Wireless Networking

Course Title: Wireless Networking
Course No: CSC320
Nature of the Course: Theory + Lab
Semester: V

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: This course familiarizes students with different concepts of wireless networking including wireless channels, communication techniques, cellular communications, mobile network, and advanced features.

Objective: The main objective of this course is to provide concepts and principles of wireless networking including protocol stacks and standards with the evolution of latest wireless networks.

Unit 1	**Introduction**	**Teaching Hours-4**
History and challenges of wireless communications	Introduction to Wireless Communication Description of history of wireless communication from 1Gup to 4G with typical feature Challenges of Wireless Communication: Wireless channel and User mobility	**2**
WLAN technologies: Infrared, UHF narrowband, spread spectrum	Introduction to WLAN, Concepts of Infrared communication and its applications UHF narrowband and spread spectrum	**1**
Wireless communications standards	Personal Area Network, Introduction to IEEE 802.15 Bluetooth WLANand standards Introduction to IEEE 802.11 a,b,g,n,ac,ad	**1**
Unit 2	**Wireless Channel Characterization**	**Teaching Hours-4**
Multipath propagation environment	Description of multipath propagation of signal in wireless communication and its effects	**0.5**
LTI channel model	Introduction to time invariant and time variant system. Channel impulse response. Time-variant transfer function of channel.	**1**
Channel correlation function	Frequency and time correlation functions	**0.5**
Large scale path loss	Free space propagation model, Okumura model, Hata model, Radio cell coverage	**1**

Small scale multipath fading	Introduction to small scale fading and Multipath, Factors affecting Small Scale Fading	**1**
Unit 3	**Wireless Communication Techniques**	**Teaching Hours-12**
3.1 Transmission techniques		
Introduction to bandpass transmission	Concept of lowpass, highpass and bandpass. Modulation for bandpass transmission	**1**
Signal space and decision reasons	Vector-space representation of M-ary signals Signal detection and optimal receiver	**1**
Digital modulation	Introduction to digital modulation techniques ASK, FSK, PSK, QPSK M-ary Phase Shift Keying (MPSK) Minimum Shift Keying (MSK) Gaussian MSK (GMSK) Introduction to Orthogonal Frequency Division Multiplexing (OFDM)	**2.5**
Power spectral density	Introduction to Power spectral density	**0.5**
3.2 Receiver Techniques		
Introduction to fading dispersive channels	Introduction to fading dispersive channels	**0.5**
Channel impairment mitigation techniques	Overview of channel impairment mitigation techniques	**1**
Diversity	Diversity mechanism Linear combining	**1**
Channel equalization	Linear equalization Decision feedback equalization	**1**
3.3 Multiple Access Technologies		
Conflict free multiple access technologies	Introduction to multiple access and its need Review of random access protocols: CSMA/CA Conflict free multiple access technologies: FDMA, TDMA, CDMA	**2**

Spectral efficiencies	Spectral efficiencies of FDMA, TDMA, CDMA systems	**1.5**
Unit 4	**Fundamentals of Cellular Communications**	**Teaching Hours-5**
Spectrum reuse and re-farming	Introduction to concept of cellular communication Components of Cellular Network Architecture Concept of Spectrum. Spectrum reuse and its need. Definition and need of Spectrum reframing	**1.5**
Cell cluster concept	Concepts of Cell. Expansion of capacity by frequency reuse. Cellular layout for frequency reuse. Geometry of hexagonal cells. Frequency reuse ratio	**1**
Co-channel and adjacent channel interference	Interference and its effect in communication. Basics of Co-channel interference and Adjacent Channel Interference. Ways to minimize the effect of interference	**1**
Cell site call blocking and delay	Congestion concepts Erlang B and Erlang C basics with formulas	**1**
Channel allocation strategies	Introduction to fixed and dynamic channel allocation strategies	**.5**
Unit 5	**Mobility Management in Wireless Networks**	**Teaching Hours-6**
Introduction	Mobility concepts and its impact in Network; Mobility Management (Hand off management and location management)	**1**
Call admission control	Basics of call admission control	**.5**
Handoff management	Handoff and its requirement Handoff management procedures Hand off strategies: MCHO, MAHO, NCHO Types of Hand Off: soft, hard, forward and backward	**1.5**
Location management for cellular and PCS networks	Concept of location Management Location management for cellular networks. SS7 network and common channel signalling. Location update procedure, call setup and paging Location management for PCS networks. Overlay approach, local anchor approach	**2**
Traffic calculation	Parameters affecting traffic calculation in handoff	

