The LNMIIT, Jaipur
Electronics and Communication Department
Next-generation Wireless Technology (ECE-XXX)

Subject Code: **ECE-XXX**	Course Title: **Next-generation Wireless Technology**	Total Contact Hours: **40**	**L: 3**	**T: 0**	**P: 0**	**C: 3**
Pre-requisite: Digital Communication, Wireless Communication		Year: **2**	Semester: **Odd**			

***** L → Lectures, T → Tutorials, P → Projects C → Credit***

Learning Objective:

The objective of the course is to introduce students to recent advances in wireless technology from the physical layer perspective. Key enabling technologies are identified and discussed along with their performance over various fading channels. Specifically, advanced technologies such as massive MIMO systems, cooperative communications, cognitive radio, AI and ML technologies, intelligent reflecting surfaces (IRS) etc. are studied. Moreover, as energy consumption minimization is a crucial factor in the current and next-generation wireless technology, therefore, concept of energy harvesting into next generation wireless networks is introduced. Finally, the physical-layer security approaches are introduced to enhance the secrecy performance of next-generation wireless networks under various security threats and misuse activities. MATLAB demos and simulation assignments will aid the students to get a better understanding about the course.

Course outcomes (COs):

On completion of this course, the students will have the ability:		**Bloom's Level**
CO-1	**Learn** about the fundamentals of current and next-generation wireless technology.	**2**
CO-2	**Identify** and **discuss** key enabling technologies along with their performance over various fading channels.	**1, 2**
CO-3	**Learn** about the application of AI and ML technologies for future wireless communication.	**2**
CO-4	**Develop** the basics of energy harvesting into next generation wireless networks.	**3**
CO-5	**Explain** the basic concepts of physical layer security and **evaluate** the secrecy performance of next-generation wireless networks.	**2, 5**
CO-6	**Design** and **understand** the MATLAB simulation techniques to verify the performance analysis of next generation systems.	**6, 2**

Course Topics	**Lecture Hours**	
UNIT – I (Introduction)		**5**
1.1 Evolution of 3G, 4G /LTE/ LTE-A cellular standards, 5G, Pillars of 5G, standardization activities, use cases and requirements.	**3**	
1.2 Spectrum and Regulations: Spectrum for 4G, spectrum challenges in 5G, spectrum landscape and requirements, limitations of 5G; requirements and vision of the 6G wireless communication.	**2**	
UNIT – II (Key Enabling Technologies I)		**10**
2.1 Introduction to massive MIMO systems: Linear precoding and decoding,	**4**	

channel estimation, performance of massive MIMO.		
2.2 Fundamentals of cooperative communications: Preliminaries of relaying, half-duplex versus full-duplex relaying, relay protocols, performance of cooperative relaying.	**3**	
2.3 Basics of cognitive Radio: Definition and overview, capacity of cognitive radio networks (Underlay and Overlay).	**3**	
UNIT – III (Key Enabling Technologies II)		**9**
3.1 Fundamentals and applications of intelligent reflecting surfaces (IRS), Channel Estimation in IRS aided wireless network systems, IRS assisted D2D communications, IRS for Wireless Power Transfer (WPT).	**5**	
3.2 Application of AI and ML technologies for future wireless communication (an overview): Research challenges and opportunities, novel design of deep-learning and convolutional neural network approaches for wireless system applications.	**4**	
UNIT – IV (Wireless Energy Harvesting)		**8**
4.1 Introduction, linear and non-linear energy harvester.	**2**	
4.2 Energy harvesting protocols: Power splitting (PS) and time-switching (TS).	**3**	
4.3 Rate-energy (R-E) tradeoffs for simultaneous wireless information and power transfer (SWIPT), performance analysis.	**3**	
UNIT – V (Physical Layer Security)		**8**
5.1 Fundamentals of physical layer security (PLS), possible countermeasures for 6G.	**2**	
5.2 Artificial noise and jamming aided PLS.	**2**	
5.3 Secure cooperative relay networks: System design, secrecy performance analysis.	**2**	
5.4 Secure cognitive radio networks: System design, secrecy performance analysis.	**2**	

Textbook References:
The course is based on lecture notes and a list of research papers from recent IEEE conferences and journals, both of which will be provided by the course instructor. The following textbooks can serve as good references:

Text Books:
Theodore S. Rappaport, *Wireless Communications: Principles and Practice*, Prentice Hall.

Reference books:
1. S. Haykin & M. Moher, *Modern Wireless Communication*, Pearson Education.

2. K. J. R. Liu, A. K. Sadek, W. Su, and A. Kwasinski, *Cooperative Communications and Networking*, Cambridge, U.K.: Cambridge Univ.Press, 2008
3. Manish, M., Devendra, G., Pattanayak, P., Ha, N., *5G and Beyond Wireless Systems PHY* Layer Perspective, Springer Series in Wireless Technology.
4. F.-L. Luo, *Machine Learning for Future Wireless Communications*. Hoboken, NJ, USA: Wiley, 2020.

Evaluation Methods:

Reviews and presentation: Students will be provided with 1-2 research papers after every alternate class. They will be asked to read the papers and write a short review (2-3 paragraphs) explaining the important aspects (central idea, pros, cons) of the papers. A format of the review will be provided beforehand. The presentation will include one oral presentation per student (likely in the second half of the semester). A list of topics/papers relevant to the course will be provided to choose from.

Item	Weightage (%)
Reviews and presentation	20
Assignment	10
Term Paper	20
Midterm	20
Final Examination	30

CO and PO Correlation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1						2	1		3	3	1	
CO2	3	3	2						2	1		3	3	1	
CO3	3	3	1						2	1		3	3	1	
CO4	3	2	1						2	1		3	3	1	
CO5	3	3	1						2	1		3	3	1	
CO6	3	3	3	2					2	1		3	3	2	2

The LNMIIT, Jaipur Electronics and Communication Department Next-generation Wireless Technology (ECE-XXX)	

Last Updated On:

Updated By: Dr. Mahendra Shukla, Dr. Anirudh Agarwal

Approved By: