INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTOR

Course Title	WIRELESS COMMUNICATION AND NETWORKS					
Course Code	AEC524					
Programme	B.Tech					
Semester	VI	Semester				
Course Type	ELECTIVE					
Regulation	IARE - R16					
Course Structure	**Theory**			**Practical**		
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**	
	3	-	3	-	-	
Chief Coordinator	Mr. A Karthik, Assistant Professor, Department of ECE					
Course Faculty	Mr. A karthik, Assistant Professor, Department of ECE					

I. COURSE OVERVIEW:

The course will make them learn the basic theory of microprocessor and their applications in this course is intended to stress the fundamentals of wireless communications and network engineering that are important to any wireless communication system. It introduces cellular mobile radio systems, performance criteria, design, operations and various generations of mobile systems. It covers various types of multiple access techniques and LAN Techniques. This course explains different frequency management and channel assignment techniques. This course also deals with handoff, dropped calls and cell splitting.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AEC005	IV	Analog Communications	4
UG	AEC009	V	Digital Communications	4
UG	AEC010	V	Computer Organization	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Wireless Communication and Networks	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz/AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Quiz
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Assignments
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** The ability to understand , analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient design of computer-based system of varying complexity.	2	Seminars and Assignments
PSO 2	**Problem-Solving Skills:** The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.	1	Quiz and Assignments
PSO 3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Understand fundamental treatment of wireless communications and the Cellular Concept- System Design, Fundamental concepts like frequency reuse, Radio Wave Propagation Basic Propagation Mechanisms and Diffraction Models.
II	Understand the concept of frequency reuse and be able to apply it in the design of mobile cellular system.
III	Understand the various modulation schemes and multiple access techniques that are used in wireless communications.
IV	Remember the analytical perspective on the design and analysis of the traditional and emerging wireless networks and discuss the nature of and solution methods to the fundamental problems in wireless networking.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Demonstrate their understanding on functioning of wireless communication system and evolution of different wireless communication systems and standards.	CLO 1	Understand the principles and fundamentals of wireless communications.
		CLO 2	Demonstrate cellular system design concepts in wireless mobile communication networks.
		CLO 3	Understand the fundamental Radio Wave Propagation Mechanisms.
CO 2	Compare different technologies used for wireless communication systems operations.	CLO 4	Analyze perspective on Fundamentals of Equalization and Mobile Radio Propagation Multipath Measurements.
		CLO 5	Analyze various multiple access schemes and techniques used in wireless communication.
		CLO 6	Discuss the Parameters of Mobile Multipath Channels and Types of Small-Scale Fading- Fading effects.
CO 3	Explain the architecture, functioning, protocols capabilities and application of various wireless communication networks I/O device with different modules.	CLO 7	Examine the perspective on Fundamentals of Equalization, Linear Equalizers, Non-linear Equalization.
		CLO 8	Study and understand the Diversity Techniques and RAKE Receiver in Radio Propagation.
		CLO 9	Demonstrate wireless local area networks and their specifications in communication system.
CO 4	Demonstrate an ability explain multiple access techniques for Wireless Communication	CLO 10	Understand the analytical perspective on the design and analysis of the traditional and emerging wireless networks
		CLO 11	Discuss the nature of and solution methods to the fundamental problems in wireless networking.
		CLO 12	Discuss the architecture of the various wireless wide area networks such as GSM, IS-95, GPRS and SMS.
CO 5	Demonstrate an ability to evaluate design challenges, constraints and security issues associated with Ad-hoc wireless networks.	CLO 13	Understand the operation of the various wireless wide area networks such as GSM, IS- 95, GPRS and SMS.
		CLO 14	Understand the existing and emerging wireless standards in wireless wide area networks
		CLO 15	Examine the emerging techniques OFDM and its importance in the wireless communications.

