**NORTH CAROLINA STATE UNIVERSITY**  
**GRADUATE COURSE ACTION FORM**

**NOTE:** Click once on shaded fields to type data. To check boxes, right click at box, click “Properties”, and click “Checked” under Default Values.

<table>
<thead>
<tr>
<th>DEPARTMENT/PROGRAM</th>
<th>Electrical and Computer Engineering, Computer Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>COURSE PREFIX/NUMBER</td>
<td>ECE/CSC 776</td>
</tr>
<tr>
<td>PREVIOUS PREFIX/NUMBER</td>
<td></td>
</tr>
<tr>
<td>DATE OF LAST ACTION</td>
<td>5/10/1990</td>
</tr>
<tr>
<td>COURSE TITLE</td>
<td>Design and Performance Evaluation of Network Systems and Services</td>
</tr>
<tr>
<td>ABBREVIATED TITLE</td>
<td>DSN&amp;PRFMANCE NTWKS</td>
</tr>
<tr>
<td>SCHEDULING</td>
<td>Fall □ Spring ☑ Summer □ Every Year ☑</td>
</tr>
<tr>
<td>COURSE OFFERED</td>
<td>BY DISTANCE EDUCATION ONLY ☑ ON CAMPUS ONLY □ BOTH ON CAMPUS AND BY DISTANCE EDUCATION ☑</td>
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<tr>
<td>CREDIT HOURS</td>
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<td>CONTACT HOURS</td>
<td>Lecture/Recitation 3 Seminar ☐ Laboratory ☐ Problem ☐</td>
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<tr>
<td></td>
<td>Studio ☐ Independent Study/Research ☐ Internship/Practicum/Field Work ☐</td>
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<tr>
<td>GRADING</td>
<td>ABCDF ☒ S/U ☐</td>
</tr>
<tr>
<td>INSTRUCTOR (NAME/RANK)</td>
<td>Michael Devetsikiotis, Professor</td>
</tr>
<tr>
<td>Graduate Faculty Status</td>
<td>Associate □ Full ☑</td>
</tr>
<tr>
<td>ANTICIPATED ENROLLMENT</td>
<td>Per semester 25 Max.Section 35 Multiple sections Yes □ No ☑</td>
</tr>
<tr>
<td>PREREQUISITE(s)</td>
<td>ECE/CSC 570 and ECE/CSC 579</td>
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<td>COREQUISITE(S)</td>
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<td>PRE/COREQUISITE FOR</td>
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<td>RESTRICTIVE STATEMENT</td>
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<td>CURRICULA/MINORS</td>
<td>Required Qualified Elective</td>
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<tr>
<td>PROPOSED EFFECTIVE DATE</td>
<td>Spring 2007</td>
</tr>
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<td>APPROVED EFFECTIVE DATE</td>
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**CATALOG DESCRIPTION** (limit to 80 words): Introduction to the design and performance evaluation of network services. Topics include top-down network design based on requirements, end-to-end services and network system architecture, service level agreements, quantitative performance evaluation techniques. Provides quantitative skills on network service traffic and workload modeling, as well as, service applications such as triple play, internet TV(IPTV), Peer-to-peer(P2P), voice over IP(VoIP), storage, network management, and access services.

**DOCUMENTATION AS REQUIRED**

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<td>Syllabus (Old and New) ☒</td>
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<td>Explanation of differences in requirements of dual-level courses □</td>
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**RECOMMENDED BY:**

<table>
<thead>
<tr>
<th>Department Head/Director of Graduate Programs</th>
<th>Date</th>
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<tr>
<td>ENDORSED BY:</td>
<td></td>
</tr>
<tr>
<td>Chair, College Graduate Studies Committee</td>
<td>Date</td>
</tr>
<tr>
<td>College Dean(s)</td>
<td>Date</td>
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**APPROVED:**

<table>
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<tr>
<th>Dean of the Graduate School</th>
<th>Date</th>
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Course Justification

ECE/CSC 776: Design and Performance Evaluation of Network Systems and Services is one of the “core” graduate level networking courses offered by the Electrical and Computer Engineering and Computer Science departments. The revised course, while continuing to cover quantitative methods in performance evaluation, gives a top-down introduction to providing services based on modern high-speed telecommunication networks and to the related quantitative design and performance evaluation methods for the design of service-driven network systems.

List of Proposed Revisions with Reasons for Each

Content: This course has not been revised since its inception in 1990. A revision is proposed that will not only update the course contents to the current state of the art, but will also align the course to the new initiative on service management and engineering. Hence, the revision consists of updating the performance methods introduced, while casting the material in a stronger “top-down” design orientation, set in a modern context of network services, systems and applications.

Description and Title: The new description and title reflect the newly revised content, while retaining the main character of the course as a “network performance modeling” course.

Pre/Corequisite: The current prerequisite, ECE/CSC 571 has not been taught in years. We are setting two logical prerequisites, namely an introductory 500-level networks course (ECE/CSC 570), and a 500-level introductory course to performance methods (ECE/CSC 579).