	Impact of handoff on traffic	**1**
Unit 6	**Overview of Mobile Network and Transport Layer**	**Teaching Hours-8**
Mobile IP: IP packet delivery, Agent discovery, tunnelling and encapsulation	Introduction to Mobile IP and its need. Functional Entities of Mobile IP. Operation of Mobile IP (Agent discovery, tunnelling and encapsulation)	**2**
IPv6-Network layer in the internet	Basics of Ipv6 Addressing (Include Zero Suppression and Compression) IPv6 Packet header format with function of each field. Comparison of IPv6 with IPv4 packet	**1.5**
Mobile IP session initiation protocol	Basics of SIP SIP and Mobility Components of SIP architecture and explanation	**1**
Wireless application protocol	Introduction to WAP and its main features. Basic Architecture of WAP	**1**
Mobile routing protocols: DSDV, AODV and DSR	Introduction to Routing and Mobile Routing Basics of DSDV, AODV and DSR	**1**
Classical TCP improvements: Mobile TCP, Time out freezing, Selective retransmission	Basics of TCP protocol and its working. Flow Control Basics TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission	**1.5**
Unit 7	**Advances in Wireless Networking**	**Teaching Hours-6**
4G: Features, Challenges and Applications	Main features of 4G Challenges to 4G service Applications of 4G	**.5**
Overview of 4G technologies	**Multicarrier Modulation**: Modulation and single carrier Modulation. Concepts of Multicarrier Modulation **Smart antenna techniques**: Smart Antenna and its Main Functions **Adaptive Modulation**: Introduction to Adaptive Modulation and its benefits **Cognitive Radio**: Basic Concepts of Cognitive Radio and its Benefits. Spectrum Utilization Efficiency. Primary user and Secondary user	**1.5**

Introduction to 5G and its vision	Introduction to 5G, Vision and Main features of 5G	**.5**
Introduction to wireless network virtualization	Concept of virtualization, Benefits of virtualization, Virtualization in Wireless Network (Basic concepts of Virtualization in IEEE 802.11/Wifi, Cellular Network)	**1**
Concepts of Wireless Sensor Network & RFID	Introduction to wireless sensor network and its Applications Introduction to RFID (passive and active) and applications	**.5**
Introduction to optical communication: Li-Fi	Basics of Optical Fiber Communication. Introduction to Li-Fi. Components of a Li-Fi System	**.5**
Introduction to Software Defined Wireless Networks	Concepts of Software Defined Network. Concept of Software Defined Wireless Networks and its features. Basic Architecture of SDWN	**1**
Concepts of Open BTS and Open Cellular Networks	Basic Concepts of Open BTS and Open Cellular Networks	**.5**

Laboratory Works:

The laboratory work includes the following exercises:

1. Implement DSSS, Channel coding, line coding in MATLAB or equiv. tool
2. Analyze the performance of WiMAX/WiFi network using NetSim or equiv. tool.
3. Develop QPSK detector and understand the relation between BER and SNR.
4. Implement various pulse shaping filers implemented in wireless communication.
5. Implement wireless routing protocols: DSDV & AODV
6. Create IPv6 based (Ad-hoc & Infrastructure) wireless network environment and evaluate connectivity, delay, latency, throughput etc.
7. Understand Contiki OS and implement IoT/WSN

References:

1. John W. Mark and Weisua Zhuang. "Wireless communications and Networking", Prentice hall of India Pvt. Ltd., 2005
2. Vijay Garg. "Wireless Communications and networking", First Edition, Elsevier 2007
3. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education 2012
4. Simon Haykin, Michael Moher, David Koilpillai, "Modern Wireless Communications", First Edition, Pearson Education 2013

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Section A

Attempt any two question. (2×10 = 20)

1. What do you mean by multipath propagation? Explain the effects of multipath propagation briefly. Calculate the median path loss using Okumura's model for the distance of 30Km with base station antenna height of 30m and mobile station height of 2m in a suburban environment. If the base station transmitter radiates an EIRP of 1KW at a carrier frequency of 900MHz, find the power at the receiver (assume a unity gain receiving antenna).
2. What is conflict free multiple access? List out the conflict free multiple access technologies used in wireless communication and explain each briefly.
3. What is interference? Explain the co-channel and adjacent channel interference? How can the effects of such interferences be minimized? Explain briefly.

Section B

Attempt any eight question. (8×5 = 40)

4. What are the different wireless communication standards? List out various WLAN standards with typical features of each.
5. What is bandpass transmission? Why is it used? Explain MPSK.
6. What is handoff in wireless communication? When is it required? Explain the handoff management procedure.
7. How location management is done in cellular networks? Explain briefly.
8. List out the different mobile routing protocols and explain the function of any one protocol.
9. What is mobile-TCP? How it differs with classical TCP? Explain with typical features of mobile-TCP.
10. What are the features of 4G? Explain the challenges to 4G services.
11. What is software defined wireless networks? Explain with its architecture.
12. Write short notes on: (2×2.5)
    a. Wireless application protocol
    b. RFID

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