Approved in 36th BoA Meeting

Course Name: Advance Wireless Technologies
Course Number: EE641
Credits: 3-0-0-3
Prerequisites: EE304, EE503.
Intended for: UG and PG.
Distribution: Discipline elective for 3rd/ 4th year B.Tech. (CSE and EE)/ MS/ M.Tech./ PhD and free elective for other branches.

Preamble:
This course will introduce various next generation wireless technologies to the students. The objective of the course is to help students to analyze, compare and verify the performance and suitability of the recent and upcoming wireless technologies. A firm understanding of the fundamentals of these next generation wireless technologies will motivate the students to take up challenging projects/ research problems in the related fields.

Learning outcome:
After taking this course, students will

1. be familiar with the upcoming wireless technologies of the next generation networks.
2. develop an intuitive understanding of various key wireless technologies unique to 5G networks.
3. get an analytical and conceptual understanding of the wireless technologies.
4. learn to analyze the performance of various aspects of the next generation wireless techniques, and conduct simulations to corroborate the analytical results.
5. The course will expose the students to the challenges in the next generation wireless technologies and hence will provide a platform to do cutting edge research.

Modules:
Introduction: (7 lecture hours) Challenges of next generation wireless networks. Basics of wireless communications, multipath propagation and fading nature of wireless channel, BER. Performance of multi-antenna wireless systems, precoding and power allocation for multi-user MIMO systems.

Cognitive Radio Systems: (5 lecture hours) Concepts, challenges of Software Defined Radio (SDR), spectrum-sensing techniques, optimal power allocation, Interference suppression, and robust detection.

Massive MIMO Systems: (7 lecture hours) Introduction and challenges. Signal processing with perfect & imperfect channel state information, rate scaling, performance of multi-cell massive MIMO systems and spatial modulation.

mmWave/THz Wireless Systems: (6 lecture hours) Introduction, properties and modeling of wireless channels, analog, digital and hybrid processing, sparse processing, channel estimation, optimal precoders and combiners.

Cooperative Wireless Communication: (6 lecture hours) Introduction to cooperative communication and cooperation protocols (AF, DF, and SDF). Performance analysis of DF for MIMO and multi-relay wireless systems.

Non-Orthogonal Multiple-Access (NOMA): (6 lecture hours) Introduction, system model and decoding for NOMA systems. Outage probability, opt. performance, average rate, key aspects of uplink and downlink NOMA systems.

Full-Duplex Wireless Technology: (5 lecture hours) Introduction, self-interference and resulting performance. Optimal signal processing, power allocation and performance of FD Systems.

Optional topics:

Molecular Communication, Backscatter Communication, Energy Harvesting, Low Power Wide-area Networks (LPWA), Long Range Wireless Transfer (LoRa), D2D, Distributed MIMO, Physical layer caching and Physical layer security.

Key Text books:

1. Luo, Fa-Long and Zhang, Charlie (Jianzhong), Luo, Fa-Long, *Signal processing for 5G: algorithms and implementations,* Wiley-IEEE Press, 2017.
2. Wei Xiang, Kan Zheng, Xuemin - 5G Mobile Communications, Springer, 2017.

Key Reference Material:

1. Wong V., Schober, R., Ng, D., & Wang, L. (Eds.), *Key Technologies for 5G Wireless Systems*. Cambridge, 2017.
2. Dahlman, E., Parkvall, S., & Sköld, J., *5G NR: The next generation wireless access technology*. Elsevier 2018.
3. A. Chockalingam, B. S. Rajan, *Large MIMO Systems*, Cambridge, 2014.
4. Liu, K., Sadek, A., Su, W., & Kwasinski, A, *Cooperative Communications and Networking*. Cambridge University Press, 2008.
5. Tho Le-Ngoc, Ahmed Masmoudi, *Full-Duplex Wireless Communications Systems*, Springer, 2017.
6. Biglieri, Ezio, Andrea J. Goldsmith, Larry J. Greenstein, Narayan B. Mandayam and Herve Vincent, *Principles of Cognitive.* Cambridge, 2012.
7. N. Farsad, H. B. Yilmaz, A. Eckford, C. Chae and W. Guo, "A Comprehensive Survey of Recent Advancements in Molecular Communication," in *IEEE Communications Surveys & Tutorials*, vol. 18, no. 3, pp. 1887-1919, 2016.

Content Similarity Declaration with Existing Courses: N/A

Sr #	Course code	Similarity content	Approx. % of content
1	EE517: Wireless Communication and Networking	Basics of wireless communications, multipath propagation and fading nature of wireless channel, BER. Performance of multi-antenna wireless systems.	21 %

Justification for new course proposal if cumulative similarity content is > 30%:
N.A.

Approvals:
Other Faculty who may be interested in teaching/co-teaching this course:

Dr. Samar Agnihotri
Dr. Satyajit Thakor
Dr. Gopi Shrikanth Reddy

Proposed by Dr. Adarsh Patel **School**: SCEE

Signature:

Date

Recommended/Not Recommended, with Comments:

Date: Chairman, CPC

Approved / Not Approved

Date: Chairman, Senate