B.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING FOURTH YEAR SECOND SEMESTER - 2018

Subject: Wireless Communication Systems

Time: 3 hours   **Full Marks: 100**

Answer **Five questions** each carries 20 Marks (in Q2 to Q5 there is OR, you can attempt any one set of your choice)

Answer must be written at one place for each attempted question, marks will be deducted for not following this instruction

Q1. Part I: **6x1.5 =09**

A) Use of vacuum tube and transistors made the evolution of early telephone networks possible. While low-cost -------------------------- and ------------------------------------- made _____ flourished to its present state.

B) _____ sent telegraphic signals over a distance of approximately 1800 miles from Cornwall across the Atlantic Ocean, to St. John's Newfoundland in the year _____, while at the same time Indian Scientist _____ demonstrated the mm wave technology at the laboratory.

C) In the year _____ mobile radios began operating at 2 MHz in United States in the police dept. and emergency uses, while in 1940s frequencies between _____ and _____ were made available to many individuals, companies to operate their own mobile system.

D) In the year _____ AT & T and Southwestern Bell introduced the first commercial mobile telephone system launched at Missouri in US. Three channels as _____ with _____ channel spacing were allocated by Federal Communication Commission.

E) The Bell laboratory in US introduced full duplex, automatic channel selection and direct dialing system at _____band was in 1969, known as the

_____.

F) Cellular wireless mobile services was first made available in _____ in the year _____and followed by tremendous growth in the following years. Prior to Cellular a single high power _____ located centrally was used to cover _____ users.

J) What is called Personal Communication System?   **01**

Q1. Part-2: Justify the following statements/problem cases: **2x5=10**

A) Personal and Terminal Mobility and Service portability are the main enablers for Personal Communication System.

B) Cell splitting generates micro and pico cells – supports higher users density at the cost of extra handoff.

C) If Coherence bandwidth B_c = $1/5\sigma_\tau$, where σ_τ is the rms delay spread, show that flat fading will occur when T_s >= $10\sigma_\tau$, if T_s be the reciprocal of baseband signal bandwidth.

D) GMSK is the suitable modulation scheme in GSM network than MSK.

E) The picture shows the probability of received signal envelop above 6 mv in two cases. Determine the distribution types with reason.
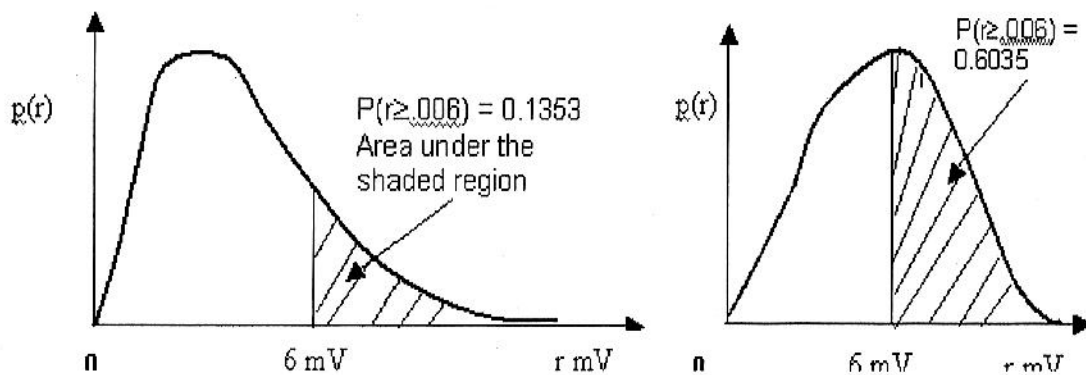
Q2. A) "Frequency reuse" is the fundamental step to mobile wireless communication to mitigate the scarce radio resources - How?   04

B) What are the challenges creep into cellular wireless communication because of frequency reuse and mobility?   04

C) Why is hexagonal cell structure mostly used in cellular array? Define frequency reuse ratio "q" for hexagonal cellular array and show that q is very important parameter to determine S/I ratio.   06

D) A cellular telephone system with 110 channels uses a modulation scheme requiring a minimum S/I ratio of 18 dB for acceptable link performance.

Assume that the propagation loss is only distance dependent and increases with the **fourth power** of the distance. Determine the cluster size (N) and channels/cell that can

be offered by the system. Assume the hexagonal cell structure with base station at the center and transmitting same power. 06

OR

Q2. A) Define the term "Mobile" and "cell". Why the term cellular? What is the basic concept to realize it? 04

B) Using set of hexagonal omnidirectional cells, draw the picture for 12 cells cluster

(i=2, j=2) in cellular array. 02

C) Define co-channel and adjacent channel interferences. 02

D) User's mobility supports roaming but invokes another challenge in wireless communication –called mobility management (MM). Explain briefly the in session and out of session MM with pictorial representation. 06

E) Consider a cellular system with 7-cell frequency reuse and a total of 392 traffic channels. Suppose the probability of call blocking is not more than 1%. Assume that every subscriber makes 1 call/hour and on average each call lasts 2.5 minutes, using omnidirectional antenna the number of calls/cell is 43.315 Erlangs (traffic load at 1% blocking), then 1+5 =06

    i. Determine number of calls/hour

    ii. Determine S/I ratio for omnidirectional cell, 120^0 sectoring and 60^0 sectoring and comments on the results in terms of capacity and interference. Use approximate formula.

