Ref: EXPG/ETC/PC/T/122B/2025

METCE First Year 2025

Second semester

Advanced Wireless and Mobile Communication

Full marks: 100 **Time: 3 hours**

Answer **five (5) questions, mention Q.no with OR if attempted**

Answer must be written at one place for each attempted question

Module 1: CO1 **Marks 20** **4x5=20**

Q.1 a) Highlight several benefits of wireless and mobile communication.

Give examples of useful application areas using wireless communication.

b) Discuss challenges faced by wireless communication due to mobility.

c) Why is frequency reuse technique used in wireless communication?

Illustrate the process of frequency reuse policy and making different cluster size.

d) What is the principle of finding S/I ratio in frequency re-use pattern. In cellular communication system the S/I ratio is 18 dB. Find the appropriate cluster size assuming path loss exponent k=3.

e) Capacity enhancement using sectored antenna is common. Explain how itis possible. Which sectoring (3 or 6) will be useful more and why?

Module 2: CO2 **Marks 20**

Q.2 a) Unlike LTI system, wireless channel is of type LTV- explain how? Illustrate LTV channel response representation. 06

b) From LTV channel response derives the four channel functions and their Fourier transform. Explain significance of each. 10

c) A wireless channel is specified by the time-variant channel impulse response,

$h(t,\tau) = (1 - \tau/t)\cos(\omega t + \phi)$, $0 \leq t \leq T$

Where T=0.1 ms, $\omega=10\pi$ and ϕ lies between $[-\pi$ to $+\pi]$ is a constant.

Determine the channel time variant transfer function. 04

Q2. OR

[Turn over

a) Explain the term fading and explain the cause for frequency selective and time selective fading, fast fading and slow fading. What are the effects of those fading on wireless transmission? 10

b) How is power delay profile defined? 04

c) Express the relationship of power delay profile with the maximum delay spread and rms delay spread in multipath propagation. Power delay $S(\tau)$ for 5 different τ (0,2,4,6,8 micro sec), are given as (-10dB, -5dB, -12 dB, -15dB and -18dB). Determine r.m.s delay spread and determine whether channel with this power profile frequency selective or non-selective. 02+04

Module 3: CO3 **Marks 20**

Q3.

a) Explain how spectrum efficiency for uplink access in FDMA method is determined. Show that for OFDMA method 50% bandwidth efficiency can be achieved. 08

b) Give pictorial representation for TDMA frame structure. Why is guard time used in TDMA frame? What will happen if sharp cutting of transmitted signal at the end of time slot occurs? 05

c) Describe DS-CDMA spread spectrum technique with pictorial representation. The number of users supported by DS-CDMA system for E_b/N_0 is $N_m= 1+\eta_f[PG/(E_b/N_0) - P_n/S]$, name all the terms used in the expression. What will be the spectrum efficiency of DS-CDMA system, if perfect power control is there? 07

Q3. OR

a) Within a wireless propagation in indoor environment the average received signal power is decreased logarithmically with distance d between transmitter and receiver. What will be the loss in dB at a distance 10 m for path loss exponent 3, and if the loss at reference distance of 1 m is 0dB. If a large obstacle is placed in the propagation media what will be the expected change in the propagation loss? 05

b) A CDMA system is defined with the parameters as follows:
Frequency reuse efficiency =0.75, E_b/N_0 = 15 dB, the information bit transmission rate = 16.2 kbps, system BW =12.5 MHz, neglecting all other sources of interference, determine the system capacity (N_m) and spectral efficiencyη in (bits/s/Hz). 05

c) With pictorial illustration explain GSM TDMA based access technique. Draw GSM single slot structure, if there is 8.25 guard bits and GSM frame is 4.615 ms, what would be the GSM wideband spectral efficiency? 07

d) There are 125 duplex channels, each having channel BW 200 kHz with 45 MHz frequency separation, find the maximum number of simultaneous users can be accommodated during one use of available frequency spectrum. 03

Module 4 : CO4 **Marks 20**

Q4. a) Define the terms SISO and MIMO? What does the difficulty arise in increasing capacity through SISO system. How does this difficulty overcome by MIMO, explain with example.
b) 1011 bit stream is to be transmitted in MIMO system. Through drawing explain MIMO diversity and spatial multiplexing scheme. How are diversity and multiplexing gain come?

c) For N_T, and N_R number of transmit and receive antenna in MIMO system, calculate the Beam Forming gain and diversity gain.

d) Explain MIMO advantages in a fading channel. 5x4=20

Q4. OR

a) With pictorial representation explain the Singular Value Decomposition pre-coding technique .Write how does it help wireless channel conditioning?

b) Considering 2x2 MIMO system explain the principle of operation of maximal ratio combining diversity. Derive the expression for pdf of $P(\gamma)$ for Rayleigh fading channel, where $\gamma=E_b/N_o$ ratio. 10x2=20

Module 5 : CO5 **Marks 20**

Q5. a) Discuss the necessity of mmWave technology for 5G Micro-femto cell and beyond 5G network. What are the hurdles need to be overcome for mmWave wave technology to be successful. 10

b) Explain cognitive radio fundamental concept developed by J. Mitola. 05

c) What is terminal capability and reconfigurable capability of cognitive radio. 05

Q5. OR

a) What are the key features of LTE and its performance targets? Draw the simplified architecture for LTE network in contrast to 3G UTRAN. 07

b) Draw 4G LTE network and then draw the concept of 5G NSA and SA mode of architectures highlighting basic difference between the two. 05

c) Discuss the basic concept of PD-NOMA system and derive expressions for SNIR and throughput for i^{th} user. How is capacity increased from NOMA system? 08

End