Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 80534

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

Sixth Semester

Electronics and Communication Engineering

EC 8652 — WIRELESS COMMUNICATION

(Common to Computer and Communication Engineering/Electronics and Telecommunication Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define Link Budget.
2. Consider a base station transmitter operating at 900 MHZ carrier frequency. For a mobile moving at a speed of 72 km/h, determine the Doppler shift.
3. Differentiate Hard and Soft Handoff.
4. How does sectoring help in reducing interference in cellular networks?
5. What do you mean by Bandwidth efficiency?
6. Why is high PAPR a challenge in OFDM systems?
7. Mention the necessary conditions for achieving diversity gain in a wireless communication system with frequency and time diversity.
8. What is the role of the error signal in the LMS algorithm?
9. Mention the purpose of using precoding in MIMO scenarios.
10. What is the need for Perfect channel State Information?

PART B — (5 × 13 = 65 marks)

11. (a) Prove that for a two-ray ground reflected model, Electric field strength is $E_{TOT} = k/d^2$, where k is a constant related to E_0 and d is the distance over a flat earth between bases of the transmitter and receiver antennas.

Or

(b) Describe how delay spread and Doppler spread play a role in determining the channel bandwidth required for a communication system.

12. (a) Compare and contrast TDMA with CDMA multiple access technique. Explain its advantages and limitations.

Or

(b) Explain the various methods used in cellular systems to improve the capacity and coverage of the system.

13. (a) (i) Compare the performance of various QPSK modem architecture. (5)

(ii) Explain the working of QPSK transmitter architecture commonly used in cellular systems. (8)

Or

(b) (i) Explain the need for multicarrier modulation. (5)

(ii) Describe the OFDM multicarrier transmission system with a neat block diagram. (8)

14. (a) (i) How does nonlinear equalization differ from linear equalization? (5)

(ii) With neat Block diagram, explain about any one Nonlinear Equalizer. (8)

Or

(b) (i) Explain why maximal ratio combining gives the best performance. (3)

(ii) How does diversity improve the performance of radio system with respect to BER? (10)

15. (a) (i) With system model, explain about MIMO spatial multiplexing. (8)

(ii) How is spatial multiplexing different from spatial diversity in MIMO systems? (5)

Or

(b) (i) Analyze the capacity of Time-Invariant and time varying frequency selective fading channels. (8)

(ii) Find the optimal power allocation policy for these channels. (5)

PART C — (1 × 15 = 15 marks)

16. (a) (i) Analyze the multipath propagation effects in the context of frequency-selective fading. (7)

(ii) Consider a wireless channel model with two paths as LOS and reflected paths. The signal is transmitted at carrier frequency f_c as 1 GHz, signal bandwidth 1 MHz, velocity of the mobile receiver as 64 km/hr. Verify whether the channel is fast fading or slow fading, if the delay requirement is 200 μs. (8)

Or

(b) (i) Assume that $\theta_0 = 0^\circ$. The bit stream 0 0 1 0 1 1 is to be sent using $\pi/4$ DQPSK. The left most bits are first applied to the transmitter. Determine the phases of θ_k. (7)

(ii) Analyze the advantages of using GMSK modulation in digital cellular communication systems. (8)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 70521

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023.

Sixth Semester

Electronics and Communication Engineering

EC 8652 – WIRELESS COMMUNICATION

(Common to : Computer and Communication Engineering/Electronics and Telecommunication Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate between large scale fading and small scale fading.

2. A vehicle is travelling at a speed of 70 km/hr towards a base station. The frequency of the signal transmitted by base station is 900 MHz. What is the frequency of the received signal at the vehicle?

3. Differentiate between co-channel and adjacent channel interference in a cellular system.

4. Determine the signal-to-noise interference ratio in dB for a cellular system with cluster size as 7, number of co-channel cells in the first tier as 6 and the path loss exponent is n=4.

5. What is the need for Cyclic Prefix in an OFDM system?

6. Find the duration of one OFDM symbol with CP, if the subcarrier spacing is 20 KHz and Guard Interval is 33 μs.

7. What is the need for Equalization? Mention its types.

8. Differentiate between micro and macro diversity techniques.

9. What is meant by spatial multiplexing? Give its advantage.

10. Mention the significance of Beam forming and its types.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Explain the parameters of multipath fading channels which affect the performance of a wireless communication system. (5)

(ii) Show how the wireless channels are classified based on the channel parameters. (8)

Or

(b) Derive the expression for the total E field measured at the receiver and the received signal power using a 2-Ray Ground Reflection model.

12. (a) Discuss the various multiple access techniques and compare their merits and demerits.

Or

(b) Explain the process of handoff, different types of handoff and the practical handoff considerations in a cellular radio system.

