BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

SECOND SEMESTER 2020-21
COURSE HANDOUT

Date: 04.01.2021

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : **EEE F431**
Course Title : **Mobile Telecommunication Networks**
Instructor-in-Charge : **Dr. Syed Mohammad Zafaruddin**
Instructor(s) : **NA**
Tutorial/Practical Instructors: NA

1. Course Description: Fundamentals of mobile telecommunications, with an overview of first generation (analog) systems and more detailed coverage of second generation (digital) technologies; technology basics including descriptions of wireless network elements, spectrum allocation, frequency re-use, characteristics of the transmission medium; over the-air (OTA) interface characteristics; capacity, coverage, speech coding, channel coding and modulation techniques of TDMA and CDMA technologies; network characteristics; architecture, signaling, element management of IS-41 and GSM networks; call processing; call setup and release, handoff, roaming, advanced services; mobile data communications; circuit and packet switched data services, third generation (wideband data) mobile communications system requirements/ architecture.

2. Scope and Objective of the Course: This course is an introduction to the field of mobile telecommunication systems and networks. The signal propagation, modulation and coding, multiplexing and link improvement techniques used in mobility management in wireless networks will be emphasized. At the physical layer, mitigation techniques for deep fading in narrowband as well as wideband mobile systems will also be discussed. At the MAC layer, the course covers multiple access and various standard protocols employed in mobile telecommunication networks. The second and third generation wireless systems will be studied thoroughly to impart the basic concepts involved in cellular operation. Different traffic routing techniques will also be discussed. Architectural and functional discussion of different wireless networks like GSM, CDMA, UMTS, WLAN, and LTE will also be introduced. Further concepts like multi-carrier modulation, Multi-user MIMO will be introduced to apprise the students of the latest trends in mobile networks. After completion of the course students will be able to understand and analyze mobile communication systems and networks. Students will also be exposed to simulate different modules of mobile networks, and analyze the impact of fading on the system performance.

3. Text Books:
T1: Wireless Communication Principles and Practice" by Theodore. S. Rappaport Second Edition. Pearson education, 2010.

4. Reference Books:

[R1]: ``Wireless communication", Andrea Goldsmith, second edition, Cambridge press, 2010.

[R2] Wireless and cellular telecommunications" by William C.Y. Lee, third Ed. McGrawHill, 2006.

[R3]: "Wireless and Mobile Network Architectures" by Yi-Bing Lin and Imrich Chaltamac, Wiley, 2001.

[R4]: "Principles of mobile communication" by Stuber Gordon L., third edition, Springer 2013.

[R5]: LTE -the UMTS Long Term Evolution from Theory to Practice, Second edition, Wiley 2011.

5. Course Plan:

Module No.	Lecture Session	Reference	Learning Objectives
(0) : Introduction to Mobile Communications and Networks	1-2: Overview of the course, general introduction, OSI Model, Summary of Linear Systems and Single-User Communication under AWGN	T1: chapter 1 R1: chapter 1	Motivation to study and fundamental basis required for the course.
(I): Wireless Channel Modelling	3-5: Motivation to channel modeling, large-scale propagation effects, two-ray models, path-loss, Shadowing, Log-Normal fading, Empirical models for 2G/3G/4G/5G channels (Okumura, Hata, ETSI, ITU-T), Cell Coverage and planning.	T1: chapter 4 R1: chapter 2	Study on physical behavior of signal propagation in mobile environments. This will help in developing PHY layer algorithms.
	6-10: Small-scale propagation effects, multipath fading, Doppler spread, delay spread, Clarke's model, level crossing, fading types, Narrowband, Wideband, statistical wireless models (Rayleigh, Rician, Nakagami etc), ITU-T 5G fading model.	T1: chapter 5 R1: chapter 3	
(II): Mitigation of Fading Effects	11-14: Flat fading, diversity techniques, diversity combining methods (MRC, SC, EGC), Macroscopic diversity, Spatial diversity, MIMO Systems: Capacity, Single-user, multiple user, water-filling algorithm.	T1: chapter 7 R1: chapter 7,10	Exploitation of independent multipath signal propagation to deal with deep fading in narrowband systems.
	15-20: Frequency selective channel, Multicarrier, OFDM.	T1: chapter 7 R1: chapter 11, 12	Mitigation of ISI with signal processing techniques and using multicarrier modulation in wideband systems.
	21-21: Duplexing: Half Duplex, Full duplex, FDD, TDD	T1: chapter 9 R1: chapter 14	Interference avoidance in uplink and downlink transmission for a single user.

(III): **Duplexing and Multiple Access Systems (MAC Layer)**	22-24: Multiple Access: FDMA, TDMA, CDMA, Random Access Protocols (ALOHA, CSMA)	T1: chapter 9 R1: chapter 14	Multiuser transmission methods and notion of interference.
(IV) : **Cellular Systems**	25-29: Cellular Concept, frequency reuse, Hand-off, Interference (CCI, ACI), System capacity and Coverage (cell-splitting, sectoring etc.), Traffic capacity and Trucking.	T1: chapter 3 R1: chapter 15	Coverage and capacity enhancement for multiuser communications.
(V): **Wireless Networking Protocols**	30-31: Introduction to wireless networks, Protocol layers, Cross-Layer Design (MAC and PHY), Traffic routing (circuit switching, packet switching, X.25), Channel Signaling (CCS, SS7), ISDN.	T1:chapter 10 R1: chapter 16	Different protocols for data packet transmission in wireless networks.
(VI): **Mobile Wireless Systems and Standards**	32-34: 1G & 2G: AMPS &ETACS, FM, GSM Standard, Architecture, Radio Subsystem, Call processing and setup, Roaming, GMSK, Frame Structure, Speech and Channel Coding, IS-41, IS-95 CDMA Standard: PN sequence, OQPSK, Convolution Codes, Multiuser interference.	T1: chapters 6, 8 &11 R1:chapter 1	Technical evaluation of various cellular and wireless systems. PHY and MAC layer specifications (spectrum allocation, modulation, channel coding, speech coding, data rate, multiple access and duplexing techniques, over-the air interface, services, signaling and switching, etc.).
	35-35: 3G: CDMA2000, QPSK, IMT2000/UMTS, Specifications	T1: chapters 6 & 11	
	36-37: 4G: LTE-Advanced, 3GPP, OFDMA, QAM, Multiuser-MIMO, Resource Block.	3GPP Technical Document	
	38-39: 5G, Radio interface, Milli-meter waves, Energy Efficiency, Full Duplex, M2M, D2D, Massive MIMO.	3GPP and Research Papers	
	40-41: Wireless Networks: WLAN (IEEE 802.11 PHY), Wireless Sensor Network, Ad hoc network, GPS, ISM Bands.	T1: Chapter 2 Research Papers	
	42: Emerging Trends: 6G Wireless Communications	Research Papers	

6. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of component (Close Book/ Open Book)
Mid-Semester Test	90 Min.	25	<TEST_1>	Open Book
Comprehensive Examination	2 h	35	<TEST_C>	Close/Open Book
Quizzes	-	20	Spread Across Semester	Close Book
Assignments	-	10	TBA	Open Book
Project	-	10	TBA	Open Book

7. Chamber Consultation Hour: 5PM on lecture hour

8. Notices: All notices will be displayed on the Learning Management System (LMS-NALANDA)

9. Make-up Policy: No make-up will be given for Assignments and Quizzes. However, for other components, make-up will be allowed ONLY in genuine cases. In such cases students must produce enough proof or must have taken the prior permission from the IC.

10. Note (if any):

Instructor-in-charge
Course No. EEE F431