Course Information

- Credits: 3
- Lecture hours: Tuesday & Thursday, 9:30 - 10:45am, AB 210
- Instructor: Murat Yuksel
  E-mail: yuksem@unr.edu
  Phone: (775) 327-2246
  Web page: http://www.cse.unr.edu/~yuksem
  Office: SEM 237 (Scrugham Engineering-Mines)
  Office hours:
    ○ Tuesday and Thursday, noon -1pm
    ○ or by appointment

Description

Advanced concepts in protocol design for inter-networking of heterogeneous computer networks; protocols for transport, congestion control, routing, multicast, network management; and address resolution.

Prerequisites

- Required:
  ○ CPE 401/601 Computer Network Systems or CPE 400/600 Computer Communication Networks or equivalent or consent of instructor

- Desirable:
  ○ Operating Systems (CS 446/646 or equivalent)

Textbooks


Note: Since this is an advanced level class, the textbook is only the starting point for the majority of topics that we will cover. The slides used will cover ideas from a broad range of sources including other books, papers, RFCs etc. The WebCampus page will have online links to resources.

Syllabus (Tentative)

This is a tentative list of topics, subject to modification and reorganization.

1. Review of Networking Concepts
   ○ Connectivity
   ○ Multiplexing
   ○ Circuit-switching vs. packet-switching
   ○ Multiple-access
   ○ Routing, addressing
   ○ Congestion control

2. Review of Networking Design Principles
   ○ End-to-end principle
3. Internetworking
   - Heterogeneity and scale
   - IP approach
   - Address resolution
   - Hierarchical addressing and subnets
   - Fragmentation and re-assembly
   - Packet format design

4. Routing Basics
   - Routing and forwarding tables
   - Routers vs. bridges
   - Addressing and routing scalability
   - Link-state vs. distance-vector routing
   - Source-based routing

5. Intra-domain Routing
   - RIP, EIGRP
   - OSPF
   - PNNI
   - IS-IS
   - QoS routing
   - Traffic engineering and routing

6. Inter-domain Routing
   - Autonomous systems
   - Policy routing
   - EGP
   - BGP
   - CIDR

7. Transport Protocol Design
   - Connectionless vs. connection-oriented service
   - Connection management: establishment, termination
   - UDP
   - TCP

8. Congestion Control
   - Congestion indications/feedbacks: explicit vs. implicit
   - Queuing disciplines: scheduling and buffer management
     - RED, ARED, FRED, REM
   - TCP congestion control variants
     - Reno, Vegas
   - TCP modeling
9. Multicast
   - Groups, scopes, trees
   - Multicast addresses
   - Group management: IGMP
   - Multicast routing and forwarding, MBONE, PIM
   - Multicast transport protocols: reliability, congestion
   - Application-layer multicast

10. Network Management
    - Auto-configuration
    - SNMP
    - DHCP
    - ICMP

11. IP Next Generation (IPv6)
    - IPv6 addressing
    - IPv6 header format
    - IPv6 features: routing flexibility, multicast support

12. Data Center Networks
    - Intra-DC
    - Inter-DC
    - Fat tree
    - Deadlocks
    - Multipath routing
    - Bulk data transfers

13. Software-Defined Networking (SDN)
    - Network function virtualization
    - OpenFlow
    - Middlebox outsourcing

Organization
- **Project**  There will be a project *individually* done by each student. The project will require programming knowledge in C/C++. You will be implementing an emulation of a network protocol stack with your own designs. The project will require your designs to stay within loose definitions of the protocols involved. There will be an in-class demo of the protocols developed during the project.
- **Final Exam**  There will be one open book/notes final exam (see Schedule for tentative date).
- **Homework**  There will be homework assignments approximately every week. The homework assignments will consist of true/false answers emphasizing important concepts. There will not be grading of these homework assignments, but your submissions will be logged as part of your grade. Each submission has an equal weight, and one missed submission is okay. Make up or late submissions of homework assignments will be not allowed.
- **Research Case Study**  You will be required to perform a case study and researching of an area in networking. You will choose from a menu of research topics. Each topic will have a list of mandatory paper readings, followed by a set of other references. Your task is to critique the material, organize it in a framework of your own, and make sound judgments about the past and future directions of work in the topic area. You will be required to (i) submit a case study report (which will be no longer than 7 pages in 12pt fonts) and (ii) make a 15min in-class presentation of the case study. We will expect the case study to be of high quality, reflecting deep understanding, and be written like a professional
technical paper.

- **Books, Papers, and RFCs** The class will involve a fair bit of reading. The reading is meant in part to supplement lectures, help you catch up, and allow lectures to be more focused and interactive.

- **WebCampus** Except this web page, all course materials will be posted at the WebCampus.

- **Academic Integrity** Except the project, there will be no team projects or reports in this class, therefore all assignments and exams must be prepared strictly *individually*. Any form of cheating such as plagiarism or ghostwriting will incur a severe penalty, usually failure in the course. Please refer to the UNR policy on Academic Standards.

- **Disability Statement** If you have a disability for which you will need to request accommodations, please contact the instructor or someone at the Disability Resource Center (Thompson Student Services - 107) as soon as possible.

- **Important Policy** Surreptitious or covert videotaping of class or unauthorized audio recording of class is prohibited by law and by Board of Regents policy. This class may be videotaped or audio recorded only with the written permission of the instructor. In order to accommodate students with disabilities, some students may have been given permission to record class lectures and discussions. Therefore, students should understand that their comments during class may be recorded.

**Grading (Tentative)**

Both grading policy and scale are subject to change.

