evaluating the Pitch
 - g. Development Agreement
2. Game Design & Requirements – Preproduction Phase
 - a. Game Design Document (GDD)
 - b. Cost and Time Estimations
 - c. Milestones
 - d. Intellectual Property
3. Game Detailed Design – Preproduction Phase
 - a. Technical Design Document (TDD)
 - b. Risk Management
 - c. Profit and Loss Analysis
4. Game Implementation – Production Phase
 - a. Profiling for efficient code
 - b. Real-time demands
 - c. Multi-processing
 - d. Early Demos
 - e. Asset Management
 - f. Team Dynamics
 - g. Overcoming obstacles (time, money, resources, technical, and personal)
 - h. Promotion
5. Game Testing and Delivery – Postproduction Phase
 - a. Play Testing and the Test Plan
 - b. Quality Assurance
 - c. Localization
 - d. ESRB Rating
 - e. Box & Docs
 - f. Release
6. Game Maintenance
 - a. Post-release fixes
 - b. Add-on packs
 - c. Post Mortem evaluations
 - d. Legal issues

Difference between 4232/5232

In addition to all normal class requirements, ITCS 5232 students will have the following additional work.

1. Graduate students will present a research paper of relevant recent work in Computer Game Design or Development. Students will identify a paper from a scholarly source, prepare a slide-based presentation, and present an informative and critical review of the paper in class.

2. Graduate students form their own project teams that do not include undergraduates. These graduate teams must develop their own coding standards and document design templates as additional requirements.

Attachment 7. Proposal for ITCS 5235/4235 Game Engine Construction

University of North Carolina at Charlotte

New Undergraduate and Graduate Course

No. CSCI-11-14-2006g

Course and Curriculum Proposal from: Department of Computer Science

TITLE: Establishment of Undergraduate and Graduate Course in Game Engine Construction

A. Proposal Summary and Catalog Copy:

ITCS 4235. Game Engine Construction. (3) Prerequisite: ITCS 4120 or Permission of Department. Introduction to principles and techniques behind modern computer and console game engines. Graphics Rendering Pipeline (transformations, lighting, shading); 2D/3D Texture Mapping; Image Based Rendering; Spatial Structures and Acceleration Algorithms; Level of Detail; Collision Detection, Culling and Intersection Methods; Vertex/Pixel Shaders; Pipeline Optimization; Rendering Hardware.(Spring, Alternate Years) (Evenings)

ITCS 5235. Game Engine Construction. (3) Prerequisite: ITCS 5120 or Permission of Department. Introduction to principles and techniques behind modern computer and console game engines. Graphics Rendering Pipeline (transformations, lighting ,shading); 2D/3D Texture Mapping; Image Based Rendering; Spatial Data Structures and Acceleration Algorithms; Level of Detail; Collision Detection, Culling and Intersection Methods; Vertex/Pixel Shaders; Pipeline Optimization; Rendering Hardware. (Spring, Alternate Years) (Evenings)

B. Justification

1. **Need:** The proposed courses address several needs of the Computer Science Department, the College of Computing and Informatics, UNC Charlotte, and the state of North Carolina, as follows:
 - a. The proposed courses will be attractive to both undergraduate and MS students, by introducing complex and advanced concepts in real-time computer graphics in the context of game applications, given their connections to the entertainment industry (computer generated movies, game industry).
 - b. The proposed courses will become part of the new certificate programs being established in Game Design and Development.
 - c. The proposed courses is aimed at combating decreasing enrollments in Computer Science and related disciplines, while at the same time fulfilling expected IT workforce shortages.
2. **Course Numbering:** This course is targeted primarily at senior level undergraduates and MS students. The numbering has been designed so as to ensure students have adequate software skills prior to enrolling in these courses. Thus a 4XXX/5XXX numbering is proposed.
3. **Prerequisites/Corequisites:** This course is targeted as a senior level course and requires some knowledge of Computer Graphics, for instance, ITCS 4120/ITCS 5120, or an equivalent course. Students are expected to be competent programmers.

4. **Effect on Scope, Quality, and Efficiency:** These courses are designed to be part of the departmental effort to build new programs in game design and development. They have the potential to motivate undergraduate and graduate students through their applications, while at the same time improve their computer science skills, especially in software and design.

C. Impact

- 1 **Students Served:** Undergraduate and graduate majors in computer science will have an additional elective course for the major. This course will also serve the graduate and undergraduate certificate programs in game design.
2. **Effect on Existing Courses and Curricula:**
 - a. ITCS 4235 and ITCS 5235 will be offered initially in alternate years; depending on demand, the frequency of offering will be adjusted.
 - b. The content of other courses will not be affected. The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.
 - c. ITCS 4235 and ITCS 5235 were offered as a Topics course (ITCS 4010/5010) in the Spring of 2006. There were a total of 10 students in the course (7 undergraduate, 3 graduate). This is not unusual for an initial offering of an advanced undergraduate or graduate course.
 - d. Affected Areas of Catalog Copy: In course descriptions, and requirements, where proposed courses should be listed as electives.

D. Resources Required to Support Proposal

1. Personnel:
 - a) *Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty:* None
 - b) *List by name qualified faculty members interested in teaching the course(s):* Drs. Kalpathi Subramanian, Michael Youngblood, Zachary Wartell, Aidong Liu
2. Physical Facility : None
3. Equipment and Supplies: None
4. Computer : The current computer labs in CCI will be used to support the proposed courses.
5. Audio-Visual: None
6. Other Resources : None
7. Indicate source(s) of funding for new/additional resources required to support this proposal: None

E. Consultation with the Library and Other Departments or Units

1. Library Consultation attached
2. Consultation with other departments or units: SIS Department

F. Initiation and Consideration of Proposal

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

G. Attachments

1. Library Consultation
2. ITCS 4235 : Course Outline and Suggested Textbooks
3. ITCS 5235 : Course Syllabus



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 2, 2006

Subject: ITCS 4235/5235: Game Engine Construction

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/02/06

Check One:

1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
15. Holdings are adequate only if Dept. purchases additional items.
16. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Game Engine Construction and related subjects retrieved 1251 pertinent items. Of this total, 416 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 14 journals and 292 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 02, 2006

Date

Atkins Library Holdings in Areas Related to

Game Engine Construction

11/02/06

Subject Heading	All Books	After 2000	Journals	Electronic Resources
3D display*	25	10	0	4
Computer game*	252	130	0	74
Computer graphic*	650	133	14	152
DirectX	21	19	0	19
Graphical user interface*	33	9	0	4
Graphics rendering	20	10	0	2
Image rendering	7	4	0	1
Real-time data processing	117	23	0	23
Real-time programming	116	73	0	11
Rendering hardware	3	3	0	0
Vertex processing	7	2	0	2
Totals	1251	416	14	292

ITCS 4235: Game Engine Construction

Topics

- 1 Graphics Rendering Pipeline
- 2 Texture Mapping
- 3 Image Based Rendering
- 4 Spatial Structures and Acceleration Algorithms
- 5 Level of Detail
- 6 Collision Detection
- 7 Culling algorithms
- 8 Intersection Techniques
- 9 Vertex/Pixel Shaders
- 10 Graphics Hardware Architectures

Suggested Textbooks

- 1 Tomas Akenine-Moller, Eric Haines, Real-Time Rendering (2nd Edition), 2002, A.K. Peters.
- 2 David Eberly, 3D Game Engine Design, 2001, Morgan Kaufman
- 3 David Eberly, 3D Game Engine Architecture, 2005, Morgan Kaufman

ITCS 5235: Game Engine Construction: Syllabus

Course Number and Title: ITCS 5235: Game Engine Construction

Catalog Description:

ITCS 5235. Game Engine Construction.(3) Prerequisite: ITCS 5120 or Permission of Department. Introduction to principles and techniques behind modern computer and console game engines. Graphics Rendering Pipeline (transformations, lighting, shading); 2D/3D Texture Mapping; Image Based Rendering; Spatial Data Structures and Acceleration Algorithms; Level of Detail; Collision Detection, Culling and Intersection Methods; Vertex/Pixel Shaders; Pipeline Optimization; Rendering Hardware. (Fall, Spring, Alternate Years).

Pre or Co-Requisites:

ITCS 5120 or equivalent, or by permission of department.

Course Objectives:

- 1 The course will introduce advanced concepts in real-time computer graphics in the design and implementation of modern game engines.
- 2 The sequence of initial projects will test the basic components of game engines, culminating in a final capstone project that will bring all of these together.
- 3 Emphasis on both software and hardware components will familiarize students to the capabilities of modern graphics accelerators.
- 4 Impart advanced software skills in large team oriented projects.
- 5 Understand the complexities of programming modern graphics accelerators.

Instructional Method

By regular lectures, lab oriented sessions, student research presentations, project demonstrations.

Means of Student Evaluation

4 multiple-choice quizzes, Midterm Exam, 3 software projects, Final Term Project. When the graduate version of this course is offered in conjunction with ITCS 4235, graduate students will be additionally required to perform a research review of a relevant topic (consisting of at least 5 research articles), write a survey paper and give an in-class oral presentation. Each of the course projects will have additional criteria to be satisfied for graduate students.

The basic graduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Policies

- 1 Students governed by UNCC Academic Integrity Policy.
- 2 Attendance required of all meeting sessions.
- 3 Grading Policy: Weighted average is computed and suitable breakpoints determined by instructor to determine final letter grade.

Topical Outline of Course Content

1. Graphics Rendering Pipeline
 - a. Pipeline Stages (Application, Geometry, Rasterizer)
 - b. Geometric Transformations and Coordinate Systems
 - c. Projections and Clipping
 - d. Lighting and Rendering

2. Texture Mapping
 - a. Generalized Texturing
 - b. Texture Pipeline
 - c. Image Texturing
 - d. Texture Caching/Compression
 - e. Multipass Texturing
 - f. Texturing Methods

3. Acceleration Algorithms
 - a. Spatial Data Structures
 - b. Culling Techniques (backface, view frustum, portal)
 - c. Occlusion Culling
 - d. Level of Detail
 - e. Point-based Rendering

4. Level of Detail
 - a. LOD Switching
 - b. LOD Selection
 - c. Time-Critical LOD Rendering

6

5. Polygonal Methods
 - a. Sources, Representation
 - b. Tessellation, Triangulation
 - c. Triangle Strips, Fans, Meshes
 - d. Simplification

6. Intersection Testing
 - a. Hardware Methods
 - b. Bounding Volume Creation
 - c. Intersection Methods: Rays with Sphere/Box/Triangle/Polygon.
 - d. Intersection Methods: Triangles with Box/Triangle.
 - e. Intersection Methods: Line/Line, BV/BV, View Frustum
 - f. Dynamic Intersection Testing

7. Collision Detection
 - a. Collision Detection With Rays
 - b. Using BSP Trees
 - c. Hierarchical Collision Detection
 - d. OBB Tree, k-DOP Tree

8. Graphics Hardware
 - a. Vertex/Fragment Shaders
 - b. Hardware Buffers and Buffering
 - c. Perspective Correct Interpolation
 - d. Example Graphics Architectures

Suggested Textbooks

- 1 Tomas Akenine-Moller, Eric Haines, Real-Time Rendering (2nd Edition), 2002, A.K. Peters.
- 2 David Eberly, 3D Game Engine Design, 2001, Morgan Kaufman
- 3 David Eberly, 3D Game Engine Architecture, 2005, Morgan Kaufman

Attachment 8. Proposal for ITCS 5236/4236 Artificial Intelligence for Computer Games

University of North Carolina at Charlotte

New Undergraduate and Graduate Course Proposal
From: Department of Computer Science

No. CSCI-11-14-2006h

TITLE: ESTABLISHMENT OF UNDERGRADUATE AND GRADUATE ELECTIVE COURSES IN GAME DESIGN & DEVELOPMENT

A. PROPOSAL SUMMARY AND CATALOG COPY:

1. SUMMARY:

The Computer Science Department proposes to add two new courses in the area of Game Design and Development: one new elective course to the undergraduate and one new course to the graduate curriculum.

2. PROPOSED CATALOG COPY:

ITCS 4236. Artificial Intelligence for Computer Games. (3) Prerequisite: ITCS 3153. Application of advanced concepts and techniques in artificial intelligence for electronic game design and development. An investigation of the artificial intelligence techniques necessary for an agent to act, or appear to act, intelligently in interactive virtual worlds. Topics include uncertainty reasoning, machine learning, perception, knowledge representation, search, and planning. Emphasis will be on implementation and experimentation with the goal of building robust intelligent agents in interactive entertainment domains. Elements of multi-agent collaboration and the use of cognitive architectures in interactive computer games will also be discussed. (On demand)

ITCS 5236. Artificial Intelligence for Computer Games. (3) Prerequisite: ITCS 6150 or permission of instructor. Application of advanced concepts and techniques in artificial intelligence for electronic game design and development. An investigation of the artificial intelligence techniques necessary for an agent to act, or appear to act, intelligently in interactive virtual worlds. Topics include uncertainty reasoning, machine learning, perception, knowledge representation, search, and planning. Emphasis will be on implementation and experimentation with the goal of building robust intelligent agents in interactive entertainment domains. Elements of multi-agent collaboration and the use of cognitive architectures in interactive computer games will also be discussed. (On demand)

B. JUSTIFICATION

1. Need:

The proposed courses address several needs for the Computer Science Department, the College of Computing and Informatics, UNC Charlotte, and the state of North Carolina. First, enrollments into computer science and related fields are dropping across the nation even though, according to the Bureau of Labor Statistics, demand for jobs in IT-related fields will be higher than demand in most other sectors of the economy. If these projections are correct and current enrollment trends continue, we may face a shortage of IT workers in the US. Game courses are very attractive to students, and gaming has surpassed film and movies in the economy. There are few game-related curricular programs at universities in the country. Providing this service will make UNC Charlotte and the College of Computing and Informatics unique.

A key component for a rounded technical education is the ability to apply classroom theory and knowledge in practice. This polishing creates better game developers for industry and scientists in this field, solidifies the knowledge learned by the student, and aids in developing a portfolio of work which is essential for gaining employment in the games industry.

North Carolina is particularly well situated to become a leader in attracting and producing game designers and developers. Two of the three main game engine companies are in North Carolina, Epic Software and Numeric Design Limited. The North Carolina Serious Games Initiative, a pioneering organization, supports the development of game technologies in business, education, training, and medical applications. Several companies, including 3DSolve and Virtual Heroes, that develop serious games technologies, reside in North Carolina. Other game companies, such as Red Storm Entertainment, are also located here in NC. These companies have already sent representatives to the Game Design course to give talks, have expressed interest in hiring student interns in the future, and are excited to see universities in NC offering courses that will prepare students to work in the game industry.

Given the size and state of the gaming and interactive media industries, supporting focused curricula is needed at universities, and can be particularly valuable for such companies here in NC. More importantly, games are becoming recognized as one avenue for increasing enrollments in computer science, as evidenced by Microsoft Research's Game Curriculum Request for Proposals in 2004-2005. Computer Science and the College of Computing and Informatics can benefit from providing this service by recruiting more students and rejuvenating interest in computing related fields.

2. Prerequisites/corequisites:

ITCS 4236 requires ITCS 3153 Introduction to Artificial Intelligence.

ITCS 5236 requires ITCS 6150 Intelligent Systems or the consent of the instructor to determine if sufficient background knowledge in basic artificial intelligence techniques exists.

3. Course numbering:

ITCS 4236 is intended as a senior-level course, so that students have had exposure to a broad range of computer science courses and experience in more complex group assignments and/or projects.

ITCS 5236 is intended to be an intermediate level graduate course.

4. Effect on scope, quality, and efficiency:

These proposed courses will broaden the scope of the computer science curriculum to include the application of a host of computing skills for entertainment computing. The use of entertainment elements will motivate students to excel in computer science, and thus improve the quality of our graduates and hence the quality of our program.