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEC524.01	CLO 1	Understand the principles and fundamentals of wireless communications.	PO 1	2
AEC524.02	CLO 2	Demonstrate cellular system design concepts in wireless mobile communication networks.	PO 1	2
AEC524.03	CLO 3	Understand the fundamental Radio Wave Propagation Mechanisms.	PO 1	2
AEC524.04	CLO 4	Analyze perspective on Fundamentals of Equalization and Mobile Radio Propagation Multipath Measurements.	PO 2	2
AEC524.05	CLO 5	Analyze various multiple access schemes and techniques used in wireless communication.	PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEC524.06	CLO 6	Discuss the Parameters of Mobile Multipath Channels and Types of Small-Scale Fading-Fading effects.	PO 1	2
AEC524.07	CLO 7	Examine the perspective on Fundamentals of Equalization, Linear Equalizers, Non-linear Equalization.	PO 2	2
AEC524.08	CLO 8	Study and understand the Diversity Techniques and RAKE Receiver in Radio Propagation.	PO 1	2
AEC524.09	CLO 9	Demonstrate wireless local area networks and their specifications in communication system.	PO 1	2
AEC524.10	CLO 10	Understand the analytical perspective on the design and analysis of the traditional and emerging wireless networks	PO 2	2
AEC524.11	CLO 11	Discuss the nature of and solution methods to the fundamental problems in wireless networking.	PO 4	2
AEC524.12	CLO 12	Understand the architecture of the various wireless wide area networks such as GSM, IS 95, GPRS and SMS.	PO 1	2
AEC524.13	CLO 13	Understand the operation of the various wireless wide area networks such as GSM, IS-95, GPRS and SMS.	PO 1	2
AEC524.14	CLO 14	Understand the existing and emerging wireless standards in wireless wide area networks	PO 1	2
AEC524.15	CLO 15	Examine the emerging techniques OFDM and its importance in the wireless communications.	PO 2	2

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes (COs)	Program Outcomes (POs)			Program Specific Outcomes (PSOs)	
	PO 1	PO 2	PO 4	PSO1	PSO2
CO 1	2			2	1
CO 2	2	2		2	1
CO 3	2	2		2	
CO 4	2	2	2		1
CO 5	2	2			1

3 = High; 2 = Medium; 1 = Low

XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CLOs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	2												2	1	
CLO 2	2												2	1	
CLO 3	2												2	1	
CLO 4		2											2	1	

CLOs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 5		2											2	1	
CLO 6	2												2	1	
CLO 7		2											2		
CLO 8	2												2		
CLO 9	2												2		
CLO 10		2												1	
CLO 11				2										1	
CLO 12	2													1	
CLO 13	2													1	
CLO 14	2													1	
CLO 15		2												1	

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1,PO2, PO4,PSO1, PSO2	SEE Exams	PO1, PO2, PO4,PSO1, PSO2	Assignments	PO1,PO2, PO4,PSO1, PSO2	Seminars	PO1, PO2, PO4,PSO1, PSO2
Laboratory Practices	PO1, PO2, PO4,PSO1, PSO2	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO1, PO2, PO4,PSO1						

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

UNIT-I	THE CELLULAR CONCEPT SYSTEM DESIGN FUNDAMENTALS
Introduction, frequency reuse, channel assignment strategies, handoff strategies; Prioritizing handoffs, practical handoff considerations, interference and system capacity; Co-channel interference and system capacity, channel planning for wireless systems, adjacent channel interference, power control for reducing interference, trunking and grade of service, improving coverage & capacity in cellular systems; Cell splitting, sectoring.	
UNIT-II	**MOBILE RADIO PROPAGATION**

Large-Scale Path Loss: Introduction to radio wave propagation, free space propagation model, relating power to electric field, the three basic propagation mechanisms; Reflection: Reflection from dielectrics, Brewster angle, reflection from prefect conductors, ground reflection (Two-Ray) mode; Diffraction Fresnel zone geometry, knife-edge diffraction model, multiple knife-edge diffraction, scattering, outdoor propagation models; Longley-Ryce model, Okumura Model, Hata Model, PCS extension to hata Model, Walfisch and Bertoni model, wideband PCS microcell model, indoor propagation models-partition losses (Same Floor), partition losses between floors, log-distance path loss model, ericsson multiple breakpoint model, attenuation factor model, signal penetration into buildings, ray tracing and site specific modeling

