UNIVERSITY OF THE DISTRICT OF COLUMBIA

PROPOSAL FOR A DOCTOR OF PHILOSOPHY IN COMPUTER SCIENCE AND ENGINEERING (CSE)

School of Engineering and Applied Sciences

December 5, 12

UNIVERSITY OF THE DISTRICT OF COLUMBIA

UNIVERSITY SENATE

ACADEMIC PROGRAMS

TRANSMITTAL FORM

TYPE OF REVIEW ____________New Program______________________

______________________________Byunggu Yu__________11/13/2012______
Department Chair Date

____
Dean, School of Engineering and Applied Sciences Date

____
Dean of Graduate Studies Date

____
Faculty Senate President Date

____
Provost Date

____
University President Date

____
Board of Trustees Chair Date

Table of Contents

Executive Summary

The School of Engineering and Applied Sciences (SEAS) proposes a new *Doctor of Philosophy* (*Ph.D.*) degree in *Computer Science and Engineering* (*CSE*). The CSE Ph.D. degree program being proposed is a 72 credit hour professional graduate degree designed to prepare students for academic and research careers. Through departmental collaboration in SEAS, students can choose their field of study from the three areas of specialization: (1) *computer science*, (2) *electrical and computer engineering*, and (3) *computational science in Engineering*.

We propose the Ph.D. degree program to begin on August 16, 2013. It is anticipated that between 10 and 20 students will be entering the program each year. The existing SEAS faculty is sufficient in advising these students and for implementing the program.

The implementation of the program is consistent with the vision and mission of the University of the District of Columbia to "*offer exceptional, research-driven graduate and professional programs of importance to the District and the nation*". The goal of the CSE Ph.D. degree program is to prepare graduate and professional degree recipients capable of meeting the needs for the Washington, DC metro area and the nation.

In summary, UDC will benefit from a CSE Ph.D. program in three ways: the program will support and expand UDC's current research profile; the university will contribute more to the community and receive more recognition in return by creating greater synergy among its departments through contributing research; the enrollment will increase and more students will be attracted as we provide the Ph.D. opportunity.

1. Demonstration of Need

The University of the District of Columbia's vision is to be a "*diverse, selective, teaching, research, and service university*". To accomplish this vision, UDC's public goal is to "*offer exceptional, research-driven graduate and professional programs of importance to the District and the nation*". In support of UDC's vision and mission, the following information was gathered to demonstrate the need for a Ph.D. program in computer science and engineering:

- **Students demand the Ph.D. degree program** A recent survey was given to our computer science graduate students in the Fall of 2012. Out of 18 students who responded to the survey, 11 indicated they are planning on pursuing a Ph.D. within the next 1-2 years, and 7 indicated 3-5 years.
- **Graduate students are the main work force in research activities**. The graduate students admitted to the program will help enhance the quality of the research conducted by the faculty. This is essential for applying to research grants from sources such as the National Science Foundation (NSF), The Department of Education (DOE), and the Department of Defense (DoD), to list a few.

- **Offering both master's and Ph.D. shall increase the number of graduate applications.** The results of the *2012 Council of Graduate Schools International Graduate Admissions Survey, Phase I: Applications* indicate that applications of prospective international students to graduate schools increased 9% between 2011 and 2012 for the seventh consecutive year. In addition, survey results show that international students are much more likely to apply to institutions offering doctoral programs than master's focused institutions.
- **Occupations needing a doctoral or professional degree are projected to grow.** In February 2012, the U.S. Department of Labor released its employment projections through 2020. The occupations needing a doctoral or professional degree are projected to grow by 19.9 percent.
- **Employment projections continue to show an increase in science, technology, and engineering fields; especially in Washington, D.C.** Employment projections in STEM fields appear promising. The U.S. Department of Labor has predicted a 29 percent increase in STEM jobs, adding about 2.1 million new jobs between 2010 and 2020. Washington, D.C. has more than two times the concentration of STEM jobs than the national average.
- **Interest in graduate studies of computer science and engineering continues to grow.** According to the *2012 Graduate Enrollment and Degrees* report by the Council of Graduate Schools, master's and doctoral enrollment for first-time students in many disciplines dropped by 1.7 percent between 2010 and 2011. However, first-time students enrollment increased for mathematics and computer science (3.8 percent) and engineering (2.2 percent) disciplines.

2. Mission Statement and Objectives

Congruent with the missions of the University of the District of Columbia (UDC), the mission of the CSE Ph.D. program is to "*prepare students for immediate entry into the nation's doctoral and professional workforce in computer science and engineering.*" The proposed Ph.D. will help provide advanced quality graduate studies, in the areas of critical importance and great demands (such as cybersecurity, cloud computing, and high-performance computing in Computer Science, Computer and Electrical Engineering, and Computational Science in Engineering), to the citizens of the District of Columbia and to the nation.

The CSE Ph.D. program should be a high-quality degree program aimed at preparing graduates who can (a) *show an ability to conduct independent and creative research that contributes to the advancement of knowledge*; (b) *demonstrate not only a sufficient breadth of understanding in computer science and engineering but also a significant depth of understanding in their chosen area of research specialization*; (c) *apply their knowledge and creativity to solve complex problems in the society*. This requires each successful Ph.D. student to produce a significant piece of original research that is presented in a written dissertation and is defended through an oral examination. The work must be of high quality such that several peer-reviewed journal and conference papers can be produced from it in premium computer science and engineering venues.

3. Rationale and Motivations

The *Department of Computer Science and Information Technology* (CSIT: http://csit.udc.edu) will manage the proposed Ph.D. program in the School of Engineering and Applied Sciences (SEAS) at the University of the District of Columbia. The school currently offers five undergraduate major programs and two Master's degree programs (i.e. MSCS in Computer Science and MSEE in Electrical Engineering). In the past, the enrollment of the MSCS program has almost doubled. We expect the MSCS program to grow at a much higher pace in light of this new Ph.D. program over the coming years.

The major factors that motivate the need for a PhD degree program in Computer Science and Engineering (CSE) include:

1) A new Vision that includes targeted and research-based doctoral programs in the University as demonstrated in Section 1.
2) Retain our graduates in the DC metro area in our own PhD in Computer Science and Engineering degree program.
3) As the only public university in the nation's capital, UDC ought to meet the Ph.D.-level demands as demonstrated in Section 1. This proposal opens up a Ph.D. degree opportunity in the most demanding areas of computer science and engineering for the residents who cannot afford the high cost of tuition at the private universities.
4) UDC is in an ideal position to increase minority PhD graduates. This will ultimately produce a great impact on (a) UDC visibility nationally and internationally and on (b) supporting various government agencies and federal research laboratories located in and around the Washington DC area with increasingly required Ph.D. scientists (see Section 1). UDC will produce future computer science and engineering professors.
5) With a strong PhD program in Computer Science and Engineering, we will be in a better position to compete for larger external funding for serious research and deeper education from NSF, DoD, NIH, DOE, etc, where many programs are open only to PhD granting institutions.
6) We also foresee that our PhD program will be a strong vehicle to fuel future multi-disciplinary research synergies with other departments and centers in the fields of humanities and natural sciences, beyond the engineering school at the university.
7) Over fifteen (15) doctoral faculty members have joined the SEAS over the last several years with nationally and internationally competitive research expertise in computer science and engineering through highly competitive and selective national searches. Competitive research needs Ph.D. disciples for growth.

4. Current Faculty Research Strengths and Projected Research Areas

The Ph.D. faculty members of the SEAS have produced numerous research publications in reputable and specialized research venues. They have experience in producing MSs and PhDs in the area of computer science and engineering. To support and sustain a full-fledged Ph.D. program in CSE, the existing faculty members have their proved records in the following targeted research areas:

- Cloud Computing (national initiatives)
- Big Data (national initiatives)
- Cyber-Security and Information Assurance (national initiatives)
- Robotics
- Visual Analytics
- Machine Learning, AI, Data Mining
- Advanced Networking
- Spatio-Temporal Databases
- Computer Architecture and Embedded System design
- Detection and Estimation in digital communication systems
- VLSI Architecture & Electronic Materials and Devices
- High-performance Computing and Scientific Applications in Computing
- Computational Science in Environmental, Nano, Energy, and Water Resource Engineering and Sciences (national initiatives)

5. Institutional Support

5.1. Faculty Lines

The faculty for the proposed CSE Ph.D. degree program will be drawn from the existing faculty in SEAS. The faculty members of SEAS have the highest qualifications needed for their profession and have many years of teaching and research experiences with, collectively, hundreds of research publications in reputable forums and venues (Appendix B details faculty qualifications). No additional faculty hires are required.

5.1. Research Space and Adequacy of Supplies and Equipment

The faculty members of the SEAS have research laboratories, which have been utilized in several federal and industry funded competitive research projects with graduate students. The initial establishment of Ph.D.-level research laboratories and teams will be organized within the existing research laboratories in the SEAS.

5.2. Student Support

Student support is important in terms of increasing the number of students in the new CSE Ph.D. degree program. At the university level, the currently existing RA/GA/TA system will be utilized to support new Ph.D. degree students. Currently, several SEAS faculty members have active research grants from federal agencies including NSF and DoD to initiate larger and deeper research activities with Ph.D. students, which will enable larger Ph.D.-level funding soon after the launch of the proposed Ph.D. program.

New and enhanced funding opportunities enabled by the Ph.D. program include the following to list a few:

- NSF, Centers of Research Excellence in Science and Technology (CREST), typically 5-year, $5M.
- NSF, HBCU Research Infrastructure for Science and Engineering (HBCU-RISE), $2M.
- Better CAREER and Young Investigator funding opportunities for junior faculty members.
- DARPA and most deep research funding programs requiring Ph.D. program.
- Federal funding programs supporting CAEIA/R NSA National Center of Academic Excellence in Information Assurance / Research.

