# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

Dundigal, Hyderabad - 500 043

## ELECTRONICS AND COMMUNICATION ENGINEERING

## COURSE DESCRIPTION FORM

| | | | | | |
|---|---|---|---|---|---|
| **Course Title** | : | **WIRELESS COMMUNICATIONS AND NETWORKS** | | | |
| **Course Code** | : | **A80454** | | | |
| **Academic year** | : | **2018-2019** | | | |
| **Regulation** | : | **R15** | | | |
| **Branch** | : | **ELECTROCNICS AND COMMUNICATION ENGINEERING** | | | |
| **Course Structure** | : | **Lectures** | **Tutorials** | **Practicals** | **Credits** |
| | | **4** | **--** | **--** | **4** |
| **Course Coordinator** | : | **Mr. MD Khadir, Assistant. Professor, ECE Dept.** | | | |
| **Team of Instructors** | : | **Mr. MD Khadir, Assistant. Professor, ECEDept.**<br>**Mr. G.Vijay Kumar, Assistant. Professor, ECEDept.**<br>**Mrs. P. Anitha, Assistant. Professor, ECEDept.** | | | |

## I. COURSE OVERVIEW

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 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. PREREQUISITES

| Level | Credits | Periods / Week | Prerequisites |
|---|---|---|---|
| UG | 4 | 4 | Analog Communications, Digital Communications, and Computer Networks |

## III. COURSE ASSESSMENTMETHODS

| Sessional Marks (25 Marks) | University End Exam Marks | Total Marks |
|---|---|---|
| There shall be 2 midterm examinations. Each midterm examination consists of subjective type and Objective type tests.<br>The subjective test is for 10 marks, with duration of 1 hour. Subjective test of each midterm exam shall contain 4 questions. The student has to answer 2 questions, each carrying 5 marks.<br>The objective type test is for 10 marks with duration of 20minutes. It consists of 10 Multiple choice and 10 objective type questions. The student has to answer all the questions and each carries half mark.<br>First midterm examination shall be conducted for the first 2 ½ units of syllabus and second midterm examination shall be conducted for the remaining 2 ½ units.<br>Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course reason whatsoever, will get zero marks(s). | **75** | **100** |

## IV. EVALUATION SCHEME

| S.No | Component | Duration(Hrs) | Marks |
|---|---|---|---|
| 1 | I Mid Examination | 1 hr 20 min | 20 |
| 2 | I Assignment | -- | 05 |
| 3 | II Mid Examination | 1 hr 20 min | 20 |
| 4 | Ii Assignment | -- | 05 |
| 5 | End Semester Examination | 3 hrs | 75 |

## V. COURSE OBJECTIVES

**At the end of the course, the students will be able 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. Design and analysis of the traditional, Mobile Radio Propagation Multipath Measurements and Fading-Fading effects. Analyze various modulation schemes and multiple access techniques that are used in wireless communications

III. Remember analytical perspective on Fundamentals of Equalization, Linear Equalizers, Non-linear Equalization, Diversity Techniques and RAKE Receiver.

IV. Understand Introduction to wireless Networks.WLAN Topologies, WLAN Standard IEEE 802.11, Wireless PANs, Hiper LAN, and WLL.

V. Examine the emerging techniques and its importance in the wireless communications.

## VI. COURSE OUTCOMES

**After completing this course the student must demonstrate the knowledge and ability to:**

1. Understand the principles and fundamentals of wireless communications.
2. Demonstrate cellular system design concepts in wireless mobile communication networks.
3. Remember fundamentals of Radio Wave Propagation Basic Propagation Mechanisms.
4. Analyze perspective on Fundamentals of Equalization and Mobile Radio Propagation Multipath Measurements.
5. Analyze various multiple access schemes and techniques used in wireless communication.
6. Discuss the Parameters of Mobile Multipath Channels and Types of Small- Scale Fading-Fading effects.
7. Examine the perspective on Fundamentals of Equalization, Linear Equalizers, Non-linear Equalization.
8. Remember the Diversity Techniques and RAKE Receiver in Radio Propagation.
9. Demonstrate wireless local area networks and their specifications in communication system.
10. Familiar with some of the existing and emerging wireless standards. Understand wireless wide area networks

