**DEPARTMENT OF ELECTRICAL ENGINEERING**

**Course Descriptive File**

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| 1 | Course Title | Wireless and Mobile Communication |
| 2 | Course Code |  TE-401 |
| 3 | Credit Hours | 3 |
| 4 | Pre-requisites | Communication Systems |
| 6 | Semester | VIII |
| 7 | Resource Person | Mr.Sajjad Rabbani |
| 8 | Contact Hours (Theory) | 48 |
| 9 | Session | 2016-2020 |
| 10 | Office Hours  | 8-4pm |
| 11 | Email | sajjadra94@gmail.com |
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| 12 | Course Outline as per Scheme of Studies ( SoS) |
| * Cellular Concepts & details, Frequency reuse , Channel Assignment strategies
* Channels Interference & System capacity, Cell splitting and cell sectoring details Trunking theory & Grade of service.
* Orthogonal Frequency Division Multiplexing (OFDM), Orthogonal Frequency Division Multiple Access (OFDMA), Time Division Multiple Access (TDMA) ,Code Division Multiple Access (CDMA).
* Path loss models (Empirical, Probabilistic, Deterministic), shadowing, Multipath Models, multipath fading, wideband models.
* Capacity of wireless channels, digital modulation, performance in wireless fading channels
* Time Diversity, Frequency Diversity , Space Diversity , Cooperative Diversity
* Introduction to Cooperative Diversity Networks, Introduction to Wireless Sensors Networks.
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| 13 | Course Objectives as per Scheme of Studies (SoS) |
| * To provide an overview of the fundamental concepts and technologies involved in wireless and mobile communication systems.
* Teach advanced concepts in communications systems including digital radio, various types of modulation, time-division multiplexing, cellular communication, GSM and 3G mobile.
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| 14 | Books  |
| **Textbook*** Theodore S. Rappaport,” Wireless Communications”, Latest Edition
* William Stallings,” Wireless Communication & Networks” Latest Edition

**Reference Books** * William Lee, Wireless & Cellular Communication”, McGraw. Hill, Latest Edition
* Andrea Goldsmith, ”Wireless Communication”, Latest Edition
* Morvin K. Simon & Slim Alouini, “ Digital Communication over Channels” Latest Edition
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| 15 | Course Learning Outcomes (CLOs) |
| After successful completion, students will be able:

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|  **Sr. No.**  | **Example CLO**  | **Domain**  | **Taxonomy level**  | **PLO**  |
| **1.** | UNDERSTAND the basics concept wireless communication and networks. | Cognitive  | C1,C2 | 1 |
| **2.** | UNDERSTAND and ANALYSE the different wireless multiple access techniques, path loss models, wireless sensors networks and cooperative diversity networks.  | Cognitive  | C3,C4 | 2 |

**Theory CLOs:**1. Cellular Concepts, Frequency reuse ,Channel Interference.
2. Path loss models (Empirical, Probabilistic, Deterministic), shadowing, Multipath Models, multipath fading, wideband models.
3. Capacity of wireless channels.
4. Digital modulation, performance in wireless fading channels.
5. Time Diversity, Frequency Diversity , Space Diversity , Cooperative Diversity.
6. Introduction to Cooperative Diversity Networks.
7. Introduction to Wireless Sensors Networks.
8. Orthogonal Frequency Division Multiplexing (OFDM), Orthogonal Frequency Division Multiple Access (OFDMA), Time Division Multiple Access (TDMA) ,Code Division Multiple Access (CDMA).
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|  16 |  RELEVANT PROGRAM LEARNING OUTCOMES (PLOs): |
|  | The course is designed so that students will achieve the following PLOs:

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| 1 | Engineering Knowledge:  |  | 7 | Environment and Sustainability: | ☐ |
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| 2 | Problem Analysis:   |  | 8 | Ethics: |  | ☐ |
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| 3 | Design/Development of Solutions: ☐ |  | 9 | Individual and Team Work: | ☐ |
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| 4 | Investigation: ☐ |  10 | Communication: | ☐ |
| 5 | Modern Tool Usage: ☐ |  | 11 | Project Management: | ☐ |
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| 6 | The Engineer and Society: ☐ |  12 | Lifelong Learning: | ☐ |

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| 17 | Marks Breakup  |
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| Quizzes | 10% |
| Homework/assignments  | 10% |
| Midterm exam | 30% |
| Terminal exam (3 hours) | 50% |
| Total (theory) | 100% |

Theory |

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| **18** |
| **Week** | **Topic** | **CLO** | **Taxonomy****Level** | **Specific Outcome** Upon successful completion of this course, the student will be able to:  | **Contact Hours 3 hrs /wk** | **Assessment** |
| 1 | The cellular revolution & concept.Historical overview of wireless communication. Design challenges in wireless communication networking. Advanced features & goals of GSM, Mobile radio systems around the world. GSM applications, GSM criteria and Introduction of all analog and digital wireless systems. Why wireless NetworkComparison of between wireless & wire line networks.`Types of Communication Networks.Basic Features of GSM networksMajor wirless standards in North America. Major Mobile radio standards in Europe and Japan.Detail of 1G, 2G,2.5G ,3G cellular networks & Trouble with GSM.Detail of terms & definitions used in GSM | CLO1 | **C2** | On successful completion of the course students will be able to::Understand the cellular revolution & wireless network applications.Design challenges of wireless network. Historical overview of wireless communication and possess the basic concepts, goals & standards of mobile radio systems around the world.Describe types & basic principles of operation cellular systems. Students will get to know the detail of 1G, 2G,2.5G ,3G & 4G wireless networks & Trouble with GSM. Acquire the basic knowledge of. generalized principles of basic wireless systems & Examples & establishments of GSM call for different scenarios. Describe and analyze the operation of various design parameters by using mathematical expression for analog cellular systems & Digital cellular systems with different spectrum/ specifications and calculate the different design parameters of GSM Multi frame structures.Students will learn about frequency reuse concept, Cell sectoring, cell splitting , signal processing in GSM, traffic /trunking theory, Wireless channel modeling, channel capacity, channel coding, modulation and demodulation, OFDM, Understand and analyze the different wireless multiple access techniques, path loss models, wireless sensors networks and diversity networks. Identify and discuss the fundamental operational and design problems of wireless communication systems. | 3 | MidAssignment 1Quiz 1MidAssignment 2Quiz 2 |
| 2 | Paging systems, operations of paging systems , cordless telephone, WalkiTalki systems etc Call setup Flow Chart in cellular systems and PSTN.Mobile –to- land sceneries & others.Analog Cellular systems (AMPS, TACS, NMT) & Digital cellular systems (P-GSM 900, E-GSM 900, GSM 1800, GSM 1900, PCS) spectrum/ specifications detail (uplink, downlink frequencies and calculations of bandwidth, Duplex distance, Carrier separation, Radio channels, Transmission rates) Calculations of GSM single channel per carrier, Multi Frame structure ( Bits & frame period etc ) & related Numerical.FDD &TDD systems.  | CLO1 | C3 |  |  |
| 3 |  Objectives & applications of WLAN 802.11 standard ? WLANs & brief overview of the IEEE802.11Context with OSI layers & IEEE standards.Summary of required features and difficulties vs 802.11 featuresWLAN securities types. 802.11 & 802.16 detals.WiFi Vs 3G, WiMax Vs 3GGPRS & EDGE Hardware Architecture & Applications. | CLO1 | C2 | .  |  |
| 4 | Detail of Development to 2.5G Mobile radio networks, HSCSD TDMA standards for 2.5G GSM and IS-136, CDMA 2000, 3G TD-SCDMA, Blue Tooth & all others.Development of CDMA systems.CDMA 2000 Network diagram & components detail.& Bit, symbol, Chip, Process gian, Forward direction & reverse direction.CDMA Process flow of signal.Source coding ,Channel Coding, Turbo codes, long Code, short code, FEC coding, scrambling, spreading/ De spreading etc. CDMA system capacity & calculations | CLO1 | C2,C3 |  |  |
| 5 | GSM Architecture, Elements & explanation of functions.GSM Network (with BSS MSN & Management Network.)Functional description of Network Switching systems MSC, BSC,BSS- BTS,NSS, HLR, VLR, AUC, EIR, EC & GMSC.Interfaces types used between GSM network Um, Abis, AterA ,B,C,D,E,F,G& H.GMSC & PSTN connectivity Detail of HLR/VLR roaming existence with MSCs & others.Transcoder- XCDR & sub- multiplexers (TCSM).Tetra Systems & GSM system comparison & Tetra system parameters  | CLO1 | C2 |  |  |