6. Marketing and Growth Projection

As we mentioned above, UDC students show interest in pursuing a Ph.D. degree. A recent survey (performed in Fall 2012) shows that all 18 MSCS graduates and students (M.S. students) positively and immediately responded to the survey indicating that they are planning to pursue a Ph.D. in Computer Science. The CSE Ph.D. program will start with about 5-10 students in Fall 2013. We expect to see reaching 5-10 new students per year over the first two years, and 10-20/year soon thereafter. Considering 5-year degree period, over the first five years, the program will grow to 50- to 100-student Ph.D. program producing 10-15 new Ph.D.s annually.

To recruit future Ph.D. students, we will chase several avenues including:

1) recruitment in our existing undergraduate and graduate programs (see Section 10),
2) government agencies and national laboratories,
3) our advisory boards,
4) the consortium universities,
5) partnership and collaboration with other universities,
6) marketing flyers advertising the program locally, nationally, and internationally, extensively utilizing the Internet and search engines, such as Google,

7) our own web sites (http://csit.udc.edu, http://informatics.udc.edu, http://informatics.udc.edu/arctic) and major online school information sites.

7. Avoidance of Duplication and Faculty Workloads

The proposed PhD program is not a duplicate of any existing program at the University of the District of Columbia. To manage the proposed PhD program, faculty workload should be adjusted. To this effort, the Department of Computer Science and Information Technology's 6 undergraduate electives in the Information Technology (BSIT) program will be removed, and the Information Technology (BSIT) program will be integrated into the Computer Science (BSCS) program as a concentration area, offering US National Security Agency's CNSS 4011 & 4012 Certifications to the graduates (the department CSIT has already acquired this certification as a preparation as shown in http://informatics.udc.edu/arctic and http://csit.udc.edu).

The department has worked on this preparation over the past three years in collaboration with the US National Security Agency, National Science Foundation, the University of Denver, and other partners. In year 2011, the National Security Agency has recognized the University of the District of Columbia for its information assurance curriculum offered by CSIT (http://csit.udc.edu) and ARCTIC (http://informatics.udc.edu/arctic), which includes specialties within the information technology and computer science degree programs. The CSIT/ARCTIC faculty team was supported in significant part by a grant from the National Science Foundation along with collaboration by the University of Denver. As a part of the concentration area in the BSCS program, UDC graduates who meet the CSIT/ARCTIC's requirements will receive institutional certificates as Information Systems Security (INFOSEC) Professionals NSTISSI No. 4011 or Senior Systems Managers CNSSI No. 4012 as approved by the Committee on National Security Systems National Training Standards.

With the Information Assurance concentration and the minimum standards for the duties and responsibilities of Information Systems Security (INFORSEC) professionals (NSTISSI 4011) and Senior Systems Managers (CNSSI 4012), the department is planning to receive NSA designation as a National Center of Academic Excellence in Information Assurance Education (CAE/IAE). With this effort, graduate students (including MS and Ph.D. students) will be engaged in Information Assurance research activities. These accomplishments and the new Ph.D. program will position us in a category of universities that are allowed to apply for the next level national designation: CAE/IAR National Center of Academic Excellence in Information Assurance Research, which requires a Ph.D. program in Computer Science.

8. Relationship with other programs/departments/schools/colleges/ with written response from those concerned.

The proposed PhD program will complement and help strengthen other graduate programs in the university such as the SEAS Master of Science programs and enable competitive research in multidisciplinary areas. Through the proposed three specialization areas, the Ph.D. students will have a deep learning opportunity in focused research application areas by being co-advised by the application domain experts (non-CS faculty participating in this Ph.D. program); other participating faculty will more competitively sustain and grow their research by having an opportunity to have Ph.D. students working in the specialization areas. In future, the specialization areas can be augmented through other areas, such as bioscience (computational biology), humanities (social networking and human interfaces), physics (data science for high-energy particle accelerator), etc., facilitating the university-wide development to meet the community's demand for increasingly higher levels of research-oriented education as presented in Section 1.

9. Effect on student development, employment, or program effectiveness, if relevant.

The PhD program will produce graduates with the state-of-the art knowledge and competitive research capabilities in the Computer Science and Engineering professions. Such program is in great demand across the nation. Many industries encourage their employ to pursue graduate studies through tuition assistance and flexible work programs. The establishment PhD degree program will have extremely positive impact on the quality of teaching, course offering, and research in SEAS departments' undergraduate and graduate programs. Sections 1 and 3 cover relevant factors with evidence.

10. Requirements

10.1. Program Requirements

The proposed Ph.D. program is a 72 semester-hour program comprising 45 credit hours of coursework (up to 30 credits can be transferred from other previous graduate programs), 24 credit hours of research, and 3 hours for attending research colloquiums.

10.2. Admission Requirements

The standards for admission are as follows:

1. B.S. or M.S. in related field (computer science, engineering, information technology, etc.). Applicants with other degrees may be admitted conditionally, subject to receiving B or better on all of the following background courses (not counted towards the 45-cr coursework requirement):
    (1) Discrete Mathematics

(2) Object-oriented programming (or CS I and II)
(3) Data Structure
(4) Fundamentals or Principles of Operating Systems
(5) Fundamentals or Principles of Databases
(6) Fundamentals or Principles of Software Engineering or UML
(7) Fundamentals or Principles of Computer Networking

2. There is no specific cut-off GRE score. However, all applicants need to submit an official GRE score.
3. A TOEFL score of 550 (paper-based) or 213 (computer-based), for applicants with degrees from schools where the primary language of instruction is not US English.
4. Three Letters of Recommendation.
5. A Personal Statement of research and career goals.
6. Other requirements as specified by the Office responsible for Graduate Admissions.

10.3. Requirements for the Degree:

The requirements for the Ph.D. degree will be:

1. Completion of 45 semester-hours of graduate coursework
2. Completion of 24 research semester-hours
3. Attendance of 3 hours of colloquiums (1 credit per semester)
4. A passing grade on the qualifying examination (written and oral)
5. An approval of proposal defense (written and oral)
6. Completion of dissertation (written)
7. Passing of dissertation defense (oral)

10.4. Course Requirements

Students need to complete at least 45 credits of required graduate coursework with a minimum GPA of 3.0 and must always obtain at least a “B” grade in every course applicable toward the degree. Any course that is nearly equivalent to the one taken during the master’s program will not be counted towards the Ph.D. credits. After passing the Ph.D. qualifying exam, a student must remain registered in the program each semester for at least 3 credits of research or dissertation. To complete the Ph.D. program, a student needs to finish minimum 24 research/dissertation credit hours.

After the completion of the M.S., students can fulfill the Ph.D. course requirements by completing at least 9 hours of coursework in the student's *specialized field* (see Appendix A) and 6 hours in *computer science specialization field* (see Appendix A). In addition, students are required to take colloquia to satisfy the minimum 3 colloquium credits.

11. Examination and Dissertation

Before candidates can register for research or dissertation credits, they must have earned at least 30 credits and passed the PhD Qualifying Exam.

11.1. Qualifying Examination Committee

If a student did not choose an academic advisor(s), a temporary academic advisor(s) is assigned when admitted to the Program. Before the end of their fourth semester in the program, students should select a Doctoral Advisor and, in consultation with their Doctoral Advisor, form a Qualifying Exam Committee. The Qualifying Exam Committee should include at least three Doctoral Faculty members, including the Doctoral Advisor who chairs the Committee.

11.2. Qualifying Examination

Students must take the PhD Qualifying exam within two semesters after completing 30 hours of coursework (out of the 45 hours coursework requirement). Each student must select a primary area of focus and then pass a qualifying exam in that area, given and evaluated by the student’s Qualifying Exam Committee. The purpose of the qualifying exam is to allow the student to demonstrate that they are capable of doing Ph.D. level research leading to a dissertation.

The Qualifying Examination consists of two mandatory components: an original written research report and an oral presentation of the report on the student’s primary area of focus. The student must file Qualifying Examination Application at least one month before the examination takes place. Copies of the original written research report must be submitted at the time of filing the Qualifying Examination Application. To satisfy this requirement, the student is required to write a technical research paper that shows his/her ability to follow a research methodology. The paper (6-8 pages in IEEE/ACM two-column format incorporating typical sections such as introduction, problem statement, proposed method, evaluation and discussion of results, and relevant references) should be in a format that can be publishable in a refereed venue. The Qualifying Examination Committee will evaluate the research report based on the corresponding rubric and grade it on a pass/fail basis.

The oral part of the Qualifying Examination is the student’s presentation of the written research report. Upon completion of the presentation of the report, exam committee will make its final decision within one month.

A second failure of the exam will result in the termination of the student's enrollment in the Ph.D. program.

After passing the Qualifying Exam, the student will be allowed to register for research and dissertation credits.

11.3. Dissertation Committee

After passing the qualifying exam, set up a Dissertation Committee of at least four graduate faculty members, which are all Ph.D. faculty members. This Committee may, but is not required to consist of the same faculty members as the Qualifying Exam Committee. Ordinarily, the chair of this committee will be the student's advisor(s), who must be a Ph.D. faculty member and will insure that the composition of the committee is appropriate. The Dissertation Committee must be approved by the Ph.D. program coordinator. After identifying and obtaining the signatures of the faculty who will be serving on the Committee, the Dissertation Committee Form must be submitted to the Graduate School.

11.4. Proposal Defense

Each student must present and successfully defend a Ph.D. dissertation proposal after passing the qualifying exam and within ten (10) semesters since entering the Ph.D. program. The proposal defense will be conducted by the student's Dissertation Committee and will be open to the Ph.D. faculty and students. The student shall provide copies of the written proposal to the Committee members at least two weeks before the scheduled defense. At the discretion of the Dissertation Committee, the defense may include questions that cover the student's program of study and background knowledge in the area of the proposal. The proposal defense will be graded as pass/fail according to the corresponding rubrics by the Committee. A pass must be unanimous decision by the committee members; otherwise the proposal defense fails. A student can re-take the proposal defense if he/she cannot pass it the first time and should consult the Ph.D. program coordinator before the second attempt. The second failed defense of a dissertation proposal will result in the termination of the student's enrollment in the Ph.D. program.

