COMP4336/9336 Mobile data networking
Quiz: Cellular Networks

Q1. What is the spectrum reuse distance if a cellular operator uses a cluster size of 3, with each cell having a radius of 1 km?

A1.

Cluster size of 3 means N=3.

D=R x sqrt{3N} = 1km x sqrt{3x3} = 3 km

Q2.

A cellular operator leases 1.2GHz – 1.4GHz spectrum (frequency band) to provide cellular services within a given service area. If the operator decides to use FDD with two 1MHz simplex channels, one for uplink and one for downlink, to connect each user to the base station, how many users can it serve simultaneously in each cell provided a cluster size of 4?

A2.

Total bandwidth = 1.4GHz – 1.2GHz = 200MHz
Available spectrum in each cell = 200/4 = 50 MHz
Each user requires a total of 2 MHz (1 MHz for uplink and 1 MHz for downlink)
Number of users that can be supported simultaneously in each cell = 50/2 = **25**

Q3. Using the cluster size formula $N = I^2+J^2+(I\times J)$, determine the smallest value of N when *I* and *J* are both non-zero and at least one is greater than 3.

a) 12
b) 21
c) 13
d) 16
e) 19

A3.
The correct answer is 21.
The smallest non-zero is 1 and the smallest integer greater than 3 is 4. Therefore, the smallest $N = 1^2+4^2+1x4 = 21$

Q4. Two cellular operators, Operator A and Operator B, use the same total bandwidth to serve the same sizes of service areas using identical cell sizes. Operator A decides to use a cluster size of 4, while operator B uses 12 as its cluster size. Which of the following is correct?

A. Operator A can guarantee lower interference at the expense of lower capacity.
B. Operator B can guarantee lower interference at the expense of lower capacity.
C. Operator A can achieve higher capacity and lower interference.
D. Operator B can achieve higher capacity and lower interference.
E. Operator B can guarantee that no adjacent cells use the same frequency, but Operator A cannot.

A4.
Lower cluster size means higher capacity (due to more aggressive spectrum reuse) at the expense of higher interference (due to the same frequency reused in a 'nearby' location), and vice versa. Option B is correct because Operator B has a larger cluster size (lower capacity but lower interference as well)

Q5. Which of the following statements accurately describes the relationship between the length of the Cyclic Prefix in LTE and the number of symbols that can be transmitted within a 0.5ms UL/DL slot?

A) A longer Cyclic Prefix allows for more symbols to be transmitted.
B) **A shorter Cyclic Prefix allows for more symbols to be transmitted.**
C) The length of the Cyclic Prefix has no impact on the number of transmitted symbols.
D) The relationship between the Cyclic Prefix and the number of transmitted symbols is unpredictable.
E) None of these

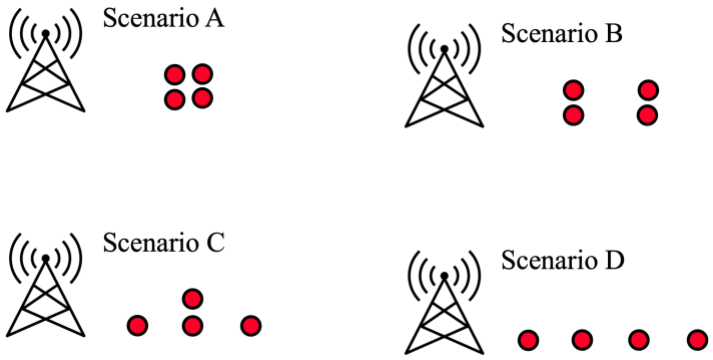
A5. Cyclic Prefix takes up some time from the finite slot time, leaving less room for actual symbol transmission.

Q6. What is the primary purpose of the 'successive interference cancellation' technique in 5G wireless communication?

A) Reducing the cell radius in cellular networks
B) Reducing latency for data transmission
C) Supporting multiple users over the same frequency simultaneously
D) Enhancing security of data transfers over cellular networks
E) Minimizing interference from neighbouring cells

A6. Correct answer is C. NOMA uses *successive interference cancellation* to support multiple users over the same frequency simultaneously.

Q7. The figure illustrates the locations of four users, represented by solid circles, surrounding a 5G base station utilising NOMA. Which scenario would offer the most effective utilisation of NOMA?



a) Scenario A
b) Scenario B
c) Scenario C
d) Scenario D

A7

Scenario D is the correct answer, where the separation between the users is the most significant. This allows the BS to use the same frequency for all users by applying different NOMA power coefficients for each one where the power coefficients are significantly different making the application of successive interference cancellation more reliable.