## VII. HOW COURSE OUTCOMES ARE ASSESSED

| Program Outcomes | | Level | Proficiency assessed by |
|---|---|---|---|
| **PO1** | **Engineering Knowledge**<br>Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems | **S** | Assignments |
| **PO2** | **Problem Analysis**<br>Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences | **H** | Design Exercises and assignments |
| **PO3** | **Design/Development of Solutions**<br>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 | **H** | Practice Sessions Assignments |
| **PO4** | **Conduct Investigations of Complex Problems**<br>Use research-based knowledge and research methods includingdesign of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions | **S** | Practice Sessions Assignments |
| **PO5** | **Modern Tool Usage**<br>Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of thelimitations | **S** | Lectures and Exercises |
| **PO6** | **The Engineer And Society**<br>Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. | **N** | --- |
| **PO7** | **Environment and sustainability**<br>Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development | **N** | --- |
| **PO8** | **Ethics**<br>Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice | **N** | --- |
| **PO9** | **Individual and Team Work**<br>Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings | **S** | Seminars, Discussions |
| **PO10** | **Communication**<br>Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions | **N** | --- |
| **PO11** | **Project management and finance**<br>Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments | **S** | Assignments |
| **PO12** | **Life-long learning**<br>Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change | **S** | Assignments, Development of Mini Projects |

**N =None** **S=Supportive** **H = Highly Related**

## VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

| Program Specific Outcomes | | Level | 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. | **H** | 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. | **S** | Tutorials |
| **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. | **S** | Seminars and Guest lectures |

**N-None** **S–Supportive** **H – Highly Related**

## IX. 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) Model, 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, lndoor 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**

**Mobile Radio Propagation:** 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, Hiper Lan, WLL.

**TEXT BOOKS**


1. Practice Theodore ,"Wireless Communications, Principles", , S.Rappaport, 2nd Ed., 2002, PHI.
2. Andrea Goldsmith ,"Wireless Communications", 2005 Cambridge University Press.
3. Gestapo Sasibhushana Rao "Mobile Cellular Communication", Pearson Education,2012.


**REFERENCE BOOKS**


1. Kaveh Pah Laven and P. Krishna Murthy "Principles of Wireless Networks" PE 2002
2. Kamilo Feher, "Wireless Digital Communications" 1999, PHI.
3. William Stallings "Wireless Communication and Networking",2003,PHI.
4. Upen Dalal,"Wireless Communication", Oxford Univ.Press
5. Vijay K. Gary "Wireless Communications and Networking", Elsevier.


## X. COURSE PLAN

At the end of the course, the students are able to achieve the following course learning outcomes:

| Lecture No. | Course Learning Outcomes | Topics to be covered | Reference |
|---|---|---|---|
| 1 | Basic idea of cellular system, Discuss frequency cell | Introduction, Frequency Reuse. | T1:chapter 3.1-3.2 |
| 2 | Describe handoff mechanism | Channel Assignment Strategies, Handoff Strategies. | T1:chapter 3.3-3.4 |
| 3 | Describe handoff mechanism | Prioritizing Handoffs, Practical Handoff Considerations. | T1:chapter 3.3-3.4 |
| 4-5 | Extreme interface in mobile communication | Interference and system capacity — Co channel Interference and system capacity. | T1:chapter 3.5 |
| 6 | Discuss about Channel planning | Channel planning for Wireless Systems. | T1:chapter 3.5 |
| 7 | Examine interface in mobile communication | Adjacent Channel interference , Power Control for Reducing interference. | T1:chapter 3.5 |
| 8 | Discriminate services of cellular system | Trunking and Grade of Service. | T1:chapter 3.6 |
| 9-10 | Identify the coverage and capacity, Concept of cell splitting | Improving Coverage & Capacity in Cellular Systems. | T1:chapter 3.7 |
| 11 | Discuss basic propagation models in mobile radio systems. | Large-Scale Path Loss: Introduction to Radio Wave Propagation. | T1:chapter 4.1 |
| 12 | Discuss the concepts of electromagnetic wave propagation | Free Space Propagation Model, Relating Power to Electric Field. | T1:chapter 4.2 |
| 13-14 | Basic idea of Propogation Mechanism | The Three Basic Propagation Mechanisms, Reflection- Reflection from Dielectrics. | T1:chapter 4.4 |
| 15 | Identify the Reflection- Reflection from | The Three Basic Propagation Mechanisms, | T1:chapter 4.4 |