13. (a) (i) Explain OFDM Transmitter and Receiver architecture with a neat block diagram. (8)

(ii) Discuss the advantages and drawbacks of OFDM over single carrier modulation techniques. (5)

Or

(b) Discuss the principle of Minimum Shift Keying modulation scheme and the transmitter and receiver architecture with a neat block diagram.

14. (a) Illustrate various diversity combining techniques used in a wireless communication system and compare their performances.

Or

(b) (i) Discuss the probability density function of Rayleigh fading model.(6)

(ii) Derive the BER expression for BPSK transmission over Rayleigh fading channel. (7)

15. (a) Derive the capacity of wireless channel with and without fading.

Or

(b) Illustrate Transmitter diversity technique with a suitable pre-coding technique.

PART C — (1 × 15 = 15 marks)

16. (a) (i) Discuss the Free space propagation model and hence determine the path loss. (7)

(ii) A vertical $\lambda/2$ dipole antenna is used at a mobile terminal (receiver) with a gain of 5 dB and it receives a carrier frequency of 2 GHz. Mobile terminal is located at a distance of 2 km from the unity gain transmitter antenna which radiates a power of 50W. The height of transmitter antenna is 80 m and that of receiver antenna is 3m above ground. Assume a free space propagation model. Determine the following:

(1) The physical length of the receiver antenna (2)

(2) The effective aperture of the receiver antenna (2)

(3) The power received by the receiver antenna. (2)

(4) Path loss in dB. (2)

Or

(b) (i) Analyze the effect of PAPR in an OFDM system and techniques used to overcome the problem. (7)

(ii) Consider a practical WiMAX system using OFDM, with the total number of subcarriers N = 256 and a bandwidth of 15.625 kHz per subcarrier. Assume that WiMAX employs a cyclic prefix which is 12.5% of the symbol time. Determine the following :

(1) Total Bandwidth of the system. (2)

(2) OFOM symbol duration with and without CP. (2)

(3) Total number of samples in OFDM symbol with and without CP. (2)

(4) Loss in spectral efficiency due to addition of CP. (2)

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Reg. No. :

Question Paper Code : 20479

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2022.

Sixth Semester

Electronics and Communication Engineering

EC 8652 – WIRELESS COMMUNICATION

(Common to : Computer and Communication Engineering/Electronics and Telecommunication Engineering)

(Regulations 2017)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the drawback of free space model.

2. Differentiate flat fading from frequency selective fading.

3. How capacity of TDMA system is computed?

4. How does keeping uncharged cell radius increase cellular capacity?

5. How PAPR issue is addressed in an OFDM system?

6. Why MSK is better than QPSK?

7. Write the significance of Zero Forcing Algorithm?

8. State the difference between micro and macro diversity.

9. What is spatial multiplexing?

10. Define beam forming in wireless communication system.

PART B — (5 × 13 = 65 marks)

11. (a) Derive the two -ray ground model expressing the relationship between received power and path loss component and compare its performance with free space propagation model.

Or

(b) (i) Find the Fraunhofer distance for an antenna with maximum dimension of 1 m and operating frequency of 40 GHz. If antennas have unity gain, calculate the path loss. (3)

(ii) If a transmitter produces 40W of power, express the transmit power in units of dBm, dBW. If 40 W is applied to a unity gain antenna with a 800 MHz carrier frequency, find the received power in dBm at a free space distance of 100m from the antenna. What is Pr (8 Km)? Assume unity gain for the receiver antenna. (10)

12. (a) With neat sketch, illustrate the Handoff mechanism adopted in cellular communication.

Or

(b) How many users can be supported for 0.6% blocking probability for following the trunked channels in a blocked calls cleared systems? 1, 10, 20, 100. Assume each user generates 0.1 Erlangs of traffic.

13. (a) Compare and contrast GMSK with other fundamental PSK modulation techniques.

Or

(b) Using IFFT and FFT architecture, explain the working principal of OFDM.

14. (a) Explain the working mechanism of adaptive Equalizer. Also list out the significance of LMS algorithm.

Or

(b) Derive the improvement that are realized using Selection diversity technique. Also compare its performance with maximal ratio combining technique.

15. (a) Derive Alamouti Block Codes for a 2 × 1 MIMO system. Also discuss about the Spatial multiplexing.

Or

(b) Can the knowledge of channel state information improve the capacity of a system under fading environment – discuss your understanding with necessary supportive mathematical models.

Reg. No. : | | | | | | | | | | | |

Question Paper Code : 90482

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Sixth Semester

Electronics and Communication Engineering

EC 8652 — WIRELESS COMMUNICATION

(Common to : Computer and Communication Engineering/Electronics and Telecommunication Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is Doppler shift? Derive the expression of Doppler shift.

2. (a) State the conditions for frequency selective fading channel.

   (b) If the rms delay spread is 2 μs, what could be the minimum signal period to avoid ISI.