11.5. Ph.D. Candidacy

A doctoral student advances to Ph.D. candidacy after the dissertation proposal has been successfully defended.

11.6. Dissertation Defense

Each student must complete a research program approved by the student's Dissertation Advisor(s) that yields a high quality, original and substantial piece of research. The Ph.D. dissertation describes this research and its results. The dissertation defense is a public presentation. A written copy of the dissertation must be made available to each member of the student Ph.D. Dissertation Committee at least two weeks before the public defense. The date of the defense must be publicly announced at least two weeks prior to the defense. The student must present the dissertation and defend it in a manner accepted by the Dissertation Committee. The dissertation will be graded as pass/fail based on the corresponding rubrics by the Dissertation Committee. A pass decision must be unanimous and must be approved by the Dean of the Graduate School. A student who fails the defense of a dissertation twice will be terminated from the Ph.D. program.

11.7. Program of study

The proposed program covers fields of Computer Science, Electrical and Computer Engineering, and Computational Sciences with a minimum of 72 hours.

1. After the M.S. course completion requirements, students can fulfill the Ph.D. course requirements by completing at least 9 hours of coursework in the student's specialized field and 6 hours in elective courses.
2. Course selection requires the approval of the student's thesis advisor.
3. To remain in good standing students must maintain a grade point average of 3.0.
4. Course Requirements (see Appendix A for pending catalog descriptions of courses).
5. Qualifying examination: The student is required to take the qualifying exam during the first 2 semesters after 30 hours of coursework (out of the 45 semester-hours coursework requirement) has been completed.
6. Dissertation Credits: Before candidates can register for research or dissertation credits, they must have passed the PhD qualifying Exam.
7. Proposal Defense: Students are expected to form a doctoral committee by discussing with his/her advisor in the 4 semester of his PhD program. The committee shall include at least three CSIT faculty members and one specialization field faculty member. Students will write a thesis proposal in a format agreed upon by their doctoral committee. The proposal should include some background information about the research topic and a timeline for completion of the thesis. The student will submit this proposal to the doctoral committee at least 14 days prior to an oral defense. Students are advanced to candidacy upon successful completion of the qualifying examinations.
8. Dissertation: The doctoral degree program requires the completion of an approved dissertation that demonstrates the student's ability to perform original, independent research and constitutes a distinct contribution to knowledge in the principal field of study.
9. Dissertation Defense: Students will defend their dissertation in an oral examination attended by the doctoral committee. The student will submit their dissertation to the doctoral committee at least two weeks prior to the defense, and the defense will be advertised at least 2 weeks prior to the defense.

APPENDIX A: COURSE DESCRIPTIONS

UDC CSE PhD Courses (Oct 11, 2012)

Computer Science (can also be a Specialization Field): 60X, 61X, 62X, 67X, 68X, 69X

CSE 601 - Advanced Algorithm Analysis (3-cr)

This course is an advanced course in algorithms design and analysis. This is the advanced version of the 500-level counterpart. It covers many new topics and also revisit some the topics covered in 500-level counterpart in more detail. It will begin by reviewing sorting and graph algorithms as well as studying approximation algorithms, NP-completeness, heuristic algorithms, randomized algorithms, linear programming, pseudorandom generators, cryptography, etc.

CSE 602 - Theory of Computational Complexity (3-cr)

This is a theoretical computer science course to identify the limitations of the computers through formalizing computation (by introducing several models including Turing Machines) and applying mathematical techniques to the formal models obtained.

CSE 603 - Pattern Recognition (3-cr)

Pattern recognition systems, statistical methods, clustering analysis, unsupervised learning, feature extraction and feature processing.

CSE 671 - Autonomous Mobile Robots (3-cr)

Fundamental constraints, technologies, and algorithms related to autonomous mobile robots. Topics include motion, kinematics, simulation testing, sensor incorporation and unmodeled factors. Develop an autonomous robot in simulation or on a physical robot.

CSE 672 - Visual Analytics (3-cr)

Science of analytical reasoning facilitated by interactive visual interfaces. Topics include visual analytics tools and techniques to synthesize information and derive insight from massive, dynamic, ambiguous, and often conflicting data, provide timely, defensible, and understandable assessments.

CSE 673 - Virtual Reality (3-cr)

Concepts and techniques including a systematic introduction to the underpinnings of Virtual Environments (VE), Virtual Worlds, advanced displays, and immersive technologies.

CSE 674 - Advanced Topics in Networking (3-cr)

Cloud computing, Mobile Ad Hoc networks, Future Internet, Internet of Things (IoT), Energy-Efficient Networks and Protocols, Mobile Multimedia, Broadband Wireless Networks (WiMAX, LTE, LTE-Advanced), Cognitive radio, Vehicular Ad Hoc Networks (VANETs) and Sensor Networking.

CSE 675 - Spatio-Temporal Databases(3-cr)

Spatial and Temporal Databases: history, applications, practices, theory, design, implementation, indexing, and querying.

CSE 676 - Big Data Science (3-cr)

Definition and applications of Big Data, Big Data in Cloud Computing, data-intensive parallel processing and column-oriented distributed data management.

CSE 689 – Special Topics in Computer Science (3-cr)

Specialization Field: Electrical and Computer Engineering: 63X, 64X

CSE 631 - Advanced Computational Intelligence (3-cr): Topics covered in this course include pattern classification, supervised learning, unsupervised learning, data clustering, time series prediction, feature selection and extraction, decision tree learning, neural networks, support vector machine, and others. Implement computational intelligence algorithms.

CSE 632 - Advanced Computer Architecture(3-cr): High performance computer architectures: instruction set principles, pipelining, multiprocessing systems, parallel processing, instruction level parallelism, fine-grain and coarse grain parallelism, SIMD, MIMD, multiple instruction issue, data coherency, memory hierarchy design, interconnection networks, vector processors.

CSE 633 - Advanced Embedded System design(3-cr): Advanced embedded system design principles and practices. Emphasizes formal design methodologies such as hardware-software co-design and co-verification, performance optimization, distributed embedded systems. Soft core and hard core embedded microprocessors. (Esther has a different description.)

CSE 634 - Detection and Estimation (3-cr): Estimation of unknown parameters, Cramer-Rao lower bound; optimum (map) demodulation; filtering, amplitude and angle modulation, comparison with conventional systems;

statistical decision theory Bayes, minimax, Neyman/Pearson, Criteria-68 simple and composite hypotheses; application to coherent and incoherent signal detection; M-ary hypotheses; application to uncoded and coded digital communication systems.

CSE 635 - VLSI Architecture (3-cr): MOS transistors: fabrication, layout, characterization; CMOS circuit and logic design: circuit and logic simulation, fully complementary CMOS logic, pseudo-nMOS logic, dynamic CMOS logic, pass-transistor logic, clocking strategies; sub system design: ALUs, multipliers, memories, PLAs; architecture design: datapath, floorplanning, iterative cellular arrays, systolic arrays; VLSI algorithms; chip design and test: full custom design of chips, possible chip fabrication by MOSIS and subsequent chip testing.

CSE 636 - Advanced Electronic Materials and Devices (3-cr): Operating principles, fabrication, characteristics and applications of advanced electronic devices will be covered. Core topics are as follows: ideal properties of electron gas; electronic states in bulk GaAs and at the heterojunctions; doping properties in heterostructures; electron transport properties at 2D interfaces (including resonant tunneling); electronic and optical properties at 2D interfaces; device applications (HEMT, HBT, QWLaser, QDLaser), low-dimensional and nanometer-scale device physics, magnetic & ferroelectric devices, single-electron transistors, quantum devices, and RTD's.

CSE 637 - Advanced Communication Systems (3-cr): Basis functions, orthogonalization of signals, vector representation of signals, optimal detection in noise, matched filters, pulse shaping, intersymbol interference, maximum likelihood detection, channel cutoff rates, error probabilities, bandwidth, and power-limited signaling.

CSE 649 – Special Topics in Computer Engineering (3-cr)

Concentration Area: Computational Science in Engineering: 65X, 66X

CSE 651 - Computational engineering and scientific modeling (3-cr): Use cloud, super computer, and even normal desktop computer (GPU or CPU based). An engineer or scientist with little to no expertise to understand the limits and capabilities of different computational systems. This may be a unique course. I can assist/co-teach such course at opportune time.

CSE 652 - Systems Engineering Approach (3-cr): Engineering of complex hardware, software systems encompasses quantitative methods to understand vague problem statements, determine what a proposed product/system must do (functionality), generate measurable requirements, decide how to select the most appropriate solution design, integrate the hardware and software subsystems and test the finished product to verify it satisfies the documented requirements.

Additional topics that span the entire product life cycle include interface management and control, risk management, tailing of process to meet organizational and project environments, configuration management, test strategies and trade-off studies.

CSE 653 - Engineering Systems: Modeling & Simulation (3-cr): This course will present principles of computational modeling and simulation of systems. General topics covered include: parametric and non-parametric modeling; system simulation; parameter estimation, linear regression and least squares; model structure and model validation through simulation; and, numerical issues in systems theory. Techniques covered include methods from numerical linear algebra, nonlinear programming and Monte Carlo simulation, with applications to general engineering systems. Modeling and simulation software is utilized in this course.

CSE 654 - Water Resources System Analysis (3-cr): This course covers planning, design and management of multi-component water resources systems. After a review of the use and nature of water resources systems, topics studied in detail are: water resource economics; methodology of design; systems analysis; systems design and decision making; applied mathematical programming; probabilistic models and water quality modeling.

CSE 655 - Water Resources System Modeling (3-cr): Water resources systems are physically complex and the solution of appropriate mathematical models is computationally demanding. This course considers physical processes in water resource systems, their mathematical representation and numerical solutions. This course covers meteorologic data analysis, deterministic and stochastic modeling techniques; Flood control: structural and nonstructural alternatives and Urban drainage and runoff control, risk analysis, economics and decision making.

