BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
WORK INTEGRATED LEARNING PROGRAMMES

COURSE HANDOUT

Part A: Content Design

Course Title	Wireless & Mobile Communication
Course No(s)	SS ZG520 / MEL ZG520/ES ZG520/CSI ZG520
Credit Units	
Content Authors	

Course Objectives

No	Course Objective
CO1	To learn the fundamentals of Mobile telecommunication systems and wireless networks.
CO2	To learn different modulation schemes and radio propagation models used in communication systems.
CO3	To learn multiple access techniques used in wireless networks.
CO4	To learn modern wireless communication systems.
CO5	To learn traffic routing in wireless networks.

Text Book(s)

T1	"Wireless Communication Principles and Practice" by Theodore. S. Rappaport Second Ed., Prentice Hall of India, 2008.
T2	"Wireless Communications and Networks" by William Stallings – Pearson Education Ltd.

Reference Book(s) & other resources

R1	"Mobile Communication" by Jochen H. Schiller, Addison –Wesley, Pearson Education Ltd., 2000.
R2	"Wireless and Mobile Network Architectures" by Yi-Bing Lin and Imrich Chaltamac, John Wiley and Sons, 2001.

Syllabus Content

1. **Introduction**
   1.1. Introduction to Wireless Communication systems
   1.2. Overview of Mobile Networks

2. **Modern Wireless Communication systems**
   2.1. Second Generation (2G) cellular networks
   2.2. Third Generation (3G) wireless networks
   2.3. Wireless Local Area Networks (WLANs) (IEEE 802.11)
   2.4. Wi-Max (IEEE 802.16) and LTE-3GPP
   2.5. Bluetooth and Personal Area Networks(PANs)

3. **Cellular Concept**
   3.1. Frequency Reuse
   3.2. Channel assignment and Handoff strategies
   3.3. Interference and system capacity

4. **Mobile Radio Propagation**
   4.1. Radio wave propagation mechanisms
   4.2. Outdoor and Indoor propagation Models
   4.3. Small scale Multi-path propagation
   4.4. Types of small scale fading and models

5. **Modulation Techniques for Mobile Radio**
   5.1. Amplitude and Angle Modulation
   5.2. Digital Modulation schemes
   5.3. Spread Spectrum Modulation techniques
   5.4. Modulation performance in fading

6. **Equalization, Diversity and Channel coding**
   6.1. Equalizers in Communication Receiver
   6.2. Diversity Techniques
   6.3. Coding and Error Correction

7. **Multiple Access Techniques for Wireless Communication**
   7.1. FDMA, TDMA, CDMA and SDMA techniques
   7.2. Packet Radio
   7.3. Capacity of Cellular systems

8. **Wireless Networking**
   8.1. Traffic Routing in Wireless networks
   8.2. Wireless Data Services
   8.3. Common channel signalling, SS7

Learning Outcomes:

No	Learning Outcomes
LO1	Students will be able to acquire the concepts of wireless and mobile communication systems.
LO2	Students will be able to differentiate various cellular technologies, modulation techniques and radio propagation models used in communication systems.
LO3	Students will be able to describe multiple access techniques and equalization, diversity and channel coding techniques used in wireless communication.
LO4	With the gained knowledge, students will be able to compare competitive technologies and the trade-offs associated.

Part B: Contact Session Plan

Academic Term	Second Semester 2022-23
Course Title	Wireless and Mobile Communications
Course No	SS ZG520 / MEL ZG520/ES ZG520/CSI ZG520
Instructor-In-Charge	

Type	Type	Description	Content Reference
M1: Introduction to Wireless systems and Modern wireless communication system.			
Pre-CS	RL_1.1	Introduction to Wireless and Mobile communication	T1: Ch1 & Ch2
	RL_1.2	Types of wireless communication	
	RL_1.3	A Modern wireless communication system	
During CS	**CS 1.0**	A brief summary of recorded lectures, Examples of wireless communication system- paging systems, wireless local loop, WLAN, Bluetooth, Prioritizing handoff	
Post-CS	HW 1	T1: Problems: 1.2, 1.5, 1.9,1.16,2.1,2.2,2.8	
	LE 1	Introduction to MATLAB/Simulink	
M2: The Cellular Concept-- System Design Fundamentals			
Pre-CS	RL_2.1.1	Cellular Concept	T1: Ch3
	RL_2.1.2	Cellular concept frequency reuse	
	RL_2.1.3	Channel Assignment strategies and Introduction to Handoff	
	RL_2.1.4	Handoff Strategies	
During CS	**CS 2.0**	A brief summary of recorded lectures, Frequency reuse, Channel assignment strategies, Prioritizing handoff, Problems on frequency re-use.	

