INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTOR

Course Title	**CELLULAR AND MOBILE COMMUNICATION**				
Course Code	AEC520				
Programme	B.Tech				
Semester	VI	ECE			
Course Type	Elective				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	**Mr. B. Santhosh Kumar, Assistant Professor**				
Course Faculty	**Mr. B. Santhosh Kumar, Assistant Professor**				

I. COURSE OVERVIEW:

This course is intended to stress the fundamentals of Cellular Mobile Radio system and network that are important to any wireless and cellular 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 describes cell coverage for signal and traffic, Generations of mobile networks, different protocols and mobile data systems and their analysis. 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

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Cellular and Mobile Communication	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	Assignments
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	3	Assignments
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety,and the cultural, societal, and environmental Considerations.	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:** An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems.	1	Lectures and Assignments
PSO 2	**Problem-Solving Skills:** An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.	-	-
PSO 3	**Successful Career and Entrepreneurship**: An understanding of social-awareness & environmental- wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real- world applications using optimal resources as an Entrepreneur**.**	1	Guest lectures

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 cellular mobile system design concepts in wireless mobile communication networks.	CLO 1	Identify the limitations of conventional Mobile Telephone Systems; understand the basic cellular mobile system.
		CLO 2	Remember Uniqueness of mobile radio environment- fading- Factors Time dispersion parameters, Coherence bandwidth, Doppler spread and coherence time.
		CLO 3	Understand the concept of frequency Reuse channels, Deduce the Co- channel interference reduction factor.
		CLO 4	Analyze perspective on Fundamentals of Equalization and Mobile Radio Propagation Multipath Measurements.
CO 2	Design of Antenna system, Antenna parameters and their effects, diversity receiver, non co-channel interference-different.	CLO 5	Explain Co-channel interference with near end far end interference.
		CLO 6	Understand Signal reflections in flat and hilly terrain, Effect of human made structures.
		CLO 7	Remember concepts of cell coverage for signal and traffic.
		CLO 8	Demonstrate wireless local area networks and their specifications in communication system.
CO 3	Understand the concepts of Handoff, dropped calls and cell splitting, Intersystem handoff	CLO 9	Understand Signal reflections in flat and hilly terrain, Effect of human made structures.
		CLO 10	Understand Cell Site and Mobile Antennas.
		CLO 11	Understand Phase difference between direct and reflected path.
CO 4	Imbibe knowledge about Wireless Systems And Standards GSM channels, multiplex access scheme, TDMA, CDMA.	CLO 12	Understand the operation of the various wireless wide area networks such as GSM, IS-95, GPRS and SMS.
		CLO 13	Understand the existing and emerging wireless standards in wireless wide area networks.
		CLO 14	Demonstrate wireless local area networks and their specifications in communication system.
CO 5	Intelligent Network For Wireless Communications SS7 network and ISDN for AIN, AIN for mobile communication.	CLO 15	Understand the existing and emerging wireless standards in wireless wide area networks.
		CLO 16	Understand the SS7 network and ISDN for AIN, AIN for mobile communication.
		CLO 17	Remember the Intelligent cell concept, advanced intelligent network.

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
AEC520.01	CLO 1	Identify the limitations of conventional Mobile Telephone Systems; understand the basic cellular mobile system.	PO1	3
AEC520.02	CLO 2	Remember Uniqueness of mobile radio environment-fading- Factors Time dispersion parameters, Coherence bandwidth, Doppler spread and coherence time.	PO1	3
AEC520.03	CLO 3	Understand the concept of frequency Reuse channels, Deduce the Co- channel interference reduction factor.	PO1	3
AEC520.04	CLO 4	Analyze perspective on Fundamentals of Equalization and Mobile Radio Propagation Multipath measurements	PO2	3
AEC520.05	CLO 5	Explain Co-channel interference with near end far end interference.	PO2	3
AEC520.06	CLO 6	Understand Signal reflections in flat and hilly terrain, Effect of human made structures.	PO3	2
AEC520.07	CLO 7	Remember concepts of cell coverage for signal and traffic.	PO3	2
AEC520.08	CLO 8	Demonstrate wireless local area networks and their specifications in communication system.	PO1	3
AEC520.09	CLO 9	Understand Signal reflections in flat and hilly terrain, Effect of human made structures.	PO3	2
AEC520.10	CLO 10	Understand Cell Site and Mobile Antennas.	PO3	2
AEC520.11	CLO 11	Understand Phase difference between direct and reflected path.	PO1	3
AEC520.12	CLO 12	Understand the operation of the various wireless wide area networks such as GSM, IS-95, GPRS and SMS.	PO3	2
AEC520.13	CLO 13	Understand the existing and emerging wireless standards in wireless wide area networks.	PO3	2
AEC520.14	CLO 14	Demonstrate wireless local area networks and their specifications in communication system.	PO3	2
AEC520.15	CLO 15	Understand the existing and emerging wireless standards in wireless wide area networks.	PO1	3
AEC520.16	CLO 16	Understand the SS7 network and ISDN for AIN, AIN for mobile communication.	PO1	3
AEC520.17	CLO 17	Remember the Intelligent cell concept, advanced intelligent network.	PO3	2