CSE 669 – Special Topics in Computational Science in Eng (3-cr)

APPENDIX B: FACULTY QUALIFICATIONS

Over the recent years, research-oriented faculty members of SEAS (10-15 faculty members) have been managing over 2 million funded research and education projects. These faculty members have many hundred peer-reviewed research papers published in reputable and premium science, engineering, and technology venues and forums. These faculty members are nationally competitive in research and have been trying hard to sustain and grow their competitive research activities by actively building their research groups with existing undergraduate and master's students in collaboration with external partners and collaborators. A sample of a number of such new research groups is found on the web at http://informatics.udc.edu and http://informatics.udc.edu/arctic. As a departmental sample, the professional web pages of CSIT faculty are found at http://csit.udc.edu/ ➔ "People" ➔ "Faculty". In addition, other departments, including Electrical Engineering and Civil and Mechanical Engineering, add their funded and well-published research capability to this qualification justification.

APPENDIX C: COURSE SYLLABI

In here, course syllabus for each course is enclosed.

Advanced Algorithm Analysis
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 601 (3 credits)

Coordinator: Dr. Li Chen
Instructor: TBA
Office Hours: TBA

I. Course Description

This course is an advanced course in algorithms design and analysis. It will cover the topics of approximation algorithms, NP-completeness, heuristic algorithms, randomized algorithms, linear programming, pseudorandom generators, cryptography, etc.

II. Course Goals, Objectives, Prerequisites, and Co-requisites

Goals:

Students learn a body of knowledge and a practical set of well known, tested, and necessary skills related to Algorithm Analysis.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:

Student learning objectives are as follows: (1) understanding approximation algorithms and linear programming; (2) identifying NP-completeness and pseudorandom generators; (3) applying heuristic, randomized algorithms to practical algorithmic problems; (4) identification of important algorithms used in information assurance.

Student Learning Outcomes:

By the end of the course, students will be able to:

1) Understand various advanced algorithms
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand how to apply approximation algorithms and linear programming approach
   Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Identify advanced algorithms used in information assurance (cryptograph, RAS, DES, etc.)
   Assessment: Assignments, Exams, Class project, and Paper presentation.
4) Know how to cope with NP-completeness
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>

- Required texts: *Algorithms by Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani*
  Publisher: McGraw-Hill Science; 1 edition (Sept. 13, 2006)
  ISBN-10: 0073523402

IV. Format and Procedures

This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources

Students are encouraged to check following resources to become successful on this course.

- Academic Support Center. "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- Blackboard. "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- UDC Email. All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures

All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades

Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F

The grading system is as follows:

1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations

From this course, students are expected to knowing the necessary concepts in Advanced Algorithm Analysis.

IX. Academic Integrity

UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures

The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Chapter 1: Algorithms with numbers			
Week 2 Chapter 2: Divide-and-conquer algorithms			
Week 3 & 4 Chapter 3: Decompositions of graphs	Assignment		
Week 5 Chapter 4: Paths in graphs			Due: Assignment
Week 6 & 7 Chapter 5: Greedy algorithms			
Week 8 Chapter 6: Dynamic programming		Mid-term Exam	
Week 9 Chapter 7: Linear programming			
Week 10 Paper Presentation	Assignment	Paper Presentation	
Week 11 Chapter 8: NP-complete problems			

Week 12 & 13 Chapter 9: Coping with NP-completeness			Due: Assignment
Week 14 Chapter 10: Quantum algorithms			
Week 15 Project Presentation		Project Presentation / Final Exam	

Theory of Computational Complexity
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 602 (3 credits)

Coordinator: Dr. Li Chen
Instructor: TBA
Office Hours: TBA

I. Course Description
This is a theoretical computer science course to identify the limitations of the computers through formalizing computation (by introducing several models including Turing Machines) and applying mathematical techniques to the formal models obtained.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students gain a clear understanding of even the most complex, highly theoretical computational theory topics.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding today's computational theory; (2) identifying theoretical treatment of deterministic context-free languages is ideal for a better understanding of parsing and LR(k) grammars; (3) gaining a solid understanding of the fundamental mathematical properties of computer hardware, software, and applications with a blend of practical and philosophical coverage and mathematical treatments, including advanced theorems and proofs.

Student Learning Outcomes:
By the end of the course, students will be able to:
1) Understand computational theory
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand deterministic context-free languages and LR(k) grammars
   Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Identify complexity theory including time complexity and space complexity
   Assessment: Assignments, Exams, Class project, and Paper presentation.
4) Know computability theory (The Church-Turing Thesis)
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>
- Required texts: *Introduction to the Theory of Computation by Michael Sipser*
  Publisher: PWS Pub. Co.; 1 edition (December 13, 1996)
  ISBN-10: 053494728X

IV. Format and Procedures

This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.

- Academic Support Center. "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- Blackboard. "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- UDC Email. All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:
1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations
From this course, students are expected to knowing the necessary concepts in the theory of computation.

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures
The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Introduction & Automata and Languages			
Week 2 Regular Languages			
Week 3 Context-Free Languages	Assignment		
Week 4 Computability Theory			
Week 5 The Church-Turing Thesis			Due: Assignment
Week 6 Decidability			
Week 7 Reducibility		Mid-term Exam	

Week 8 Advanced Topics in Computability Theory			
Week 9 Complexity Theory	Assignment		
Week 10 Time Complexity			
Week 11 Space Complexity		Paper Presentation	
Week 12 & 13 Intractability			Due: Assignment
Week 14 Advanced topics in complexity theory			
Week 15 Project Presentation		Project Presentation / Final Exam	

Pattern Recognition
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 603 (3 credits)

Coordinator: Dr. Li Chen and Dr. Lily Liang
Instructor: TBA
Office Hours: TBA

I. Course Description
This course covers Pattern recognition systems, statistical methods, clustering analysis, unsupervised learning, feature extraction and feature processing.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
The student should also have some exposure to the theoretical issues involved in pattern recognition system design such as the curse of dimensionality.

Prerequisite: It is assumed the students have a working knowledge of calculus, linear algebra, and probability theory. It is also assumed the students have some experience programming in a scientific computing environment.
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: a clear understanding of 1) the design and construction and a pattern recognition system and 2) the major approaches in statistical and syntactic pattern recognition.

Student Learning Outcomes:
By the end of the course, students will be able to:
1) Understand pattern classification algorithms
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Develop pattern recognition applications
   Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Identify parametric techniques and unsupervised methods
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>
- Required texts: *Pattern Classification by Richard O. Duda, Peter E. Hart, David G. Stork Publisher: Wiley-Interscience; 2 edition (October 2000)*

ISBN-10: 0471056693

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.

- Academic Support Center. "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- Blackboard. "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- UDC Email. All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:
1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations
From this course, students are expected to knowing the necessary concepts in pattern recognition.

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures
The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Introduction to Pattern Recognition			
Week 2 Tree Classifiers Getting our feet wet with real classifiers (a) Decision Trees: CART, C4.5, ID3. (b) Random Forests			
Week 3 Bayesian Decision Theory Grounding our inquiry	Assignment		

Week 4 Linear Discriminants Discriminative Classifiers: the Decision Boundary (a) Separability (b) Perceptrons (c) Support Vector Machines			
Week 5 Parametric Techniques Generative Methods grounded in Bayesian Decision Theory (a) Maximum Likelihood Estimation (b) Bayesian Parameter Estimation (c) Sufficient Statistics			Due: Assignment
Week 6 & 7 Non-Parametric Techniques (a) Kernel Density Estimators (b) Parzen Window (c) Nearest Neighbor Methods		Mid-term Exam	
Week 8 & 9 Unsupervised Methods Exploring the Data for Latent Structure (a) Component Analysis and Dimension Reduction (b) Clustering			
Week 10 Classifier Ensembles (a) Bagging (b) Boosting / AdaBoost	Assignment	Paper Presentation	
Week 11 & 12 Graphical Models The Modern Language of Pattern Recognition and Machine Learning (a) Introductory ideas and relation back to earlier topics (b) Bayesian Networks (c) Sequential Models			
Week 13 Algorithm Independent Topics Theoretical Treatments in the Context of Learned Tools (a) No Free Lunch Theorem (b) Ugly Duckling Theorem (c) Bias-Variance Dilemma (d) Jacknife and Bootstrap Methods			Due: Assignment
Week 14 & 15 Other Items Time Permitting (a) Syntactic Methods (b) Neural Networks		Project Presentation / Final Exam	

Autonomous Mobile Robots
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 671 (3 credits)

Coordinator: Dr. Briana Wellman
Instructor: TBA

Office Hours: TBA

I. Course Description
This course covers fundamental constraints, technologies, and algorithms related to autonomous mobile robots. Topics include motion, kinematics, simulation testing, sensor incorporation and unmodeled factors. Develop an autonomous robot in simulation or on a physical robot.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students understand theoretical concepts in autonomous robots and gain a practical knowledge on developing an autonomous robot.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding fundamentals of mobile robotics; (2) examining the basic principles of locomotion, kinematics, sensing, perception, and cognition that are key to the development of autonomous mobile robots; (3) gaining the mechanisms that allow a mobile robot to move through a real world environment to perform its tasks.

Student Learning Outcomes:
By the end of the course, students will be able to:
1) Understand fundamentals of mobile robotics
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand the basic principles of locomotion, kinematics, sensing, perception, and cognition
   Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Identify different aspect of mobility (from low-level to high-level)
   Assessment: Assignments, Exams, Class project, and Paper presentation.
4) Discuss and understand higher-level challenges of localization and cognition
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>
- Required texts: *Introduction to Autonomous Mobile Robots (Intelligent Robotics and Autonomous Agents series) by Roland Siegwart, Illah R. Nourbakhsh*
  Publisher: The MIT Press (March 5, 2004)
  ISBN-10: 026219502X

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.
- <u>Academic Support Center.</u> “Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level.”
- <u>Blackboard.</u> “From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays.”
- <u>UDC Email.</u> All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades

Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F

The grading system is as follows:

1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations

From this course, students are expected to knowing the necessary concepts in autonomous robots.

