

الإجابة النموذجية

قسم الاتصالات. أسئلة الامتحان النهائي لمادة: أجهزة اتصالات II.
 لطلبة الفصل: السادس. رمز المادة: CM312 التاريخ: 2019-09-22 م



الفصل الدراسي: ربيع 2019
 اسم الأستاذ/المنسق: حسام الدين الهنشيرى. الزمن: ساعتان. الدرجة القصوى: 50 درجة
 اسم الطالب: رقم القيد:

(يسمح للطلاب بإدخال ورقة قوانين جهة واحدة A4 وجداول Erlang مع ضرورة كتابة الاسم عليها وتسليمها مع كراسة الإجابة)

Q1. (6 Marks) A satellite at a distance of 40000 km from an earth station radiates a power of 3 W from an antenna with a gain of 15 dB in the direction of the earth station. If the receiving antenna has an effective area of 10 m², find the flux density and the power received by the antenna?

Solution:

Flux density: $F = EIRP - 10\log(4\pi d^2) = 10\log(3) + 15 - 10\log(4\pi(40000e3)^2) = -143.2621 \text{ dBW/m}^2$

power received: $Pr = EIRP / (4\pi d^2) * A_{eff} = F + 10\log(A_{eff}) = -143.26 + 10\log(10) = -133.2621 \text{ dBW}$

Q2. (6 Marks) An earth station antenna is located at 89°W longitude and 35°N latitude. It is intended to transmit and receive signals to a satellite in geostationary orbit at 82°W longitude. Calculate Satellite Range from earth station?

$L_e = 35^\circ N, l_e = 89^\circ W, L_s = 0, l_s = 82^\circ W, r_e = 6378.137 \text{ km}, r_s = 38000 \text{ km} + 6378.137 \text{ km} = 44378.14 \text{ km}$

$\cos(\gamma) = \cos(L_e) \cos(L_s) \cos(l_s - l_e) + \sin(L_e) \sin(L_s)$
 $= \cos(35) * \cos(0) * \cos(82-89) + \sin(35) * \sin(0) = 0.81$

$d = r_s \left[1 + \left(\frac{r_e}{r_s}\right)^2 - 2\left(\frac{r_e}{r_s}\right) \cos(\gamma) \right]^{1/2} = 44378.14 * \text{sqrt}(1 + (6378.137/44378.14)^2 - 2 * (6378.137/44378.14) * 0.81) = 39389.84 \text{ km}$

Q3. (6 Marks) Derive the co-channel reuse ratio for a hexagonal geometry, where $N = i^2 + ij + j^2$ is used to find the nearest co-channel neighbors for a particular cell?

have

$D^2 = [i(2R')]^2 + [j(2R')]^2 - 2i(2R') \cdot j(2R') \cdot \cos(120^\circ)$

where $R' = \frac{\sqrt{3}}{2} R$, therefore

$D = \sqrt{i^2 R'^2 + j^2 R'^2 + ij 3R'^2}$

$= \sqrt{3(i^2 + j^2 + ij)} R$

$= \sqrt{3N} \cdot R$

Hence, $Q = \frac{D}{R} = \sqrt{3N}$





Q4. (8 Marks) A cellular system with cluster size of 7, probability of blocking of 1%, average call duration of 2 minutes, each user has a call rate of 1 call per hour, and omnidirectional antenna cells with 60 traffic channels each. Assuming that blocked call cleared system is used, Find the following:

- Maximum number of users that can be supported per cell.
- Co-channel reuse ratio and frequency reuse distance, if the cell radius is 1.3 km.
- Traffic capacity loss due to trunking the traffic channels when going from omnidirectional to 60° sectored antennas.
- What is co-channel interference? And how it can be reduced?

Solution:

- $N = 7$, $GOS = 1\%$, $H = 2$ minutes, $\lambda = 1$ call/hour, $\#Ch = 60$, Erlang B (blocked-call cleared system)
from Erlang B table, $A = 46.95$ erlangs
 $A_u = H \cdot \lambda = 2 \cdot 1/60 = 1/30$ erlangs
 $\# U_{cell} = A / A_u = 46.95 / (1/30) = 1408$ users per cell
 $\# U_{cluster} = 1408 \cdot 7 = 9856$ users per cluster
- Co-channel reuse ratio: $Q = D/R = \sqrt{3N} = \sqrt{3 \cdot 7} = 4.58$
Frequency reuse distance: $D = R \cdot Q = 1.3 \text{ km} \cdot 4.58 = 5.96 \text{ km}$
- When employing 60° sectoring, there are only 10 channels per antenna sector 60/6, So
 $GOS = 1\%$, $H = 2$ minutes, $\lambda = 1$ call/hour, $\#Ch = 60/6$, from Erlang B table, $A = 4.461$ erlangs
 $A_u = H \cdot \lambda = 2 \cdot 1/60 = 1/30$ erlangs
 $\# U_{sector} = A / A_u = 4.461 / (1/30) = 133$ users per sector
 $\# U_{cell} = \# U_{sector} \cdot 6 = 133 \cdot 6 = 798$ users per cell
 $\# U_{cluster} = 798 \cdot 7 = 5586$ users per cluster
Traffic capacity loss when compared to the unsectored case = $1 - 798/1408 = 0.433 = 43.3\%$
Thus, sectoring decreases the trunking efficiency while improving the S/I for each user in the system.
- The interference between signals from co-channel cells (cells that use the same set of frequencies) is called co-channel interference.
Co-channel interference can be reduced by using:
 - directional antennas (Cell sectoring)
 - Adaptive Power Control



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Q5. (12 points) Consider a GSM system with the frequency spectrum allocation of 890-915MHz UL and 935-960MHz DL, with channel spacing of 200 kHz and a reserved guard band of 100 kHz at the beginning and the end for each of the UL and DL spectrum and 8 voice channels per digital channel.