C. IMPACT

1. Students served:

Undergraduate and graduate majors in computer science will have an additional pair of courses as electives for the major, which integrate their computing skills.

2. Effect on existing courses and curricula:

- a. ITCS 4236/5236 will be offered every other spring semester on demand.
- b. The content of other courses will not be affected. The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.
- c. The anticipated enrollment is ITCS 4236: 10 students/ spring semester, ITCS5236: 15 students/ spring semester
- d. These new courses are part of the CS MS program revision.
- e. ITCS 4236/5236 was offered in Fall 2006 as a special topics course (ITCS 4010/5010) with an enrollment of 6 graduate and 5 undergraduate students.
- f. Affected areas of catalog copy: In curriculum outlines, and requirements for the degree, the proposed courses should be listed as elective options.

L. RESOURCES REQUIRED TO SUPPORT PROPOSAL.

1. Personnel

- a. Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty.

No requirements for new faculty or increased load on present faculty.

- b. List by name qualified faculty members interested in teaching the course(s).

Drs. Michael Youngblood and Tiffany Barnes are qualified to teach these courses.

2. Physical Facility

No new physical facilities are needed, beyond a regular classroom to teach the class.

3. Equipment and Supplies

No new equipment and supplies are needed to teach the courses.

4. Computer

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use their own computers or those in the Woodward 335 for course assignments and projects. Faculty will use their own existing computers for course preparation. Computing resources are adequate for both courses.

5. Audio-Visual

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None needed.

M. CONSULTATION WITH THE LIBRARY AND OTHER DEPARTMENTS OR UNITS

1. Library Consultation
Attached
2. Consultation with other departments or units
SIS Department

N. INITIATION AND CONSIDERATION OF THE PROPOSAL

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

O. ATTACHMENTS

1. LIBRARY CONSULTATION LETTER
2. ITCS 4236 course outline including basic topics to be covered and suggested textbooks and reference materials with dates of publication
3. Syllabi for graduate courses ITCS 5236



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 2, 2006

Subject: ITCS 4236/5236: Artificial Intelligence for Computer Games

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/02/06

Check One: 1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
17. Holdings are adequate only if Dept. purchases additional items.
18. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Artificial Intelligence for Computer Games and related subjects retrieved 3637 pertinent items. Of this total, 1020 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 45 journals and 619 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 02, 2006

Date

**Atkins Library Holdings in Areas Related to
Artificial Intelligence for Computer Games
11/02/06**

Subject Heading	All Books	After 2000	Journals	Electronic Resources
Artificial intelligence	1121	93	20	155
C (Computer programming language)	124	42	0	44
Cognitive architecture	36	18	0	7
Cognitive model*	385	185	5	31
Computer game*	252	130	0	74
DirectX	21	19	0	19
Evolutionary programming	39	17	1	10
Fuzzy logic	71	18	0	14
Game theory	342	88	3	24
Intelligent agent*	92	50	1	23
Interactive game*	119	35	0	1
Knowledge representation	176	73	0	16
Machine learning	182	52	2	26
Neural network*	465	111	11	135
Virtual reality	201	81	2	36
“Visual Studio”	11	8	0	4
Totals	3637	1020	45	619

ITCS 4236 Artificial Intelligence for Computer Games - Outline

Course Catalog Description

ITCS 4236. Artificial Intelligence for Computer Games. (3) Prerequisite: ITCS 3153. Application of advanced concepts and techniques in artificial intelligence for electronic game design and development. An investigation of the artificial intelligence techniques necessary for an agent to act, or appear to act, intelligently in interactive virtual worlds. Topics include uncertainty reasoning, machine learning, perception, knowledge representation, search, and planning. Emphasis will be on implementation and experimentation with the goal of building robust intelligent agents in interactive entertainment domains. Elements of multi-agent collaboration and the use of cognitive architectures in interactive computer games will also be discussed. (On demand)

Prerequisites

ITCS 3153 Introduction to Artificial Intelligence

Objectives of the course

At the end of this course, students should be able to:

7. Develop intelligent agents following the Perceive-Reason-Act model
8. Apply basic elements of game theory to understand the balance and equilibrium of games
9. Apply uninformed, informed, and local search techniques to state space problems
10. Develop unique behavioral patterns in agents by tuning elements of search algorithms
11. Apply adversarial search to interactive agent-based games
12. Understand reactive and deliberative control of agents
13. Understand Finite and Fuzzy State Machines and their use in agents
14. Understand basic cognitive modeling
15. Utilize a neural network for agent learning and control
16. Utilize evolutionary computing techniques (e.g., genetic algorithms) for producing unique behavior in agents
17. Apply machine learning mechanisms to games
18. Understanding steering and flocking behaviors in agents
19. Understand emergent behavior and its role in game AI

Instructional Method

This course incorporates lectures, guest lectures, in-class exercises and discussions, homework, quizzes, a team project, and many student demonstrations and presentations.

Method of Student Evaluation

3-5 Homeworks (40%), Project (25%), Class Participation (5%), 2-3 Quizzes (15%), Final Exam or Paper (15%). Attendance and participation are required in class. For each absence beyond the third absence, up to 5 percentage points in total may be deducted from a student's overall grade.

A standard 10-point grading scale will be used for the class (A: 90-100, B: 80-90, ...).

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, and fully cite any sources used. Assignments or projects that are not appropriate in an academic setting, subject to the instructor's discretion, will not be accepted for a grade.

Attendance: Attendance is mandatory. For each absence beyond the third absence, 5 points may be deducted from a student's overall grade.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

Title: Artificial Intelligence: A Modern Approach, Second Edition

Authors: Stuart Russell and Peter Norvig

ISBN: 0-13790-395-2

Prentice Hall, 2003

Additional Optional Texts:

- *AI Game Development* by Alex J. Champandard. New Riders Games; 1st edition (October 31, 2003)

Software:

- DirectX
 - This software is available for free download at www.microsoft.com
- C/C++/C#
 - Any development environment (Visual Studio available on campus and through www.msdn.com)
- Microsoft XNA Game Studio Express
 - Freely downloadable.

Topics

1. Introduction to AI Review
2. Intro to Game Theory
3. Uninformed Search
4. Informed Search
5. Local Search & Agents
6. Pathfinding
7. Adversarial Search
8. Intelligent Agents, Deterministic AI, Patterns and Basic Control Scripting
9. Modeling Behavioral State Systems
10. Tactics, Planning, and Decision-making
11. Cognitive modeling and situation calculus
12. Neural Networks
13. Genetic Algorithms
14. Learning
15. Fuzzy Logic
16. Flocking and Boids
17. AI Case Studies
18. Reasoning Under Uncertainty and Constraints
19. Emergent behaviors
20. Conclusion and Future directions

ITCS 5236 Artificial Intelligence for Computer Games - Syllabus

Course Catalog Description

ITCS 5236. Artificial Intelligence for Computer Games. (3) Prerequisite: ITCS 6150 or permission of instructor. Application of advanced concepts and techniques in artificial intelligence for electronic game design and development. An investigation of the artificial intelligence techniques necessary for an agent to act, or appear to act, intelligently in interactive virtual worlds. Topics include uncertainty reasoning, machine learning, perception, knowledge representation, search, and planning. Emphasis will be on implementation and experimentation with the goal of building robust intelligent agents in interactive entertainment domains. Elements of multi-agent collaboration and the use of cognitive architectures in interactive computer games will also be discussed. (On demand)

Prerequisites

ITCS 6150 Intelligent Systems or permission of instructor

Objectives of the course

At the end of this course, students should be able to:

1. Develop intelligent agents following the Perceive-Reason-Act model
2. Apply basic elements of game theory to understand the balance and equilibrium of games
3. Apply uninformed, informed, and local search techniques to state space problems
4. Develop unique behavioral patterns in agents by tuning elements of search algorithms
5. Apply adversarial search to interactive agent-based games
6. Understand reactive and deliberative control of agents
7. Understand Finite and Fuzzy State Machines and their use in agents
8. Understand basic cognitive modeling
9. Utilize a neural network for agent learning and control
10. Utilize evolutionary computing techniques (e.g., genetic algorithms) for producing unique behavior in agents
11. Apply machine learning mechanisms to games
12. Understanding steering and flocking behaviors in agents
13. Understand emergent behavior and its role in game AI

Instructional Method

This course incorporates lectures, guest lectures, in-class exercises and discussions, homework, quizzes, a team project, and many student demonstrations and presentations.

Method of Student Evaluation

3-5 Homeworks (40%), Project (25%), Class Presentation (10%), Class Participation (5%), 2-3 Quizzes (10%), Final Exam or Paper (10%). Attendance and participation are required in class. For each absence beyond the third absence, up to 5 percentage points in total may be deducted from a student's overall grade.

A standard 10-point grading scale will be used for the class (A: 90-100, B: 80-90, ...).

The basic graduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, and fully cite any sources used. Assignments or projects that are not appropriate in an academic setting, subject to the instructor's discretion, will not be accepted for a grade.

Attendance: Attendance is mandatory. For each absence beyond the third absence, 5 points may be deducted from a student's overall grade.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

Title: Artificial Intelligence: A Modern Approach, Second Edition
Authors: Stuart Russell and Peter Norvig
ISBN: 0-13790-395-2
Prentice Hall, 2003

Additional Optional Texts:

- *AI Game Development* by Alex J. Champandard. New Riders Games; 1st edition (October 31, 2003)

Software:

- DirectX
 - This software is available for free download at www.microsoft.com
- C/C++/C#
 - Any development environment (Visual Studio available on campus and through www.msdn.com)
- Microsoft XNA Game Studio Express
 - Freely downloadable.

Topics

1. Introduction to AI Review
2. Intro to Game Theory
3. Uninformed Search
4. Informed Search
5. Local Search & Agents
6. Pathfinding
7. Adversarial Search
8. Intelligent Agents, Deterministic AI, Patterns and Basic Control Scripting
9. Modeling Behavioral State Systems
10. Tactics, Planning, and Decision-making
11. Cognitive modeling and situation calculus
12. Neural Networks
13. Genetic Algorithms
14. Learning

15. Fuzzy Logic
16. Flocking and Boids
17. AI Case Studies
18. Reasoning Under Uncertainty and Constraints
19. Emergent behaviors
20. Conclusion and Future directions

Difference between 4236/5236

In addition to all normal class requirements, ITCS 5236 students will have the following additional work.

3. Graduate students will present a research paper of relevant recent work in Artificial Intelligence used in Computer Games. Students will identify a paper from a scholarly source, prepare a slide-based presentation, and present an informative and critical review of the paper in class.
4. Graduate students form their own project teams that do not include undergraduates.

Attachment 9. Proposal for ITCS 5237/4237 Audio Processing for Entertainment Computing

University of North Carolina at Charlotte

New Undergraduate and Graduate Course Proposal
From: Department of Computer Science

No. CSCI-11-14-2006i

TITLE: ESTABLISHMENT OF UNDERGRADUATE AND GRADUATE ELECTIVE COURSES IN GAME DESIGN & DEVELOPMENT

A. PROPOSAL SUMMARY AND CATALOG COPY:

1. SUMMARY:

The Computer Science Department proposes to add two new courses in the area of Game Design and Development: one new elective course to the undergraduate and one new elective course to the graduate curriculum.

2. PROPOSED CATALOG COPY:

ITCS 4237. Audio Processing for Entertainment Computing. (3) Prerequisite: MATH 1242, MATH 2164, and ITCS 2215 or equivalents. Introduction to the principles and applications of audio (digital signal) processing focusing on entertainment domains. Topics include: analysis of signals, transforms, digital filter design techniques, audio engine development, file encoding/decoding, spatial sound rendering, optimization, and advanced audio techniques. (On demand)

ITCS 5237. Audio Processing for Entertainment Computing. (3) Prerequisite: MATH 1242, MATH 2164, and ITCS 6114 or equivalents. Introduction to the principles and applications of audio (digital signal) processing focusing on entertainment domains. Topics include: analysis of signals, transforms, digital filter design techniques, audio engine development, file encoding/decoding, spatial sound rendering, optimization, and advanced audio techniques. (On demand)

B. JUSTIFICATION

1. Need:

The proposed courses address several needs for the Computer Science Department, the College of Computing and Informatics, UNC Charlotte, and the state of North Carolina. First, enrollments into computer science and related fields are dropping across the nation even though, according to the Bureau of Labor Statistics, demand for jobs in IT-related fields will be higher than demand in most other sectors of the economy. If these projections are correct and current enrollment trends continue, we may face a shortage of IT workers in the US. Entertainment computing courses are very attractive to students; gaming has surpassed film and movies in the economy and digital music is replacing more traditional forms of playback and distribution. There are few game-related curricular programs at universities in the country. Providing this service will make UNC Charlotte and the College of Computing and Informatics unique.

A key component for a rounded technical education is the ability to apply classroom theory and knowledge in practice. This polishing creates better game developers for industry and scientists in this field, solidifies the knowledge learned by the student, and aids in developing a portfolio of work which is essential for gaining employment in the games industry.

North Carolina is particularly well situated to become a leader in attracting and producing game designers and developers. Two of the three main game engine companies are in North Carolina, Epic Software and Numeric Design Limited. The North Carolina Serious Games Initiative, a pioneering organization, supports the development of game technologies in business, education, training, and medical applications. Several companies, including 3DSolve and Virtual Heroes, that develop serious games technologies, reside in North Carolina. Other game companies, such as Red Storm Entertainment, are also located here in NC. These companies have already sent representatives to the Game Design course to give talks, have expressed interest in hiring student interns in the future, and are excited to see universities in NC offering courses that will prepare students to work in the game industry.

Given the size and state of the gaming and interactive media industries, supporting focused curricula is needed at universities, and can be particularly valuable for such companies here in NC. More importantly, games and interactive media are becoming recognized as one avenue for increasing enrollments in computer science, as evidenced by Microsoft Research's Game Curriculum Request for Proposals in 2004-2005. Computer Science and the College of Computing and Informatics can benefit from providing this service by recruiting more students and rejuvenating interest in computing related fields.

2. Prerequisites/corequisites:

ITCS 4237 requires MATH 1242, MATH 2164, and ITCS 2215 or equivalents. ITCS 5237 requires MATH 1242, MATH 2164, and ITCS 6114 or equivalents.

3. Course numbering:

ITCS 4237 is intended as a senior-level course, so that students have had exposure to a broad range of computer science courses and experience in more complex group assignments and/or projects.

ITCS 5237 is intended to be an intermediate level graduate course.

4. Effect on scope, quality, and efficiency:

These proposed courses will broaden the scope of the computer science curriculum to include the application of a host of computing skills for entertainment computing. The use of entertainment elements will motivate students to excel in computer science, and thus improve the quality of our graduates and hence the quality of our program.

C. IMPACT

1. Students served:

Undergraduate and graduate majors in computer science will have an additional pair of courses as electives for the major, which integrate their computing skills.

2. Effect on existing courses and curricula:

- a. ITCS 4237/5237 will be offered every other spring semester on demand.
- b. The content of other courses will not be affected. The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.
- c. The anticipated enrollment ITCS 4237: 10 students/ spring semester, ITCS5237: 15 students/ spring semester
- d. These new courses are part of the CS MS program revision.
- e. This class has not been offered before, but many of the students have an interest in

audio processing especially given the popularity of such as items as portable music players, the move towards music in electronic only form, and the incorporation of sound and music into games and applications.

f. Affected areas of catalog copy: In curriculum outlines, and requirements for the degree, the proposed courses should be listed as elective options.

P. RESOURCES REQUIRED TO SUPPORT PROPOSAL.

1. Personnel

a. Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty.

No requirements for new faculty or increased load on present faculty.

b. List by name qualified faculty members interested in teaching the course(s).

