

**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI,
HYDERABAD CAMPUS
FIRST SEMESTER 2022-2023
Course Handout (Part-I)**

Date: 15/08/2022

Course No. : **EEE G614**

Course Title : **Advanced Wireless Communications.**

Instructor-in-charge :Dr. Prashant K. Wali

Course Description:

Evolution of wireless cellular technologies to 5G and beyond, review of matrix and signal theory for communication applications, introduction to stochastic geometry for performance analysis of wireless networks, D2D communications- modeling and analysis, cooperative communications-buffer-aided relaying and performance analysis, modulation and multiple access techniques NOMA, OTFS, OAM. Introduction to potential technologies for beyond 5G/6G communications: IRS, molecular communications, and AI in wireless communications

Scope and Objective:

With the exponential increase in the number of mobile devices there has been a lot of advancement in industrial and academic research towards designing and modeling the new heterogeneous wireless communication networks. The advances in the wireless communications have been in the new techniques for modulation, multiple access, and network designing.

- a) This course aims to introduce the students to the advances in the wireless communications and expose them to the research options available for applications in the real world implementation of the next generation wireless networks.
- b) The course will introduce the students to current trends in the wireless industry with a specific focus on the 5G communication networks.
- c) The course aims to equip students with tools for designing the engineering aspects of the wireless communications.
- d) New techniques envisaged to be a part of the next generation wireless networks like the D2D communications, NOMA, OTFS, and stochastic geometry applied to wireless communications, to name a few, will be covered to make the student industry and research ready.

Text Book(s):

1. David Tse and Pramod Viswanath, Fundamentals of Wireless Communications, Cambridge University Press.
2. Stefan Sesia, Issam Toufik and Mathew Baker, "LTE-The UMTS Long Term Evolution, From Theory to Practice", Wiley, 2nd Edition.
3. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", Wiley, 2015.
4. M. Haenggi, Stochastic Geometry for Wireless Networks. New York, NY, USA: Cambridge Univ. Press, 2013.

Reference Book(s):

1. Andrea Goldsmith, Wireless Communications, Cambridge University Press.
2. Steven Kay, Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory, Prentice Hall.

3. C. Johnson, 5G New Radio in Bullets. Independent Publishing, ISBN: 978-1081444594,2019.
4. Asif Oseiran, Jose F. Monserrat and Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016.
5. Patrick Marsch, Omer Bulakci, Olav Queseth and Mauro Boldi, "5G System Design Architectural and Functional Considerations and Long Term Research", Wiley, 2018.
6. D. Stoyan, W. Kendall, and J. Mecke, Stochastic Geometry and Its Applications, 2nd ed., New York, NY, USA: Wiley, 1987.

Reference papers (suggested, will be updated):

1. J. G. Andrews et al., "What will 5G be?", *IEEE J. Sel. Areas Commun.*, vol. 32, no. 6, pp. 1065-1082, Jun. 2014.
2. A. Asadi, Q. Wang and V. Mancuso, "A survey on device-to-device communication in cellular networks", *IEEE Commun. Surveys Tuts.*, vol. 16, no. 4, pp. 1801-1819, Nov. 2014.

Lecture No.	Topic	Learning Objective	Ref. To TB/RB
1	Evolution of wireless communications and technologies	How wireless communication has evolved, wireless systems, cellular networks.	Text Book [1] Ref [1]
2 -12.	Recap of fundamentals of wireless communications	The Wireless Channel, Point-to-Point Communication: Detection, Diversity and Channel Uncertainty, Time Diversity, Frequency Diversity, Space Diversity, Transmit Diversity, Receive Diversity, Beamforming, V-BLAST, Opportunistic Communication, MIMO Techniques, , Space time codes, multiuser communication.	Text Book [1] Ref [1]
13-20	4G LTE Technology: From Theory to Practice	4G Physical Layer Frame Structure, OFDM, Traffic Scheduling, Peak Data Rate, Channel Estimation Techniques; MLE, MAP. MMSE.	Text Book [2], published papers and Internet Resources.
21-22	Evolution of requirements from 4G to 5G and enabling technologies	Key Performance Parameters, Peak data rate, Application Scenarios,embb traffic, URLLC and so on, Evolution of Existing RATs (NR, new modulation techniques, Massive MIMO), Hyperdense Small-Cell Deployment, Self-Organising Network, Machine Type Communication, Developing Millimetre-Wave RATs, Redesigning Backhaul Links, Energy Efficiency, Allocation of New Spectrum for 5G, Spectrum Sharing, RAN Virtualisation	Text Book [2] Ref [2], Ref[3], Ref[4] and published papers, Internet resources.
23-25	New Radio for 5G	Designing New Radio for 5G, Waveform in 5G numerology, Frame Structure in 5G Numerology, Adaptive subcarrier bandwidth	Published papers, 3GPP standards, Internet resources (Will be provided as and when used)
26-32	Modulation and multiple access techniques	NOMA, Power Domain NOMA, SCMA. SIC, OTFS.	Published papers and Internet Resources. (Will be provided as and when used)
33-40	Introduction to stochastic geometry for performance analysis of wireless networks, D2D communications- modeling and analysis.	Mathematical foundations of Stochastic Geometry, Point Processes, Modeling HetNets and Dense Networks using Stochastic Geometry, Performance Analysis of Wireless Networks, D2D Communications, its modeling and analysis.	Text Book [3] Ref [5], Other published papers and Internet Resources

2. Evaluation Scheme

Component	Duration	Weightage	Marks	Date & Time	Evaluation type
Mid sem	90 min	30%	60	01/11 9.00 - 10.30AM	Closed Book
Lab		15%	30	-	Open Book
Term Project (Research Paper presentation and extension of ideas + Report)		25%	50	-	Open Book
Compre. Exam.	3 hours	30%	60	20/12 FN	Closed Book
Total			200		

5. Chamber Consultation Hour: To be announced in the class
email: wali@hyderabad.bits-pilani.ac.in
Notices: EEE Notice Board and CMS.

6. Make-up Examination:

Make-up examination will be given only in **extremely genuine cases** for which prior permission of the instructor-in-charge is required.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable

Instructor-in-charge
EEE G 614