48. Course Specification of Mobile Communications

I. Course Identification and General Information:

1.	Course Title:	Mobile Communications				
2.	Course Code & Number:	CNE435				
3.	Credit hours:	C.H				Total
		Th.	Tu.	Pr.	Tr.	
		2	2	2	-	4
4.	Study level/ semester at which this course is offered:	5^{th} year / 1^{st} semester				
5.	Pre –requisite (if any):	None.				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered:	Communication Engineering and Networks				
8.	Language of teaching the course:	English				
9.	Location of teaching the course:	Classes & Labs at the Faculty of Engineering				
10.	Prepared By:	Asst. Prof. Dr. Nasser H. Almofari				
11.	Date of Approval	2020				

II. Course Description:

This course is developed to provide principal concepts of Mobile Communications. It covers the characterization of the radio signal, including radio wave propagation, Path loss, slow fading, fast fading, Multipath and statistical channel models. Topics of this course include the multiple access technologies such as TDMA/FDMA, CDMA, OFDMA and NOMA. This course also covers the cellular systems from GSM to LTE-Advanced with their network architecture, techniques, procedures, channels and protocol stack. The tutorials enhance the understanding of the theoretical part by introducing examples and solving problems. The practical part covers the radio signal fundamentals, characteristics and propagation in different environment and for different modulation schemes. Finally, a coverage and capacity of LTE network is studied using Atoll software.

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	III. Course Intended learning outcomes (CILOs) of the course	Referenced PILOs
a1	Demonstrate the knowledge and understanding of radio channel models and effects on the radio signal	A1
a2	Demonstrate the understanding of the evolution, basics, techniques, structure, and function of each element of a cellular system of any generation	A2
b1	Characterize the behavior of the radio signal, model it and compare its characteristics in different operating environments	B1
b2	Evaluate and the different cellular systems standards and techniques	B2
c1	Apply the acquired knowledge to calculate the effect of a radio channel on the signal in different environment such as free space	C1
c2	Conduct tests related to wireless and mobile communication	C3
d1	Acquire the ability to work within a team	D1
d2	Communicate effectively both orally and in written forms	D4

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a1- Demonstrate the knowledge and understanding of radio channel models and effects on the radio signal	▪ Active lectures ▪ Tutorials ▪ Interactive class discussions ▪ Exercises and home works ▪ Laboratory based session	▪ Midterm and final tests. ▪ Homework and assignments ▪ reports ▪ laboratory reports
a2- Demonstrate the understanding of the evolution, basics, techniques, structure, and function of each element of a cellular system of any generation	▪ Active lectures ▪ tutorials ▪ Exercises and home works ▪ Laboratory based session	▪ Midterm and final tests. ▪ Homework and assignments reports ▪ laboratory reports

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1- Characterize the behavior of the radio signal, model it and compare its characteristics in different operating environments	▪ Active lectures ▪ Tutorials ▪ Exercises and Homework ▪ Laboratory based session	▪ Midterm and final tests. ▪ Homework and assignments reports ▪ laboratory reports
b2- Evaluate the different cellular systems standards and techniques	▪ Active lectures ▪ tutorials ▪ Exercises and Homework ▪ Laboratory based session	▪ Midterm and final tests. ▪ Homework and assignments reports ▪ laboratory reports

© Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1- Apply the acquired knowledge to calculate the effect of a radio channel on the signal in different environment such as free space	▪ Active lectures, Tutorials ▪ Exercises and Homework ▪ Laboratory based session ▪ Small groups	▪ Midterm and final tests. ▪ Homework and assignments reports ▪ laboratory reports ▪ individual and group reports.
c2- Conduct tests related to wireless and mobile communication	▪ Active lectures, Tutorials ▪ Exercises and Homework ▪ Laboratory based session ▪ Small groups	▪ Midterm and final tests. ▪ Homework and assignments reports ▪ laboratory reports ▪ individual and group reports.

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(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1- Acquire the ability to work within a team	▪ Seminars ▪ Laboratory based session ▪ Small groups	▪ laboratory reports ▪ individual and group reports.
d2- Communicate effectively both orally and in written forms	▪ Seminars ▪ Exercises and Homework	▪ laboratory reports ▪ Homework and assignments reports

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	contact hours
1.	Overview of wireless and mobile communication	a1, a2	▪ History and evolution of Wireless and Mobile Communications ▪ Current wireless and mobile communication systems	1	2
2.	Radio Wave Propagation	a1, b1, c1, c2, d1, d2	▪ Radio Wave Propagation ▪ Free space propagation, Path loss, path loss models, ▪ Slow fading & Fast Fading, Fading and Multipath Propagation ▪ statistical channel models, narrowband and wideband models	2	4
3.	Multiple Access Techniques for Mobile Communications	a2, b2, c2, d1, d2	▪ Introduction to multiplexing and multiple access ▪ Frequency Division Multiple Access (FDMA)	2	4