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|---|---|---|---|
| | Dielectrics. | Reflection- Reflection from Dielectrics. | |
| 16-17 | Discuss the Brewster Angle, Reflection from prefect conductors | Brewster Angle, Reflection from prefect conductors. | T1:chapter 4.5.1,4.5.2 |
| 18 | Examine the Ground Reflection (Two-Ray) Model, Diffraction-Fresnel Zone Geometry | Ground Reflection (Two-Ray) Model, Diffraction-Fresnel Zone Geometry. | T1:chapter 4.6 |
| 19-20 | Examine Knife-edge Diffraction Model. | Knife-edge Diffraction Model, Multiple knife-edge Diffraction, Scattering. | T1:chapter 4.7 |
| 21-22 | Develop Knife-edge Diffraction Model. | Outdoor Propagation Models- Longley- Ryce Model, Okumura Model, Hata Model, PCS Extension to Hata Model. | T1:chapter 4.10 |
| 23 | Develop Walfisch and Bertoni Model, Wideband PCS Microcell Model. | Walfisch and Bertoni Model, Wideband PCS Microcell Model. | T1:chapter 4.10.6 |
| 24 | Develop lndoor Propagation Models. | lndoor Propagation Models-Partition losses (Same Floor).Partition losses between Floors. | T1:chapter 4.11 |
| 25 | Discuss and examine Log- distance path loss model, Ericsson Multiple Breakpoint Model, Attenuation Factor Model. | Log-distance path loss model, Ericsson Multiple Breakpoint Model, Attenuation Factor Model. | T1:chapter 5.1.1 |
| 26 | Basics of Signal penetration into buildings, Ray Tracing and Site Specific Modeling. | Signal penetration into buildings, Ray Tracing and Site Specific Modeling. | T1:chapter 5.1.1 |
| 27 | Discuss about Signal penetration into buildings, Ray Tracing and Site Specific Modeling. | Small Scale Multipath propagation- Factors influencing small scale fading, Doppler shift. | T1:chapter 5.1.1,5.1.2 |
| 28 | Describe Impulse Response Model of a multipath channel. | Impulse Response Model of a multipath channel- Relationship between Bandwidth and Received power. | T1:chapter 5.2 |
| 29 | Examine Small-Scale Multipath Measurements | Small-Scale Multipath Measurements- Direct RF Pulse System. | T1:chapter 5.3 |
| 30 | Describe Spread Spectrum Sliding Correlator Channel Sounding. | Spread Spectrum Sliding Correlator Channel Sounding. | T1:chapter 5.3.2 |
| 31-32 | Discuss about Frequency Domain Channels Sounding, Parameters of Mobile Multipath Channels. | Frequency Domain Channels Sounding, Parameters of Mobile Multipath Channels-Time Dispersion Parameters. | T1:chapter 5.3.3, 5.4 |
| 33 | Basics of Coherence Bandwidth, Doppler Spread and Coherence Time. | Coherence Bandwidth, Doppler Spread and Coherence Time. | T1:chapter 5.4.2 |
| 34 | Describe Types of Small-Scale Fading-Fading. | Types of Small-Scale Fading-Fading effects Due to Multipath Time Delay Spread, Flat fading. | T1:chapter 5.5 |
| 35 | Examine Frequency selective fading. | Frequency selective fading.Fading effects Due to Doppler Spread-Fast fading. | T1:chapter 5.11 |
| 36-37 | Describe slow fading, Statistical Models for multipath Fading Channels. | slow fading, Statistical Models for multipath Fading Channels-Clarke's model for flat fading. | T1:chapter 5.11 |
| 38-39 | Develop spectral shape due to Doppler spread in Clarke's model, Simulation of Clarke and Gans Fading Model. | spectral shape due to Doppler spread in Clarke's model, Simulation of Clarke and Gans Fading Model. | T1:chapter 5.11 |
| 40-41 | Analysis of Level crossing and fading statistics, Two-ray Rayleigh Fading Model. | Level crossing and fading statistics, Two- ray Rayleigh Fading Model. | T1:chapter 5.11 |
| 42 | Basics of Fundamentals of equalization | Introduction, Fundamentals of Equalization. | T1:chapter 7.1,7.2 |
| 43 | Discuss Generic Adaptive Equalizer | Training A Generic Adaptive Equalizer, Equalizers in a communication Receiver. | T1:chapter 7.3 |
| 44 | Discuss Linear and Non- Equalizers | Linear Equalizers, Non-linear Equalization-Decision Feedback Equalization (DFE). | T1:chapter 7.6 |
| 45 | Describe Maximum Likelihood Sequence Estimation (MLSE)Equalizer | Maximum Likelihood Sequence Estimation (MLSE) Equalizer. | T1:chapter 7.7 |