| 6 | GSM identifiers types & detail.International mobile equipment identifier (IMEI)International mobile subscriber identifier (IMSI)Temporary mobile subscriber identifier(TMSI). Mobile station roaming number (MSRN) Location area identifier (LAI)Cell identifier (CI)Base station identity code (BSIC)Mobile Equipment(ME) –Subscriber Identity Module (SIM) & other terms reviewed.FDMA & TDMA , efficiency of TDMA and number of channels in TDMA system Calculations & related Numericals.NSS ,O&M Support & Functions. Introduction of system design fundamentals & system capacity. Description of cells, Clusters, frequency reuse concept, reuse factor, geometry of Hexagon & approximated to be a hexagonal coverage. | CLO 1 | C2, C3 |  |  |
| 7 | To find the nearest co-channel by moving I& j non--- negative integers. Calculations & cell pattern practices. Compute the co-channel reuse ratio for cluster size (N=3,4,7,9,12,19) illustration of cellular frequency reuse with diagram. , Calculation of channel band width, total available channels for different values of N.Calculations of voice & control channels for given spectrum of control channels/ Examples. Frequency reuse related calculations & Numericals. | CLO1 | C4 |  |  |
| 8 | Trunking Theory overview ,GOS & other terms, Erlang B , Erlang C formula and CalculationsTrunking /GOS related examples& NumericalsAdjacent Channel interference, Co-channel interference & signal capacity calculations. Intoduction of Cell sectoring & Cell splitting ..Reviewed some topics | CLO1 | C4 |  |  |  |
| 9 | Channel assignment strategies, handoff strategies Detail of Cell sectoring & Cell splitting & equations.  | CLO2 | C2 |  |  |  FinalAssignment1Quiz 1 FinalAssignment2Quiz 2 |
| 10 | Reviewed Multiple Access Technologies detail.Introduction to Modulation Techniques.Modulation , Transmission & detection techniques & calculations. | CLO2 | C3 |  |  |
| 11 | Detail & types of Diversity Techniques.  GSM Speech Encoder & decoder Mobile radio propagation fundamental & factors | CLO2 | C2 |  |  |
| 12 |  Large scale path loss &Small scale fading overviewFree space propagation Model ( Friis free space equation ) calculations & related numericalsThree basic propagation Mechanism ( Reflection, diffraction & scattering )  Two- Ray ground reflection Model method of images ,calculation and related numerical/problems | CLO2 | C4 |  |  |
| 13 | Fresnel zone geometry & knife edge diffraction geometry & calculationsKnife edge diffraction Model explanation & calculations and related numerical.Detail of scattering, Radar cross section model, Practical link budget design using Path loss models, Log distance Path loss & Log normal shadowing model & Equations | CLO2 | **C4** |  |  |
| 14 |  Out door propagation Models overview.Durkin’s Model, Okumura Model calculations & Numerical, Hata model and walfisch & Bertoni Model  | CLO2 | C4 |  |  |
| 15 | Detail of Longley – Rice propagation Model. Introduction to Out door/indoor.Small scale Multipath propagation details- Factors influencing small scale Fading, Doppler shift & calculations.Small Scale Multipath Measurements techniques: Direct RF pulse system,Spread spectrum sliding correlator channel sounding & Parameters of Mobile Multipath channel and Numerical | CLO2 | C4 |  |  |
| 16 | Time dispersion parameters / power delay profile calculations & related numerical, Coherence bandwidth & calculations, and Doppler spread & Coherence time parameters for time varying nature of channel Modulation,  Types of small scale fading—Fading effects due to multipath time delay spread & Fading effects due to Doppler spread and c calculations.Detail of wireless sensors networks | CLO2 | C4 |  |  |
|  | Final Term exam |  |  |  |  |

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| **18** | **Course Learning Outcomes (CLOs) and Assessment Plan** |
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| CLOActivity  | CLO 1 | CLO2 | CLO3 |
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| Quiz 1 | C1 |  |  |
| Quiz 2 | C1 |   |  |
| Assignment 1 | C1 |  |  |
| Assignment 2 | C1 |   |  |
| MID TERM EXAM | C1 |
| Quiz 1 |  | C2 |  |
| Quiz 2 |  | C2 |  |
| Assignment 1 |  | C2 |  |
| Assignment 2 |  | C2 |  |
| FINAL TERM EXAM | C2 |

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| **19** | **Mapping of CLOs to PLOs**  |

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| PLOCLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 | PLO12 |
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| CLO1 |  C1 |  |  |  |  |  |  |  |  |  |  |  |
| CLO2 |  | C2 |  |  |  |  |  |  |  |  |  |  |