زانکۆی پۆلیتەکنیکی هەولێر
ERBIL POLYTECHNIC UNIVERSITY

Kurdistan Region Government
Ministry of Higher Education
and Scientific Research
Erbil Polytechnic University

Module (Course Syllabus) Catalogue

2023-2024

College/ Institute	Technology college
Department	Information and Communication Technology Engineering (ICTE)
Module Name	Wireless communication
Module Code	WIC502
	Technical Diploma ☐ Bachelor ☑ High Diploma ☐ Master ☐ PhD ☐
Semester	5th semester
Qualification	Electrical and Electronic Engineering
Scientific Title	Assistant Lecturer
ECTS (Credits)	5
Module type	Prerequisite ☐ Core ☑ Assist. ☐
Weekly hours	4
Weekly hours (Theory)	(2) hr Class (135)Total hrs Workload
Weekly hours (Practical)	(2) hr Class (135) Total hrs Workload
Number of Weeks	15
Lecturer (Theory)	Jabbar Majeed Sadeq
E-Mail & Mobile NO.	jabbar.sadeq@epu.edu.iq 07504487044
Lecturer (Practical)	Jabbar Majeed Sadeq
E-Mail & Mobile NO.	jabbar.sadeq@epu.edu.iq 07504487044
Websites	

Course Book

Course Description	Introduction to wireless communications systems. The cellular concept and system design fundamentals: frequency reuse, interference and system capacity. Radio propagation and large-scale path loss. Small-scale fading and multipath propagation: Doppler shift, mobile multipath channel parameters such as coherence bandwidth and coherence time. Diversity techniques and diversity combining. Spread spectrum communication techniques. Multiple access techniques: TDMA, FDMA, CDMA, SDMA. Current and future wireless systems and standards
Course objectives	To expose the students to understand mobile radio communication principles and to study the recent trends adopted in cellular systems and wireless standards. The principles of wireless communication theory are covered with emphasis on the essential concept delivery to non-major learners in the easiest way. Then, it will be covered how such principles are realized and how multimedia services can be delivered in practical LTE cellular systems by which learners are connected and enjoys together in their lives.
Student's obligation	The student should be attended to the class every week four hours and prepare himself for weekly quizzes and do assignments and home works in the theory class and must be write a report for every experiment done weekly
Required Learning Materials	1- Power point presentation 2-white board 3- sheets 3- seminars zoom meeting and Moodle program.

Task		Weight (Marks)	Due Week	Relevant Learning Outcome
Paper Review				
Assignments	Homework	5	3-6-9-12	Understanding the principles of wireless communication systems. use different tools and techniques for evaluating the WCS performance.
	Class Activity	2	Over all weeks	Understanding the path loss and understand the dynamics of radio wave propagation and path loss
	Report	5	4	Understanding the frequency re-use, system capacity,
	Seminar	5	6	On GSM mobile communication and wireless communication in general
	Essay			
	Project		6-11	
Quiz		8	Every week	Weekly outcomes
Lab.		10	Over all weeks	other related telecommunications equipment
Midterm Exam		25	12	
Final Exam		40	15	All the outcomes

	Total	100		

Specific learning outcome:	1- Explain the Classification of mobile communication systems 2- Analyze the radio channel characteristics and the cellular principle 3- Analyze the measures to increase the capacity in GSM systems- sectorization and Spatial Filtering for Interference Reduction 4- Ability to analyze improved data services in cellular communication
Course References:	1- Wireless communications, Principles and practice, second edition, by Theodor Rappaport. 2-Mobile and Wireless Communication Networks IFIP 19th World Computer Congress, TC-6, 8th IFIP/IEEE Conference on Mobile and Wireless Communications Networks, August 20-25, 2006, Santiago, Chile 3- Cognitive Radio, Mobile Communications and Wireless Networks, Hardcover Mobile and Wireless Networks by Uyless Black 1996.

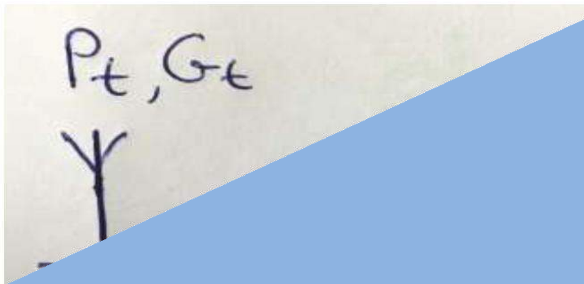
Course topics (Theory)	**Week**	**Learning Outcome**
Introduction to wireless communications systems	1	Understanding the principles of wireless communication systems
The cellular concept and system design fundamentals:	2-3	understand the basic terminology used in Wireless Communications Systems (WCS), cellular concept
Frequency reuse, interference and system capacity	3-5	Understanding the frequency re-use, system capacity,
Radio propagation and large-scale path loss.	5-6	Understanding the path loss and understand the dynamics of radio wave propagation and path loss.
Small-scale fading and multipath propagation: Doppler shift, mobile multipath channel parameters such as coherence bandwidth and coherence time.	7-8	Understanding multipath, fading, Doppler effect.
Diversity techniques and diversity combining.	9	use different tools and techniques for evaluating the WCS performance.
Spread spectrum communication techniques.	10	Understanding the Spread spectrum communication techniques.
Mid-Term Examination	11	An ability to identify, formulate, and solve complex engineering
Multiple access techniques: TDMA, FDMA, CDMA, SDMA.	12-13	Understanding multiple access techniques: TDMA, FDMA, CDMA, SDMA.