IX. Academic Integrity

UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures

The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Locomotion			
Week 2 Kinematic Models and Constraint			
Week 3 Mobile Robot Maneuverability	Assignment		
Week 4 Mobile Robot Workspace			
Week 5 Sensors for Mobile Robots			Due: Assignment
Week 6 Representing Uncertainty & Feature Extraction			
Week 7 The Challenge of Localization: Noise and Aliasing & Belief Representation		Mid-term Exam	
Week 8 & 9 Probabilistic Map-Based Localization	Assignment		
Week 11 Autonomous Map Building		Paper Presentation	
Week 12 & 13 Competences for Navigation: Planning and Reacting			Due: Assignment
Week 14 & 15 Navigation Architectures		Project Presentation / Final Exam	

Visual Analytics

Class location: TBA

Class Meeting time(s): TBA

Course level and # of credit hours: CSE 672 (3 credits)

Coordinator: Dr. Dong H. Jeong
Instructor: TBA
Office Hours: TBA

I. Course Description
This course covers the topics include visual analytics tools and techniques to synthesize information and derive insight from massive, dynamic, ambiguous, and often conflicting data, provide timely, defensible, and understandable assessments.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students gain a clear understanding of topics in visual analytics.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding Visual Analytics; (2) identifying Visualization Concepts and Design; (3) gaining knowledge on Data Sciences/Processing for visualization; (4) Understand the context of Use, Sensemaking and Human Factors.

Student Learning Outcomes:
By the end of the course, students will be able to:
1) Understand techniques in visual analytics
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand how to create visual analytics systems
   Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Identify the importance of visual analytics
   Assessment: Assignments, Exams, Class project, and Paper presentation.
4) Understand human factors in visual analytics
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>
- Required texts: *Illuminating the Path: The Research and Development Agenda for Visual Analytics by James J. Thomas and Kristin A. Cook*
  Publisher: National Visualization and Analytics Ctr (2005)
  ISBN-10: 0769523234

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.
- <u>Academic Support Center.</u> “Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level.”
- <u>Blackboard.</u> “From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays.”
- <u>UDC Email.</u> All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the

instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades

Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:

7) Project: 20 (%)
8) Mid-term exam: 20 (%)
9) Final exam: 20 (%)
10) Assignments: 20 (%)
11) Attendance: 10 (%)
12) Paper presentation: 10 (%)

VIII. Expectations

From this course, students are expected to knowing the necessary concepts in visual analytics.

IX. Academic Integrity

UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures

The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Introduction			
Week 2 & 3 Mental and visualization models			
Week 4 Data Foundations & Storage	Assignment		
Week 5 Data Retrieval and Transform			Due: Assignment
Week 6 & 7 Visualization survey		Mid-term Exam	
Week 8 & 9 Interaction and analysis	Assignment		
Week 10 & 11 VAST Challenges		Paper Presentation	
Week 12 & 13 Disseminating approaches			Due: Assignment
Week 14 & 15 Evaluation methods		Project Presentation / Final Exam	

Virtual Reality
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 673 (3 credits)

Coordinator: Dr. Dong H Jeong
Instructor: TBA
Office Hours: TBA

I. Course Description
This course covers concepts and techniques including a systematic introduction to the underpinnings of Virtual Environments (VE), Virtual Worlds, advanced displays, and immersive technologies.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students understand theoretical concepts in visual environments (VE).

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding fundamentals of immersive technologies; (2) examining the basic principles in visual worlds including locomotion, sensing, perception, and cognition; (3) identifying mechanisms that are used for designing virtual worlds.

Student Learning Outcomes:
By the end of the course, students will be able to:

1) Understand fundamentals in VEs
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand the basic locomotion and interaction techniques in VEs
   Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Identify different aspect of immersive technologies
   Assessment: Assignments, Exams, Class project, and Paper presentation.
4) Discuss and understand higher-level challenges in VEs
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>

- Required texts: *3D User Interfaces: Theory and Practice by Doug A. Bowman, Ernst Kruijff, Joseph J. LaViola Jr., Ivan Poupyrev*
  Publisher: Addison-Wesley Professional; 1 edition (August 5, 2004)
  ISBN-10: 0201758679

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.

- <u>Academic Support Center.</u> "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- <u>Blackboard.</u> "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- <u>UDC Email.</u> All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:

1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations
Students are expected to knowing the necessary concepts in VEs

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures
The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Chapter 1: Introduction to 3D User Interfaces			
Week 2 Chapter 2: 3D User Interfaces: History and Roadmap			
Week 3 Chapter 3: 3D User Interface Output Hardware	Assignment		
Week 4 Chapter 4: 3D User Interface Input Hardware			
Week 5 Chapter 5: Selection and Manipulation			Due: Assignment
Week 6 & 7 Chapter 6: Travel		Mid-term Exam	
Week 8 Chapter 7: Wayfinding			
Week 9 Chapter 8: System Control	Assignment		
Week 10 Chapter 9: Symbolic Input		Paper Presentation	
Week 11 Chapter 10: Strategies for Designing and Developing 3D User Interfaces			
Week 12 Chapter 11: Evaluation of 3D User Interfaces			
Week 13 Chapter 12: Beyond Virtual: 3D User Interfaces for the Real World			Due: Assignment
Week 14 & 15 Chapter 13: The Future of 3D User Interfaces		Project Presentation / Final Exam	

Advanced Topics in Networking
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 674 (3 credits)

Coordinator: Dr. Sherali Zeadally
Instructor: TBA
Office Hours: TBA

I. Course Description
This course covers Cloud computing, Mobile Ad Hoc networks, Future Internet, Internet of Things (IoT), Energy-Efficient Networks and Protocols, Mobile Multimedia, Broadband Wireless Networks (WiMAX, LTE, LTE-Advanced), Cognitive radio, Vehicular Ad Hoc Networks (VANETs) and Sensor Networking.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students understand theoretical advanced concepts in networking.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding advanced topics in networking; (2) examining principles of various advanced networking technologies; (3) identifying broadband wireless networks.

Student Learning Outcomes:
By the end of the course, students will be able to:
1) Understand concepts in networking
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand advanced networking technologies
   Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Identify wireless and wired networking
   Assessment: Assignments, Exams, Class project, and Paper presentation.
4) Understand mobile networking environments
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>
- Required texts: *Network Systems Design Using Network Processors by Douglas E. Comer*
  Publisher: Prentice Hall (February 9, 2003)
  ISBN-10: 0131417924

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.
- <u>Academic Support Center.</u> "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- <u>Blackboard.</u> "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."

- UDC Email. All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:
1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations
Students are expected to knowing the necessary concepts in advanced networking.

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures
The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Large-Scale Dynamics of the Internet			
Week 2 Network Protocols and Security			
Week 3 Network Interface Design	Assignment		
Week 4 Switching Networks			
Week 5 & 6 Wireless Ad Hoc Networks			Due: Assignment
Week 7 Game theory in Networks		Mid-term Exam	
Week 8 Network Economics	Assignment		
Week 9 & 10 Worms & Web Security and Privacy		Paper Presentation	
Week 11 Cloud computing			
Week 12 Mobile Ad Hoc networks			
Week 13 Broadband wireless networks			Due: Assignment
Week 14 & 15 Sensor networking		Project Presentation / Final Exam	

Spatio-Temporal Databases
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 675 (3 credits)

Coordinator: Dr. Byunggu Yu
Instructor: TBA
Office Hours: TBA

I. Course Description
This course covers Spatial and Temporal Databases: history, applications, practices, theory, design, implementation, indexing, and querying.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students understand theoretical concepts in spatial and temporal databases.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding fundamentals of spatial and temporal databases; (2) understanding how to design and implement spatial and temporal databases; (3) identifying mechanisms to perform querying.

Student Learning Outcomes:
By the end of the course, students will be able to:
1) Understand fundamentals in spatial and temporal databases
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand theoretical considerations in designing spatial and temporal databases
   Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Identify to perform indexing and querying
   Assessment: Assignments, Exams, Class project, and Paper presentation.
4) Understand how to design and implement spatial and temporal databases
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>
- Required texts: *None*
- *Reading materials and lecture notes will be provided*

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.
- <u>Academic Support Center.</u> "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- <u>Blackboard.</u> "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."

- UDC Email. All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:
1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations
Students are expected to knowing the necessary concepts in spatial and temporal databases.

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures
The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 & 2 Introduction to Spatial and temporal databases	Assignment		
Week 3 & 4 Data structure and query processing			Due: Assignment
Week 5 & 6 Spatial database and system design		Mid-term Exam	
Week 7 & 8 Moving object query processing			
Week 8 & 9 Temporal indexing & data mining		Paper Presentation	
Week 10 & 11 Data warehousing and mining	Assignment		
Week 12 & 13 Temporal indexing			
Week 14 & 15 Spatial indexing		Project Presentation / Final Exam	Due: Assignment

Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 676 (3 credits)

Coordinator: Dr. Byunggu Yu
Instructor: TBA
Office Hours: TBA

I. Course Description
This course covers definitions and applications of Big Data, Big Data in Cloud Computing, data-intensive parallel processing and column-oriented distributed data management.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students understand theoretical concepts in Cloud Computing.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding fundamentals of cloud computing; (2) examining the basic principles of big data problems; (3) identifying mechanisms to perform parallel processing; (4) understanding the concepts of column-oriented distributed data management.

Student Learning Outcomes:
By the end of the course, students will be able to:

1) Understand fundamentals in Cloud Computing
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand the basic principles of Big Data problems
   Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Identify different aspect of cloud computing technologies
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>

- Required texts: *Cloud Computing: Principles and Paradigms by Rajkumar Buyya, James Broberg and Andrzej M. Goscinski*
  Publisher: Wiley, 2011
  ISBN-10: 0470887990

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.