Drs. Michael Youngblood and Tiffany Barnes are qualified to teach these courses.

2. Physical Facility

No new physical facilities are needed, beyond a regular classroom to teach the class.

3. Equipment and Supplies

No new equipment and supplies are needed to teach the courses.

4. Computer

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use their own computers or those in the Woodward 335 for course assignments and projects. Faculty will use their own existing computers for course preparation. Computing resources are adequate for both courses.

5. Audio-Visual

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None needed.

Q. CONSULTATION WITH THE LIBRARY AND OTHER DEPARTMENTS OR UNITS

1. Library Consultation
Attached
2. Consultation with other departments or units
SIS Department

R. INITIATION AND CONSIDERATION OF THE PROPOSAL

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

S. ATTACHMENTS

1. LIBRARY CONSULTATION LETTER
2. ITCS 4237 course outline including basic topics to be covered and suggested textbooks and reference materials with dates of publication
3. Syllabi for graduate courses ITCS 5237



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 2, 2006

Subject: ITCS 4237/5237: Audio Processing for Entertainment Computing

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/02/06

Check One: 1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
19. Holdings are adequate only if Dept. purchases additional items.
20. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Audio Processing for Entertainment Computing and related subjects retrieved 1709 pertinent items. Of this total, 461 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 20 journals and 676 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 02, 2006

Date

**Atkins Library Holdings in Areas Related to
Audio Processing for Entertainment Computing
11/02/06**

Subject Heading	All Books	After 2000	Journals	Electronic Resources
Audio processing	55	16	3	18
C (Computer programming language)	124	42	0	44
Computer composition	11	2	0	0
Computer music	134	59	1	33
Digital audio	71	21	1	15
Digital filter*	121	42	0	23
Digital signal processing	269	56	2	62
DirectX	21	19	0	19
Electronic music	531	94	3	372
MIDI	47	8	2	8
MP3	10	6	0	6
Music computer program*	42	25	0	18
Sound processing	58	7	6	19
Sound recording and producing	89	28	2	28
Sound wave*	115	28	0	6
“Visual Studio”	11	8	0	4
Totals	1709	461	20	676

ITCS 4237 Audio Processing for Entertainment Computing - Outline

Course Catalog Description

ITCS 4237. Audio Processing for Entertainment Computing. (3) Prerequisite: MATH 1242, MATH 2164, and ITCS 2215 or equivalents. Introduction to the principles and applications of audio (digital signal) processing focusing on entertainment domains. Topics include: analysis of signals, transforms, digital filter design techniques, audio engine development, file encoding/decoding, spatial sound rendering, optimization, and advanced audio techniques. (Spring)

Prerequisites

Permission of instructor

Objectives of the course

At the end of this course, students should be able to:

1. Understand the basic fundamentals and theory of sound
2. Understand digital signal processing basics of time domain, convolution, and frequency domain
3. Apply band-pass, spectra, Fourier, and other common filtering techniques to an audio signal
4. Develop a basic audio engine
5. Understand how to develop script-driven sound, mixing, and additional elements of high-level audio systems
6. Understand various common audio file formats (e.g., WAV, MP3, AAC) and how to encode/decode
7. Understand MIDI (Musical Instrument Device Interface)
8. Understand spatial sound and rendering
9. Understand CD audio
10. Understand optimizations and advanced audio processing and generation techniques

Instructional Method

This course incorporates lectures, guest lectures, in-class exercises and discussions, homework, quizzes, a team project, and many student demonstrations and presentations.

Method of Student Evaluation

3-5 Homeworks (40%), Project (25%), Class Participation (5%), 2-3 Quizzes (15%), Final Exam or Paper (15%). Attendance and participation are required in class. For each absence beyond the third absence, up to 5 percentage points in total may be deducted from a student's overall grade.

A standard 10-point grading scale will be used for the class (A: 90-100, B: 80-90, ...).

The basic graduate grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, and fully cite any sources used. Assignments or projects that are not appropriate in an academic setting, subject to the instructor's discretion, will not be accepted for a grade.

Attendance: Attendance is mandatory. For each absence beyond the third absence, 5 points may be deducted from a student's overall grade.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

Title: *Digital Signal Processing Fundamentals*

Author: Ashfaq A. Khan

ISBN: 1-58450-281-9

Charles River Media, 2005

Title: *Game Audio Programming*

Author: James Boer

ISBN: 1-58450-245-2

Charles River Media, 2002

Software:

- DirectX
 - This software is available for free download at www.microsoft.com
- C/C++/C#
 - Any development environment (Visual Studio available on campus and through www.msdn.com)
- Microsoft XNA Game Studio Express
 - Freely downloadable.
- OpenAL
 - This software is available for free download at www.openal.org

Topics

1. Acoustics fundamentals: Sound, waves, waveguides, resonance, energy transfer.
2. Theory of sound, digital audio, modern hardware, and design theory.
3. Basics: Time domain, convolution, frequency domain, z domain
4. Filters: run average filter applied, high and low band-pass filtering, spectra filtering, finding spectrum from impulse response and difference equations, filter in z domain; stability of 1st-order and 2nd-order filters, poles-zeros analysis, cosine generator, Fourier transform method, band-pass from low-pass filter
5. Auditory perception fundamentals: the ear, auditory physiology, psychophysics, auditory scene analysis
6. Interactive music system development (audio engine development)
7. High-level audio systems, including script-driven sound templates.
8. Understanding file formats WAV (AIFF), WMA, MP3, Ogg Vorbis, and AAC.
9. MIDI (Musical Instrument Device Interface)

10. Spatial Sound and Rendering: Discuss 3D audio techniques and hardware extensions such as EAX, ZoomFX, and MacroFX.
11. Discuss how to play redbook audio from a CD
12. General audio optimizations and strategies
13. Discuss concurrency with an audio engine
14. Discuss procedural music generation

ITCS 5237 Audio Processing for Entertainment Computing - Syllabus

Course Catalog Description

ITCS 5237. Audio Processing for Entertainment Computing. (3) Prerequisite: MATH 1242, MATH 2164, and ITCS 6114 or equivalents. Introduction to the principles and applications of audio (digital signal) processing focusing on entertainment domains. Topics include: analysis of signals, transforms, digital filter design techniques, audio engine development, file encoding/decoding, spatial sound rendering, optimization, and advanced audio techniques. (Spring)

Prerequisites

Permission of instructor

Objectives of the course

At the end of this course, students should be able to:

1. Understand the basic fundamentals and theory of sound
2. Understand digital signal processing basics of time domain, convolution, and frequency domain
3. Apply band-pass, spectra, Fourier, and other common filtering techniques to an audio signal
4. Develop a basic audio engine
5. Understand how to develop script-driven sound, mixing, and additional elements of high-level audio systems
6. Understand various common audio file formats (e.g., WAV, MP3, AAC) and how to encode/decode
7. Understand MIDI (Musical Instrument Device Interface)
8. Understand spatial sound and rendering
9. Understand CD audio
10. Understand optimizations and advanced audio processing and generation techniques

Instructional Method

This course incorporates lectures, guest lectures, in-class exercises and discussions, homework, quizzes, a team project, and many student demonstrations and presentations.

Method of Student Evaluation

3-5 Homeworks (40%), Project (25%), Class Participation (5%), 2-3 Quizzes (15%), Final Exam or Paper (15%). Attendance and participation are required in class. For each absence beyond the third absence, up to 5 percentage points in total may be deducted from a student's overall grade.

A standard 10-point grading scale will be used for the class (A: 90-100, B: 80-90, ...).

The basic grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code

of Student Academic Integrity. Students are expected to submit their own work, and fully cite any sources used. Assignments or projects that are not appropriate in an academic setting, subject to the instructor's discretion, will not be accepted for a grade.

Attendance: Attendance is mandatory. For each absence beyond the third absence, 5 points may be deducted from a student's overall grade.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

Title: *Digital Signal Processing Fundamentals*

Author: Ashfaq A. Khan

ISBN: 1-58450-281-9

Charles River Media, 2005

Title: *Game Audio Programming*

Author: James Boer

ISBN: 1-58450-245-2

Charles River Media, 2002

Software:

- DirectX
 - This software is available for free download at www.microsoft.com
- C/C++/C#
 - Any development environment (Visual Studio available on campus and through www.msdn.com)
- Microsoft XNA Game Studio Express
 - Freely downloadable.
- OpenAL
 - This software is available for free download at www.openal.org

Topics

1. Acoustics fundamentals: Sound, waves, waveguides, resonance, energy transfer.
2. Theory of sound, digital audio, modern hardware, and design theory.
3. Basics: Time domain, convolution, frequency domain, z domain
4. Filters: run average filter applied, high and low band-pass filtering, spectra filtering, finding spectrum from impulse response and difference equations, filter in z domain; stability of 1st-order and 2nd-order filters, poles-zeros analysis, cosine generator, Fourier transform method, band-pass from low-pass filter
5. Auditory perception fundamentals: the ear, auditory physiology, psychophysics, auditory scene analysis
6. Interactive music system development (audio engine development)
7. High-level audio systems, including script-driven sound templates.
8. Understanding file formats WAV (AIFF), WMA, MP3, Ogg Vorbis, and AAC.
9. MIDI (Musical Instrument Device Interface)
10. Spatial Sound and Rendering: Discuss 3D audio techniques and hardware extensions such as EAX, ZoomFX, and MacroFX.
11. Discuss how to play redbook audio from a CD

12. General audio optimizations and strategies
13. Discuss concurrency with an audio engine
14. Discuss procedural music generation

Difference between 4237/5237

In addition to all normal class requirements, ITCS 5237 students will have the following additional work.

1. Graduate students will present a research paper of relevant recent work in Audio Processing used in Entertainment. Students will identify a paper from a scholarly source, prepare a slide-based presentation, and present an informative and critical review of the paper in class.
2. Graduate students form their own project teams that do not include undergraduates.

Attachment 10. Proposal for ITCS 6124/8124 Illustrative Visualization

The University of North Carolina at Charlotte

New Graduate Course Proposal
from the Department of Computer Science

No. CSCI-11-14-2006j

Title: Addition of two new graduate courses ITCS 6124 and ITCS 8124: **Illustrative Visualization**

A. Proposal Summary and Catalog Copy

1. Summary

The Computer Science Department proposes to add two new courses to the graduate curriculum, ITCS 6124, ITCS 8124: Illustrative Visualization

2. Proposed Catalog Copy

ITCS 6124. Illustrative Visualization Prerequisites: ITCS 4120 or ITCS 5120. This course focuses on advanced concepts and techniques related to the design, implementation, integration, and management of illustrative visualization and computer graphics. Topics include various advanced visualization topics: feature extraction, non-photorealistic rendering, point-based rendering, hardware-accelerated rendering, segmentation, image generation, animation, evaluation, design, and interaction. (Spring) (Evenings)

ITCS 8124. Illustrative Visualization Prerequisites: ITCS 4120 or ITCS 5120. This course focuses on advanced concepts and techniques related to the design, implementation, integration, and management of illustrative visualization and computer graphics. Topics include various advanced visualization topics: feature extraction, non-photorealistic rendering, point-based rendering, hardware-accelerated rendering, segmentation, image generation, animation, evaluation, design, and interaction. (Spring) (Evenings)

B. Justification

1. Need:

Data Visualization is one important and fast developing area in Computer Science. Illustrative Visualization has included multiple essential technologies in advanced data visualization and computer graphics. The results of this course can benefit students from various backgrounds, including gaming, virtual reality, bioinformatics, multimedia, visual data mining, etc. The important role of data visualization research in Computer Science, Charlotte Visualization Center, and collaborations between visualizations and multiple departments has led to a significant growth of the research community. The goal of this class is to present advanced concepts and techniques in illustrative data visualization. We expect to have many graduate students taking this class. Lu has taught the related courses in UNCC once with 6 students in the course.

2. Prerequisites/Corequisites:

Students should have had basic knowledge of computer graphics and programming skills. Completion of an introductory graphics course at undergraduate or graduate level (such as ITCS4120/5120) is required.

3. Course numbering:

The course numbers position this course as an advanced graduate course.

4. Effect on scope, quality, and efficiency:

The proposed course will broaden the scope of visualization concentration in our master program. The new advanced concepts and techniques taught in the proposed course will enhance the students' specialization in the data visualization area. Thus, the proposed course will improve the quality of our graduates and hence the quality of our program.

C. Impact

1. Students Served:

The course will serve the curricular needs of graduate students in Computer Science Department. The graduate students will have an advance course in data visualization.

2. Effect on existing courses and curricula:

- g. The course will be offered each spring.
- h. The content of other courses will not be affected. The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.
- i. The anticipated enrollment is 10 students/spring semester.
- j. This new course is part of the CS MS program revision.
- k. This course has been offered as a special topic course (ITCS 6010/8010) in Spring 2006. The enrollment for the course in Spring 2006 was 6 graduate students.
- l. Affected areas of catalog copy: In curriculum outlines, and requirements for the degree, the proposed courses should be listed as elective options.

D. Resources Required to Support Proposal

1. Personnel:

- c. *Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty.*

No requirements for new faculty or increased load on present faculty.

- d. *List by name qualified faculty members interested in teaching the course(s).*

Drs. Aidong Lu, Kalpathi Subramanian, and William Ribarsky are interested and qualified to teach this course.

2. Physical Facility:

No new physical facilities are needed, beyond a regular classroom to teach the class.

3. Equipment and Supplies:

No new equipment and supplies are needed to teach the courses.

4. Computer:

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use their own computers or those in the Woodward 335 for course assignments and projects. Faculty will use their own existing computers for course preparation. Computing resources are adequate for the proposed course.

5. Audio-Visual:

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources:

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None.

E. Consultation with Library and Other Departments or Units

1. **Library Consultation:** Attached

2. **Consultation with other Departments or Units:** SIS Department

F. Initiation and Consideration of Proposal

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

G. Attachments

1. Consultation with Library memo
2. Syllabus for the proposed graduate course



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 2, 2006

Subject: ITCS 6124/8124: Illustrative Visualization

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/02/06

Check One: 1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
21. Holdings are adequate only if Dept. purchases additional items.
22. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Illustrative Visualization and related subjects retrieved 1868 pertinent items. Of this total, 492 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 35 journals and 373 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 02, 2006

Date

Atkins Library Holdings in Areas Related to

Illustrative Visualization

11/02/06

Subject Heading	All Books	After 2000	Journals	Electronic Resources
2D graphic*	7	5	0	2
3D graphic*	33	18	0	13
Animation	262	82	2	34
Computer drawing*	68	23	2	8
Computer graphic*	650	133	14	152
Data visualization	78	40	1	14
Digital illustration	14	5	0	8
Flow visualization	58	10	0	4
Image processing	507	114	14	113
Medical visualization	10	5	1	3
Multivariate visualization	5	4	0	0
Network visualization	11	11	0	1
Rendering	147	35	0	13
Time varying visualization	2	2	0	0
Volume visualization	16	5	1	8
Totals	1868	492	35	373

ITCS 6124/8124: Illustrative Visualization - Syllabus

Course Catalog Description

ITCS 6124/8124. Illustrative Visualization Prerequisites: ITCS 4120 or ITCS 5120. This course focuses on advanced concepts and techniques related to the design, implementation, integration, and management of illustrative visualization and computer graphics. Topics include various advanced visualization topics: feature extraction, non-photorealistic rendering, point-based rendering, hardware-accelerated rendering, segmentation, image generation, animation, evaluation, design, and interaction. (Spring).

Prerequisites

ITCS 4120 or ITCS 5120 Introduction to Computer Graphics

Objectives of the course

This course will cover diverse topics of advanced data visualization techniques, including visualizations in medicine, bioinformatics, nanotechnology, flow, large-scale data, time-dependent data, information, security and privacy, etc. The main objective is to let students to understand the essential visualization components: design, representation, transformation, interaction, and evaluation; and apply these in real visualization applications.