UNIT-III **CELLULAR SYSTEM DESIGN FUNDAMENTALS**

Small-scale fading and multipath: Small scale multipath propagation; Factors influencing small scale fading, Doppler shift, impulse response model of a multipath channel; Relationship between bandwidth and received power, small; Scale multipath measurements; Direct RF pulse system, spread spectrum sliding correlator channel sounding, frequency domain channels sounding, parameters of mobile multipath channels; Time dispersion parameters.
Coherence Bandwidth, Doppler spread and coherence time, types of small - Scale fading; Fading effects due to multipath time delay spread, flat fading, frequency selective fading, fading effects due to Doppler Spread-Fast fading, slow fading, statistical models for multipath fading channels; Clarke,,s model for flat fading, spectral shape due to Doppler spread in Clarke,,s model, simulation of Clarke and Gans Fading model, level crossing and fading statistics, two-ray Rayleigh fading model.

UNIT-IV **EQUALIZATION AND DIVERSITY**

Introduction, fundamentals of equalization, training a generic adaptive equalizer, equalizers in a communication receiver, linear equalizers, non-linear equalization; Decision feedback equalization (DFE), maximum likelihood sequence estimation (MLSE) equalizer, algorithms for adaptive equalization; Zero forcing algorithm, least mean square algorithm, recursive least squares algorithm; Diversity techniques; Derivation of selection diversity improvement, derivation of maximal ratio combining improvement, practical space diversity consideration; Selection diversity, feedback or scanning diversity, maximal ratio combining, equal gain combining, polarization diversity, frequency diversity, time diversity, RAKE receiver.

UNIT-V **WIRELESS NETWORKS**

Introduction to wireless networks, advantages and disadvantages of wireless local area networks, WLAN topologies, WLAN standard IEEE 802.11, IEEE 802.11 medium access control, comparison of IEEE 802.11 a,b,g and n standards, IEEE 802.16 and its enhancements, wireless PANs, Hipper LAN, WLL.

Text Books:

1. Theodore .S. Rapport, ―Wireless Communications‖, Pearson Education, 2nd Edition, 2010.
2. Upen Dalal, "Wireless communication", oxford University press.
3. Kaveh Pahlvan, Prashant Krishnamurthy, "Principle of wireless networks", A United Approach‖, Pearson Education, 2004.
4. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.

Reference Books:

1. P.Nicopolitidis, M.S. Obaidat, G.I.Papadimitria, A.S. Pomportsis,"Wireless Networks" John Wiley & sons, 1st Edition, 2003.
2. Vijay K Garg,"Wireless Communications and Networks", Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian Reprint).
3. Mark Ciampa Jorge Olenewa, "wireless communication and Networking", IE, 2009.
4. X.Wang, H.V.Poor ,Wireless communication system, Pearson Education, 2004.
5. Jochen Schiller,"Mobile Communication", Pearson Education, 2nd Edition, 2003.