- <u>Academic Support Center.</u> "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- <u>Blackboard.</u> "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- <u>UDC Email.</u> All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the

instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades

Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:

1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations

Students are expected to knowing the necessary concepts of Cloud Computing

IX. Academic Integrity

UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures

The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Introduction to cloud computing			
Week 2 & 3 Introduction to data centers: servers, data storage, networking and virtualization	Assignment		
Week 4 & 5 Introduction to the Green Data Center			Due: Assignment
Week 6 & 7 Introduction to server virtualization software: VMware VSphere		Mid-term Exam	
Week 8 & 9 Virtual machine management: provisioning, placement, resource allocation, fault tolerance, etc.	Assignment		
Week 10 & 11 Data center networking: Ethernet, network topologies, routing, addressing, transport layer protocols, etc.		Paper Presentation	
Week 12 Platform-as-a-Service			Due: Assignment
Week 13 & 14 The MapReduce model and Hadoop			
Week 14 & 15 Mobile cloud computing		Project Presentation / Final Exam	

Advanced Computational Intelligence
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 631 (3 credits)

Coordinator: Dr. Nian Zhang
Instructor: TBA
Office Hours: TBA

I. Course Description
Topics covered in this course include pattern classification, supervised learning, unsupervised learning, data clustering, time series prediction, feature selection and extraction, decision tree learning, neural networks, support vector machine, and others. Implement computational intelligence algorithms.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students understand theoretical concepts in computational intelligence.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding fundamentals of computational approaches; (2) identify mechanisms of classification, supervised and unsupervised learning techniques; (3) knowing how to implement computation intelligence algorithms.

Student Learning Outcomes:
By the end of the course, students will be able to:

1) Understand fundamentals in computational intelligence
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand supervised and unsupervised learning techniques
   Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Identify different aspect of computational intelligence technologies
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>

- Required texts: *TBA*

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.

- <u>Academic Support Center.</u> "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- <u>Blackboard.</u> "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- <u>UDC Email.</u> All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F

The grading system is as follows:
1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations
Students are expected to knowing the necessary concepts in Computational Intelligence.

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures
The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Mimicking Nature for Problem Solving: The Basic Concepts			
Week 2 Single-Layer and Multi-Layer Feedforward Neural Networks			
Week 3 Feedback Neural Networks	Assignment		
Week 4 Associative Memories			
Week 5 Learning Vector Quantizer (LVQ)			Due: Assignment
Week 6 Self-Organizing Feature Maps			
Week 7 Radial Basis Function Neural Networks		Mid-term Exam	
Week 8 Support Vector Machines			
Week 9 Genetic Algorithms			
Week 10 Harmony Search	Assignment		
Week 11 Fuzzy Sets and Fuzzy Logic		Paper Presentation	
Week 12 Fuzzy Neural Networks			
Week 13 Fuzzy ARTMAP			
Week 13 Swarm Intelligence and Ant Colony Optimization			Due: Assignment
Week 15 The Power and Computational Complexity of Computational Intelligence Models		Project Presentation / Final Exam	

Advanced Computer Architecture
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 632 (3 credits)

Coordinator: Dr. Dong H Jeong
Instructor: TBA
Office Hours: TBA

I. Course Description
This course covers concepts in high performance computer architectures: instruction set principles, pipelining, multiprocessing systems, parallel processing, instruction level parallelism, fine-grain and coarse grain parallelism, SIMD, MIMD, multiple instruction issue, data coherency, memory hierarchy design, interconnection networks, vector processors.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students understand theoretical concepts in advanced computer architecture.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding fundamentals of computer architecture concepts; (2) understand the basic principles of high performance computer architectures; (3) identifying systematic architectural mechanisms.

Student Learning Outcomes:
By the end of the course, students will be able to:
1) Understand fundamentals in high performance computer architectures
   Assessment: Assignments, Exams, and Paper presentation.
2) Discuss and understand higher-level concepts in high performance computer architectures
   Assessment: Assignments, Exams, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>
- Required texts: *Modern Processor Design: Fundamentals of Superscalar Processors (McGraw-Hill Series in Electrical and Computer Engineering) by John Shen*
  Publisher: McGraw-Hill Science/Engineering/Math; 1 edition (July 7, 2004)
  ISBN-10: 0070570647

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.
- <u>Academic Support Center.</u> "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- <u>Blackboard.</u> "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- <u>UDC Email.</u> All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades

Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:

1) Mid-term exam: 30 (%)
2) Final exam: 30 (%)
3) Assignments: 20 (%)
4) Attendance: 10 (%)
5) Paper presentation: 10 (%)

VIII. Expectations
Students are expected to knowing the necessary concepts in high performance computer architectures

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures
The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Processor Design			
Week 2 Pipelined Processors			
Week 3 Memory and I/O Systems	Assignment		
Week 4 Superscalar Organization			
Week 5 Superscalar Techniques			Due: Assignment
Week 6 & 7 The PowerPC 620		Mid-term Exam	
Week 8 Intel's P6 Microarchitecture	Assignment		
Week 9 Survey of Superscalar Processors		Paper Presentation	
Week 10 Advanced Instruction Flow Techniques			Due: Assignment
Week 11 Advanced Register Data Flow Techniques			
Week 12 Executing Multiple Threads		Final Exam	

Advanced Embedded System Design
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 633 (3 credits)

Coordinator: Dr. Wagdy Mahmoud or Dr. Esther Ososanya
Instructor: TBA
Office Hours: TBA

I. Course Description
This course covers concepts in advanced embedded system design principles and practices based on emphasizing formal design methodologies such as hardware-software co-design and co-verification, performance optimization, distributed embedded systems. Soft core and hard core embedded microprocessors. (Esther has a different description.)

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Expose students to the state-of-the-art design and analysis techniques for embedded systems.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding fundamental concepts in hardware/software co-design of embedded systems; (2) exposing students to the cutting edge research works and the emerging trends in the related topic areas; (3) providing students with research experience in embedded system design and analysis.

Student Learning Outcomes:
By the end of the course, students will be able to:
1) Understand concepts in embedded systems
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand cutting edge research works
   Assessment: Assignments, Exams, Class project, and Paper presentation.
   Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Discuss and understand how to design embedded systems
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>
- Required texts: *none*
- Referenced texts*:*
  a. *D.D. Gajski, F. Vahid, S. Narayan and J. Gong, Specification and Design of Embedded Systems, Prentice-Hall, 1994.*
  b. *J. Straustrup and W. Wolf (Eds.), Hardware/Software Co-Design Principles and Practices,Kluwer Academic Publishers, 1997.*

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.

- Academic Support Center. "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- Blackboard. "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- UDC Email. All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:
1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations
Students are expected to knowing the necessary concepts in embedded systems.

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures
The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 & 2 - Introduction and Overview • What is an embedded system? • Design challenges • Current design methodologies			
Week 3 & 4 - Modeling and Specication • Basic concepts • Common models of computation • Specication languages • Internal representations	Assignment		
Week 5 ~ 7 - Analysis and Estimation • Software performance estimation • System performance analysis • Real-time system analysis • Power estimation		Mid-term Exam	Due: Assignment

Week 8 ~ 11 - Partitioning, Synthesis and Interfacing • Basic partitioning issues • Two earlier cosynthesis frameworks • System-level partitioning • Interface generation • A design environment • Memory issues	Assignment	Paper Presentation	
Week 12 ~ 15 - Other Codesign Issues • Hw/sw co-verications • Prototyping and emulation • Recongurable platforms		Project Presentation / Final Exam	Due: Assignment

---

Detection and Estimation
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 634 (3 credits)

Coordinator: Dr. Sasan Haghani
Instructor: TBA
Office Hours: TBA

I. Course Description
This course covers concepts including Estimation of unknown parameters, Cramer-Rao lower bound; optimum (map) demodulation; filtering, amplitude and angle modulation, comparison with conventional systems; statistical decision theory Bayes, minimax, Neyman/Pearson, Criteria-68 simple and composite hypotheses; application to coherent and incoherent signal detection; M-ary hypotheses; application to uncoded and coded digital communication systems.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students understand theoretical concepts in conventional systems and digital communication.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding fundamentals of digital communication systems; (2) identifying various mechanisms and theoretical models in conventional systems.

Student Learning Outcomes:
By the end of the course, students will be able to:
1) Understand fundamentals in digital communication
   Assessment: Assignments, Exams, and Paper presentation.
2) Understand concepts in theoretical conventional systems including statistical signal processing and estimation theory.
   Assessment: Assignments, Exams, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>
- Required texts: *Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory (v. 1) by Steven Kay*
  Publisher: Prentice Hall; 1 edition (April 5, 1993)
  ISBN-10: 0133457117

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.

- Academic Support Center. "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- Blackboard. "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- UDC Email. All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:
1) Mid-term exam: 30 (%)
2) Final exam: 30 (%)
3) Assignments: 20 (%)
4) Attendance: 10 (%)
5) Paper presentation: 10 (%)

VIII. Expectations
Students are expected to knowing the necessary concepts in VEs

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures
The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Introduction			
Week 2 Review of Linear and Matrix Algebra			
Week 3 Review of Probability, Statistics, and Random Processes			
Week 4 Classical Spectral Estimation	Assignment		
Week 5 Parametric Modeling			

Week 6 Autoregressive Spectral Estimation: General			Due: Assignment
Week 7 Autoregressive Spectral Estimation: Methods		Mid-term Exam	
Week 8 Moving Average Spectral Estimation			
Week 9 Autoregressive Moving Average Spectral Estimation: General	Assignment		
Week 10 Autoregressive Moving Average Spectral Estimation: Methods			
Week 11 Minimum Variance Spectral Estimation		Paper Presentation	
Week 12 Summary of Spectral Estimators			
Week 13 Sinusoidal Parameter Estimation			Due: Assignment
Week 14 Multichannel Spectral Estimation			
Week 15 Two-Dimensional Spectral Estimation & Other Applications of Spectral Estimation Methods		Final Exam	

VLSI Architecture
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 635 (3 credits)

Coordinator: Dr. Samuel Lakeou
Instructor: TBA
Office Hours: TBA

I. Course Description

This course covers MOS transistors: fabrication, layout, characterization; CMOS circuit and logic design: circuit and logic simulation, fully complementary CMOS logic, pseudo-nMOS logic, dynamic CMOS logic, pass-transistor logic, clocking strategies; sub system design: ALUs, multipliers, memories, PLAs; architecture design: datapath, floorplanning, iterative cellular arrays, systolic arrays; VLSI algorithms; chip design and test: full custom design of chips, possible chip fabrication by MOSIS and subsequent chip testing.