Instructional Method

The format of the course will be lectures, paper presentations, and project discussions.

Method of Student Evaluation

Students will be evaluated based on: a final exam, 3 class projects, and paper presentations. They will count toward the grade as follows:

3 Projects:	60%
Presentation	20%
Final:	20%

The three class projects can be selected from a suggested list provided by the instructor or proposed by students. Attendance and participation are required in class.

The basic grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, and fully cite any sources used. Assignments or projects that are not appropriate in an academic setting, subject to the instructor's discretion, will not be accepted for a grade.

Attendance: Class attendance is a responsibility of each individual. If a student chooses not to attend class, he/she is responsible for any handouts, announcement, and contents of missed lectures.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

There is no official textbook for this course. A reading list, including electronic copies of the papers, from recent conference proceedings and journals will be posted on the website for this course.

Additional Optional Texts:

- The Visualization Handbook, C. Hansen and C. Johnson, Academic Press, 2004. ISBN: 012387582X
- Non-Photorealistic Rendering, B. Gooch and A. Gooch, A K Peters, 2001. ISBN: 1568811330
- Non-Photorealistic Computer Graphics, modeling, rendering, and animation, T. Strothotte and S. Schlechtweg, Elsevier Science, 2002. ISBN: 1558607870
- The Guild Handbook of Scientific Illustration, E. Hodges, Wiley, 2003. ISBN: 0471288969
- The Visualization Toolkit: An Object-Oriented Approach to 3D Graphics, W. Schroeder, K. Martin, and B. Lorensen, Prentice-Hall, 1997. ISBN: 1930934076

Software:

- C/C++
 - Any development environment

Topics

1. Introduction:
 - a. Basic visualization concepts
 - b. Example data visualization applications
 - c. Example data visualization topics
2. Volume Visualization
 - a. Indirect volume visualization
 - b. Direct volume visualization
 - c. Multi-resolution transfer functions
3. Point-based Visualization
 - a. 2D point-based visualization
 - b. 3D point-based visualization
4. Silhouettes and Contours
 - a. Image-spaced techniques
 - b. Object-spaced techniques
 - c. Suggestive contours
5. Colors
 - a. Color models and perception
 - b. Color transfer techniques
 - c. Colors in visualization
6. Composition

- a. Artistic composition concepts
 - b. Computer-generated composition techniques
 - c. Visualization composition approaches
7. Evaluation
 - a. User study basics
 - b. Visualization evaluation approaches
 8. Advanced Illustrative Volume Visualization
 9. Advanced Illustrative Flow Visualization
 10. Advanced Illustrative Time-varying Visualization
 11. Advanced Illustrative Network Visualization
 12. Advanced Illustrative Security Visualization

Difference between 6000/8000

Ph. D. students who register the course at 8000 level will be asked for additional homework and components of projects.

Attachment 11. Proposal for ITCS 6126/8126 Large Scale Information Visualization

The University of North Carolina at Charlotte

New Undergraduate and Graduate Course Proposal
from the Department of Computer Science

No. CSCI-11-14-2006k

Title: Addition of new MS course ITCS 6126 and Ph.D. course ITCS 8126: **Large Scale Information Visualization**

A. Proposal Summary and Catalog Copy

1. Summary

The Computer Science Department proposes to add one new MS and one new Ph. D course to the respective curricula, ITCS 6126 and ITCS 8126: Large Scale Information Visualization

2. Proposed Catalog Copy

ITCS 6126. Large Scale Information Visualization (3) Prerequisites: ITCS 4121 or ITCS 5121 Information Visualization. Concept, theory, design principles, data processing techniques, and visual metaphors and interaction techniques for massive, multi-dimensional, multi-source, time-varying information exploration. (Fall) (Evenings)

ITCS 8126. Large Scale Information Visualization (3) Prerequisites: ITCS 4121 or ITCS 5121 Information Visualization. Concept, theory, design principles, data processing techniques, and visual metaphors and interaction techniques for massive, multi-dimensional, multi-source, time-varying information exploration. (Fall) (Evenings)

B. Justification

1. Need:

Scalability is an important issue in both information visualization and visual analytics fields since nowadays data are growing at an incredible rate and humans are able to access far more information than they can possibly process. This course will look deeply into the scalability issue, including information scalability, visual scalability, display scalability, human scalability, and software scalability. Up-to-date techniques explored in this class will help graduate students specialize in processing, visually analyzing, and effectively presenting abstract data which they may meet in their own research areas. This course will also help graduate students specialize in the areas of information visualization and visual analytics. There is no advanced course in the area of information visualization in our curriculum.

2. Prerequisites/Corequisites:

Prerequisite for this course is ITCS 4121/5121 Information Visualization.

3. Course numbering:

The course is positioned as suitable for master students and Ph. D. students.

4. Effect on scope, quality, and efficiency:

Large scale Information visualization considerably broadens the scope of courses taught in the computer science department. It provides students deep insight to information visualization and visual analytics, and provides students useful concepts and techniques that

could be applied in their own research areas, where large scale datasets are collected, analyzed, and presented, or where scalability issues are also concerned.

C. Impact

1. Students Served:

The course will serve CS majors as well as students from diverse fields such as finance, engineering and bioinformatics. It is positioned as an accessible outreach course to give the CS students deep insight into one of the major visualization fields, and to teach students from other departments techniques that can be applied to their own fields.

2. Effect on existing courses and curricula:

- r. The course will be offered each fall.
- s. The content of other courses will not be affected. The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.
- t. The anticipated enrollment is 10-15 students/fall semester.
- u. This new course is part of the CS MS program revision.
- v. Affected areas of catalog copy: In curriculum outlines, and requirements for the degree, the proposed courses should be listed as elective options.

D. Resources Required to Support Proposal

1. Personnel:

- g. *Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty.*

No requirements for new faculty or increased load on present faculty.

- h. *List by name qualified faculty members interested in teaching the course(s).*

Jing Yang is interested and qualified to teach the course.

2. Physical Facility:

No new physical facilities are needed, beyond a regular classroom to teach the class.

3. Equipment and Supplies:

No new equipment and supplies are needed to teach the courses.

4. Computer:

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use their own computers or those in the Woodward 335 for course assignments and projects. Faculty will use their own existing computers for course preparation. Computing resources are adequate for the proposed course.

5. Audio-Visual:

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources:

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None needed.

E. Consultation with Library and Other Departments or Units

1. Library Consultation: Attached

2. Consultation with other Departments or Units: SIS Department

F. Initiation and Consideration of Proposal

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

G. Attachments

1. Consultation with Library memo

2. Syllabus for the proposed graduate course



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 2, 2006

Subject: ITCS 6126/8126: Large scale Information Visualization

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/02/06

Check One:

1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
23. Holdings are adequate only if Dept. purchases additional items.
24. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Large Scale Information Visualization and related subjects retrieved 1938 pertinent items. Of this total, 530 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 36 journals and 398 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 02, 2006

Date

Atkins Library Holdings in Areas Related to

Large Scale Information Visualization

11/02/06

Subject Heading	All Books	After 2000	Journals	Electronic Resources
2D graphic*	7	5	0	2
3D graphic*	33	18	0	13
Animation	262	82	2	34
Computer drawing*	68	23	2	8
Computer graphic*	650	133	14	152
Data visualization	78	40	1	14
Digital illustration	14	5	0	8
Flow visualization	58	10	0	4
Image processing	507	114	14	113
Information visualization	58	33	1	18
Large datasets	12	5	0	7
Medical visualization	10	5	1	3
Multivariate visualization	5	4	0	0
Network visualization	11	11	0	1
Rendering	147	35	0	13
Time varying visualization	2	2	0	0
Volume visualization	16	5	1	8
Totals	1938	530	36	398

ITCS 6126/8126: Large Scale Information Visualization - Syllabus

Course Description (catalog description):

ITCS 6126/8126. Large Scale Information Visualization (3) Prerequisites: ITCS 4121/5121 Information Visualization. Concept, theory, design principles, data processing techniques, and visual metaphors and interaction techniques for massive, multi-dimensional, multi-source, time-varying information exploration. (Fall)

General Information:

Data are growing at an incredible rate. The goal of this course is to explore up-to-date techniques that help humans get insight from the massive, multi-dimensional, multi-source, time-varying information stream.

Topics of this course include: a) techniques for extracting relevant information from massive data; b) visual metaphors and interaction techniques for visualizing large scale multi-dimensional, hierarchical, graphical, time serious and multi-dimensional geospatial data; c) quality measurement, analysis, optimization, and representation for large datasets; d) techniques that scale to a variety of displays including wall-sized displays to a PDA or phone-sized display; e) information visualization in a collaborative environment; f) the privacy and security issue when scaling to multi-user environments; and applications of the above techniques.

The exact selection of topics is driven by three criteria: (1) essentials that must be covered, (2) advances in research, and (3) the interests of the participants.

Pre- or co-requisites:

Prerequisite for this course is ITCS 4121/5121 Information Visualization.

Objectives of the course:

Scalability is an important issue in both information visualization and visual analytics fields since nowadays data are growing at an incredible rate and humans are able to access far more information than they can possibly process. This course will look deeply into the scalability issue of information visualization and visual analytics, including information scalability, visual scalability, display scalability, human scalability, and software scalability. Up-to-date techniques that help humans get insight from the massive, multi-dimensional, multi-source, time-varying information stream will be explored in the class. This course will help graduate students specialize in the areas of information visualization and visual analytics.

Instructional method

The course is offered as a regular class with advanced research topics, combining lecture, and discussion.

Means of student evaluation

Critiques:30%, Presentations: 30%, Projects: 20%, Class Participation: 20%.

90-100% of total grade - A

80-90% of total grade - B or better.

70-80% of total grade - C or better.

60-70% of total grade - D or better.

1) Critiques: This course is reading intensive. The instructor will assign reading tasks to the students in the following approaches: a. The teacher will distributes papers to students each week

and ask the students to write critiques on the papers and turn the critiques in the next weeks. The teacher will grade the critiques and give feedbacks on them in the weeks followed. The grades on the critiques will greatly affect the final grades. Regarding to the critiques, the teacher will give several questions related to the papers for students to answer in the critiques. Students are encouraged put their own thinking about the paper into the critiques. b. The teacher will give some topics and ask students to find papers on those topics. Students will be asked to write critiques and sometimes give presentations on the papers they find.

b) Presentations: Each student will give an in-class 10-minute presentation every three weeks. Students are required to send the presentation topics to the teacher one day before their presentation. Students will get the teacher's feedback on their slides if they send the slides to the teacher one day before the presentation.

c) Project: The students will be required to implement one information visualization prototype to practice what they learn in class. The students are not required to know OpenGL before they take this course since all the basic drawing elements will be provided to them (they can do the projects from scratch though). The students will be asked to present their projects in class.

Here is a list of sample projects: Sample Projects: Build a multi-resolution image or document browser; Increase the scalability of star glyphs; Analyze and visually represent the visualization quality of an existing multi-resolution visualization system; Build a table browser that allows multiple users working collaboratively.

d) Class participation: There will be lots of in-class discussions in the classes. Students' performance in the discussions will also greatly affect their final grade.

PH.D. STUDENTS (ITCS 8126): Ph.D. students will have additional work in reading and critique writing. The project has an additional challenge part to be done by Ph.D. students. This part is available to master students for extra credit.

The basic grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Attendance Policy

Attendance of all scheduled classes is mandatory. 5% of total grade will be deducted for every class that you are absent, unless a good reason is given.

Late policy

Critiques: The full score of each critique assignment is 100 points. You will be deducted 10 points for each day delayed.

Academic Integrity

Unless otherwise specified, the UNC Charlotte guidelines on Academic Integrity fully apply to all work in this course. This includes critique and programming assignments.

Textbooks and resources

The woodward 335 Lab will be used for projects in the class.

Suggested textbook:

R. Spence. Information Visualization. Addison-Wesley.

Suggested reading list:

- 1) J. Thomas and K.Cook. Illuminating the Path, 2005
- 2) U. Fayyad, G. Grinstein, and A. Wierse. Information Visualization in Data Mining and Knowledge Discovery. Morgan Kaufmann, San Francisco, 2001
- 3) R. Heuer. Psychology of Intelligence Analysis. Government Printing Office, Washington, D. C., 1999. Available at <https://www.cia.gov/csi/books/19104/index.html>.
- 4) C. Ware. Information Visualization: Perception for Design (2nd Edition). Morgan-Kaufmann, 2004.
- 5) P. Keller, and M. Keller. Visual Cues: Practical Data Visualization. IEEE Press.
- 6) E. Tufte. The Visual Display of Quantitative Information (2nd Edition). Graphics Press, 2001.
- 7) E. Tufte. Envisioning Information. Graphics Press, 1990.
- 8) E. Tufte. Visual Explanations: Images and Quantities, Evidence and Narrative. Graphics Press, 1997.

Useful Resources

- 1) Dr. Daniel Keim's tutorials

http://dbvis.inf.uni-konstanz.de/group/get_tutorials.php?name=keim

- 2) Dr. George Robertson's tutorials

<http://research.microsoft.com/~ggr/pubs.htm>

- 3) Dr. John Stasko's Information Visualization course materials

http://www-static.cc.gatech.edu/classes/AY2006/cs7450_spring/index.html

- 4) XmdvTool homepage

<http://davis.wpi.edu/~xmdv/>

Software:

Two existing information visualization prototypes will be provided to the students for developing their projects. One was written in java and another was written in C++. Basic input, output and drawing functions are provided in them. Students can select one of them and build their projects on it. They can also build their project from scratch using any C++ or Java environment.

Attachment 12. Proposal for ITCS 6127/8127 Real-time Rendering Engine

The University of North Carolina at Charlotte

New Graduate Course Proposal
from the Department of Computer Science

No. CSCI-11-14-20061

Title: Addition of two new graduate courses ITCS 6127 and ITCS 8127: **Real Time Rendering Engines**

A. Proposal Summary and Catalog Copy

1. Summary

The Computer Science Department proposes to add two new courses to the graduate curriculum, ITCS 6127, ITCS 8127: Real Time Rendering Engines.

2. Proposed Catalog Copy

ITCS 6127. Real-Time Rendering Engines (3G). Prerequisites: ITCS 5120 or ITCS 6120. This course focuses on advanced concepts and techniques employed in building real-time rendering systems that support a high level of realism as well as handle large geometric models. Topics include: modern graphics hardware, programmable shaders, shadow and environment mapping, image-based modeling and rendering, large data models (simplification, level of detail), high quality interactive rendering. (On Demand).

ITCS 8127. Real-Time Rendering Engines (3G). Prerequisites: ITCS 5120 or ITCS 6120. This course focuses on advanced concepts and techniques employed in building real-time rendering systems that support a high level of realism as well as handle large geometric models. Topics include: modern graphics hardware, programmable shaders, shadow and environment mapping, image-based modeling and rendering, large data models (simplification, level of detail), high quality interactive rendering. (On Demand).

B. Justification

1. Need:

Currently there is no course in advanced computer graphics that is targeted at advanced graduate students, especially those students who are engaged in graphics research. An earlier course (ITCS 6130), developed over 10 years back, is out-dated due to recent advances in this field. The proposed course will serve as a follow-on course to both the introductory graphics course (ITCS 5120/6120) as well as the game engine construction course (ITCS 4235/ITCS5235).

2. Prerequisites/Corequisites:

Students should have knowledge fundamentals of computer graphics, through ITCS 5120 or ITCS 6120, and possess excellent programming skills.

3. Course numbering:

The course numbers position this as an advanced graduate course.

4. Effect on scope, quality, and efficiency:

The proposed course will broaden the scope of graphics and visualization concentration in our masters and doctoral programs. The new course permits us to explore the state of the art

in real-time rendering techniques, including the use of GPU programming and handling extremely large geometric models.

