Applied Telecommunications: TCOM500

Syllabus: Fall 2022

Instructor: Amit Katti

E-mail & MS Teams: akatti2@gmu.edu

Course Description: This course provides a comprehensive overview of telecommunications, enabling students to choose an area of expertise. Topics include every aspect of a telecom ecosystem, including but not limited to Analog Communications, Digital Communications, Transmission Systems, Communication Theory, Computer Networking, Wireline & Wireless Communications, and Regulatory Affairs. Examples of real-life networks illustrate basic concepts and offer further insight.

Prerequisites: Graduate Students or Senior +

Textbooks & Course Content: Topics covered in the course will include a selection of the material contained in the following textbooks:

- Telecommunications by Warren Hioki
- Data Networks by Dimitri Bertsekas & Robert Gallaher
- Fundamentals of Telecommunications and Networking for IT by Riki Morikawa

While a textbook is not mandatory, it is highly recommended that students refer to these for an advanced understanding of theoretical context. All course content covered during the lecture will be available in PowerPoint slides on blackboard, and these are sufficient for getting through the coursework.

Course objectives: Students will gain literacy in the understanding the fundamentals of modern telecommunication systems. The course has three major objectives:

1. Help students understand fundamental theoretical telecommunications concepts
2. Explore different aspects and areas of expertise in modern telecom industry
3. Based on the above 2 objectives, help students pick a subject matter expertise in the field of telecommunications

Communication: Registered students will be given access to a section of the Blackboard Learning System for this course. Blackboard will be used as the primary mechanism to disseminate course information, lecture slides and materials, and homework assignments. Per university policy 1315 you must use university email for all formal requests and accommodations. Failure to do so risks a FERPA violation.

Grade Distribution: Coursework is spread throughout the semester – the number of assignments that require completion on time results in a sustained effort from the students throughout the semester, thus reducing the impact of a poor performance on a single exam or assignment.

Midterm Exam	30%
Final Exam	30%
Homework	30%
Paper Author & Presentation	10%

Grading: Grades will be awarded in accordance with GMU grading system for Graduate Students. Raw scores may be adjusted as needed.

Course Completion Requirements: Students are required to adhere to the below course requirements to successfully complete the course:

- **Homework:** There will be 9 homework assignments available on blackboard. Homework will be released the day of the lecture, and students are expected to turn in their homework before midnight on the previous day of the lecture (i.e. if the lecture falls on a Tuesday, students are expected to submit the homework before 11:59 PM on Monday before that Tuesday). Failure to do so will result in the loss of a grade for that submission, no exceptions. All homework submission must be on blackboard. For mathematical formulae and equations, students are expected to represent appropriate steps using tools available at their disposal. No handwritten content will be tolerated, please use reasonable digital formats only for your submission.
- **Exams:** Exams will be conducted online on blackboard using the Respondus LockDown browser. Webcam video of the student taking the exam will be automatically processed by the Respondus application, and any anomalies (e.g., persons entering the room, additional voices, absence of the student from the camera view, etc.) will be recorded and flagged for the instructor to review. For the duration of the exam online, students are not allowed to leave the room (i.e., disappear from the webcam view) except for emergency or urgent reasons. It is the responsibility of the student to contact the instructor if this is the case. If no reasonable explanation is given by the student for leaving the room, then a grade of 0% will be automatically assigned for the exam. Therefore, students should plan accordingly prior to starting the exam.
    - All exams are closed notes, closed book, and test the student's conceptual understanding and problem-solving abilities. Except for the computer used to take the test, no other computer is permitted.
    - Students must bring proper photo identification (Student ID, Driver license, etc.). You will be asked to display your photo ID to the webcam.
    - Scrap paper is allowed for calculations. Students are required to show the scrap paper on the camera before using it.
    - It is the student's responsibility to ensure that schedules are clear for the final exam, no exceptions. Make up exams will be offered to students with legitimate reasons.
- **Paper Presentation:** Each student will have to develop a research paper and make a brief class presentation, that will be evaluated on the technical content and on the quality of presentation. The research paper should address a technological advancement or development in Telecommunications. The research paper must use the IEEE conference paper format.
- **Honor Code:** All members of the Mason community are expected to uphold the principles of scholarly ethics. On admission to Mason, students agree to comply with the requirements of the GMU Honor System and Code. The Honor Code will be strictly enforced in this course! Any use of the words or ideas of another person(s), without explicit attribution that clearly identifies the material used and its source in an appropriate manner, is plagiarism and will not be tolerated. All student written work will be submitted via plagiarism tools such as SafeAssign.