3 = High; 2 = Medium; 1 = Low

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

Course Outcomes	Program Outcomes and Program Specific Outcomes					
	PO 1	PO 2	PO 3	PSO 1	PSO 2	PSO 3
CO 1	3	3				
CO 2	3	3	2		2	
CO 3	3	2	2	2		2
CO 4		2	2	2	2	
CO 5	3		2		2	2

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3														
CLO 2	3														
CLO 3	3														
CLO 4		3													
CLO 5		3												2	
CLO 6			2											2	
CLO 7			2											2	
CLO 8	3													2	
CLO 9			2										2		2
CLO 10			2										2		2
CLO 11	3												2		2
CLO 12			2										2	2	
CLO 13			2										2	2	
CLO 14			2										2	2	
CLO 15	3														2
CLO 16	3														2
CLO 17			2											2	2

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1	SEE Exams	PO 1	Assignments	-	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

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

XV. SYLLABUS

UNIT-I	CELLULAR MOBILE RADIO SYSTEMS	Classes: 10
Introduction to cellular mobile System, performance criteria, uniqueness of mobile radio environment, operation of cellular systems, hexagonal shaped cells, analog and digital Cellular systems, General description of the problem, concept of frequency channels, Co-channel Interference Reduction Factor, desired C/I from a normal case in a omni directional Antenna system, Cell splitting, consideration of the components of Cellular system.		
UNIT -II	**INTERFERENCE AND CELL COVERAGE FOR SIGNAL AND TRAFFIC**	**Classes: 09**
Introduction to Co-Channel Interference, real time Co-Channel interference, Co-Channel measurement, design of Antenna system, Antenna parameters and their effects, diversity receiver, non-cochannel interference-different types, Signal reflections in flat and hilly terrain, effect of human made structures, phase difference between direct and reflected paths, constant standard deviation, straight line path loss slope, general formula for mobile propagation over water and flat open area, near and long distance propagation antenna height gain, form of point to point model.		
UNIT -III	**CELL SITE AND MOBILE ANTENNAS**	**Classes: 10**
Sum and difference patterns and their synthesis, omni directional antennas, directional antennas for interference reduction, space diversity antennas, umbrella pattern antennas, minimum separation of cell site antennas, high gain antennas, Numbering and grouping, setup access and paging channels channel assignments to cell sites and mobile units, channel sharing and borrowing, sectorization, overlaid cells, non fixed channel assignment, Handoff, dropped calls and cell splitting, types of handoff, handoff invitation, delaying handoff, forced handoff, mobile assigned handoff. Intersystem handoff, cell splitting, micro cells, vehicle locating methods, dropped call rates and their evaluation		
UNIT -IV	**WIRELESS SYSTEMS AND STANDARDS**	**Classes: 08**
Second generation and Third generation Wireless Networks and Standards, WLL, Bluetooth, GSM, IS95, DECT, GSM architecture, GSM channels, multiplex access scheme, TDMA, CDM.		
UNIT -V	**INTELLIGENT NETWORK FOR WIRELESS COMMUNICATIONS**	**Classes: 08**
Intelligent cell concept, advanced intelligent network, SS7 network and ISDN for AIN, AIN for mobile communication, asynchronous transfer mode technology, future public land mobile telecommunication system, wireless information superhighway.		

Text Books:

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

I. 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 a 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
35	Zero forcing algorithm, least mean square algorithm, recursive	CLO 10	T1-7.8.1,8.2

Lecture No	Topics to be covered	CLOs	Reference
	least squares algorithm;		
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

II. 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 towards 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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