C. Impact

1. Students Served:

The course will serve the curricular needs of graduate students in the Computer Science Department. The graduate students will have an advanced course in computer graphics.

2. Effect on existing courses and curricula:

- m. The course will be offered on demand. We expect it to be scheduled once every 2-3 years, in the Spring semester.
- n. The content of other courses will not be affected. The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.
- o. The anticipated enrollment is about 10 students.
- p. This new course is part of the CS MS program revision.
- q. An advanced graphics course was offered many years ago; in Spring 2006, a related course on game engine design was offered as a Topics course. The proposed course will include more advanced topics to be dealt with in greater detail, as well as made more relevant to doctoral students doing research in advanced graphics or visualization.
- r. Affected areas of catalog copy: In curriculum outlines, and requirements for the degree, the proposed courses should be listed as elective options.

D. Resources Required to Support Proposal

1. Personnel:

- e. *Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty*

No requirements for new faculty or increased load on present faculty

- f. *List by name qualified faculty members interested in teaching the course(s).*

Possible instructors include Drs. Kalpathi Subramanian, Zachary Wartell, Aidong

Lu.

2. Physical Facility:

No new physical facilities are needed.

3. Equipment and Supplies:

No new equipment or supplies are needed to teach the courses.

4. Computer:

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use the Woodward 335 computer lab for course assignments and projects. Existing computing resources in CCI are adequate for the proposed course.

5. Audio-Visual:

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources:

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None needed.

E. Consultation with Library and Other Departments or Units

1. Library Consultation: Attached

2. Consultation with other Departments or Units: SIS Department

F. Initiation and Consideration of Proposal

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

G. Attachments

1. Consultation with Library memo
2. Syllabus for the proposed graduate course



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 2, 2006

Subject: ITCS 6127/8127: Real-time Rendering Engines

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/02/06

Check One: 1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
25. Holdings are adequate only if Dept. purchases additional items.
26. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Real-time Rendering Engines and related subjects retrieved 2138 pertinent items. Of this total, 766 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 18 journals and 649 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 02, 2006

Date

Atkins Library Holdings in Areas Related to

Real-time Rendering Engines

11/02/06

Subject Heading	All Books	After 2000	Journals	Electronic Resources
2D graphic*	7	5	0	2
3D graphic*	33	18	0	13
Computer art	272	91	0	35
Computer drawing*	68	23	1	8
Computer game*	252	130	0	74
Computer graphic*	650	133	14	152
Computer illustration*	15	8	0	2
Digital graphic*	74	24	0	34
Digital illustration*	14	5	0	8
Electronic game*	382	152	1	263
Graphics hardware	12	8	0	1
Image modeling	36	19	0	6
Interactive rendering	5	2	0	0
OpenGL	5	5	0	5
Real-time rendering	8	7	0	2
Video game*	104	55	0	8
Virtual reality	201	81	2	36
Totals	2138	766	18	649

ITCS 6127/8127: Real Time Rendering Engines - Syllabus

Course Catalog Description

ITCS 6127. Real-Time Rendering Engines (3G). Prerequisites: ITCS 5120 or ITCS 6120. This course focuses on advanced concepts and techniques employed in building real-time rendering systems that support a high level of realism as well as handle large geometric models. Topics include: modern graphics hardware, programmable shaders, shadow and environment mapping, image-based modeling and rendering, large data models (simplification, level of detail), high quality interactive rendering. (On Demand).

ITCS 8127. Real-Time Rendering Engines (3G). Prerequisites: ITCS 5120 or ITCS 6120. This course focuses on advanced concepts and techniques employed in building real-time rendering systems that support a high level of realism as well as handle large geometric models. Topics include: modern graphics hardware, programmable shaders, shadow and environment mapping, image-based modeling and rendering, large data models (simplification, level of detail), high quality interactive rendering. (On Demand)

Prerequisites

ITCS 5120 or ITCS 6120 or permission of instructor.

Objectives of the course

Providing computer science graduate students with the state of the art in advanced graphics design and techniques pertaining to real-time rendering engines. Students will be equipped with marketable skills such as OpenGL and GPU programming, at the end of the course, besides serving as an essential course in advanced graphics.

Instructional Method

This course incorporates lectures, lab sessions and demonstrations, student presentations and demonstrations, and a term project.

Method of Student Evaluation

Students will be evaluated based on: individual projects, seminar presentations(journal/conference articles), and a term project, evaluated as follows:

Projects:	30%
Student PaperPresentations	20%
Term Project(Final):	50%

Students who are enrolled in the 8000 level of this course will have additional project requirements in the individual projects and paper presentations (for instance, a more detailed critique of research articles). Where possible, 8000 level students will be grouped together for the final project with a higher expectation.

The basic grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, except when working as part of a team, such as the term project.

Attendance: Class attendance is mandatory. If a student misses a class, he/she is responsible for any handouts, announcement, and contents of missed lectures.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

There is no official textbook for this course. A reading list, including electronic copies of the papers, from recent conference proceedings and journals will be posted on the website for this course.

Suggested References:

- Real-Time Rendering, 2nd Edition, Tomas Akenin-Moller, Eric Haines, 2002
- **Level of Detail for 3D Graphics (The Morgan Kaufmann Series in Computer Graphics)** , [David Luebke](#), [Martin Reddy](#), [Jonathan D. Cohen](#), [Amitabh Varshney](#), [Benjamin Watson](#), and [Robert Huebner](#), 2003.
- OpenGL Programming Guide, 5th Edition, 2006
- OpenGL Shading Language, Randi Rost, 2004
- Game Programming Gems Series, Charles River Media

Software:

All needed software tools are either available or are open-source.

Topics

13. Introduction

- a. Graphics pipeline
- b. OpenGL pipeline

14. Modern Graphics Hardware

- e. Geometry engine, fixed function pipelines
- f. Programmable shaders (vertex, fragment shaders)
- g. Example graphics systems

15. Image-based Modeling and Rendering

- a. Texture, Bump, Environment Maps
- b. View Interpolation

- c. Layered Depth Images
- d. Light Fields, Reflectance Fields, Lumigraph

16. Shadow and Environment Mapping

- e. Early techniques (planar shadows, shadow volumes, shadow maps)
- f. Hardware shadows
- g. Environment and Reflection Maps
- h. Cube Maps, Bump Maps

17. Large Model Rendering

- a. Level of Detail Frameworks (Discrete, Continuous, View-dependent)
- b. Mesh Simplification (Local and Global)
- c. Simplification Error Metrics
- d. Out-of-core techniques

18. High Quality Interactive Rendering

- a. Precomputed radiance transfer based techniques
- b. Precomputed image-based techniques

Attachment 13. Proposal for ITCS 6128/8128 3D Display and Advanced Interfaces

The University of North Carolina at Charlotte

New Graduate Course Proposal
from the Department of Computer Science

No. CSCI-11-14-2006m

Title: Addition of two new graduate courses ITCS 6128 and ITCS 8128: **3D Display and Advanced Interfaces**

A. Proposal Summary and Catalog Copy

1. Summary

The Computer Science Department proposes to add two new courses to the graduate curriculum, ITCS 6128, ITCS 8128: 3D Display and Advanced Interfaces.

2. Proposed Catalog Copy

ITCS 6128. 3D Display and Advanced Interfaces (3G). Prerequisites: ITCS 4120 or ITCS 6120. The course covers the fundamentals of 3D display hardware and software technology. Topics include: human visual spatial perception of natural and synthetic 3D images, 3D display hardware, human computer interface algorithms for effective stereoscopic display, 3D display rendering techniques. (On Demand).

ITCS 8128. 3D Display and Advanced Interfaces (3G). Prerequisites: ITCS 4120 or ITCS 6120. The course covers the fundamentals of 3D display hardware and software technology. Topics include: human visual spatial perception of natural and synthetic 3D images, 3D display hardware, human computer interface algorithms for effective stereoscopic display, 3D display rendering techniques. (On Demand).

B. Justification

1. Need:

Currently there is no course in 3D display systems and advanced interfaces using these systems targeted at advanced graduate students, especially those students who are engaged in related research. In particular, in Spring of 2007, The Charlotte Visualization Center acquired and installed a \$150K state-of-the-art stereoscopic, projected display system available to researchers as well as students in the proposed class. ITCS 6128/8128 will prepare graduate students to do research on these types of display systems.

A complementary course, ITCS 6125 Virtual Environments does exist. However, the ITCS 6125 lecture content has a broader focus and the student projects focus on human-computer interfaces that use a different type of display system. The proposed course covers 3D display and associated psychophysical and human-factors issues in much greater detail and gives students the opportunity to work on a state-of-the-art head-tracked, stereoscopic display system. ITCS 6128/8128 does not assume a student has taken ITCS 6125 Virtual Environments nor assumes a student is taking ITCS 6125 concurrently.

2. Prerequisites/Corequisites:

Students should have knowledge fundamentals of computer graphics, through

a course such as ITCS 4120 or ITCS 5120 or ITCS 6120, and possess excellent programming skills.

3. Course numbering:

The course numbers position this as an advanced graduate course.

4. Effect on scope, quality, and efficiency:

The proposed course will broaden the scope of graphics and visualization concentration in our masters and doctoral programs. The new course permits us to explore the state of the art human-computer interfaces that use large, projected or flat screen stereoscopic 3D display systems for interactive 3D graphics applications.

C. Impact

1. Students Served:

The course will serve the curricular needs of graduate students in the Computer Science Department. The graduate students will have an advance course in computer graphics.

2. Effect on existing courses and curricula:

- s. The course will be offered on demand. We expect it to be scheduled once every 2-3 years, in the Spring semester.
- t. The content of other courses will not be affected. The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.
- u. The anticipated enrollment is about 10 students.
- v. This new course is part of the CS MS program revision.
- w. The course will complement ITCS 6125 Virtual Environments. It will cover 3D display, human stereoscopic vision, and related human-computer interface issues in much greater detail than ITCS 6125. Depending on an individual student's interests, the student may take ITCS 6125 alone, ITCS 6128 alone or take both courses in whatever order the student desires.
- x. Affected areas of catalog copy: In curriculum outlines, and requirements for the degree, the proposed courses should be listed as elective options.

D. Resources Required to Support Proposal

1. Personnel:

- g. *Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty.*

No requirements for new faculty or increased load on present faculty.

- h. *List by name qualified faculty members interested in teaching the course(s).*

The primary instructor is Dr. Zachary Wartell who has developed and taught this course in Spring 2006 at ITCS 8010. Dr. Larry F. Hodges, who teach ITCS 6125, could also teach this course.

2. Physical Facility:

No new physical facilities are needed.

3. Equipment and Supplies:

No new equipment or supplies are needed to teach the courses.

4. Computer:

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use the Woodward 335 computer lab for certain course assignments and projects and use the facilities of the Charlotte Visualization Center for the large project assignments. Existing computing resources in CCI are adequate for the proposed course.

5. Audio-Visual:

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources:

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None needed.

E. Consultation with Library and Other Departments or Units

1. Library Consultation: Attached

2. Consultation with other Departments or Units: SIS Department

F. Initiation and Consideration of Proposal

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

G. Attachments

1. Library Consultation
2. Syllabus for the proposed graduate course



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 3, 2006

Subject: ITCS 6128/8128: 3D Display and Advanced Interfaces

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/03/06

Check One: 1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
27. Holdings are adequate only if Dept. purchases additional items.
28. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of 3D Display and Advanced Interfaces and related subjects retrieved 1479 pertinent items. Of this total, 466 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 24 journals and 315 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 03, 2006

Date

Atkins Library Holdings in Areas Related to

3D Display and Advanced Interfaces

11/03/06

Subject Heading	All Books	After 2000	Journals	Electronic Resources
3D Display*	25	10	0	4
3D Graphic*	33	18	0	13
Computer graphic*	650	133	14	152
Data visualization	78	40	1	14
Graphic display*	40	28	0	4
Human-computer interaction	201	59	4	62
Information visualization	58	33	1	18
Spatial perception	101	33	2	10
Stereo display	4	0	0	0
Stereoscop*	16	2	0	0
Virtual reality	201	81	2	36
Visual display*	72	29	0	2
Totals	1479	466	24	315

Course Catalog Description

ITCS 6128. 3D Display and Advanced Interfaces (3G). Prerequisites: ITCS 4120 or ITCS 6120. The course covers the fundamentals of 3D display hardware and software technology. Topics include: human visual spatial perception of natural and synthetic 3D images, 3D display hardware, human computer interface algorithms for effective stereoscopic display, 3D display rendering techniques. (On Demand).

ITCS 8128. 3D Display and Advanced Interfaces (3G). Prerequisites: ITCS 4120 or ITCS 6120. The course covers the fundamentals of 3D display hardware and software technology. Topics include: human visual spatial perception of natural and synthetic 3D images, 3D display hardware, human computer interface algorithms for effective stereoscopic display, 3D display rendering techniques. (On Demand).

Prerequisites

ITCS 4120 or ITCS 5120 or ITCS 6120 or permission of instructor.

Objectives of the course

Providing computer science graduate students with knowledge and experience in the state of the art in advanced 3D display technologies (focusing on stereoscopic displays), human spatial perception as it relates to 3D displays, and development of algorithms for rendering and human-computer interfaces using these displays.

Instructional Method

This course incorporates lectures, lab sessions and demonstrations, student presentations and demonstrations, and a term project.

Method of Student Evaluation

Students will be evaluated based on: individual projects, seminar presentations(journal/conference articles), and a term project, evaluated as follows:

Project:	35%
Class Participation:	15%
(presentation of selected papers)	
Quiz 1	15%
Quiz 2	15%
Final	20%

6128 versus 8128 – This class will be cross-listed for both Masters and Ph.D. students. All students will take the same quiz’s and final and make class presentations of papers and will be graded equivalently on these aspects. The class project will be done individually and formulated by the students themselves with review and possible modification by the professor. The expectations, however, for Masters and Ph.D. student projects will be different. Ph.D. students projects will be more research oriented. Simply implementing prior work is not sufficient for Ph.D. students but is sufficient for Master students. This additional research oriented requirement for Ph.D. students can take the form of any of the following, as appropriate for a given project:

- implement some aspects of the future work described in a paper read in class

- implement and experiment with novel algorithms and techniques
- implement a known technique within a larger research project with in which the student is already involved
- implement a set of known techniques within a software framework created by the student that is suitable for making experimental comparisons between techniques
- implement a set of known techniques but perform a small, pilot study using several 6128/8128 students and/or the professor as subjects

The basic grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, except when working as part of a team, such as the term project.

Attendance: Class attendance is mandatory. If a student misses a class, he/she is responsible for any handouts, announcement, and contents of missed lectures.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

There is no official textbook for this course. A reading list, including electronic copies of the papers, from recent conference proceedings and journals will be posted on the website for this course. (See Topics for detailed list).

Software:

All needed software tools are either available or are open-source.