3. Handoff threshold should neither be too large nor too small-justify.

4. Mention the drawbacks of cell splitting in cellular mobile communication.

5. What is inter-block interference? How can it be removed?

6. In Minimum Shift Keying, let δf be the change in carrier frequency from f_{c1} to f_{c2} due to the transition from 0 to 1 and T_b is the bit duration. Express δf in terms of T_b. If $f_c = \frac{f_{c1}+f_{c2}}{2}$, express f_{c1} and f_{c2} in terms of f_c and δf.

7. What is the function of an equalizer in a communication system? Write the major drawback of the zero-forcing equalizer?

8. How diversity techniques helps in combating fading? Write down the use of Microscopic and Macroscopic diversity techniques.

9. Explain how MRC diversity improves the capacity of a MIMO system.

10. What is the difference between frequency diversity and time diversity? Give one example for each type of diversity.

PART B — (5 × 13 = 65 marks)

11. (a) (i) What is coherence time? Define fast fading and slow fading.

(ii) (1) Calculate the mean excess delay and rms delay spread for the multipath profile given in figure 1.

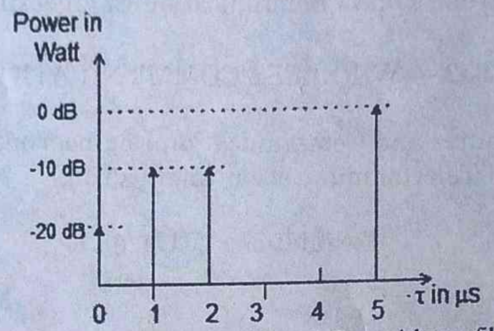

Figure 1: Power delay profile

(2) Find the type of fading if the modulated symbol duration is 10 μs.

(3) Estimate the coherence bandwith for 50% correlation of the channel. (3+5+3+2)

Or

(b) (i) How the received signal power in the case of Two-ray model is different from free-space propagation model.

(ii) A mobile phone that is 5 kilometres away from a base station receives cellular radio signals using a vertical monopole antenna with effective aperture 0.016 m^2. At a distance of 1 km from the transmitter, the E-field is measured to be 0.001 V/m. The carrier frequency is used in this system is 900 MHz. Find the received electric field and power at the mobile using the two-way ground reflection model assuming the height of the transmitting antenna is 50 m and the receiving antenna is 1.5 m above ground.

(iii) Estimate the median path loss using Okumura's model for d = 50 Km, $h_{te} = 100\,\text{m}$ and $h_{re} = 10m$ in an suburban environment, if the base station transmitter transmits with 2 kW at a carrier frequency of 900 MHz, find the received power at the receiver (transmitting antenna gain = 2, receiving antenna gain = 3).

$G_{area} = 9dB$; $A_{mu}(900\,MHZ, 50\,Km) = 43$ dB. (3+6+4=13)

12. (a) (i) Why dynamic channel assignment strategy is better compared to the fixed channel assignment in cellular networks?

(ii) During the busy hour, 1000 calls were offered to a group of trunks and 10 calls were lost. The average call duration is 2 minutes. Estimate the traffic carried and GOS.

(iii) A cellular service provider decides to use a TDMA scheme that can tolerate SIR of 15 dB in worst case and n = 3. Find the cluster size in the case of

(1) Omni-directional antenna.

(2) 120° sectoring

(3) 60° sectoring

(4) Out of 120° sectoring and 60° sectoring, which one is better. (3+3+7=13)

Or

(b) (i) Explain the umbrella cell concept in connection with cellular communication.

(ii) How microcell zone concept helps is reducing hand-offs?

(iii) Consider a cluster of seven cells. There are a total of 105 channels. Each cell has a surface area of 5 square kilometers. The probability of a call being delayed is 0,05. Find the probability that a call will be delayed for more than 5 seconds if the traffic intensity and arrival rate per user is 0.029 Erlang and 1 call every hour. (3+6+4)

13. (a) (i) Explain the working principle of OFDM and mention its mathematical equation with proper diagram.

(ii) A 64 Kbps voice frame is to be modulated by OFDM scheme. The duration of OFDM symbol is 1000 μs. Total of 32 subcarriers are to be designed to this frame. Find

(1) The null-to-null sub-channel BW

(2) Total BW occupied, and

(3) The number of bits in OFDM frame. (7+6=13)

Or

(b) (i) Explain the working principle of MSK with proper block diagram.

(ii) Binary data is transmitted using MSK at a rate of 1 Mb/s over a RF link having bandwidth of 3 MHz. assume the noise power spectral density at the coherent receiver input to be 10^{-10} W/Hz, find the maximum signal power per bit required at the receiver input to maintain the probability of error less than or equal to 2×10^{-6}. Given $erfc^{-1}\left(2\times10^{-6}\right) = 3.3$. (6+7=13)

14. (a) (i) What is selection combining technique? Describe the selection combining technique with proper diagram.