			▪ Time Division Multiple Access (TDMA) ▪ Code Division Multiple Access (CDMA) ▪ Orthogonal Frequency Division Multiple Access (OFDMA) ▪ Non-Orthogonal Multiple Access (NOMA)		
4.	Cellular Concept	a2, b2, c2, d1, d2	▪ Introduction to Cell and Cluster ▪ Frequency reuse ▪ Channel assignment ▪ Handoff ▪ Co-channel interference and adjacent channel interference ▪ Power control ▪ Cell splitting, Sectors, Relays and repeaters, Micro cells	2	4
5.	2G- GSM	a2, b2, c2, d1, d2	▪ Introduction ▪ System Architecture ▪ GSM Interfaces ▪ GSM Addresses & Identifiers ▪ GSM Channel Organization ▪ TDMA Frames & Slots – GSM Frame Structure ▪ Localization and Calling, Initial channel Usage, Call establishment to MS, Location Registration, Location Update, Message Flow ▪ Handover in GSM ▪ Soft & Hard Handover ▪ BSS – Internal/External HO	3	6

			▪ Intra/Inter MSC – HO ▪ Security in GSM ▪ FDD/TDD Combined Duplex mode ▪ GPRS and EDGE. ▪		
6.	3G (CDMA, UMTS and HSPA)	a2, b2, c2, d1,d2	▪ what is 3G? and why we need 3G? ▪ CDMA Basics ▪ Spreading and scrambling ▪ BS codes and orthogonality ▪ PN codes and synchronization ▪ Multi user recovery and CDMA frequency reuse ▪ Rake receiver ▪ UMTS access tech., Duplex tech. and UMTS bands ▪ UMTS Codes and Channels, UMTS Network Architecture ▪ Physical layer processing ▪ Cell Search ▪ Power control ▪ UMTS admission control and cell breathing ▪ Handover ▪ LS and UMTS call scenario ▪ HSPA introduction	2	4
7.	4G- LTE	a1, a2, b2, c2, d1, d2	▪ Introduction ▪ OFDMA, OFDM Disadvantages, SC-FDMA ▪ MIMO ▪ LTE Network Architecture, E-UTRAN, EPC	2	4

			▪ LTE air interface, LTE Resources, LTE Channels, LTE Protocol stack, LTE Physical layer ▪ Cell Synchronization, Power control, TA updating, Hanover and Security procedures ▪ Voice calls in LTE ▪ LTE-A, LTE-A PRO and 5G		
Number of Weeks /and Units Per Semester				**14**	**28**

B- Tutorials Aspect:

Order	Tutorial Skills List	Nº of Weeks	C.H.	CILOs
1.	Radio Wave Propagation • Radio Wave Propagation • Free space propagation, Path loss, path loss models, • Slow fading & Fast Fading, Fading and Multipath Propagation • statistical channel models, narrowband and wideband models	2	4	a1, b1, c1, c2, d1, d2
2.	Multiple Access Techniques for Mobile Communications • Introduction to multiplexing and multiple access • Frequency Division Multiple Access (FDMA) • Time Division Multiple Access (TDMA) • Code Division Multiple Access (CDMA) • Orthogonal Frequency Division Multiple Access (OFDMA) • Non-Orthogonal Multiple Access (NOMA)	2	4	a2, b2, c2,d1,d2

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3.	Cellular Concept • Introduction to Cell and Cluster • Frequency reuse • Channel assignment • Handoff • Co-channel interference and adjacent channel interference • Power control • Cell splitting, Sectors, Relays and repeaters, Micro cells	2	4	a2, b2, c2, d1, d2
4.	2G- GSM • Introduction • System Architecture • GSM Interfaces • GSM Addresses & Identifiers • GSM Channel Organization • TDMA Frames & Slots – GSM Frame Structure • Localization and Calling, Initial channel Usage, Call establishment to MS, Location Registration, Location Update, Message Flow • Handover in GSM • Soft & Hard Handover • BSS – Internal/External HO • Intra/Inter MSC – HO • Security in GSM • FDD/TDD Combined Duplex mode • GPRS and EDGE	3	6	a2, b2, c2, d1, d2
5.	3G (CDMA, UMTS and HSPA) • what is 3G? and why we need 3G? • CDMA Basics • Spreading and scrambling • BS codes and orthogonality • PN codes and synchronization	3	6	a2, b2, c2, d1, d2