Topics

The following topics and readings were covered when Dr. Wartell taught this class as 6010/8010 in Spring 2006. 6128/8128 will follow this same format. The class lecture slides are available at:

<http://www.cs.uncc.edu/~zwartell/ITCS 6010 3D Displays/ITCS 6010 3D Displays - Wartell.html>

Lectures

- Lecture Set 1: Light, Displays, and the Eyes
 - Topics:

- Computer Graphics Review - light properties, display technology, eye anatomy
 - Radiometry, Photometry, “Brightness”
 - colorimetry – chromaticity, color gamut, color temperature, white point
 - Slides: [ITCS 6010 - Eye and Displays.ppt](#)
 - Reading: [Majumder99](#)
- Lecture Set 2: Depth and Size Perception
 - Topics:
 - Depth Perception
 - oculomotor cues
 - pictorial cues
 - SFM (Structure From Motion): movement-produced cues
 - binocular disparity cues – stereopsis, corresponding points, horopter, Panum’s fusion area
 - Size Perception – law of size constancy, Emmert’s Law,
 - Slides: [ITCS 6010 - Depth and Size Perception.ppt](#)
 - Reading: [Wartell](#) pg 6-28, [Lipton](#) pg 17-28, [Lipton](#) pg 53-67
- Lecture Set 3: 3D Display Technologies Overview
 - Topics:
 - 3D displays - definition
 - ideal surface display vs stereoscopic surface display - accommodation and image blur, accommodation and vergence link
 - fusion metrics - screen parallax, HVA, vergence difference, empirical limits
 - stereoscopic view frustum – correct geometry and common mistakes, HMD vs HTD, coordinate system hierarchy, distinguishing eye separation measurements, significance of scale
 - Slides: [ITCS 6010 - 3D Displays Overview.ppt](#)
- Lecture Set 4: Stereoscopic Display Techniques: An HCI Perspective
 - Topics:
 - Goals - fusibility, minimize frame cancellation, reachable geometry, accuracy and spatial distortion
 - Geometric Fusion Control Algorithms – properties and classification of techniques
 - Accuracy and Spatial Distortion – distortion components, induced stereo motion, tracker error, perceptual distortions & sub-classifications
- Lecture Set 5: Example 3D Displays
 - Topics:
 - Display Technology - stereoscopic, lenticular, parallax barrier, slice-stacking, and holographic displays
 - Detailed Characteristics - spatial resolution, depth resolution, field of view, viewing zone, bandwidth
 - Slides: [\[McKenna 1992 \(Part I\).ppt\]](#) [\[McKenna 1992 \(Part II\).ppt\]](#) [\[McKenna 1992 \(Part III\).ppt\]](#) [\[McKenna 1992 Supplement.ppt\]](#)
 - Reading: Michael McKenna and David Zeltzer. "Three Dimensional Visual Display Systems for Virtual Environment." Presence, Volume 1, Number 4, Fall 1992.
- Lecture Set 6: Efficient Stereoscopic Rendering Techniques
 - Topic: Rendering algorithms that take advantage of Stereo Image Pair Coherence
 - Slides: [\[Adelson 1993.ppt\]](#)

- Reading: Stephen J. Adelson and Larry F. Hodges, "Stereoscopic raytracing ", *The Visual Computer*, vol. 10, no. 3, pp. 127--144, 1993. (<http://citeseer.ist.psu.edu/adelson93stereoscopic.html>)
- Lecture Set 7: HCI Experiments with Interactive Stereoscopic Applications
 - Topics:
 - Effect of modeled eye separation variation on 3D target selection.
 - Effect of stereoscopic display, shadows and inter-reflections on human perception of impending contact between moving 3D block and surface.
 - Effect of stereoscopic display and the kinetic depth effect on the ability of users to comprehend linkages in 3D networks.
 - Slides: [\[Rosenberg 1993.ppt\]](#) [\[Hu 2002.ppt\]](#)
 - Reading:
 - Louis B. Rosenberg, The Effect of Interocular Distance upon Operator Performance using Stereoscopic Displays to Perform Virtual Depth Tasks, *Proceedings of IEEE Virtual Reality Annual International Symposium 93*, Sept. 1993, pg 27-32. (see [IEEE Xplore](#))
 - Helen H. Hu, Amy A. Gooch, Sarah H. Creem-Regehr, William B. Thompson. "Visual Cues for Perceiving Distances from Objects to Surfaces". *Presence*, Vol. 11, No. 6, December 2002, 652– 664 (www.cs.utah.edu/npr/papers/Hu_cues.pdf)
 - Colin Ware and Peter Mitchell. "Reevaluating stereo and motion cues for visualizing graphs in three dimensions." *ACM International Conference Proceeding Series*; Vol. 95, Proceedings of the 2nd symposium on Applied perception in graphics and visualization. Pp 51-58. (<http://portal.acm.org/citation.cfm?id=1080411>)
- Lecture Set 8: Experiments in Depth Perception in Stereoscopic Display
 - Topics:
 - An experimental comparison of multiple distance cues' effectiveness and accuracy at multiple distances
 - An experimental comparison of the effect of combining stereo display and structure from motion on the human visual system's ability to perceive geometrically correct depths.
 - Readings:
 - R. Troy Surdick, Elizabeth Thorpe Davis, Robert A. King, Larry F. Hodges: The Perception of Distance in Simulated Visual Displays: A Comparison of the Effectiveness and Accuracy of Multiple Depth Cues Across Viewing Distances. 513-531. (class handout) [\[Surdick 1997.ppt\]](#)
 - P. Scarfe, P.B. Hibbard. Disparity-defined objects moving in depth do not elicit three-dimensional shape constancy." *Vision Resions*, Vol 46., 2006, 1599-1610. (class handout) [\[Scarfe 2006.ppt\]](#)
- Lecture Set 9: Stereoscopic Interface Techniques
 - Topics:
 - dynamic adjustment of modeled eye separation and view scale
 - microstereopsis
 - techniques to enhance fish-tank/desktop VR
 - characterizing geometric image fusion techniques
 - analytic comparisons of geometric image fusion techniques
 - approaches to balancing image fusion, image depth and 3D image distortion
 - multi-region approaches to geometric fusion control
 - cross-talk reduction in passive stereo displays

- Reading & Slides
 - Colin Ware, Cyril Gobrecht, and Mark Andrew Paton, Dynamic Adjustment of Stereo Display Parameters, *IEEE Transactions on Systems, Man and Cybernetics—Part A: Systems and Humans*, vol. 28, no. 1, January 1998, pg 56-65. (see [IEEE Xplore](#)) [[Ware 1998.ppt](#)]
 - Mel Seigel and Shojiro Nagata. Just Enough Reality: Comfortable 3-D Viewing via Microstereopsis. *IEEE TCSVT*, Vol 10., No. 3, April 2000, 387-397. (see [IEEE Xplore](#)) [[Seigel 2000.ppt](#)]
 - Jurriaan D. Mulder and Robert van Liere. Enhancing Fish Tank. *Proceedings of IEEE VR 2000*, 91-98. (see [IEEE Xplore](#))
 - Zachary Wartell and Larry Hodges and William Ribarsky, "Characterizing Image Fusion Techniques in Stereoscopic HTDs", *Proceedings of Graphics Interface 2001*, Ottawa, Canada, June 2001, p223-232. (<http://www.cs.uncc.edu/~zwartell/Papers/wartell-gi-2001.pdf>)
 - Zachary Wartell, Larry F. Hodges, William Ribarsky. "An Analytic Comparison of Alpha-False Eye Separation, Image Scaling and Image Shifting in Stereoscopic Displays," *IEEE Transactions on Visualization and Computer Graphics*, April-June 2002, Volume 8, Number 2, pp. 129-143. (see [IEEE Xplore](#))
 - Zachary Wartell, Larry F. Hodges, William Ribarsky. "Balancing Fusion, Image Depth, and Distortion in Stereoscopic Head-Tracked Displays." *SIGGRAPH 99 Conference Proceedings*, Annual Conference Series. ACM SIGGRAPH, Addison Wesley, August 1999, p351-357. (Paper: [Abstract](#) , [PDF](#) , [Postscript](#) ; SIGGRAPH CD-ROM Supplement, [supplement.zip](#), [supplement.tar.Z](#)) - [Wartell](#) Chapter 5 & 6
 - N. S. Holliman. Mapping perceived depth to regions of interest in stereoscopic images. *Stereoscopic Displays and Virtual Reality Systems XI*, *Proceedings of SPIE-IST Electronic Imaging*. 2004. [<http://www.comp.leeds.ac.uk/edemand/publications/hol04a.pdf>]
 - N. S. Holliman. Smoothing Region Boundaries in Variable Depth Mapping for Real Time Stereoscopic Images. *Stereoscopic Displays and Virtual Reality Systems XI*, *Proceedings of SPIE-IST Electronic Imaging*. 2005. [<http://www.dur.ac.uk/n.s.holliman/Presentations/EI5664A-31.pdf>].
 - Stanislav Klimenko, Pavel Frolov, Lialia Nikitina, and Igor Nikitin. Crosstalk reduction in passive stereo-projection systems. *EUROGRAPHICS 2003: Short Presentations*. [http://www.eurasian-dhx.org/ghost_eg03.pdf]

Excerpted Readings

- Zachary Wartell, "Stereoscopic Head-Tracked Displays: Analysis and Development of Display Algorithms," Ph.D. Dissertation, Georgia Institute of Technology, August 2001. ([Abstract](#) , [PDF](#) , [Postscript](#))
- Lenny Lipton, "Foundations of the Stereoscopic Cinema". ([PDF](#))
- ADITI MAJUMDER, "Color Perception and Measurement", Technical Report, University of North Carolina, Chapel Hill, 1999. (<http://www.cs.unc.edu/~majumder/color/paper.html>)

Optional Readings

- Mark Lucente. "Interactive holographic displays: the first 10 years", *Holography. The first 50 years*. Springer Series in Optical Sciences Vol. 78), Springer-Verlag (Berlin),

editor J.-M. Fournier. ISBN 3540670750, 2004 February.
(<http://www.lucente.us/pubs/holo50/index.html>)

Attachment 14. Proposal for ITCS 6159/8159 Intelligent Tutoring Systems

University of North Carolina at Charlotte

New Graduate

No. CSCI-11-14-2006n

Course Proposal from: Department of Computer Science

TITLE: ESTABLISHMENT OF GRADUATE COURSES IN INTELLIGENT TUTORING SYSTEMS

A. PROPOSAL SUMMARY AND CATALOG COPY:

1. SUMMARY:

The Computer Science Department proposes to create two new graduate courses in Intelligent Tutoring Systems.

2. PROPOSED CATALOG COPY:

ITCS 6159. Intelligent Tutoring Systems. (3) Prerequisite: Graduate standing or permission of the instructor. This course introduces the issues relevant to creating adaptive learning systems using artificial intelligence and includes a project to build a small Intelligent Tutoring System (ITS). Topics include: representation of knowledge and cognition, ITS design, adaptive user interfaces, design and evaluation of feedback, experimental methods, educational data mining, history of intelligent tutoring, tutor authoring, and issues for implementation. (Fall, alternate years) (Evenings)

ITCS 8159. Intelligent Tutoring Systems. (3) Prerequisite: Graduate standing or permission of the instructor. This course introduces the issues relevant to creating adaptive learning systems using artificial intelligence and includes a project to build a small Intelligent Tutoring System (ITS). Topics include: representation of knowledge and cognition, ITS design, adaptive user interfaces, design and evaluation of feedback, experimental methods, educational data mining, history of intelligent tutoring, tutor authoring, and issues for implementation. (Fall, alternate years) (Evenings)

B. JUSTIFICATION

1. Need:

The proposed courses address the need to train computer science students in the design, implementation, and evaluation of computer-based educational systems. Learning systems which adapt to individual users and provide relevant feedback are increasingly important in delivering high-quality education to students at different locations at low cost.

2. Prerequisites/corequisites:

Graduate standing or permission of the instructor.

3. Course numbering:

ITCS 6159 is intended as a graduate level course. ITCS 8159 is intended as a doctoral level course.

4. Effect on scope, quality, and efficiency:

These proposed courses will broaden the scope of the computer science curriculum to include the application of a host of computing skills to designing and implementing intelligent tutoring systems. The courses will also strengthen the connections between cognitive science

and computing research.

C. IMPACT

1. Students served:

This course is first designed to serve the needs of the graduate population within the Department of Computer Science. This course may serve as an elective course for related disciplines, such as psychology. In addition, this course may serve the educational needs of local and regional professionals who are seeking knowledge on this important subject.

2. Effect on existing courses and curricula:

- a. The course will be taught once every other academic year (or more often on demand).
- b. The content and frequency of offering of other courses will not be affected as this course is to be taught relatively infrequently.
- c. The course is not expected to significantly change the enrollment of other courses.
- d. The anticipated enrollment is approximately 10 students every other year.
- e. Enrollment in other elective courses will not be affected.
- f. ITCS 6159/8159 has been offered twice as a special topic course (ITCS 6010/8010) with 6 graduate students in each of Fall 2004 and Spring 2006. Students were very enthusiastic about the course, finding the course readings and discussions very interesting and useful. As a result of the course, one student is now working with Dr. Barnes to build intelligent tutoring systems for his PhD.
- g. Affected areas of catalog copy: In curriculum outlines, and requirements for the graduate degrees, the proposed courses should be listed as elective options.

T. RESOURCES REQUIRED TO SUPPORT PROPOSAL.

1. Personnel

- a. Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty.

No requirements for new faculty or increased load on present faculty. A student assistant will be needed when the course enrollment exceeds 10 students.

- b. List by name qualified faculty members interested in teaching the course(s).

Tiffany Barnes is interested and qualified to teach both courses.

2. Physical Facility

No new physical facilities are needed, beyond a regular classroom to teach the class.

3. Equipment and Supplies

No new equipment and supplies are needed to teach the courses. Software for the courses may include: Jess, which is available with a free academic license, CTAT, which is also available with a free academic license, C/C++, which is already available through Visual Studio.

4. Computer

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use their own computers or those in the Woodward 335 for course assignments and projects. Faculty will use their own existing computers for course preparation. Computing resources are adequate for both courses.

5. Audio-Visual

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None needed.

U. CONSULTATION WITH THE LIBRARY AND OTHER DEPARTMENTS OR UNITS

1. Library Consultation

Attached

2. Consultation with other departments or units

Department of Software and Information Systems

Department of Psychology

V. INITIATION AND CONSIDERATION OF THE PROPOSAL

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

W. ATTACHMENTS

1. Library consultation.
2. Consultation with Psychology Department
3. Syllabi for graduate courses ITCS 6159/8159



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 3, 2006

Subject: ITCS 6159/8159: Intelligent Tutoring Systems

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/03/06

Check One: 1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
29. Holdings are adequate only if Dept. purchases additional items.
30. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Intelligent Tutoring Systems and related subjects retrieved 3166 pertinent items. Of this total, 918 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 45 journals and 468 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 03, 2006

Date

Atkins Library Holdings in Areas Related to

Intelligent Tutoring Systems

11/03/06

Subject Heading	All Books	After 2000	Journals	Electronic Resources
Adaptive learning system*	56	34	1	13
Artificial intelligence	1122	94	20	155
Cognitive model*	385	185	5	31
Cognitive science*	474	130	6	66
Computer aided instruction	14	0	0	2
Computer aided learning	8	3	1	3
Computer based education	140	66	3	20
Computer based instruction	157	55	4	19
Computer based learning	155	88	1	23
Computer learning system*	181	87	0	29
Data mining	316	122	4	102
Intelligent tutor*	59	7	0	3
“Learning assessment”	14	8	0	0
“Learning style*”	85	39	0	2
Totals	3166	918	45	468

From: "Cutler, Brian" <blcutler@email.uncc.edu>

Date: November 7, 2006 11:49:11 AM EST

To: "Barnes, Tiffany" <tbarnes2@uncc.edu>

Subject: RE: Consultation on new Computer Science course proposal: Intelligent tutoring systems

Tiffany, thank you for sharing this proposal. The proposed new courses (CICS 6159 and 8159) do not overlap with Psychology courses and appear to represent unique contributions to the curriculum. The Department of Psychology supports this proposal and wishes you success with its implementation.

Brian L. Cutler, Ph.D.