- How many voice channels in this system?
- Calculate the cluster size N for this system if the required signal to interference ratio S/I is 14 dB and the path loss exponent $n=4$? (Assume that there are 6 co-channels cells in the first tier, and all of them are at the same distance from the mobile)
- Calculate the Co-channel distance?
- What is the number of voice channels per cell in GSM under the given S/I condition?
- How many omnidirectional base stations having 2 km coverage radius are required to cover an area of 312 km²? Use the hexagonal cell shape.
- What is the maximum number of simultaneous users in the network?

Solution:

- 890-915 MHz for uplink \rightarrow 25 MHz bandwidth
935-960 MHz for downlink \rightarrow 25 MHz bandwidth
We have $25\ 000\ \text{KHz}/200\ \text{kHz} = 125$ channels, one of which is reserved for guard band and 124 channels remain for users. On each channel 8 voice channels are carried by using 8 time-multiplexing.
Total number of voice channels = $124 \times 8 = 992$.
- $S/I = Q_n / 6 = 1/6 (3N)^{n/2}$,,
Cluster size for a given S/I is: $N = 1/3 (6 S/I)^{2/n}$
14 dB $\Leftrightarrow S/I = 25.11$
 $N = 1/3 (6 \times 25.11)^{2/4} = 4.09 \rightarrow N=7$
- Co-channel distance $D = R \sqrt{3N} = R \sqrt{3 \times 7}$ for $N=7$
- [124 RF channels / 7 Cells/cluster] = 18 channels per cell for 5 cells and 17 channels per cell for 2 cells.
[124 RF channels / 7 Cells/cluster] x 8 voice channel = 136 voice channels per cell for 2 cells and 144 channels per cell for 5 cells.
- Cell area is = $2.6 R^2 = 2.6 \times 22 = 10.4\ \text{km}^2$
Number of required base stations = $312/10.4 = 30$ base stations
- Maximum number of simultaneous users (channels) = $136\ \text{user/cell} \times 30\ \text{cells} = 4080$ channels



Q6. (12 Marks, 0.5 each) Choose the correct answer: (your selection must be on the exam paper)

1. Modulation used in GPS is called Direct Sequence Spread Spectrum
 a) a True b) False
2. The rain attenuation is caused by of electromagnetic waves
 a) Scattering b) Absorption c) c Both (a and b)
3. Cellular communication systems are
 a) Simplex b) Half duplex c) c Full duplex
4. First Generation (1G) Cellular Mobile Radio Systems use
 a) Analog / AM / FDMA b) b Analog / FM / FDMA c) Analog / FM / TDMA
5. Power control enables MS's and BTS s to increase or decrease the transmission power
 a) a True b) False
6. Which one of the following is NOT a technique to reduce the effects of multi-path fading?
 a) Frequency hopping b) Equalization c) c Sectorization d) Diversity
7. is the dialed number to reach to MS
 a) a MSISDN b) IMSI c) MSRN
8. Which type of coding provides error protection in GSM
 a) Encryption coding b) b Convolutional coding c) GMSK
9. connects PLMN with other networks
 a) MSC b) b GMSC c) BSC
10. One of the main Cellular System problems is interference due to
 a) Trunking b) Sectoring c) c Frequency re-use
11. Frequency re-use is used to
 a) Reduce interference b) b Increases capacity c) Both (a and b)
12. If cluster size (N = 7) and cell Radius (R = 1.5km), then the co-channel re-use ratio is
 a) a 4.58 b) 5.66 c) 6.87
13. Fixed Channel Allocation has
 a) High call setup delay b) Channel Borrowing c) c Maximum frequency reuse
14. GSM-R Standard is used for
 a) Rural environment b) b Railway c) Both (a and b)
15. Transcoding and Rate Adaptation Unit (TRAU) is used for
 a) Speech compression b) Rate Adaptation c) c Both (a and b)
16. In GSM system Kc key is used for



- a) Cyphering b) Authentication c) Triples generation
17. Modulation technique used in GSM is:
a) 8ASK b) GMSK c) 8PSK
18. Temporary information of users is stored in
a) MSC b) VLR c) HLR
19. The function of MSC is
a) Paging b) Channel coding c) Switching and call routing
20. The new Hardware elements have to be implemented for GPRS network are
a) GGSN and SGSN b) GGSN, SGSN and PCU c) GMSC/HLR/EIR
21. With GPRS it is possible to combine 1-8 physical channels for one user
a) True b) False
22. Modulation technique used in EDGE is
a) 8ASK b) GMSK c) 8PSK
23. is used overcome near far problem.
a) Sectorization b) Power control c) Rake receiver
24. Cell splitting co-channel interference.
a) Increase b) Decrease c) does not affect
25. Cell splitting technique.....the capacity
a) Increase b) Decrease c) does not affect
26. Cell sectoring technique.....the capacity
a) Increase b) Decrease c) does not affect
27. Timeslot represents.....
a) Physical channel b) logic channel c) control channel

Good Luck