Post-CS	HW 2	T1: Problems: 3.1, 3.2, 3.3,3.5,3.6.	
	LE 2	MATLAB experiment based on the frequency reuse/ CS 2.0	
M3: Cellular Network			
Pre-CS	RL_2.2.1	Interference and System Capacity	T1: Ch4
	RL_2.2.2	Trunking and Grade of Service	
	RL_2.2.3	Improving the coverage and capacity in cellular system	
During CS	CS 3.0	A brief summary of recorded lectures, channel capacity, Trunking and grade of service, Interference and system capacity	
Post-CS	HW 3	T1: Problems:3.8, 3.10,3.12	
	LE 3	MATLAB experiment based on CS 3.0	
M4: Mobile Radio Propagation: Large Scale Path Loss_ Part 1			
Pre-CS	RL_3.1.1	Mobile Radio Propagation	T1: Ch4
	RL_3.1.2	Propagation Mechanism of Radio waves	
	RL_3.2.1	Free space Propagation model and Two Ray ground reflected model	
During CS	CS 4.0	A brief summary of recorded lectures, Reflection co-efficient for parallel and Horizontal polarization of radio waves, Problems on Brewster angle, Radar cross section model. Problems on Free space propagation model	
Post-CS	HW 4	T1: Problems: 4.1, 4.2, 4.4,4.5,4.6	
	LE 4	MATLAB experiment based on the received power using Free space propagation/ **CS 4.0**	
M5: Mobile Radio Propagation: Large Scale Path Loss_ Part 2			
Pre-CS	RL_3.2.2	Fresnel Zone and knife edge diffraction model	T1: Ch4
	RL_3.3.1	Practical link budget design using path loss model	
During CS	CS 5.0	A brief summary of recorded lectures, two ray ground reflected model, Fresnel zone geometry, knife edge diffraction model, Practical link budget design using path loss model	
Post-CS	HW 5	T1: Problems: 4.9, 4.10, 4.17, 4.18	
	LE 5	MATLAB experiment based on the Ground reflected model, Knife-edge Diffraction/ **CS 5.0**	
M6: Mobile Radio Propagation: Large Scale Path Loss_ Part 3			
Pre-CS	RL_3.3.2	Outdoor and Indoor Propagation Models	T1: Ch4
	RL_4.1.1	Multipath Propagation and Fading	T1: Ch5

		Doppler shift and Impulse response model of a multipath channel	
	RL_4.1.2		
During CS	CS 6.0	A brief summary of recorded lectures, Problems on propagation models ,Multipath Propagation, Effects of multipath Propagation, factors influencing multipath propagation, Doppler shift, Impulse response model of a multipath channel	
Post-CS	HW 6	T1: Problems:4.29, 4.31, 4.33, 4.34, 4.35,5.2,	
	LE 6	MATLAB experiment based on the Indoor/Outdoor propagation models/CS 6.0	

M7: Small Scale Fading_Part 1			
Pre-CS	RL_4.2.1	Small-scale multipath measurement	T1: Ch5
	RL_4.2.2	Parameters of multipath channel	
During CS	CS 7.0	A brief summary of recorded lectures, Statistical models for multipath fading channels, Theory of multipath shape factors for small scale fading wireless channels.	
Post-CS	HW 7	T1: Problems: 5.10, 5.11,5.12, 5.17	
	LE 7	MATLAB experiment based on CS 7.0	

M8: Small Scale Fading_Part 2			
Pre-CS	RL_4.3.1	Small Scale fading	T1: Ch5
	RL_4.3.2	Small scale fading due to doppler effect	
During CS	CS 8.0	A brief summary of recorded lectures, fading due to doppler spread, Review	
Post-CS	HW 8	T1: Problems: 5.27, 5.5.28, 5.29, 5.30	
	LE 8	MATLAB experiment based on CS 8.0	

M9: Modulation Techniques for Mobile Radio_ Amplitude Modulation			
Pre-CS	RL_5.1.1	Review of Fourier Transforms_1	T1: Ch6
	RL_5.1.2	Review of Fourier Transforms_2	
	RL_5.2.1	AM Modulation	
	RL_5.2.2	Generation of AM Wave	
	RL_5.3	DSB-SC Modulation	
	RL_5.4	SSB-SC Modulation	
During CS	CS 9.0	A brief summary of recorded lectures, AM Modulation and Demodulation, Problems based on AM.	
Post-CS	HW 9	T1: Problems 6.1, 6.2/ Problems based on AM	
	LE 9	MATLAB Exercises based on Amplitude Modulation Techniques	

		M10: Modulation Techniques for Mobile Radio_ Angle Modulation	
Pre-CS	RL_6.1	Frequency Modulation_1	T1: Ch6
	RL_6.2	Frequency Modulation_2	
	RL_6.3	Phase Modulation	
During CS	CS 10.0	A brief summary of recorded lectures, Frequency & Phase variation of FM and PM Demodulation of FM, Problems based on Angle Modulation	
Post-CS	HW 10	T1: Problems 6.4,6.5/Problems based on FM & PM	
	LE 10	MATLAB Exercises based on Angle Modulation Techniques	