Professor and Chair, Department of Psychology

University of North Carolina Charlotte

9201 University City Boulevard

Charlotte, NC 28223-0001

Office: (704) 687-4775; Fax: (704) 687-3096

Email Address: blcutler@uncc.edu

From: Barnes, Tiffany

Sent: Monday, October 23, 2006 1:53 AM

To: Cutler, Brian; plgoolka@uncc.edu

Subject: Consultation on new Computer Science course proposal: Intelligent tutoring systems

Dear Brian & Paula,

My name is Tiffany Barnes and I am sending this email to initiate a consultation with the psychology department on the attached proposal for a course in intelligent tutoring systems. Please accept my apologies if I am not sending this request to the right person, and let me know if you know to whom this consultation request should be sent!

I would also be interested in having this course listed to fulfill elective requirements for the cognitive science certificate, if you feel it would be appropriate.

Please let me know if you have any questions, or how I can facilitate review of this proposal.

Thank you,
Tiffany Barnes

ITCS 6159/8159 Intelligent Tutoring Systems - Syllabus

Course Catalog Description

ITCS 6159. Intelligent Tutoring Systems. (3) Prerequisite: Graduate standing or permission of the instructor. This course introduces the issues relevant to creating adaptive learning systems using artificial intelligence and includes a project to build a small Intelligent Tutoring System (ITS). Topics include: representation of knowledge and cognition, ITS design, adaptive user interfaces, design and evaluation of feedback, experimental methods, educational data mining, history of intelligent tutoring, tutor authoring, and issues for implementation. (Fall, alternate years) (Evenings)

ITCS 8159. Intelligent Tutoring Systems. (3) Prerequisite: Graduate standing or permission of the instructor. This course introduces the issues relevant to creating adaptive learning systems using artificial intelligence and includes a project to build a small Intelligent Tutoring System (ITS). Topics include: representation of knowledge and cognition, ITS design, adaptive user interfaces, design and evaluation of feedback, experimental methods, educational data mining, history of intelligent tutoring, tutor authoring, and issues for implementation. (Fall, alternate years) (Evenings)

Prerequisites

Graduate standing or permission of the instructor. Programming skills, artificial intelligence, or cognitive science experience would be beneficial but are not required.

Objectives of the course

At the end of this course, students should be able to:

1. Understand the basic history of computer-aided instruction and intelligent tutoring systems
2. List the most important and/or effective intelligent tutoring systems
3. Demonstrate an understanding of the elements that compose an intelligent tutoring system
4. Explain the design tradeoffs inherent in modeling knowledge
5. Explain the issues important in implementing ITSs in schools
6. Explain the issues important in developing feedback in ITSs
7. Design and implement basic educational interactions for an intelligent tutoring system
8. Design and implement basic cognitive models for intelligent tutoring systems
9. Design and implement a study to evaluate an intelligent tutoring system
10. Understand and critically evaluate literature relevant to intelligent tutoring systems

Instructional Method

This course incorporates lectures, readings and seminar-type discussions. Individual course assignments lead students through the basic elements of intelligent tutoring system design, building a basis for the final course project, a complete intelligent tutoring system, to be implemented in teams of 2-4 students.

Grading

Approximately 3-5 assignments emphasize learning the basic elements of intelligent tutoring systems, while 1-3 quizzes assess reading of course reading materials. The project, a team implementation of a complete tutoring system, includes evaluation of the ITS as well as one or more presentations in the course of the project. Attendance and participation are required in class. For each absence beyond the third absence, 5 points may be deducted from a student's overall grade.

Class participation 30%

Assignments/Quizzes	30%
Project	40%

A standard 10-point grading scale will be used for the class (A: 90-100, B: 80-90, ...).

For credit in the 8000 version of the course, doctoral students must: 1) complete all assignments, (which have added components for doctoral students), 2) prepare and lead one class discussion based on two or more modern research references, and 3) incorporate and demonstrate a significant portion of original scripting or programming in the final project. Assignments will also include additional exercises required for doctoral students.

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, and fully cite any sources used. Assignments or projects that are not appropriate in an academic setting, subject to the instructor's discretion, will not be accepted for a grade.

Attendance: Attendance is mandatory. For each absence beyond the third absence, 5 points may be deducted from a student's overall grade.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

Readings will be assigned from current and historical primary literature sources, including conference and journal proceedings and books, where most of these articles are available online.

Course website: <http://www.cs.uncc.edu/~tbarnes2/ITS/>

Readings and slides will be linked to the course website during the semester.

Software: Jess, Java, C/C++, MySQL, as needed for projects

Topics

1. Introduction and history of ITSs and computer-aided instruction
2. Methods for modeling knowledge
3. Methods for assessment
4. Educational data mining
5. Learning styles
6. Meta-cognition
7. Help-seeking behavior and feedback design
8. ITS design
9. Tutor/adaptive interface design
10. Experimental methods for evaluating ITSs
11. Tutor authoring
12. Implementation issues

Attachment 15. Proposal for ITCS 6167/8167 Advanced Networking Protocols

The University of North Carolina at Charlotte

New Graduate Course Proposal
from the Department of Computer Science

No. CSCI-11-14-2006o

Title: Addition of two new graduate courses ITCS 6167 and ITCS 8167: **Advanced Networking Protocols**

A. Proposal Summary and Catalog Copy

1. Summary

The Computer Science Department proposes to add two new courses to the graduate curriculum, ITCS 6167, ITCS 8167: Advanced Networking Protocols

2. Proposed Catalog Copy

ITCS 6167. Advanced Networking Protocols (3) Prerequisites: ITCS 6166 or ITCS 6168. This course focuses on advanced networking concepts and protocols related to the design, implementation, integration, and management of networking and communication systems. Topics include: topology control protocols, ad hoc routing protocols, power management protocols, distributed data processing protocols for various networking systems (Internet, wireless mesh networks, ad hoc networks, sensor networks, peer-to-peer networks). (Spring) (Evenings)

ITCS 8167. Advanced Networking Protocols (3) Prerequisites: ITCS 6166 or ITCS 8166 or ITCS 6168 or ITCS 8168. This course focuses on advanced networking concepts and protocols related to the design, implementation, integration, and management of networking and communication systems. Topics include: topology control protocols, ad hoc routing protocols, power management protocols, distributed data processing protocols for various networking systems (Internet, wireless mesh networks, ad hoc networks, sensor networks, peer-to-peer networks). (Spring) (Evenings)

B. Justification

1. Need:

Networking is one of the major popular areas in Computer Science. Recently, there are two strong trends: the significant broadening of the scope of networking research and the dramatic growth of the network research community in both academic and industry. The range of topics in the networking area is continuously broadening, and now includes, among many other new topics, wireless sensor networks, ubiquitous computing, peer-to-peer networks, optical networks, network security, Internet measurements, control theory applications in networking, and cross-layer optimizations. The central role of network research in computer science and engineering has led to a significant growth of the research community. However, there is no advanced course in the area of networking and communication in our curriculum. The goal of this class is to present advanced concepts and techniques in networking area. We expect to have many graduate students taking this class. Wang has taught the related courses in UNCC twice. There were 13 students the first time and 19 the second time.

2. Prerequisites/Corequisites:

Students should have had basic knowledge of computer networking and programming skill. Completion of the introductory network courses at the graduate levels (ITCS6166/8166 or ITCS 6168/8168) is required.

3. Course numbering:

The course numbers position this as an advanced graduate course.

4. Effect on scope, quality, and efficiency:

The proposed course will broaden the scope of networking concentration in our master program. The new advanced concepts and techniques taught in the proposed course will enhance the students' specialization in the networking area. Thus, the proposed course will improve the quality of our graduates and hence the quality of our program.

C. Impact

1. Students Served:

The course will serve the curricular needs of graduate students in Computer Science Department. The graduate students will have an advance course in networking and communications.

2. Effect on existing courses and curricula:

- y. The course will be offered each spring.
- z. The content of other courses will not be affected. The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.
- aa. The anticipated enrollment is 20 students/spring semester.
- bb. This new course is part of the CS MS program revision.
- cc. This course has been offered twice as a special topic course (ITCS 6010/8010) in Fall 2004 and Spring 2006. The enrollment for the course in Fall 2004 was 13 graduate students. The enrollment for the course in Spring 2006 was approximately 19 graduate students.
- dd. Affected areas of catalog copy: In curriculum outlines, and requirements for the degree, the proposed courses should be listed as elective options.

D. Resources Required to Support Proposal

1. Personnel:

- i. *Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty.*

No requirements for new faculty or increased load on present faculty.

- j. *List by name qualified faculty members interested in teaching the course(s).*

Both Yu Wang and Teresa Dahlberg are interested and qualified to teach this course.

2. Physical Facility:

No new physical facilities are needed, beyond a regular classroom to teach the class.

3. Equipment and Supplies:

No new equipment and supplies are needed to teach the courses.

4. Computer:

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use their own computers or those in the Woodward 335 for course assignments and projects. Faculty will use their own existing computers for course preparation. Computing resources are adequate for the proposed course.

5. Audio-Visual:

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources:

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None needed.

E. Consultation with Library and Other Departments or Units

1. Library Consultation: Attached

2. Consultation with other Departments or Units: SIS Department

F. Initiation and Consideration of Proposal

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

G. Attachments

- 1.** Consultation with Library memo
- 2.** Syllabus for the proposed graduate course



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 3, 2006

Subject: ITCS 6167/8167: Advanced Topics in Networking

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/03/06

Check One: 1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
31. Holdings are adequate only if Dept. purchases additional items.
32. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Advanced Topics in Networking and related subjects retrieved 4410 pertinent items. Of this total, 1587 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 48 journals and 1317 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 03, 2006

Date

Atkins Library Holdings in Areas Related to

Advanced Topics in Networking

11/03/06

Subject Heading	All Books	After 2000	Journals	Electronic Resources
Ad hoc network*	29	19	0	12
Ad hoc routing	8	8	0	5
C (computer programming language)	124	42	0	45
Communication network*	113	27	2	20
Computer network*	2303	772	29	757
Distributed data processing	207	29	7	61
Internet network*	1214	507	7	249
Network architecture*	18	2	0	3
Network protocol*	215	66	1	97
Network security	56	36	0	15
Optical network*	36	20	0	16
“Peer-to-peer network*”	10	7	0	4
Sensor network*	44	28	1	20
Topology control*	23	17	1	8
Ubiquitous computing	6	3	0	4
Wireless mesh network*	4	4	0	1
Totals	4410	1587	48	1317

ITCS 6167/8167: Advanced Networking Protocols - Syllabus

Course Catalog Description

ITCS 6167/8167. Advanced Networking Protocols (3G) Prerequisites: ITCS 6166/8166 or ITCS 6168/8168. This course focuses on advanced networking concepts and protocols related to the design, implementation, integration, and management of networking and communication systems. Topics include: topology control protocols, ad hoc routing protocols, power management protocols, distributed data processing protocols for various networking systems (Internet, wireless mesh networks, ad hoc networks, sensor networks, peer-to-peer networks). (Spring).

Prerequisites

ITCS 6166/8166 or ITCS 6168/8168

Objectives of the course

Providing computer science graduate students with an overview of the advanced concepts and protocols in new networking and communication systems (such as ad hoc networks, sensor networks, and future Internet). Student will also learn to use the network simulator and advanced skills in network research.

Instructional Method

This course incorporates lectures, guest lectures, in-class exercises and discussions, a group project, individual assignments, and student presentations.

Method of Student Evaluation

Students will be evaluated based on: 2 exams, a group project, and individual assignments and presentations. They will count toward the grade as follows:

Homework:	30%
Project:	15%
Presentation	20%
Midterm/Final:	35%

The project, a team implementation of a network protocol in network simulator, includes evaluation of the protocol as well as one or more presentations in the course. The grading criteria for the course assignments as well as the term project will be higher for Ph.D. students than for M.S. students. Attendance and participation are required in class.

The basic grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, and fully cite any sources used. Assignments or projects that are not appropriate in an academic setting, subject to the instructor's discretion, will not be accepted for a grade.

Attendance: Class attendance is a responsibility of each individual. If a student chooses not to attend class, he/she is responsible for any handouts, announcement, and contents of missed lectures.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

There is no official textbook for this course. A reading list, including electronic copies of the papers, from recent conference proceedings and journals will be posted on the website for this course.

Additional Optional Texts:

- Ad Hoc Networking, by Charles E. Perkins, Addison-Wesley, 2000. ISBN: 0201309769
- Wireless Sensor Networks: An Information Processing Approach, by Feng Zhao and Leonidas Guibas. Morgan Kaufmann; 2004. ISBN: 1558609148
- Protocols and Architectures for Wireless Sensor Networks, by Holger Karl and Andreas Willig. John Wiley & Sons, 2005. ISBN: 0470095105
- Ad hoc Networking, by Stefano Basagni, Marco Conti, Silvia Giordano, Ivan Stojmenovi. John Wiley & Sons; 2004. ISBN: 0471373133
- Topology Control in Wireless Ad Hoc and Sensor Networks, by Paolo Santi, Wiley, 2005. ISBN: 0470094532
- Computer Networking: A Top-Down Approach Featuring the Internet, F. Kurose and Keith W. Ross, Third Edition, Addison Wesley, 2005. ISBN: 0321227352

Software:

- NS2 network simulator, <http://www.isi.edu/nsnam/ns/>
 - NS2 is a discrete event simulator targeted at networking research. NS2 provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless networks. This software is open source and downloadable from the website. The website contains several tutorials and samples.
- C/C++
 - Any development environment

Topics

19. Introduction:

- a. Internet
- b. Peer-to-peer networks
- c. Wireless ad hoc and sensor networks
- d. Wireless mesh networks

20. Routing Protocols

- a. Ad hoc routing protocols
- b. Power aware routing protocols
- c. Geographic routing protocols
- d. Internet routing protocols

21. Resource Management Protocols
 - a. QoS
 - b. Power assignment protocols
 - c. Power management protocols
22. Topology Control Protocols
 - a. Location-based topology control
 - b. Cluster-based topology control
 - c. Bluetooth scatternet formation protocols
23. Broadcasting and Multicasting Protocols
 - a. Broadcasting
 - b. Multicasting
 - c. Geocasting
 - d. Mobicasting
24. Location and Localization Services
25. Data Management and Data-Centric Storage
26. Network Security

Attachment 16. Proposal for ITCS 6228/8228 Medical Informatics

The University of North Carolina at Charlotte

New Graduate Course Proposal
from the Department of Computer Science

No. CSCI-11-14-2006p

Title: Addition of a new graduate course ITCS/ITIS 6228/8228: **Medical Informatics**

A. Proposal Summary and Catalog Copy

1. Summary

The Computer Science Department proposes to add a new course to the graduate curriculum, ITCS 6228/8228: Medical Informatics. It will be cross-listed as ITIS 6228/8228 by the request of Software and Information Systems Department during consultation.

2. Proposed Catalog Copy

ITCS 6228. Medical Informatics (3) Prerequisites: Graduate Standing. This course focuses on methods and techniques used in storage, communication, processing, analysis, integration, management, and distribution of medical information. The course emphasizes the applications of telemedicine and intelligent computer-aided decision making systems in different medical and surgical systems. The course also discusses the computational methods to accept or reject a new drug or a new treatment for a given disease. (Fall, Alternate years) (Evenings)

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B. Justification

1. Need:

Medical Informatics is one of the emerging areas of Computer Science. Recently, the role of Digital Signal Processing, Artificial Intelligence and Machine Learning in processing and management of medical information has become much more significant. This area of computer science, which has been named “Medical Informatics”, is now an urgent need for the local healthcare systems, in particular for Carolinas Healthcare Systems (CHS). There have been three funded research in the area of Medical Informatics conducted at the Computer Science Department, all funded by the CHS, only during the last two years. However, currently UNC Charlotte offers no courses in the area of Medical Informatics. In order to have more grants and funded projects in medical informatics, there is a need to train more students in this field. The goal of the proposed course is to provide the students the concepts and techniques in Medical Informatics. Dr Hadzikadic has already taught this course twice at UNC Charlotte; both times the course was offered as a topic course.

2. Prerequisites/Co-requisites:

Graduate Standing.