II. Course Goals, Objectives, Prerequisites, and Co-requisites

Goals:

Students understand theoretical concepts in VLSI Architecture

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:

Student learning objectives are as follows: (1) understanding the basic approaches and methodologies for VLSI design of signal processing and communication systems; (2) having hands-on VLSI system design experience using hardware description language (HDL) and commercial EDA tools (Synopsys); (3) identifying real-life case studies of communication system integrated circuit (IC) design and implementation.

Student Learning Outcomes:
By the end of the course, students will be able to:

1) Understand fundamentals in VLSI Architecture
Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand integrated circuit (IC) design and implementation
Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Understand hardware description language (HDL) and commercial EDA tools
Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>

- Required texts: *Keshab K. Parhi "VLSI Digital Signal Processing Systems, Design and Implementation", John Wiley & Sons, 1999*

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.

- <u>Academic Support Center.</u> "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- <u>Blackboard.</u> "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- <u>UDC Email.</u> All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:

1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations
Students are expected to knowing the necessary concepts in VLSI architecture.

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures
The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Introduction to Digital Signal Processing Systems & Iteration Bound			
Week 2 Pipelining and Parallel Processing			
Week 3 Retiming	Assignment		
Week 4 Unfolding & Folding			
Week 5 Systolic Architecture Design			Due: Assignment
Week 6 Fast Convolution			
Week 7 Algorithmic Strength Reduction in Filters and Transforms		Mid-term Exam	
Week 8 Pipelined and Parallel Recursive and Adaptive Filters			
Week 9 Scaling and Roundoff Noise			
Week 10 Digital Lattice Filter Structures	Assignment	Paper Presentation	
Week 11 Bit-Level Arithmetic Architectures			
Week 12 Redundant Arithmetic			
Week 13 Numerical Strength Reduction			
Week 14 Synchronous, Wave, and Asynchronous Pipelines			Due: Assignment
Week 15 Low-Power Design & Programmable Digital Signal Processors		Project Presentation / Final Exam	

Advanced Electronic Materials and Devices
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 636 (3 credits)

Coordinator: Dr. Samuel Lakeou
Instructor: TBA
Office Hours: TBA

I. Course Description
Operating principles, fabrication, characteristics and applications of advanced electronic devices will be covered. Core topics are as follows: ideal properties of electron gas; electronic states in bulk GaAs and at the heterojunctions; doping properties in heterostructures; electron transport properties at 2D interfaces (including resonant tunneling); electronic and optical properties at 2D interfaces; device applications (HEMT, HBT, QWLaser, QDLaser), low-dimensional and nanometer-scale device physics, magnetic & ferroelectric devices, single-electron transistors, quantum devices, and RTD's.

II. Course Goals, Objectives, Prerequisites, and Co-requisites

Goals:
Students understand theoretical concepts in electronic materials and devices.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding fundamentals of immersive technologies; (2) examining the basic principles in visual worlds including locomotion, sensing, perception, and cognition; (3) identifying mechanisms that are used for designing virtual worlds.

Student Learning Outcomes:
By the end of the course, students will be able to:

1) Understand fundamentals in electronic materials
   Assessment: Assignments, Exams, and Paper presentation.
2) Understand operating principles, fabrication, characteristics and applications of advanced electronic devices
   Assessment: Assignments, Exams, and Paper presentation.

III. Course Requirements

A. Course content

- Required texts: *TBA*

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.

- Academic Support Center. "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- Blackboard. "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- UDC Email. All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:

1) Mid-term exam: 30 (%)
2) Final exam: 30 (%)
3) Assignments: 20 (%)
4) Attendance: 10 (%)
5) Paper presentation: 10 (%)

VIII. Expectations
Students are expected to knowing the necessary concepts in Electronic materials

IX. Academic Integrity

UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures

The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Introduction			
Week 2 Operating principles, fabrication, characteristics and applications of advanced electronic devices			
Week 3 Ideal properties of electron gas	Assignment		
Week 4 & 5 Electronic states in bulk GaAs and at the heterojunctions			
Week 6 & 7 Doping properties in heterostructures			Due: Assignment
Week 8 & 9 Electron transport properties at 2D interfaces (including resonant tunneling)	Assignment	Mid-term Exam	
Week 10 ~ 12 Electronic and optical properties at 2D interfaces		Paper Presentation	Due: Assignment
Week 13 ~ 15 Device applications (HEMT, HBT, QWLaser, QDLaser), low-dimensional and nanometer-scale device physics, magnetic & ferroelectric devices, single-electron transistors, quantum devices, and RTD's		Final Exam	

Advanced Communication Systems

Class location: TBA

Class Meeting time(s): TBA

Course level and # of credit hours: CSE 637 (3 credits)

Coordinator: Dr. Paul Cotae
Instructor: TBA
Office Hours: TBA

I. Course Description

This course covers basis functions, orthogonalization of signals, vector representation of signals, optimal detection in noise, matched filters, pulse shaping, intersymbol interference, maximum likelihood detection, channel cutoff rates, error probabilities, bandwidth, and power-limited signaling.

II. Course Goals, Objectives, Prerequisites, and Co-requisites

Goals:

Students understand theoretical concepts in communication systems.

Prerequisite: None

Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding fundamentals of communication systems; (2) identifying techniques used in communication.

Student Learning Outcomes:
By the end of the course, students will be able to:
1) Understand fundamentals in communication systems
   Assessment: Assignments, Exams, and Paper presentation.
2) Understand communication techniques
   Assessment: Assignments, Exams, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>
- Required texts: *TBA*

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.
- <u>Academic Support Center.</u> "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- <u>Blackboard.</u> "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- <u>UDC Email.</u> All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:
1) Mid-term exam: 30 (%)
2) Final exam: 30 (%)
3) Assignments: 20 (%)
4) Attendance: 10 (%)
5) Paper presentation: 10 (%)

VIII. Expectations
Students are expected to knowing the necessary concepts in communication systems

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures
The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Introduction			
Week 2 Bsis functions			
Week 3 Orthogonalization of signals	Assignment		
Week 4 Vector representation of signals			
Week 5 Optimal detection in noise			Due: Assignment
Week 6 & 7 Matched filters		Mid-term Exam	
Week 8 Pulse shaping			
Week 9 Intersymbol interference	Assignment		
Week 10 Maximum likelihood detection		Paper Presentation	
Week 11 Channel cutoff rates			
Week 12 & 13 Error probabilities			Due: Assignment
Week 14 & 15 Bandwidth & power-limited signaling.		Project Presentation / Final Exam	

Computational Engineering and Scientific Modeling
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 651 (3 credits)

Coordinator: Dr. Pawan Tyagi
Instructor: TBA
Office Hours: TBA

I. Course Description
This course covers computational modeling techniques including how to examine the features, types, uses, construction and simulation of models in management of decision making processes.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students understand theoretical concepts in computational modeling.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding computational modeling; (2) examining the basic principles in simulation and validation.

Student Learning Outcomes:
By the end of the course, students will be able to:
1) Understand fundamentals in computational modeling
   Assessment: Assignments, Exams, Class project, and Paper presentation.

2) Identify different aspect of modeling techniques
   Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Understand simulation and validation methods
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. Course content

- Required texts: *Discrete-Event System Simulation, 5/E by Jerry Banks, John S. Carson, II, Barry L. Nelson, David M. Nicol*
  Publisher: Prentice Hall, 2010
  ISBN-10: 0136062121

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.

- Academic Support Center. "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- Blackboard. "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- UDC Email. All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:
1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations
Students are expected to knowing the necessary concepts in computational modeling.

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures
The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	

Week 1 Introduction to Simulation			
Week 2 Examples of Simulation			
Week 3 Principles of Simulation	Assignment		
Week 4 Simulation Software			
Week 5 Statistical Models			Due: Assignment
Week 6 & 7 Queueing Models		Mid-term Exam	
Week 8 Random-Number Generation			
Week 9 Random-Variate Generation	Assignment		
Week 10 Input Modeling		Paper Presentation	
Week 11 Verification and Validation			
Week 12 Output Analysis for a Single Model			
Week 13 Comparison and Evaluation of Alternative System Designs			Due: Assignment
Week 14 & 15 Simulation of Manufacturing and Material-Handling Systems		Project Presentation / Final Exam	

Systems Engineering Approach
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 652 (3 credits)

Coordinator: Dr. Stephen Arhin
Instructor: TBA
Office Hours: TBA

I. Course Description
This course covers engineering of complex hardware, software systems encompasses quantitative methods to understand vague problem statements, determine what a proposed product/system must do (functionality), generate measurable requirements, decide how to select the most appropriate solution design, integrate the hardware and software subsystems and test the finished product to verify it satisfies the documented requirements.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students understand theoretical concepts in systems engineering.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding fundamentals of engineering systems; (2) identifying measurable requirements; (3) understanding how to integrate the hardware and software subsystems and test the finished product to verify it satisfies the documented requirements.

