

## ECE4221: Fundamentals of 5G Wireless Systems

Programme: B. Tech. (ECE)

Year: 4<sup>th</sup>Semester: 1<sup>st</sup>

Course: Program Elective

Credits: 3/4

Hours: 40

**Course Context and Overview (100 words):** 5G would play a prominent role in meeting the requirements of continuously increasing demand of high data rate, high reliability, low latency and good Quality of Experience in the next generation wireless communication. This course is focused on developing the fundamentals of 5G wireless technologies including D2D Communication, Massive MIMO, Small Cells, Cloud-RAN. Various modulation, multiplexing and multiple access schemes are covered, which are necessary for the design and analysis of 5G wireless systems. Further, a notion of cooperative relaying in the context of energy harvesting and UAV communication would also be introduced for optimal resource allocation in 5G.

**Prerequisites Courses:** Digital Communication, Wireless Communication.

**Course outcomes (COs):**

On completion of this course, the students will have the ability to:
CO1: Learn about the basics of modern wireless technologies like D2D, Massive MIMO, CRAN
CO2: Apply modulation techniques such as spatial, index modulation in 5G wireless communication
CO3: Implement novel multiplexing formats based communication systems viz. GFDM, FBMC
CO4: Analyze the performance of green and aerial 5G wireless communications systems

**Course Topics:**

Topics	Lecture Hours	
<b>UNIT – I. Introduction to 5G</b>		6
1.1 Evolution of 3G, 4G /LTE/ LTE-A cellular standards	2	
1.2 5G NR Application Scenarios: eMBB, URLLC and MMTC	4	
<b>UNIT – II. Modulation, Multiplexing and Multiple Access Technologies in 5G</b>		14
2.1 Novel modulation schemes: Spatial modulation, Index modulation	4	

2.2 Novel Multiplexing Formats; GFDM, FBMC and UFMC	5	
2.3 Multiple access; SCMA, Power Domain NOMA, SDMA	5	
<b>UNIT – III. Massive MIMO and D2D Communication</b>		
3.1 Introduction to Massive MIMO systems - key features	2	10
3.2 Signal processing for Massive MIMO with perfect CSI	2	
3.3 Fundamentals of D2D communication	2	
3.4 Multichannel allocation in underlay D2D communication	4	
<b>UNIT – IV. Special topics in 5G Wireless</b>		
4.1 Network Densification; small cell concepts	3	10
4.2 Cooperative wireless communication in UAV and green 5G network	5	
4.3 mm-Wave communication for 5G	2	

#### Textbook references (IEEE format):

1. A. Osseiran, “5G Mobile and Wireless Communication Technology”, Cambridge Univ. Press.

#### Reference books:

1. S. Haykin & M. Moher, “Modern Wireless Communication”, Pearson Education.
2. Fa-Long Luo, “Signal Processing for 5G: Algorithms and Implementations”, Wiley.
3. A Chockalingam, “Large MIMO Systems”, Cambridge Univ. Press.

#### Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.): NPTEL Course Link

<https://nptel.ac.in/courses/108/105/108105134/>

#### Evaluation Methods:

Evaluation criteria will be shared by the concerned course instructor.

**Instructor: Dr. Anirudh Agarwal (ECE)**