Special Accommodations: The Office of Disability Services (ODS) works with disabled students to arrange for appropriate accommodations to ensure equal access to university services. Any student with a disability of any kind is strongly encouraged to register with ODS as soon as possible and take advantage of the services offered. Accommodations for disabled students must be made in advance – ODS cannot assist students retroactively, and at least one week's notice is required for special accommodations related to exams. Any student who needs accommodation should contact the instructor during the first week of the semester to allow sufficient time to make arrangements. The accommodations provided will be limited only to those specified on the ODS form.

Course Schedule

Session#	Description	Dates
1	**Introduction to the course** • Sine Wave – Concepts of Phase, Frequency, Wavelength • Time Domain vs Frequency Domain • Concept of dB (and why use it?) • Basic Communications Concepts: S/N, C/N, BER • Difference between Performance & Availability • Modulation of Analog Carriers: Analog (AM, FM, PM) vs Digital (ASK, FSK, PSK, QAM)	**8/23/2022**
2	**Building blocks of Telecommunications Systems** • Digitization, Sampling, Quantization, concept of Spectral Efficiency • TDM, FDM • Digital Communications System (Source <> Encoder <> Modulator <> Channel <> Demodulator <> Decoder <> Destination • Shannon Hartley Theorem: Channel Capacity vs Bandwidth • Line Coding & Error Control	**8/30/2022** **HW 1 Due**
3	**Communications Theory** • EM Wave Propagation & Polarization • Power Density & Antenna Theory • System Noise Temperature, Noise & Interference, Attenuation • Link Budgets • Multiplexing: TDM, FDM •Channel Access: TDMA, FDMA, DAMA, CDMA, OFDMA	**9/6/2022** **HW 2 Due**
4	**Transmission Systems - 1** • SNR, Propagation Delay • Guided Propagation (UTP, Fiber Optic Cables, TIR) • Unguided propagation (RF Microwave, Satellite, Free Space Optics) • Source Coding vs Channel Coding • Concept of Baseband & Passband Signal	**9/13/2022** **HW 3 Due**
5	**Transmission Systems – 2** • Serial Transmission • Transmission Media (Coax, UTP, SMF, MMF) • OSI 7 Layer Model è DoD TCP/IP Model • Data Transmission Standards Introduction (IEEE 802.x, DVB)	**9/20/2022**
6	**Paper Presentation Introduction** **Mid Term Review**	**9/27/2022** **HW 4 Due**
7	**Mid Term Exam**	**10/5/2022**
8	**Fall Break - No Class**	**10/11/2022**
9	**Computer Networking - 1** • LAN Networking Devices • Routing vs Switching • IP Addresses, Introduction to Subnetting, IPv4 & IPv6 • 802.3 Ethernet • 802.11 Wireless LAN • Firewalls, NAT vs PAT	**10/18/2022**

10	**Computer Networking – 2** • WAN Networking Devices • T-1, FR, ATM • SONET, WDM, Carrier Ethernet • SD-WAN • Network Infrastructure (Data Centers, Cloud Computing) • Cyber Security & Computer Networking	**10/25/2022**
11	**Cellular Communications** • Introduction, Concept of Cells, Frequency Reuse, Frequency Borrowing etc • Fundamental concept of Signaling/Control, Traffic Channels • History of Cellular Communications & different Paths (CDMA / GSM) • Fresnel Zones, Path Loss, Multipath Fading, Diffraction • 1G & 2G • 3G, 4G & 5G	**11/1/2022** **HW 6 Due**
12	**Satellite Communications** • LEO, MEO & GEO • Satellite Payloads & Applications • RF Ground Station • Baseband Ground Station • What's out there: Starlink, Kuiper, OneWeb, o3b mPOWER etc	**11/8/2022** **HW 7 Due**
13	**Voice Communications & Economics of Telecommunications** • PSTN, PBX, CENTREX, ACD • PSTN evolution to VoIP • SIP, RTP, SRTP • What factors drive technology? • Telecommunication Economics & Financial Analysis • R&D, Products, Services • Systems Engineering & Integration	**11/15/2022** **HW 8 Due**
14	**Future of Telecom** • Future of Telecommunication Systems • Sensors, IoT & contribution to 5G • LoRa, TOR, Dark Web, Quantum Networking • Encryption, Cryptography & VPNs • Software defined radio	**11/22/2022** **HW 9 Due**
15	**Regulatory Affairs** • Role of FCC & ITU in Telecommunications • Transmit Authority • Spectrum Regulation necessity • Host Nation Agreements • Other topics TBD	**11/29/2022**
16	**Paper Presentations** **Final Exam Review**	**12/6/2022** **Paper Due**
17	**Final Exam**	**12/13/2022**