Student Learning Outcomes:
By the end of the course, students will be able to:
1) Understand fundamentals in engineering systems
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand the integration of the hardware and software subsystems
   Assessment: Assignments, Exams, Class project, and Paper presentation

III. Course Requirements

A. <u>Course content</u>
- Required texts: *Systems Engineering Guidebook: A Process for Developing Systems and Products by James N. Martin, CRC-Press; 1 edition (January 14, 1997), ISBN-10: 0849378370*

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.
- <u>Academic Support Center.</u> "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- <u>Blackboard.</u> "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- <u>UDC Email.</u> All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:
1) Mid-term exam: 30 (%)
2) Final exam: 30 (%)
3) Assignments: 20 (%)
4) Attendance: 10 (%)
5) Paper presentation: 10 (%)

VIII. Expectations
Students are expected to knowing the necessary concepts in System Engineering Approach

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures
The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	

Week 1 Introduction to Systems Engineering			
Week 2 Systems Concepts			
Week 3 Process Concepts	Assignment		
Week 4 Systems Engineering Process Overview I			Due: Assignment
Week 5 & 6 Systems Engineering Process Overview II		Mid-term Exam	
Week 7 & 8 SE Process Tailoring	Assignment		
Week 9 SE Management Subprocess			
Week 10 ~ 12 SE Requirements and Arch. Definition Subprocess		Paper Presentation	
Week 13 ~ 15 SE System Integration and Verification Subprocess		Final Exam	Due: Assignment

---

Engineering Systems: Modeling & Simulation
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 653 (3 credits)

Coordinator: Dr. Stephen Arhin
Instructor: TBA
Office Hours: TBA

I. Course Description
This course will present principles of computational modeling and simulation of systems. General topics covered include: parametric and non-parametric modeling; system simulation; parameter estimation, linear regression and least squares; model structure and model validation through simulation; and, numerical issues in systems theory. Techniques covered include methods from numerical linear algebra, nonlinear programming and Monte Carlo simulation, with applications to general engineering systems. Modeling and simulation software is utilized in this course.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students understand theoretical concepts in computational modeling and simulation of systems.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding fundamentals of computational modeling and simulation of systems; (2) identifying modeling and simulation techniques; (3) Exploring systems engineering processes.

Student Learning Outcomes:
By the end of the course, students will be able to:
1) Understand fundamentals in computational modeling
   Assessment: Assignments, Exams, and Paper presentation.
2) Understand simulation techniques
   Assessment: Assignments, Exams, and Paper presentation.

3) Examine foundational technologies and simulation design issues
Assessment: Assignments, Exams, and Paper presentation.

III. Course Requirements

A. Course content

- Required texts: *TBA*

IV. Format and Procedures

This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources

Students are encouraged to check following resources to become successful on this course.

- Academic Support Center. "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- Blackboard. "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- UDC Email. All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures

All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades

Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:

1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations

Students are expected to knowing the necessary concepts in modeling and simulation

IX. Academic Integrity

UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures

The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Modeling & Simulation Development Process			

Week 2 Fidelity, Accuracy, and Resolution of Models			
Week 3 Verification & Validation in Systems Engineering	Assignment		
Week 4 Reference Architectures			
Week 5 Systems Modeling Language (SysML)			Due: Assignment
Week 6 & 7 Simulation Methodologies: Continuous, Discrete, Monte Carlo, Agent-based, System Dynamics, Games and Virtual Worlds		Mid-term Exam	
Week 8 & 9 System Engineering Life Cycle	Assignment		
Week 10 Design of Experiments, Surrogate Modeling, and Optimization		Paper Presentation	
Week 11 Simulation ROI			
Week 12 & 13 Distributed Simulation Standards			Due: Assignment
Week 14 & 15 Case Studies of M&S in Acquisition Process		Project Presentation / Final Exam	

Water Resources System Analysis
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 654 (3 credits)

Coordinator: Dr. Pradeep Behera
Instructor: TBA
Office Hours: TBA

I. Course Description
This course covers planning, design and management of multi-component water resources systems. After a review of the use and nature of water resources systems, topics studied in detail are: water resource economics; methodology of design; systems analysis; systems design and decision making; applied mathematical programming; probabilistic models and water quality

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students understand water resources systems and analytical techniques.

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding systematic approaches to the mathematical modeling of various water resources issues; (2) understanding of simulation, optimization, multi-criterion-decision-making, as well as engineering economics and time series analysis.

Student Learning Outcomes:

By the end of the course, students will be able to:

1) Understand fundamentals in water resources systems
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand for prioritizing and addressing critical issues such as flood control, power generation, and water quality management
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>

- Required texts: *Water Resources Systems Analysis by Mohammad Karamouz, Ferenc Szidarovszky, Banafsheh Zahraie*
  Publisher: CRC Press; 1 edition (June 27, 2003)
  ISBN-10: 1566706424

IV. Format and Procedures

This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources

Students are encouraged to check following resources to become successful on this course.

- <u>Academic Support Center.</u> "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- <u>Blackboard.</u> "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- <u>UDC Email.</u> All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures

All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades

Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F

The grading system is as follows:

1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations

Students are expected to knowing the necessary concepts in water resources systems

IX. Academic Integrity

UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures

The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Ch. 1. Introduction			
Week 2 Ch. 2. Decision Making: Optimization and Conflict Resolution			
Week 3 Ch. 3. Decision Making under Uncertainty	Assignment		
Week 4 Ch. 4. Water Resources Economics			
Week 5 Ch. 5. Time Series Analysis			Due: Assignment
Week 6 & 7 Ch. 6. River Basin Modeling		Mid-term Exam	
Week 8 Ch. 7. Groundwater Management			
Week 9 Ch. 8. River-Reservoir Systems Modeling	Assignment		
Week 10 Ch. 9. Water Quality Management		Paper Presentation	
Week 11 Ch. 10. Hydroelectric Systems Analysis			
Week 12 & 13 Ch. 11. Water Demand Analysis and Management			Due: Assignment
Week 14 & 15 Ch. 12. Drought Management		Project Presentation / Final Exam	

Water Resources System Modeling
Class location: TBA
Class Meeting time(s): TBA
Course level and # of credit hours: CSE 655 (3 credits)

Coordinator: Dr. Pradeep Behera
Instructor: TBA
Office Hours: TBA

I. Course Description
Water resources systems are physically complex and the solution of appropriate mathematical models is computationally demanding. This course considers physical processes in water resource systems, their mathematical representation and numerical solutions. This course covers meteorologic data analysis, deterministic and stochastic modeling techniques; Flood control: structural and nonstructural alternatives and Urban drainage and runoff control, risk analysis, economics and decision making.

II. Course Goals, Objectives, Prerequisites, and Co-requisites
Goals:
Students understand theoretical concepts in visual environments (VE).

Prerequisite: None
Course Credits: 3 credits

Learning Objectives:
Student learning objectives are as follows: (1) understanding the current status of water resources utilization; (2) examining advantages and disadvantages of systems techniques in water resources; (3) identifying statistical tools for data analysis.

Student Learning Outcomes:
By the end of the course, students will be able to:

1) Understand fundamentals in water resources systems
   Assessment: Assignments, Exams, Class project, and Paper presentation.
2) Understand approaches of analysis water resources
   Assessment: Assignments, Exams, Class project, and Paper presentation.
3) Identify emerging techniques such as Remote Sensing, GIS, Artificial Neural Networks, and Expert Systems
   Assessment: Assignments, Exams, Class project, and Paper presentation.

III. Course Requirements

A. <u>Course content</u>

- Required texts: *Water Resources Systems Planning and Management (Developments in Water Science) by Sharad K. Jain, V.P. Singh*
  Publisher: Elsevier Science; 1 edition (September 26, 2003)
  ISBN-10: 0444514295

IV. Format and Procedures
This course will employ lectures, discussions, projects, assignments, and examinations. Students are strongly encouraged to participate extensively, ask questions, express ideas and opinions, and challenge traditional ideas and concepts. Instructional methodologies will emphasize critical thinking, problem solving, and reasoning over simple memorization.

V. Student Resources
Students are encouraged to check following resources to become successful on this course.

- <u>Academic Support Center.</u> "Here you may have a trained English major or English professional proofread your work. Visit Building 32, B-level."
- <u>Blackboard.</u> "From http://udc.blackboard.com, you can review and complete assignments, view your grades, send messages to your professor or your classmates, access course content, print another syllabus, or read sample essays."
- <u>UDC Email.</u> All students must use a UDC e-mail account. UDC e-mail is the only e-mail for academic use and will be the address that instructors use to communicate with students from inside Blackboard.

VI. Assessment Procedures
All students need to finish all given assignments in a timely manner. In order to get feedbacks from the instructor, all students are encouraged to ask questions in the classroom. Mid-term exam, and Final exam will take place to measure their gained knowledge on the covered topics.

VII. Grades
Grade will be assigned on the scale: 90-100= A, 80-90=B, 70-80=C; 60-70=D; Below 60=F
The grading system is as follows:

1) Project: 20 (%)
2) Mid-term exam: 20 (%)
3) Final exam: 20 (%)
4) Assignments: 20 (%)
5) Attendance: 10 (%)
6) Paper presentation: 10 (%)

VIII. Expectations
Students are expected to knowing the necessary concepts in water resources systems

IX. Academic Integrity
UDC standards on academic integrity (see UDC Academic Policies and Procedures Manual). As they apply, include industry or specialized accreditation standards.

X. Statement on ADA (Americans with Disabilities Act) Procedures

The University is committed to providing an educational environment that is accessible to all students. If any student requires assistance, support services, or verification of a disability, then he or she should please visit the Office of Services to Students with Disabilities.

XI. Course Schedule (Tentative)

Topics	Readings/other Assignments	Assessments	
Week 1 Water Resources Planning and Management: An Overview			
Week 2 Water Resource Systems Modeling: Its Role in Planning and Management			
Week 3 Modeling Methods for Evaluating Alternatives	Assignment		
Week 4 Optimization Methods			
Week 5 Fuzzy Optimization			Due: Assignment
Week 6 & 7 Data-Based Models		Mid-term Exam	
Week 8 Concepts in Probability, Statistics and Stochastic Modeling			
Week 9 Modeling Uncertainty	Assignment		
Week 10 Model Sensitivity and Uncertainty Analysis		Paper Presentation	
Week 11 Performance Criteria			
Week 12 River Basin Planning Models			
Week 13 Water Quality Modeling and Prediction			Due: Assignment
Week 14 & 15 Urban Water Systems		Project Presentation / Final Exam	