Learning Objectives

See syllabus

Enrollment for the Last Five Years

<table>
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<tr>
<th>Semester</th>
<th>ECE enrollment</th>
<th>CSC enrollment</th>
<th>Total</th>
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<tr>
<td>Spring 02</td>
<td>13</td>
<td>5</td>
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<td>Spring 03</td>
<td>11</td>
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<td>Spring 04</td>
<td>14</td>
<td>7</td>
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<td>Spring 05</td>
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<td>5</td>
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</tr>
<tr>
<td>Spring 06</td>
<td>9</td>
<td>1</td>
<td>10</td>
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Consultation with other Departments

This course is cross-listed between the ECE and CSC Departments, and it is taught by both ECE and CSC instructors. In recent meetings and communications among CSC and the ECE instructors who teach networking courses, these revisions have been discussed and agreed upon.

Old Syllabus

**Syllabus and Policies:**

**Instructor:**
Professor [Michael Devetsikiotis](http://www.example.com)
Office: 3060 EB II
Telephone: 515-5253
[Personal home page](http://www.example.com)

**Lectures:**
Twice a week, Mon and Wed, 15:50 - 17:05, in **1212 EB II**.

**Course Objectives:**
To provide an introduction to advanced topics in the design and performance evaluation of modern high-speed telecommunication networks, and the services that networks deliver. Under the guidance of the instructor, and in an interactive and participatory manner, students will gain familiarity with and some critical understanding of the state-of-the-art in the areas of

- Network traffic and service workload modeling
- Multiplexing/Scheduling
- Admission/Access control
End-to-end quality of service and effective bandwidths
Quantitative/mathematical performance evaluation techniques including simulation methods
Special topics, time permitting (e.g., next generation services, closed-loop congestion control, pricing/charging, more advanced mathematical techniques)

Students will participate and learn by following reading assignments before coming to class, by asking and answering questions during in-class discussions, by preparing essays/reports and presenting them to class, by performing simulation projects, and by preparing for in-class exams.

Prerequisites:
ECE 570 or equivalent and ECE 579 or equivalent.

Office Hours (in 3060 EB II):
- Monday 17:15 - 18:15
- Wednesday 11:00 - 12:00
- Outside the hours above, only by appointment.

Laboratory:
Effort is being made to develop more demo exercises in OPNET and/or ns2. Depending on the status of the labs in EB II and the installation of OPNET and ns2 on the EOS/Unity network, laboratories may be assigned for grade later in the term.

P/A Sessions:
Problem and question/answer sessions may be scheduled during the term, as needed, and based on student demand. Day, time and place will be announced in class and posted on the Web.

Textbook:

Library reserves:

Additional References:
Simulation Project

OPNET and ns2 are installed on EOS and, at least, on some of the ECE/CSC departmental networks. However, you can still use the software of your choice (or any language such as C/C++) for the course simulation project(s). Additional references:

- Simulation course page in Canada
- The "project" appendices in Chapters 6 and 7 of the book by H. Perros (on the simulation of an ATM switch).
- The book on simulation by Paul Fishwick at the University of Florida.
- The NS simulator (*NOT* available yet on the public EOS system) and its tutorial

Lecture Outline by Week:

- 1. Course arrangements and administration. Introduction to high-speed networks, services and end-to-end performance evaluation.
- 7. Transport layer congestion control.
- 9. Spring Break
- 10. Scheduling.
- 11. Connection admission control and policing.
- 13. - 15. Selected topics on stochastic modeling of communication networks relevant to the design and performance evaluation of broadband multi-service systems (e.g., simulation techniques, multiple access, fluid approximations, large deviations and rare event analysis, long range dependence and self-similar models).
16. Discuss simulation project; catch-up and review.

**Attendance Policy:**
In accordance with university policy, regular attendance at classes, laboratory period and examinations is expected of all students.

**Exams:**
The first, 75 minute mid-term exam will be held in class on Wednesday March 1, 2006. The final exam will be held on Wednesday May 3, 2006, between 13:00 and 16:00.

*You will be allowed to bring to each exam any related material that you believe will assist you ("open book"). A calculator (or two, for reliability) will be useful.*

**Grading:**
- Assignments: 40% (Essay 20%, hwk and simulation projects 20%)
- Mid-term: 30%
- Final: 30%

**Audit Requirements:**
Completion of all assignments and exams with a total of at least 60% (normalized if needed, and if done for the rest of the class).

**Drop date:**
Last day to withdraw or switch to audit is Friday March 17, 2006.

**Assignments:**
Assignments will include simulation project(s) (at least one), research papers (essays) (at least one), and possibly conventional homework problem sets.