<table>
<thead>
<tr>
<th>Grading Policy</th>
<th>Grading Scale</th>
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<tbody>
<tr>
<td>Final Exam</td>
<td>90% - 100%</td>
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<td>A-, A</td>
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<tr>
<td>Project</td>
<td>80% - 89%</td>
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<td>B-, B, B+</td>
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<td>Homework</td>
<td>65% - 79%</td>
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<td>C-, C, C+</td>
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<td>Research Case Study</td>
<td>55% - 64%</td>
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<td>0% - 54%</td>
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**Important Note:** Re-grading requests can only be made within the first week after the graded assignments/tests are returned to the students.

**Schedule (Tentative), Notes & Assignments**

This is a tentative schedule including the exam dates. It is subject to readjustment depending on the time we actually spend in class covering the topics. Slides presented in class and assignments will be posted at the WebCampus. See the acknowledgment for the course materials.

<table>
<thead>
<tr>
<th>Date</th>
<th>Lectures</th>
<th>Assignments &amp; Notes</th>
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<tbody>
<tr>
<td>Tue, Jan 19</td>
<td>Lecture 1: Introduction</td>
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<tr>
<td>Thu, Jan 21</td>
<td>Lecture 2: Review of Networking Concepts (1)</td>
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<td>Tue, Jan 26</td>
<td>Lecture 3: Review of Networking Concepts (2)</td>
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<td>Thu, Jan 28</td>
<td>Lecture 4: Review of Networking Concepts (3)</td>
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<td>Tue, Feb 2</td>
<td>Lecture 5: Internetworking (1)</td>
<td><em>Project is out</em></td>
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<td>Date</td>
<td>Lecture Topic</td>
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<td>Thu, Feb 4</td>
<td>Lecture 6: Internetworking (2)</td>
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<td>Tue, Feb 9</td>
<td>Lecture 7: Routing Basics (1)</td>
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<td>Thu, Feb 11</td>
<td>Lecture 8: Routing Basics (2)</td>
<td><em>Research Case Study topics due</em></td>
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<td>Tue, Feb 16</td>
<td>Lecture 9: Intra-domain Routing (1)</td>
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<td>Thu, Feb 18</td>
<td>Lecture 10: Intra-domain Routing (2)</td>
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<td>Tue, Feb 23</td>
<td>Lecture 11: Inter-domain Routing (1)</td>
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<td>Thu, Feb 25</td>
<td>Lecture 12: Inter-domain Routing (2)</td>
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<td>Tue, Mar 1</td>
<td>Lecture 13: Inter-domain Routing (3)</td>
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<td>Thu, Mar 3</td>
<td>Lecture 14: Inter-domain Routing (4)</td>
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<td>Tue, Mar 8</td>
<td>Lecture 15: Transport Protocol Design (1)</td>
<td><em>Project Design Report due</em></td>
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<td>Thu, Mar 10</td>
<td>Lecture 16: Transport Protocol Design (2)</td>
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<td>Tue, Mar 15</td>
<td>Lecture 17: Transport Protocol Design (3)</td>
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<td>Thu, Mar 17</td>
<td>Lecture 18: Transport Protocol Design (4)</td>
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<td><strong>Tue, Mar 22</strong></td>
<td><em>Spring Break – NO CLASS</em></td>
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<td><strong>Thu, Mar 24</strong></td>
<td><em>Spring Break – NO CLASS</em></td>
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<td>Thu, Mar 29</td>
<td>Lecture 19: Congestion Control (1)</td>
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<td>Thu, Mar 31</td>
<td>Lecture 20: Congestion Control (2)</td>
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<td>Tue, Apr 5</td>
<td>Lecture 21: Multicast</td>
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<td>Thu, Apr 7</td>
<td>Lecture 22: Network Management</td>
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<td>Tue, Apr 12</td>
<td>Lecture 23: IPv6</td>
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<tr>
<td>Thu, Apr 14</td>
<td>Research Case Study Presentations</td>
<td><em>Research Case Study reports due</em></td>
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<tr>
<td>Tue, Apr 19</td>
<td>Research Case Study Presentations</td>
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<td>Thu, Apr 21</td>
<td>Research Case Study Presentations</td>
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<td>Tue, Apr 26</td>
<td>Research Case Study Presentations</td>
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<tr>
<td>Thu, Apr 28</td>
<td>Project Demos</td>
<td><em>Project Complete Implementation due</em></td>
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<td>Tue, May 3</td>
<td>Project Demos</td>
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<tr>
<td>Tue, May 10 (12:30pm)</td>
<td>Final Exam</td>
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Acknowledgment
The slides and other materials for this course are in part based upon the materials from a number of people/sources, including:

- Shivkumar Kalyanaraman from RPI http://www.shivkumar.org
- Official website for the Kurose & Ross text: Computer Networking: A Top-Down Approach
- Constandine Dovrolis from GTech: http://www.cc.gatech.edu/~dovrolis
- Mehmet H. Gunes from UNR: http://www.cse.unr.edu/~mgunes
- Nick Feamster from Georgia Tech: http://www.cc.gatech.edu/~feamster
- Hari Balakrishnan from MIT: http://nms.lcs.mit.edu/~hari
- Luis von Ahn from CMU: http://www.cs.cmu.edu/~biglou
- Jason D. Hartline from Northwestern: http://www.eecs.northwestern.edu/hartline
- Nicole Immorlica from Northwestern: http://users.eecs.northwestern.edu/~nickle
- Adam Wierman from CalTech: http://www.cs.caltech.edu/~adamw

Course Information - Description - Prerequisites - Textbooks - Syllabus - Organization - Grading - Schedule, Notes & Assignments - Acknowledgment

Last updated on January 13, 2016