3. Course numbering:

The course numbering positions this as an advanced graduate course.

4. Effect on scope, quality, and efficiency:

The proposed course will broaden the scope of medical informatics and computer science applications concentration in our master program. The new concepts and techniques taught in the proposed course will enhance the students’ specialization in Medical Informatics. Thus, the proposed course will improve the quality of our graduates and hence the quality of our program.

C. Impact

1. Students Served:

The course will serve the curricular needs of graduate students in Computer Science Department and Software and Information Systems Department. In particular, M.S. students in the Applications M.S. track, will take this course as one of the courses in the Applications track.

2. Effect on existing courses and curricula:

- ee. The course will be offered each fall.
- ff. The content of other courses will not be affected. The new rotation schedule of CS graduate courses is attached with the Computer Science MS Program Revision Proposal.
- gg. The anticipated enrollment is 10 students/spring semester.
- hh. This new course is part of the CS MS program revision.
- ii. This course has been offered twice as a special topic course (by Dr Hadzikadic).
- jj. Affected areas of catalog copy: In curriculum outlines, and requirements for the degree, the proposed courses should be listed as elective options.

D. Resources Required to Support Proposal

1. Personnel:

- k. *Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty.*

No requirements for new faculty or increased load on present faculty.

- l. *List by name qualified faculty members interested in teaching the course(s).*

Both Kayvan Najarian and Mirsad Hadzikadic are interested and qualified to teach this course.

2. Physical Facility:

No new physical facilities are needed, beyond a regular classroom to teach the class.

3. Equipment and Supplies:

No new equipment and supplies are needed to teach the courses.

4. Computer:

Specify requirements for computer usage by students and/or faculty, and include an assessment of the adequacy of computing resources by Computing Services.

Students will use their own computers or those in the Woodward 335 for course assignments and projects. Faculty will use their own existing computers for course preparation. Computing resources are adequate for the proposed course.

5. Audio-Visual:

Specify requirements for audio and/or visual equipment and media production services from Media Services.

No A/V services are necessary for the courses, beyond existing presentation equipment in classrooms.

6. Other Resources:

Specify and estimate cost of other new/added resources required, e.g., travel, communication, printing and binding.

No additional resources are required.

7. Indicate source(s) of funding for new/additional resources required to support this proposal.

None needed.

E. Consultation with Library and Other Departments or Units

1. Library Consultation: Attached

2. Consultation with other Departments or Units: SIS Department

F. Initiation and Consideration of Proposal

1. Originating Unit

This proposal was approved by Computer Science Faculty on November 14, 2006.

2. Other Considering Units

This proposal was approved by the Faculty of the College of Computing and Informatics on December 12, 2006.

G. Attachments

1. Consultation with Library memo
2. Syllabus for the proposed graduate course



Consultation on Library Holdings

To: Dr. Ken Chen
College of Computing and Informatics

From: Joanne S. Klein
Reference Librarian, Engineering and Information Technology

Date: November 3, 2006

Subject: ITCS 6228/8228: Medical Informatics

Summary of Librarian's Evaluation of Holdings:

Evaluator: Joanne S. Klein **Date:** 11/03/06

Check One: 1. Holdings are superior
2. **Holdings are adequate (Please see comments) YES**
33. Holdings are adequate only if Dept. purchases additional items.
34. Holdings are inadequate

Comments:

A search of the Atkins Library online catalog reveals the following holdings in support of this program. See the table that follows. A search in the areas of Medical Informatics and related subjects retrieved 4356 pertinent items. Of this total, 1017 have been acquired since 2000, so this is a current and relevant collection. Because there is some overlap of subject headings, the actual total number of titles will be somewhat less than this, but the collection, especially if bolstered by ongoing purchases, is quite adequate to support this program. The Library owns or has electronic access to 72 journals and 1177 other electronic resources that support this program. In addition, the library has approximately 20 electronic databases, many with links to full text articles, supporting the overall Computing and Informatics programs.

Joanne S. Klein

Evaluator's Signature

November 03, 2006

Date

Atkins Library Holdings in Areas Related to

Medical Informatics

11/03/06

Subject Heading	All Books	After 2000	Journals	Electronic Resources
Artificial intelligence	1122	94	20	155
Bayesian	172	78	1	9
Bioinformatics	56	40	4	23
Clinical decision support	2	2	0	0
Computational method*	331	105	3	38
Computer aided decision*	10	4	1	2
Digital signal processing	269	56	2	62
Hospital information system*	11	2	1	2
Imaging system*	176	22	7	33
Machine learning	183	53	2	26
Medical informatics	148	67	9	41
Medical information	1327	336	12	616
Neural network*	455	106	9	133
Soft computing	30	16	1	13
Telecommunication* and Health	10	8	0	5
Telemedicine	54	28	0	19
Totals	4356	1017	72	1177

ITCS/ITIS 6228/8228: Medical Informatics - Syllabus

Course Catalog Description

ITCS 6228. Medical Informatics (3) Prerequisites: Graduate Standing. This course focuses on methods and techniques used in storage, communication, processing, analysis, integration, management, and distribution of medical information. The course emphasizes the applications of telemedicine and intelligent computer-aided decision making systems in different medical and surgical systems. The course also discusses the computational methods to accept or reject a new drug or a new treatment for a given disease. (Fall, Alternate years) (Evenings)

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Prerequisites

Graduate Standing.

Objectives of the course

Providing computer science graduate students with an overview of the computational techniques and methods applied for processing and management of medical information. The students will learn how to use these methods to improve the quality of the decisions made in medical decision making processes and improve the performance of the high-tech surgical procedures.

Instructional Method

This course incorporates lectures, guest lectures, in-class exercises and discussions, individual term projects, individual assignments, and student presentations.

Method of Student Evaluation

Students will be evaluated based on one Midterm Exam, one Final Exam, one Individual

Term Project, and a few Individual Assignments and Presentations. They will count toward the overall grade as follows:

Assignments:	10%
Project:	40%
Presentation	15%
Midterm:	15%
Midterm/Final:	20%

A list of potential topics for term projects will be provided to students at the first session of the course; however students will have the option of proposing their own topics for the term project. The grading criteria for the course assignments as well as the term project will be higher for Ph.D. students than for M.S. students.

The basic grading scale is

90 – 100	A
80-89.9	B
70 – 79.9	C
Below 70	U

Course Policies

University integrity: Students are expected to know and abide by the UNC Charlotte Code of Student Academic Integrity. Students are expected to submit their own work, and fully cite any sources used. Assignments or projects that are not appropriate in an academic setting, subject to the instructor's discretion, will not be accepted for a grade.

Attendance: Class attendance is a responsibility of each individual. If a student chooses not to attend class, he/she is responsible for any handouts, announcement, and contents of missed lectures.

Communication: Students are expected to read email and check the course website several times each week.

Textbook and resources

There is no official textbook for this course. A reading list, including lectures notes, and electronic copies of the papers from recent conference proceedings and journals will be posted on the website for this course.

Additional Optional Texts:

- Telemedicine: A Guide to Assessing Telecommunications in Health Care, by Medicine Institute, National Academies Press, 20005, ISBN 0309055318.
- Clinical Decision Support Systems, by Eta S Berner, M J Ball, and K J Hannah, Springer, 1999, ISBN 0387985751.
- Decision Making in Health Care, by Gretchen B. Chapman, Frank A. Sonnenberg, Cambridge University Press, 2003, ISBN: 0521541247.

- Computer-Integrated Surgery, by Stephane Lavealle, Grigore C Burdea, Russell Taylor, MIT Press, 1995, ISBN: 026220097X.
- Strategic Information Management in Hospitals, by Reinhold Haux, Alfred Winter, Elske Ammenwerth, Birgit Brigl, Springer, 2004, ISBN: 0387403566.

Software:

N/A.

Topics

27. Introduction:

- What is Medical Informatics?
- Hospital Information System
- Imaging Systems
- PACS

28. Computer-Aided Decision Making System

- Rule-Based Systems
- Neural Networks
- Soft Computing Methods
- Bayesian Methods
- Computational Methods for Diagnostics
- Computational Methods for Drug Planning and Delivery
- Computational Methods for Surgery Planning

29. Telemedicine

- Remote Surgery
- Computational Methods for Optimization of Surgeries
- Computational Methods for Radiology

30. Treatment and Drug Testing

- Computational Methods for Testing of New Drugs
- Computational Methods for Testing of New Treatments

31. Storage and Communication of Data

- Networking
- Database
- Security

Attachment 17. Two-Year Rotation Schedule for Computer Science graduate courses

Category	Fall Even	Spring Odd	Fall Odd	Spring Even
Core	ITCS 6112	ITCS 6112	ITCS 6112	ITCS 6112
Core	ITCS 6114	ITCS 6114	ITCS 6114	ITCS 6114
Core	ITCS 5141	ITCS 6182	ITCS 5141	ITCS 6182
Core	ITCS 5102	ITCS 5102	ITCS 5102	ITCS 5102
Data Management	ITCS 6160	ITCS 6160	ITCS 6160	ITCS 6160
Data Management	ITCS 6162	ITCS 6163	ITCS 6162	ITCS 6163
Data Management	ITCS 6157	ITCS 6155	ITCS 6161	ITCS 6155
Networked Systems	ITCS 6166	ITCS 6167	ITCS 6166	ITCS 6167
Networked Systems	ITCS 6132	ITCS 5146	ITCS 6132	ITCS 5146
Networked Systems	ITCS 5145	ITCS 6168	ITCS 5145	ITCS 6168
Visualization and Computer Graphics	ITCS 5122	ITCS 5121	ITCS 5122	ITCS 5121
Visualization and Computer Graphics	ITCS 6126	ITCS 5123	ITCS 6126	ITCS 5123
Visualization and Computer Graphics	ITCS 5120/6120	ITCS 6124	ITCS 5120/6120	ITCS 6124
Intelligent & Interactive Systems	ITCS 6150	ITCS 6134	ITCS 6150	ITCS 6134
Intelligent & Interactive Systems	ITCS 6125	ITCS 6151	ITCS 5152	ITCS 6111
Intelligent & Interactive Systems	ITCS 6050	ITCS 6156	ITCS 6050	ITCS 6158/6267
Applications	ITCS 5230	ITCS 5231	ITCS 5230	ITCS 5231
Applications	ITCS 6226	ITCS 6224	ITCS 6228	ITCS 6165
Applications	ITCS 6222	ITCS 5235	ITCS 6159	ITCS 5232
On Demand	ITCS XXXX	ITCS XXXX	ITCS XXXX	ITCS XXXX
On Demand	ITCS XXXX	ITCS XXXX	ITCS XXXX	ITCS XXXX
Total	21	21	21	21

Attachment 18. Current degree requirements of MS program in Computer Science

Degree Requirements

The Master of Science program in Computer Science requires 30 graduate credit hours, which may optionally include 6 hours of thesis. At least 15 hours must be ITCS or ITIS courses at the 6000 level or above. A maximum of 6 hours of graduate credit may be transferred from other institutions.

Core Subjects and Breadth

Each student must demonstrate knowledge in the following three core subjects listed below. A student can satisfy the requirement of a core subject by having a prior undergraduate course on the subject, or completing the ITCS undergraduate course (which carries no graduate credit hours), or completing a related graduate course.

- 1) Programming Languages (ITCS 3102 or equivalent) or related graduate course: ITCS 5102
- 2) Algorithm Analysis (ITCS 2215 or equivalent) or related graduate course: ITCS 6114
- 3) Computer Architecture (ITCS 3182 or equivalent) or related graduate course: ITCS 5141

All of the above three core subjects must be completed before the end of the first year.

In addition, to ensure breadth, each student must demonstrate knowledge in at least two of the following four subjects listed below before graduation. A student can satisfy the breadth requirement on a subject by having a prior undergraduate course on the subject, or completing the ITCS undergraduate course (which carries no graduate credit hours), or completing a related graduate course.

- 1) Operating Systems (ITCS 3143 or equivalent) or related graduate course: ITCS 6144
- 2) Software Engineering (ITCS 3155 or equivalent) or related graduate course: ITCS 6112
- 3) Data Bases (ITCS 3160 or equivalent) or related graduate course: ITCS 6160
- 4) Communications and Networks (ITCS 3166 or equivalent) or related graduate course: ITCS 6166

Systems Course

Each student must complete at least one systems course:

ITCS5141 Computer Organization and Architecture
ITCS6112 Software System Design and Implementation
ITCS6144 Operating System Design
ITCS6148 Advanced Object Oriented Systems
ITCS6160 Database Systems
ITCS6166 Computer Communication and Networks
ITCS6182 Advanced Computer Architecture

Theory Course

Each student must complete at least one theory course:

ITCS5110 Programming Languages and Compilers
ITCS5165 Coding and Information Theory
ITCS5170 Formal Languages and Automata
ITCS6114 Algorithms and Data Structures
ITCS6115 Adv. Topics in Algorithms and Data Structures
ITCS6170 Logic for Artificial Intelligence
ITCS6175 Computability and Complexity

Areas of Concentration

Each student must take at least three related courses (9 hours) to form an area of concentration. The three courses forming the student's area of concentration must have the written approval of the student's academic advisor. Students are encouraged to have their areas of concentration aligned with the faculty research areas.

Attachment 19. Consultation letters from the Library are attached to individual new course sub-proposals.

Attachment 20. Consultation letter from Software and Information Systems Department

From: Bill Chu [mailto:billchu@uncc.edu]
Sent: Monday, December 18, 2006 10:57 AM
To: Chen, Ken
Cc: Hodges, Larry
Subject: Re: Computer Science MS Program Revision Proposal

Larry and Ken,

The Software and Information Systems Department supports the new Computer Science MS program proposal.

--Bill Chu
Professor and Chair
Department of Software and Information Systems
UNC Charlotte
341C Woodward Hall
704-687-8661

Chen, Ken wrote:

<<Computer Science MS Program Revision Proposal 11-15-06.doc>>

Bill:

Attached please find Computer Science MS Program Revision Proposal, which was approved by CS faculty yesterday. I sent to you the 16 new course sub-proposals involved a few weeks ago. I believe SIS graduate & undergraduate committees had sufficient time to review them. Please provide us a consultation letter from SIS Department for the whole proposal at your earliest convenience. In the letter please mention SIS supports the 16 new CS courses. In that way, SIS Department does not need to write 16 individual consultation letters for the 16 new courses separately. Thank you very much.

Ken

Keh-Hsun Chen (Ken), Ph.D.
Professor and Associate Chair
Department of Computer Science
410D Woodward Hall
704-687-8545
chen@uncc.edu

Dear Larry,

The Software and Information Systems (SIS) Department supports the following courses as proposed:

ITCS 5121/4121 Information Visualization
ITCS 5122/4122 Visual Analytics
ITCS 5123/4123 Visual Communications
ITCS 5133/4133 Numerical Computation Methods and Analysis
ITCS 5146/4146 Grid Computing
ITCS 5232/4232 Game Design and Development Studio
ITCS 5235/4235 Game Engine Construction
ITCS 5236/4236 Artificial Intelligence for Computer Games
ITCS 5237/4237 Audio Processing for Entertainment Computing
ITCS 6124/8124 Illustrative Visualization
ITCS 6126/8126 Large Scale Information Visualization
ITCS 6127/8127 Real-time Rendering Engines
ITCS 6128/8128 3D Display and Advanced Interfaces
ITCS 6159/8159 Intelligent Tutoring Systems
ITCS 6167/8167 Advanced Networking Protocols

We feel ITCS 6228/8228 Medical Informatics should be crossed listed as both ITCS and ITIS. One of the main instructors for this course listed in the course proposal is from the SIS department. We have no problems with the content of the proposed course.

Sincerely,

Bill Chu
Professor and Chairman
Department of Software and Information Systems
UNC Charlotte.