**Policies and Procedures:**
- Reading assignments are assumed as *actual assignments*, in other words, the instructor will assume each time during the lecture that the reading assignment material has been studied by the students *before* the class.
- Due date will be shown on each writing assignment and posted on the web. Late assignments will *NOT* be accepted.
- New assignments and deadlines will be announced in class. Hard copies of handouts, assignments etc. will usually *not* be distributed. Updates and copies of assignments will be available only from the web and/or e-mail. It is your responsibility to check whether anything new has been issued if you miss a class.
- Collaboration is allowed and, in fact, encouraged, on assignments other than exams. However, each student must turn in his/her own report and be responsible for understanding all the material involved.
- The purpose of assignments is to help you learn the material and prepare for examinations. It is essential that you fully understand all the assignments. If you perform badly on some questions, ensure that you find out afterwards what you should have done.
- If you are unable to turn in an assignment or take a test due to illness or similar reason, you are expected to inform the instructor *before* the due date or exam time, or by the end of that day at the latest (by phone or e-mail).
- Objections to grading of assignments or exams have to be submitted in writing at most one week after the date they are handed out. Any question or objection has to be taken up with the TA first, and only after that, if the issue is not resolved, with the instructor.
- Please do not expect the instructor to return phone calls, unless it is a true emergency. Outside office hours, e-mail is strongly preferred.
A passing grade in both the combination of Assignments and Lab, and a passing grade in the Final Exam is required to pass this course.

Incremental grades will be posted frequently, please check them. Requests for correction of errors must be received before final exam.

When possible, sketches to solutions to the assignment problems will be posted below under password.

Students with disabilities
Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 515-7653. Also see http://www.ncsu.edu/provost/offices/affirm_action/dss/

For more information on NC State's policy on working with students with disabilities, please see http://www.ncsu.edu/provost/hat/current/appendix/appen_k.html

New Syllabus

Title: Design and Performance Evaluation of Network Systems and Services

Instructor: Michael Devetsikiotis

Office: 3060 EB II
Office Hours: 10-11am M, 4:40-5:30pm W.
Telephone: 515-5253

Personal home page

Description:
ECE/CSC 776: Design and Performance Evaluation of Network Systems and Services
Introduction to the design and performance evaluation of network services. Topics include top-down network design based on requirements, end-to-end services and network system architecture, service level agreements, quantitative performance evaluation techniques. Provides quantitative skills on network service traffic and workload modeling, as well as, service applications such as triple play, IPTV, P2P, VoIP, storage, network management, and access services.

Student Learning Objectives:

Under the guidance of the instructor and in an interactive and participatory manner, students will

- Apply the basic principles of top-down design of networks based on requirements
- Describe end-to-end services and network system architectures
- Utilize network traffic and application workload modeling for real workload characterization
- Critically evaluate the performance of multiplexed/scheduled network resources.
- Categorize admission and access control methods
- Incorporate end-to-end quality of service, service level agreements and service envelopes into the design of networks
- Use quantitative/mathematical performance evaluation techniques including simulation methods

There will also be special topics, including closed-loop congestion control, pricing/charging, more advanced mathematical techniques and optimization.

Students will be introduced to the fundamental concepts of performance of network services and the design of network infrastructure to deliver such services. Furthermore, they will receive an introduction to the design of network systems for selected applications and services such as triple and quadruple play, voice-over-IP, IPTV and peer-to-peer systems. At the end of the course, students should be able to handle advanced tools such as analysis and simulation for the design of network services and systems. Students will also obtain some practical experience, through real-life case-studies and projects.

Grading
There will be a midterm exam, a final exam, a major project, and homework assignments.

Homework: 20%
Project: 30%
Midterm exam: 20%
Final exam: 30%

**Prerequisites:** ECE/CSC 570 and ECE/CSC 579.

**Late Assignments:**
Assignments are due at the beginning of class on the specified date. Late assignments will be not be accepted, except for university-excused absences. If you have a medical excuse or instructor approval, you may receive full credit if the assignment is turned in as soon as possible. [http://www.ncsu.edu/policies/academic_affairs/pols_regs/REG205.00.4.php](http://www.ncsu.edu/policies/academic_affairs/pols_regs/REG205.00.4.php)

**Text:**
Publisher: Morgan Kaufmann, Elsevier
Copyright: 2004
ISBN: 0124287514

**Additional References:**

**Lecture Outline (75 minute lectures)**

1. Course arrangements and administration. Recap and discussion of high-speed network technologies and background (1)
2. Network services: Introduction and motivation - discussion of pertinent text sections (1)
3. End to end services – introduction to network service systems – examples and cases (2)
4. Overview of quantitative performance modeling: analysis and simulation (2)
5. Network architecture and components (2)
6. Stream versus elastic services (1)
7. Network traffic and workload characterization (2)
8. Open loop solutions: Connection admission control and Effective bandwidths (2)
9. Midterm review. (1)
10. Midterm exam. (1)
11. Service routing and scheduling (3)
12. End to end solutions (2)
13. Closed loop systems: TCP (2)
14. Pricing and management of services (3)
15. Student presentations on selected topics (e.g., simulation techniques, multiple access, fluid approximations, large deviations and rare event analysis, long range dependence and self-similar models). (2)
16. Discussion of simulation project; catch-up and final review (1)

Students with disabilities
Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 515-7653.
http://www.ncsu.edu/provost/offices/affirm_action/dss/ For more information on NC State's policy on working with students with disabilities, please see http://www.ncsu.edu/provost/hat/current/appendix/appen_k.html

Academic integrity
All the provisions of the code of academic integrity apply to this course. In addition, it is my understanding and expectation that your signature on any test or assignment means that you neither gave nor received unauthorized aid.