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	• Multi user recovery and CDMA frequency reuse • Rake receiver • UMTS access tech., Duplex tech. and UMTS bands • UMTS Codes and Channels, UMTS Network Architecture • Physical layer processing • Cell Search • Power control • UMTS admission control and cell breathing • Handover • LS and UMTS call scenario • HSPA introduction			
6.	4G- LTE • Introduction • OFDMA, OFDM Disadvantages, SC-FDMA • MIMO • LTE Network Architecture, E-UTRAN, EPC • LTE air interface, LTE Resources, LTE Channels, LTE Protocol stack, LTE Physical layer • Cell Synchronization, Power control, TA updating, Hanover and Security procedures • Voice calls in LTE • LTE-A, LTE-A PRO and 5G	2	4	a1, a2, b2, c2, d1, d2
Number of Weeks /and Units Per Semester		**14**	**28**	

C - Practical Aspect:

Order	Tasks/ Experiments	Number of Weeks	Contact hours	Learning Outcomes
1.	An introduction to basic mobile communications through MATLAB simulation	**1**	**2**	**a1, a2, d1**

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2.	Understanding waveforms and their properties	**2**	**4**	**a1, b1, c1, c2, d1, d2**
3.	Study the performance of a mobile communication system using different modulation formats	**2**	**4**	**a2, b2, c2, d1, d2**
4.	Extract the unique features of signals used in very popular mobile communication standards such as GSM, CDMA	**2**	**4**	**a1, a2, b1, b2, c1, c2, d1, d2**
5.	Introduction to OFDM.	**1**	**2**	**a2, b2, c1, c2, d1, d2**
6.	Channel impact in mobile communication (distance dependent path loss, frequency selectivity and the line-of-sight (LOS) and non-line-of-sight (NLOS))	**3**	**6**	**a1, b1, c1, c2, d1, d2**
7.	Using Atoll to study LTE capacity and coverage	**3**	**6**	**a2, b2, c1,c2,d1, d2**
8.	Practical Exam	**1**	**2**	**a1, a2, b1, b2, c1, c2, d2**
Number of Weeks /and Units Per Semester		**15**	**30**	

V. Teaching strategies of the course:

- Active lectures
- Tutorials
- Interactive class discussions
- Exercises and Homework
- Laboratory based session
- Small groups
- Seminars

VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark

1.	Identify the different channel models	a1, b1, c1, d1, d2	4th week	2.5
2.	Compare different multiple access techniques	a2, b2, d1, d2	7th week	2.5
3.	Study the coverage and capacity of LTE network	a2, b2, d1, d2	9th week	2.5
4.	What is new? 5G and beyond	a1,a2, b1, b2, c1,d1, d2	13th week	2.5
	Total			**10**

VII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Assignments	4th, 7th, 9th, 13th	10	5%	a1,a2, b1, b2, c1 ,d1, d2
2.	Laboratory reports	All weeks	10	5%	a1,a2, b1, b2, c1 , c2,d1, d2
3.	Midterm Exam	8th	40	20%	a1, a2, b1, b2, c1
4.	Practical Exam	15th	20	10%	**a1, a2, b1, b2, c1, c2, d2**
5.	Final Exam	16th	120	60%	a1, a2, b1,b2, c1
Sum			**200**	**100%**	

VIII. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1- A. Goldsmith, 2005, "Wireless communications, New York, Cambridge University Press
2- Martin Sauter, 2014, "From GSM To LTE-Advanced", Revised 2nd Edition Germany, John Wiley & Sons, Ltd

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2- Essential References.	
	1- Theodore S. Rappaport, 2002, "Wireless Communication: principles and practice", 2nd Edition, Upper Saddle River, NJ: Prentice Hall, John Wiley and Sons Ltd. **2-** Sabih Güzelgöz and Hüseyin Arslan, 2010, "A Wireless Communications Systems Laboratory Course", IEEE Transactions on Education, vol. 53, no. 4
3- Electronic Materials and Web Sites *etc*.	
	1- https://www.upc.edu/grau/guiadocent/pdf/ing/300038/wireless-communications-laboratory.pdf

IX. Course Policies:

1.	**Class Attendance:** - The students should have more than 75% of attendance according to rules and regulations of the faculty.
2.	**Tardy:** - The students should respect the timing of attending the lectures. They should attend within 15 minutes from starting of the lecture.
3.	**Exam Attendance/Punctuality:** - The student should attend the exam on time. The punctuality should be implemented according to rules and regulations of the faculty for mid-term exam and final exam.
4.	**Assignments & Projects:** - The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.
5.	**Cheating:** - If any cheating occurred during the examination, the student is not allowed to continue and he has to face the examination committee for enquiries.
6.	**Plagiarism:** - If one student attends the exam on another behalf; he will be dismissed from the faculty according to the policy, rules and regulations of the university.
7.	**Other policies:** - All the teaching materials should be kept out the examination hall and mobile phones are not allowed. - Mutual respect should be maintained between the student and his teacher and also among students. Failing in keeping this respect is subject to the policy, rules and regulations of the university.

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Reviewed By	**Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat** **President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi** **Name of Reviewer from the Department: Asst. Prof. Dr.Mohammed Al-Suraby**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed** **Asst. Prof. Dr. Munasar Alsubri**

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