Current and future wireless systems and standards.	14	An ability to develop and conduct appropriate future wireless communication
Final Examination	15	Exam
Practical Topics	**Week**	**Learning Outcome**
Simulation of Amplitude Modulation (AM) Using Simulink	1	Student understand the principle of amplitude modulation using Matalab simulation
Frequency-division multiplexing (FDM)	2	Student understand the frequency division multiplexing
Frequency-division demultiplexing (FDM)	3	Student the frequency division demultiplexing
Time Division Multiplexing (TDM)	4	Student understand to the principle of TDM multiplexing
Time Division demultiplexing (TDM)	5	Student understand to the principle of TDM demultiplexing
Direct Sequence Spread Spectrum (DSSS) in Transmitter	6	Student able to use the DSSS Transmitter
Direct Sequence Spread Spectrum (DSSS) in Receiver	7	Student able to use the DSSS Receiver
First Generation (1G) – AMPS using FM modulator	8	Student know the principles of frequency modulation and demodulation
Second Generation (2G) – D-AMPS using Binary phase shift keying	9	Student know the principles of binary phase shift keying
A simulation of OFDM system for 4G communications	10	Understanding the OFDM in 4G communication
A simulation of OFDM Transmitter and Receiver Using Matlab commands	11	Students able to use the (Transmitted signal) & (Received signal) plotting, modulation and demodulation scatter plotting, scatter plotting of the channel after we added (AWGN)for multipath channel and plotting the (magnitude and phase of the channel)in OFDM SYSTEM.
A simulation of OFDM Transmitter and Receiver Using Matlab Simulink	12	OFDM using simulation

Questions Example Design

Q1) A transmitter provides 10 W to an antenna having 10 dB gain. The receiver antenna has a gain of 3 dB and the receive
bandwidth is 25 kHz. If the receiver system Noise Figure is 10 dB and the carrier frequency is 1500 MHz, f
maximum distance between the transmitter and the receiver that will ensure that a SNR of 20 dB is prov
clear picture and label all parameters used on the figure. Note that the path loss exponent of the mobi
channel of interest is $n = 4$. (You may need these, $\sigma = 10\ dB$ and $d_0 = 1$ km. Noise Figure

Soln.



The Noise Figure is given as $F = 10$ dB = 10 times. With the Rx $B_w = 25$ kHz, then the Noise Floor will be

$\lambda = \frac{c}{f} = 3 \times \frac{10^8}{1500} \times 10^6 = \frac{3}{15} = 0.2\text{m}$ 7

$Noise\ Floor = k \times B_w \times F \times T_0 = 1.38 \times 10^{-23} \times 25 \times 10^3 \times 1$
1.0005×10^{-15} W or -120 dBm.

Noise Floor(dBm) + SNR(dB) = −120 + 20

No need to these Since $P_\gamma[\Pr(d_{max} > \gamma)] = \text{Q}\left(\frac{\gamma - \overline{\Pr}}{}\right.$
$\text{Q}\left(\frac{-100-\overline{\Pr(d_{max})}}{\sigma}\right) = 100\%$

Since $SNR_0 = 20$ dB, and Noise Figure
$*\ 100 = 1000$ or 30 dB 7

$SNR_i = Pr$ / Noise Floor (

Since $P_r = \frac{P_t \times G_t \times G_r \times}{(4\times\pi)}$
found as

$d^4 = 0.0$

Q2) For a frequency division duplex cellular telephone system 24 MHz of bandwidth is allocated. The cellular uses two 30 kHz simplex channels to provide full duplex voice and control channels. Assume each cell phone user generates 0.1 Erlangs of traffic. Assume Erlang B is used.

a) Find the number of channels in each cell for a four-cell reuse system.
b) If each cell is to offer capacity that is 90% of perfect scheduling, find the maximum number of users that can be supported per cell where omnidirectional antennas are used at each base station.
c) What is the blocking probability of the system in (b) when the maximum number of users are available in the user pool?
d) If each new cell now uses 120° sectoring instead of omnidirectional for each base station, what is the new total number of users that can be supported per cell for the same blocking probability as in c)?
e) If each cell covers five square kilometers, then how many subscribers could be supported in an urban market that is 50 km × 50 km for the case of omnidirectional base station antennas?
f) If each cell covers five square kilometers, then how many subscribers could be supported in an urban market that is 50 km × 50 km for the case of 120° sectored antennas?

(a) $\frac{24\ MHz}{2 \cdot 30\ kHz} = 400$ channels (5)

$\frac{400\ \text{channels}}{4\ \text{cells}} = 100$ channels/cell (5)

(b) 90% of 100 Erlangs = 90 Erlangs (5)

$90 = U A_u = U(0.1) \Rightarrow U = 900$ users (5)

(c) offered: 90E ; C = 100 ⇒ 0.03 from graph (Fig. 3-6) (5)

3% GOS

(d) Each sector has 33.3 channels ; GOS = 3%

from graph (Fig. 3-6) ⇒ ≈ 25 Erlangs/sector (5)

$25 = U A_u$ (per sector)

⇒ U = 250 × 3 sectors (5)

U = 750 users

(e) $\frac{2500\ km^2}{5\ km^2} = 500$ cells ⇒ 500 × 900 users/cell = 450,000 users (7.5)

(f) 500 cells ⇒ 500 × 750 user/cell = 375,000 users (7.5)

Extra notes:

External Evaluator

1- The course book of communication system is completely related to the syllabus of communication system of practical syllabus and satisfy the goal of communication subjects.

2- The practical course is completely defined the theoretically lectures.

Dr. Moufaq Jalil: Assistant professor at Physics department, Education college. Salahuddin University