(ii) If the number of diversity branches is 3, the average SNR is 10 dB. Find the improvement in SNR achieved through diversity.

(iii) In a communication system, Selection Combining technique is employed at a receiver to detect the message signal where the links are Rayleigh faded

(1) Determine the order of diversity such that the instantaneous SNR doesn't drop below 10 dB to keep the outage probability less than or equal to 0.00086178. Consider the average link SNR is 20 dB,

(2) Find the improvement in SNR for the above scenario. (6+2+5=13)

Or

(b) (i) Write down the working principle of RAKE receiver. Write down the advantages of using Rake receiver.

(ii) Write down the working principle of LMS algorithm with necessary equation.

(iii) The received signal at a receiver is combined with Maximal Ratio Combining technique. There are four diversity branches and each one is Rayleigh faded.

(1) Determine probability of distribution of the modified instantaneous SNR γ_i if the average link SNR is 20 dB.

(2) Estimate the improved in link capacity for 10 KHz channel bandwidth and compare the same with and without diversity case. (4+4+5=13)

15. (a) (i) Write down the difference between transmitter diversity and receiver diversity. Why receiver diversity is better than transmit diversity.

(ii) In a 2 × 1 communication system, a transmitter transmits a message signal over a wireless medium. The received signal vectors at the receiver antennas are described as follows :

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} h_1 \\ h_2 \end{bmatrix} x + \begin{bmatrix} n_1 \\ n_2 \end{bmatrix}$$

where h_i is link coefficient, and n_i is the additive white Gaussian noise, $i = 1,2$. Find the beam forming vector for this given diversity.

(iii) In a MIMO system, let $\bar{x}$ be the transmit vector, $\bar{y}$ be the received vector and H be channel matrix. Show that the estimated signal for zero-forcing receiver is $\hat{x} = \left(H^T H\right)^{-1} H^T \bar{y}$. (4+3+6=13)

Or

(b) (i) Design the received signal model for a 3 × 2 MIMO system.

(ii) What is spatial multiplexing? How it improves the system performance?

(iii) Consider a MIMO system with number of receiving antennas (r) = 3. Let the noise vector be $\overline{n}$ where $E\left\{|n_i|^2\right\}=1/2$ and $E\{n_i\, n_j\}=0$ while $i \neq j$. Show that the covariance matrix (R) is

$$R=\frac{1}{2}\, I_{3\times 3} \text{ where } \overline{n}=\begin{bmatrix} n_1 \\ n_2 \\ n_3 \end{bmatrix}.$$ (3+4+6=13)

PART C — (1 × 15 = 15 marks)

16. (a) Consider a 1 × 1 communication system where the channel coefficient between a transmitter and a receiver is $h=\frac{1}{\sqrt{2}}+j\frac{1}{\sqrt{2}}$. The transmitter transmits a message with the power of 0.1 W. Find the received SNR and channel capacity of the given system considering the channel bandwidth is 10 KHz, and noise variance (σ^2) is 1. Given $\log_{10}(1.1) = 0.04139$. Now, the system is upgraded to a 2 × 1 communication system where the channel coefficients between a transmitter and a receiver are $h_1=\frac{1}{\sqrt{2}}+j\frac{1}{\sqrt{2}}$ and $h_2=\frac{1}{\sqrt{2}}-j\frac{1}{\sqrt{2}}$ respectively. For the same transmit power, channel bandwidth, and noise variance finds the impact on SNR and capacity. Given $\log_{10}(1.2)=0.07918$.

Or

(b) (i) In a typical communication system, OFDM scheme is used to modulate the frames. If the OFDM symbol duration is 1280 μs and it reaches the receiver after 450 ns, answer the following :

(1) What should be the minimum duration of cyclic prefix? What would be the OFDM duration after appending the cyclic prefix?

(2) If 64 point IFFT is used for frame modulation, how much spectrum is required for transmission?

(3) If one sample period is cyclically prefixed, would it be enough to avoid ISI? Justify your answer.

(ii) For a vehicle travelling 50 m/s using a 900 MHz carrier, find the coherence time of the channel. Given the duration of a frame is 20 ms, determine the number of fades the frame has to face while it is transmitted over the channel. If the frame has to avoid the impact of fading, what should be the frame duration?

(iii) The sum of squared errors between measured and estimated values of the received powers is given by 147 dB, It is assumed that the path loss for these measurements follows the model of Log Normal Shadowing, where the reference distance is $d_0 = 100\,m$, received power at reference distance is 0 dBm and $n = 3$.

(1) Calculate the standard deviation of shadowing about the mean value.

(2) Estimate the received power at $d = 2\,\text{km}$ using the Log-distance model. (6+4+5=15)

Reg. No. : | | | | | | | | | | | | |

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Sixth Semester

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