Course Name: Wireless Communications and Networking

Course Number: EE 517

Credits: 3-0-0-3

Prerequisites: EE-304 Communication Theory, EE-503 Advance Communication Theory or their equivalents, or the instructor's consent

Intended for: UG/PG

Distribution: Elective

Semester: Even or odd

Preamble: The proposed elective course, building on top of discipline core course on *Communication Theory* (EE304) and another elective on *Advanced Communication Theory* (EE503), offers first formal introduction to wireless communication and networking. It aims at introducing students to model various wireless communication scenarios, design schemes to achieve desired performance, and analyze performance of those schemes.

Course Objective: After students have gone through a course on basic communication systems, where they learn about different analog and digital modulation schemes, to evaluate their performance in the presence of noise, and the concepts of signal sampling and quantization; and another course on advanced communication systems where they learn about carrier and symbol synchronization, channel equalization, multichannel and multicarrier systems and get their first formal introduction to Information Theory, a first course on wireless communications and networking should teach the students how to model different wireless communication scenarios, how to compute information-theoretic capacity of some such scenarios, how to design schemes to communicate over such scenarios, and how to evaluate the performance of such schemes. On completion of such a course, students should be able to

- demonstrate their familiarity with various characteristics of wireless communications and approaches to model some such wireless communication scenarios
- compute information-theoretic capacity of various wireless communication scenarios
- demonstrate their knowledge of major schemes to achieve communication objectives in different wireless communication scenarios
- evaluate the performance of various communication schemes for wireless communications
- familiarity with various protocols and standards for different wireless networking applications

Course Modules:

1. <u>Review of Information Theory, and Detection and Estimation Theory</u>: channel coding theorems, capacity of various channel models; detection and estimation in additive Gaussian noise. (3 hours)

2. <u>Wireless Channel:</u> Path loss, Physical modeling, I/O models, Channel models. (4 hours)

3. <u>Point to Point Communication:</u> Detection in Rayleigh fading channels, Diversity: time, frequency, antenna, receiver and transmitter; Impact of channel uncertainty.   (5 hours)

4. <u>Capacity of Wireless Channels:</u> AWGN channel capacity, LTI Gaussian channels, Capacity of fading channels.   (4 hours)

5. <u>Multiuser Channel Capacity:</u> Up/down-link AWGN channel, Up/down-link fading channel, frequency selective fading channels, multiuser diversity.   (5 hours)

6. <u>MIMO Channels:</u> Physical modeling, Slow and fast fading channels, Capacity, Multiplexing architectures: V-BLAST and D-BLAST, Diversity gain, Diversity-multiplexing tradeoff and universal code design for optimal DM tradeoff, Multiuser communication.   (9 hours)

7. <u>Cellular Systems:</u> Channel reuse, Multiple access, Interference management, Dynamic resource allocation: Cognitive Radio, Narrowband systems: GSM, Wideband systems: OFDM and CDMA, Cellular phone standards.   (9 hours)

8. <u>Other Topics:</u> Wireless LANs: Aloha, CSMA/CA, Protocols, Mesh networks: capacity, routing, and scheduling.   (3 hours)

Reference Books:

1. D. Tse and P. Viswanath, *Fundamentals of Wireless Communication*, Cambridge Univ. Press, 2005.

2. A. Goldsmith, *Wireless Communications*, Cambridge Univ. Press, 2005.

3. A. Kumar, D. Manjunath, and J. Kuri, *Wireless Networking*, Morgan Kaufmann, 2008.

4. B. Clerckx and C. Oestges, *MIMO Wireless Networks*, Academic Press, 2/e, 2013.

5. Related research papers.