Scenario A would probably need four different frequencies for the four users, because they are all bunched up around the same location, which means they are likely to experience similar channel gains. Similarly, Scenario B and C both may need 2 frequencies.

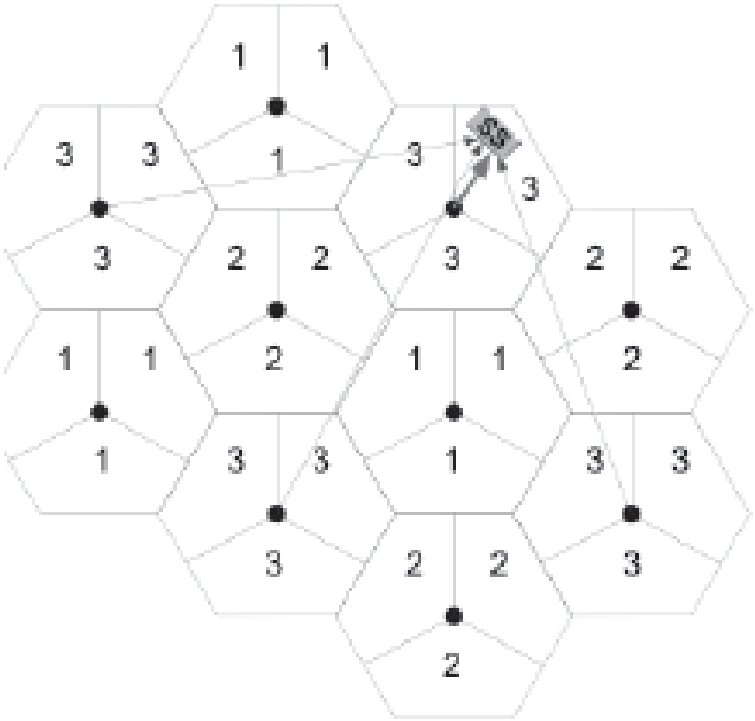
Q8. Which of the following would enable use of the same frequency to be used for both uplink and downlink communication at the same time?

a) TDD
b) NOMA
c) 3D beamforming
d) Massive MIMO
e) Self-interference cancellation

A8

Correct answer is e) Self-interference cancellation, which allows FDD to use the same frequency to be used for both uplink and downlink at the same time.

Q9.



For the above figure, which of the following statements is true?

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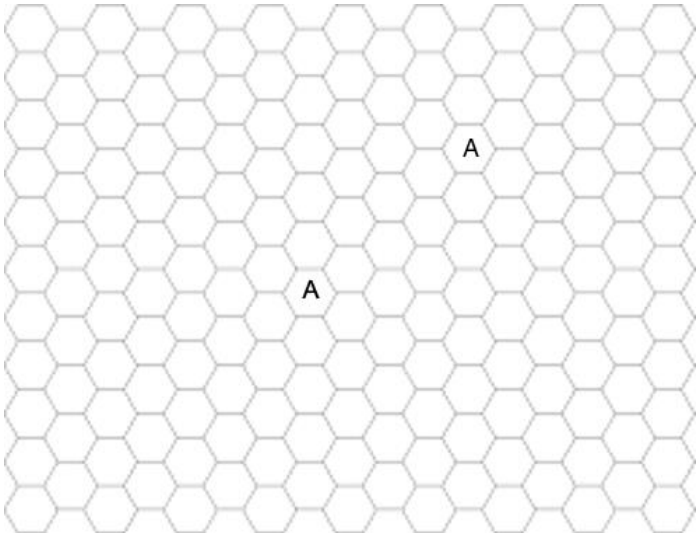
a) It consists of three cells within each cluster, with three sectors allocated to each cell.
b) It consists of four cells within each cluster, with three sectors allocated to each cell.
c) It consists of three cells within each cluster, with three frequencies allocated to each cell.
d) It consists of a single cell within each cluster, with three sectors allocated to each cell.
e) It consists of single cells within each cluster, with three frequencies allocated to each cell.

A9. This cell pattern is shown in Fig 11 of Chapter 7 in the text. It is a 3x3x1 pattern, which means 3 cells per cluster, 3 sectors per cell and 1 frequency per cell. Correct answer: a)

Q10.



What is the cluster size for the illustrated cellular network shown in the figure above, where the letter 'A' designates two cells that share the same frequencies?

A10. I=4, J=1. Cluster size (N) = $I^2 + J^2 + IxJ = 16+1+4 = 21$

End of Quiz: Cellular Networks