Q3. A) What are the **different mechanisms** related to multipath propagations in wireless media. Use pictorial representation to explain. 05

B) Multipath propagation in the wireless environment results in a fading dispersive channel, also as the mobile station moves and/or any surrounding scatterers , signal propagation environment changes – with respect to these phenomena define **time and frequency dispersion fading** and **frequency selective and time selective fading**. 06

C) Show that in wireless communication media, the channel impulse response is time varying. 04

D) With respect to channel response define the time variant transfer function, Doppler Spread function and delay Doppler spread function. Write significance of each function. 05

OR

Q3. A) Show that fast fading model is represented by Rayleigh pdf for the received signal. What will be the outage probability for such model? 08

B) When the fading is called slow and fast? 02

C) Show that if a direct line of sight (LOS) component is added in fast fading model, the distribution for received signal will no longer follow Rayleigh but Rician. What is the relationship between Rayleigh and Rician if LOS component strength varies from 0 to infinity? 05

D) 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 8 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

Q.4 A) The wireless channel impulse response $h(t,\tau)$ is Wide Sense Stationary process and the impulse responses at two different time are uncorrelated. Find the autocorrelation function of $h(t,\tau)$ as $\varphi_h(\tau; \Delta t)$. From this define the scattering function of the random channel. 04

B) Power delay profile PDP is very important parameter to represent average power with multipath delay. From this profile determine the expressions for average delay and rms delay spread. 04

C) Explain how the knowledge of these delay spread parameters help to determine ISI free transmission and symbol rate in digital communication. 04

D) The PDP for a multipath channel is shown in the following figure. Find the mean and rms delay spread. Now if a particular modulation, say BPSK provides suitable BER performance, determine the smallest **symbol duration** and the **maximum bit rate** that may be sent through RF channels without using equalizer.

How would the bit rate vary if QPSK modulation be used? 6+2 = 08
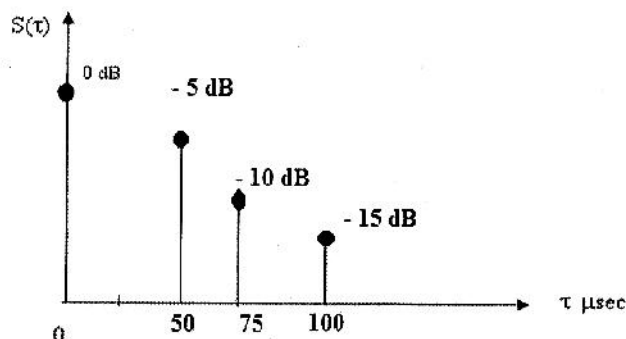
OR

Q4. A) Define Level Crossing rate (LCR) and average fading duration τ_{av}. Highlight the most important statistics of these two parameters with speed and maximum Doppler frequency shift f_m.   08

B) Determine τ_{av} for a threshold level ρ =0.707 and f_m = 40 Hz. If a binary modulation signal with bit duration T_b = 50 bps is transmitted over this Rayleigh fading channel, determine the fading type as fast or slow.   06

C) If a baseband binary message with bit rate R_b = 100 kbps is modulated by a RF carrier at 5.8 GHz is transmitted using BPSK modulation, what will be the coherence time of the channel, assuming a vehicle speed of 32 miles/hour? How many bits are sent while the channel remains static?   06

Q.5 A) Define spectral efficiency in terms of Ch/MHz/km^2 and Earlans/MHz/km^2

On what other factors does the overall spectrum efficiency depend?   03

B) Determine what type of system the following figure represents? Find the spectral efficiency expression for it.   04
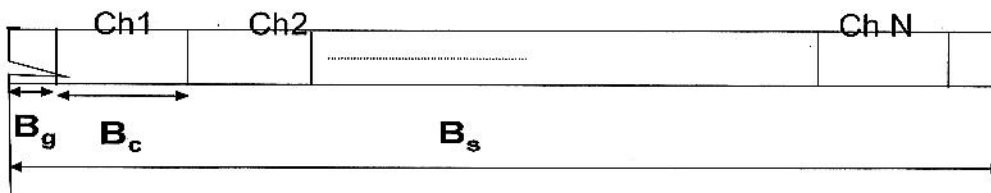
C)   Total bandwidth in AMPS cellular system is allocated 12.5 MHz. Using FDMA, 416 numbers of available channels with spacing 30 KHz is allocated to the users. If the cell area is 8 km^2 and frequency reuse factor is 4, find the overall spectral efficiency of the system.   03

D) Draw the basic GSM cellular network architecture and explain the functionalities of the following entities in 2G GSM networks: BTS, MSC, HLR and VLR.   06

E) With the pictorial representation explain the use of TDMA/FDD access in GSM systems.   04

OR

Q5. A) CDMA system is different from FDMA/TDMA systems. For getting spectral efficiency, the term E_b/N_0 (bit energy per total noise power spectral density) plays a

great role for DS-CDMA. By defining suitable terms, calculate the number of users that can be supported in a DS-CDMA system to define its spectral efficiency. 06

(b) A CDMA system is defined with the following parameters:

Frequency reuse efficiency η_f = 0.65, E_b/N_0 = 12 dB, the information bit transmission rate is 19.2 kbps, system bandwidth is W= 12.5 MHz. Neglecting all other sources of interference determine the system capacity and spectral efficiency of the CDMA system.

04

C) With pictorial representation show the architectural changes required to support packet data over GSM networks? 04

D) Discuss the process of PDP context activation in GPRS network with pictorial representation. Is there any relation between PDP context and session management for data communication over GPRS network? 05

E) What was the basic change happened in RAN (Radio Access Network) for 3G from 2G? 01