Course Overview
This course covers the concepts and principles that underlie the transmission of continuous media, such as digital audio and video across, IP internetworks. The emphasis will be on technologies and techniques for satisfying the requirements of applications requiring real-time, low-latency delivery of media. Course topics include the representation of audio and video as a basic data type, compression methods, and techniques for effective management of continuous media data in a distributed system. Students will study the evolving Internet integrated and differentiated services network architectures for real-time communications, and learn how they can be used to establish and maintain levels of quality-of-service in a network. Protocols for wide-area dissemination of multimedia data including multicast transport, multicast routing, RSVP, and RTP will also be studied. Finally we will consider the impact of multimedia traffic on the Internet in general and on TCP-based applications in particular.

The course will have a laboratory component in which over the course of the semester students will develop a simple standards-based Internet telephone and measure its performance over the Internet.

Prerequisites
Students should have a general background in networking and distributed systems that includes a basic understanding of packet switching and internetworking based on the IP protocol suite. A first course in operating systems as well as sockets programming experience are an additional course prerequisites.

UNC courses sufficient for satisfying these prerequisites include COMP 143/INLS 186 (TCP/IP Networks and Networking Programming) and COMP 243 (Distributed Systems).

Students lacking the proper background may enroll in the course with the consent of the instructor but will be expected to acquire the necessary background on their own through readings outside of class.

Course Materials
The primary source of reading material for this course will come from papers in the literature. Copies of papers will be distributed in class throughout the course. A $30, non-fundable, course fee must be paid by all students to cover the costs of duplicating papers. The fee can be paid to Karen Thigpen at the front desk of Sitterson Hall.

In addition, there are several optional texts that students may find useful for a more introductory treatment of some of the material covered in this course. An excellent reference text, and the recommended (but not required) text for this course is:


For a more introductory treatment of multimedia computing and communications, consider:

A more in-depth reference for the sections on routing, try

**Grading and Course Credit**

Course grades will be based on the degree of completion and quality of programming assignments (35% of course grade), performance on one or more midterm examinations (25%), final examination (30%), and class participation (10%). These percentages are only approximate and subject to change without notice.

The first (and possibly only) in-class midterm examination is tentatively scheduled for Tuesday, October 12. The final examination is scheduled for Tuesday, December 14, at 12 PM.

This is a 3 credit hour course. However, graduate students from Departments other than Computer Science may elect to take this course for 1 credit hour and skip the programming assignments. *All students in the course will be required to take the midterm and final examinations.*
Course Outline

0. Introduction to multimedia
   - Survey of multimedia applications
   - Canonical application structures
   - User and application performance (“quality-of-service”) requirements

1. Audio and video as a data type
   - Audio & video coding and compression technologies
     - PCM, DPCM, ADPCM, LPC
     - DCT-based compression, motion estimation and interpolation
   - Common compression algorithms
     - JPEG, H.261, H.263, MPEG

2. The multimedia networking problem
   - Review of unicast routing in the Internet.
   - Technologies for wide-area & real-time dissemination of multimedia streams
     - Multicast routing techniques and algorithms
       - Reverse-path forwarding, core-based trees
     - Multicast routing and group membership protocols
       - IGMP, DVMRP, MOSPF, PIM, SM
     - The MBONE multicast backbone
     - Multimedia transport protocols
       - Real-time transport protocol RTP
   - The performance of interactive multimedia applications on the Internet today
     - Case study I: Videoconferencing on the Internet

3. Best-effort multimedia networking
   - Application-level protocols for best-effort real-time communication
     - Trading-off latency for delay-jitter control
     - Forward error correction
   - Adaptive congestion control
     - Media scaling and packaging
     - Reliable multicast protocols
     - Multicast congestion control
   - On the limits of best-effort communication
     - Case study II: Adaptive videoconferencing on the Internet
     - On the impact of real-time traffic on “traditional” TCP traffic

4. Quality-of-service based networking
   - The Integrated Services Architecture for the Internet
   - Resource reservation on the Internet
     - RSVP
   - Packet scheduling, admission control, and traffic management
     - Fair queuing and weighted fair queuing algorithms
• The Differentiated Services Architecture for the Internet
  — Service models
  — Active queue management
  — The Qbone quality-of-service backbone