		M11: Digital Modulation Techniques_1	
Pre-CS	RL_7.1	ASK, PSK Modulation	T1: Ch6
	RL_7.2	FSK Modulation	
During CS	CS 11.0	A brief summary of recorded lectures, Spread Spectrum modulation techniques, Problems based on Digital Modulation techniques and spread spectrum techniques.	
Post-CS	HW 11	T1: Problems based on digital modulation techniques	
	LE 11	MATLAB Exercises based on Digital modulation Modulation Techniques	

		M12: Digital Modulation Techniques_2	
Pre-CS	RL_7.3	QPSK Modulation	T1: Ch6; T2: Ch7
	RL_7.4	Constellation Diagrams	
During CS	CS 12.0	A brief summary of recorded lectures, Linear Modulation Techniques, Spread spectrum modulation techniques	
Post-CS	HW 13	T1: Problems based on digital modulation techniques	
Lab Reference	LE 13	MATLAB Exercises based on Digital modulation Modulation Techniques	

		M13: Equalization & Diversity Techniques	
Pre-CS	RL_8.1	ISI & Pulse Shaping	T1: Ch7; T2: Ch8
	RL_8.2	ISI & Equalization	
	RL_8.3	Diversity Techniques	
During CS	CS 13.0	A brief summary of recorded lectures, Adaptive equalizers, error correction codes	
Post-CS	HW 13	Problems on error correction codes	
	LE 13	MATLAB Exercises based on CS	

		M14: Concepts of OFDM & MIMO	
Pre-CS	RL_9.1	OFDM	

	RL_9.2	MIMO	
During CS	CS 14.0	A brief summary of recorded lectures, Adaptive equalizers, error correction codes	
Post-CS	HW 14	Problems on error correction codes	
	LE 14	MATLAB Exercises based on CS	

M15: Multiple Access Techniques			
Pre-CS	RL_10.1	Introduction to Multiple Access Techniques & FDMA	T1: Ch9
	RL_10.2	TDMA &SDMA	
	RL_10.3	Spread Spectrum Multiple Access	
During CS	CS 15.0	A brief summary of recorded lectures, Packet Radio Pure ALOHA, Slotted ALOHA, Problems based on multiple access techniques	
Post-CS	HW 15	Problems on packet radio technology and multiple access techniques	
	LE 15	MATLAB Exercises based on CS	

M16: Wireless Networking			
During CS	CS 16.0	Wireless networking, Traffic routing in wireless networks, CCS, Review	T1: Ch10
Post-CS	HW 16		
	LE 16		
	SS 16	SS7	

Experiential learning components

1. Case study:

    a. MIMO-OFDM technology

    b. Comparing 3G, Wi-Fi and Wi-Max technologies and seamlessly integrating to form a ubiquitous connection.

2. Work integration: Students can apply the learning to the work they are doing in communications field and present briefly in the class about it.

Evaluation Scheme

Evaluation Component	Name (Quiz, Lab, Project, Midterm exam, End semester exam, etc)	Type (Open book, Closed book, Online, etc.)	Weight	Duration	Day, Date, Session, Time
EC - 1	Quiz – I	Online	5%	*	
	Quiz – II	Online	5%	*	
	Lab/Assignment	Online	10%	*	

EC - 2	Mid-term Exam	Closed book	30%	2 Hour	
EC - 3	End Semester Exam	Open book	50%	3 Hours	

Note - *Evaluation components can be tailored depending on the proposed model.*

Important Information

Syllabus for Mid-Semester Test (Closed Book): Upto contact session 8
Syllabus for Comprehensive Exam (Open Book): All topics given in plan of study

Evaluation Guidelines:
1. EC-1 consists of either two Assignments or three Quizzes. Announcements regarding the same will be made in a timely manner.
2. For Closed Book tests: No books or reference material of any kind will be permitted. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
3. For Open Book exams: Use of prescribed and reference text books, in original (not photocopies) is permitted. Class notes/slides as reference material in filed or bound form is permitted. However, loose sheets of paper will not be allowed. Use of calculators is permitted in all exams. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
4. If a student is unable to appear for the Regular Test/Exam due to genuine exigencies, the student should follow the procedure to apply for the Make-Up Test/Exam. The genuineness of the reason for absence in the Regular Exam shall be assessed prior to giving permission to appear for the Make-up Exam. Make-Up Test/Exam will be conducted only at selected exam centres on the dates to be announced later.

It shall be the responsibility of the individual student to be regular in maintaining the self-study schedule as given in the course handout, attend the lectures, and take all the prescribed evaluation components such as Assignment/Quiz, Mid-Semester Test and Comprehensive Exam according to the evaluation scheme provided in the handout.