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	CLOs	Reference
1	Introduction, Frequency Reuse.	CLO 1	T1-3.1-3.2
2	Channel Assignment Strategies, Handoff Strategies.	CLO 2	T1-3.3-3.4
3	Prioritizing Handoffs, Practical Handoff Considerations.	CLO 2	T1-3.3-3.4
4	Interference and system capacity -Co channels Interference and system capacity.	CLO 3	T1-3.5
5	Channel planning for Wireless Systems.	CLO 4	T1-3.5
6	Adjacent Channel interference, Power Control for Reducing interference.	CLO 4	T1-3.5
7	Trunking and Grade of Service.	CLO 6	T1-3.6
8	Improving Coverage & Capacity in Cellular Systems.	CLO 6	T1-3.7
9	Large-Scale Path Loss: Introduction to Radio Wave Propagation.	CLO 7	T1-4.2
10	The Three Basic Propagation Mechanisms, Reflection-Reflection from Dielectrics	CLO 8	T1-4.4
11	Brewster Angle, Reflection from prefect conductors.	CLO 8	T1-.5.1,4.5.2
12	Ground Reflection (Two-Ray) Model, Diffraction-Fresnel Zone Geometry.	CLO 9	T1-4.6
13	Knife-edge Diffraction Model, Multiple knife-edge Diffraction, Scattering.	CLO 7	T1-4.7
14	Outdoor Propagation Models- Longley- Ryce Model, Okumura Model, Hata Model, PCS Extension to Hata Model.	CLO 9	T1-4.10
15	Walfisch and Bertoni Model, Wideband PCS Microcell Model.	CLO 10	T1-4.10.6
16	Indoor Propagation Models-Partition losses (Same Floor).Partition losses between Floors.	CLO 12	T1-4.11
17	Log-distance path loss model, Ericsson Multiple Breakpoint Model, Attenuation Factor Model.	CLO 10	T1-5.1.1
18	Signal penetration into buildings, Ray Tracing and Site Specific Modeling.	CLO 11	T1-5.1.1
19	Small Scale Multipath propagation- Factors influencing small scale fading, Doppler shift.	CLO 11	T1-.1.1,5.1.2
20	Impulse Response Model of a multipath channel- Relationship between Bandwidth and Received power.	CLO 6	T1-5.2
21	Small-Scale Multipath Measurements- Direct RF Pulse System.	CLO 6	T1-5.3
22	Spread Spectrum Sliding Correlator Channel Sounding.	CLO 7	T1-5.3.2
23	Frequency Domain Channels Sounding, Parameters of Mobile Multipath Channels-Time Dispersion Parameters.	CLO 7	T1-5.3.3,5.4
24	Coherence Bandwidth, Doppler Spread and Coherence Time.	CLO 6	T1-5.4.2
25	Types of Small-Scale Fading-Fading effects Due to Multipath Time Delay Spread, Flat fading.	CLO 7	T1-5.5
26	Frequency selective fading. Fading effects Due to Doppler Spread-Fast fading	CLO 5	T1-5.11
27	Slow fading, Statistical Models for multipath Fading Channels-Clarke‟s model for flat fading.	CLO 4	T1-5.11
28	Spectral shape due to Doppler spread in Clarke‟s model, Simulation of Clarke and Gans Fading Model.	CLO 7	T1-5.11
29	Level crossing and fading statistics, Two- ray Rayleigh Fading Model.	CLO 8	T1-5.11
30	Introduction, Fundamentals of Equalization.	CLO 7	T1-7.1,7.2
31	Training A Generic Adaptive Equalizer, Equalizers in communication Receiver.	CLO 7	T1-7.3,7.4
32	Linear Equalizers, Non-linear Equalization-Decision Feedback Equalization (DFE).	CLO 7	T1-7.6,7.7
33	Maximum Likelihood Sequence Estimation (MLSE) Equalizer.	CLO 9	T1-7.7.2
34	Algorithms for adaptive equalization ,	CLO 9	T1-7.8

Lecture No	Topics to be covered	CLOs	Reference
35	Zero forcing algorithm, least mean square algorithm recursiveleast squares algorithm;	CLO 10	T1-7.8.1,8.2
36	Diversity techniques; Derivation of selection diversity improvement,	CLO 10	T1-7.10,11
37	Derivation of maximal ratio combining improvement, practical space diversity consideration;	CLO 10	T1-7.10.2-3
38	Selection diversity, feedback or scanning diversity	CLO 11	T1-7.10.3
39	Maximal ratio combining, equal gain combining,	CLO 11	T1 7.10.3.3
40	Polarization diversity, frequency diversity, time diversity, RAKE receiver.	CLO 12	T1-7.10.
41	Introduction to wireless networks, advantages and disadvantages of wireless local area networks	CLO 12	R3-P184
42	WLAN topologies, WLAN standard IEEE 802.11	CLO 13	R3-P185
43	IEEE 802.11 medium access control,	CLO 13	R3-P191
44	Comparison of IEEE 802.11 a,b,g and n standards	CLO 14	R3-P190
45	IEEE 802.16 and its enhancements, Wireless PANs, Hipper LAN, WLL.	CLO 14	R3-P191

XVII. GAPS IN THE SYLLABUS-TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with POs	Relevance with PSOs
1	Encourage students to solve real time applications and prepare to wards competitive examinations.	Guest Lectures	PO 1	PSO 1
2	Analyze the wireless communication networks	Seminars / NPTEL	PO 2	PSO 1
3	Formulate the communication standards applicable to real time applications.	NPTEL	PO 2	PSO 1

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