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|---|---|---|---|
| 46 | Techniques of reducing Zero Forcing Algorithm | Algorithms for adaptive equalization- Zero Forcing Algorithm. | T1:chapter 7.8 |
| 47 | Develop Least Mean Square Algorithm, Recursive least squares algorithm | Least Mean Square Algorithm, Recursive least squares algorithm. | T1:chapter 7.8.2 |
| 48 | Derive the Diversity Techniques | Diversity Techniques-Derivation of selection Diversity improvement | T1:chapter 7.10 |
| 49 | Derivation of Maximal Ratio Combining improvement | Derivation of Maximal Ratio Combining improvement, Practical Space Diversity Consideration-Selection Diversity | T1:chapter 7.10.2 |
| 50 | Discuss about diversity with all types of diversity. | Feedback or Scanning Diversity, Maximal Ratio Combining | T1:chapter 7.10.3.2 |
| 51-52 | Discuss Equal Gain Combining, Polarization Diversity,FrequencyDiversity | Equal Gain Combining, Polarization Diversity, Frequency Diversity | T1:chapter 7.10.3.4 |
| 53 | Explain Time Diversity, RAKE Receiver | Time Diversity, RAKE Receiver. | T1:chapter 7.10.6 |
| 54 | Justify the need wireless communication | Introduction to wireless Networks | T3:chapter2.1 |
| 55 | Support the local area network | Advantages and disadvantages of Wireless Local Area Networks. | T3:chapter2.2 |
| 56-57 | Discuss techniques in LAN | WLAN Topologies | T3:chapter2.3 |
| 58-59 | Explain the physical layer | WLAN Standard IEEE 802.11 ,IEEE 802.11 Medium Access Control | T3:chapter2.4 |
| 60-61 | Differentiate the LAN technologies | Comparison of IEEE 802.11 a,b,g and n standards, IEEE 802.16 and its enhancements, Wireless PANs, Hiper Lan, WLL. | T3:chapter2.5 |

## XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OFPROGRAM OUTCOMES:

| Course Objectives | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| I. | S | S | S | S | | | | | S | S | | | S | | S |
| II. | | H | H | S | | | | | S | S | | | H | S | |
| III. | S | | S | | | | | | | | S | | S | | S |
| IV. | S | S | | S | | | | | S | S | S | | | S | S |
| V. | | H | H | | | | | | | | | | H | | |

S=Supportive H = Highly Related

## XII. MAPPING COURSE OUTCOMES LEADING TO ACHIEVEMENT OF PROGRAM OUTCOMES:

| Course Outcomes | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| 1. | S | S | | S | S | | | | S | S | S | | | | S |
| 2. | S | H | | S | | | | | H | S | S | | | S | |
| 3. | | S | H | | S | | | | | | | S | H | | |
| 4. | S | | S | S | | | | | S | H | S | | S | | S |
| 5. | | S | | S | | | | | | | | S | | S | |
| 6. | | H | | | S | | | | | | | | | S | |
| 7. | S | | S | S | S | | | | S | S | S | | | | |
| 8. | | S | S | | | | | | S | S | | | H | | S |
| 9. | S | | S | S | | | | | S | H | S | | S | | S |

S=Supportive H = HighlyRelated

**Prepared By:** Mr. MD Khadir, Assistant.Professor
Mr.U.Somanaidu, Assistant Professor, ECE Dept.

HOD,ECE