

COMP4336/9336 Mobile data networking
W7 Quiz: Cellular Networks

Q1. Using a cluster size of 3, a cellular operator can reuse its spectrum every 6 km if each cell has 2 km radius.

- a) TRUE
- b) FALSE

A1.

TRUE.

Cluster size of 3 means $N=3$.

$$D=R \times \sqrt{3N} = 2\text{km} \times \sqrt{3 \times 3} = 6 \text{ km}$$

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.

$$\text{Total bandwidth} = 1.4\text{GHz} - 1.2\text{GHz} = 200\text{MHz}$$

$$\text{Channel (to serve one user) bandwidth} = 1\text{MHz} \times 2 = 2\text{MHz}$$

$$\text{Total available channels for the entire cluster} = 200/2 = 100 \text{ channels}$$

$$\text{Total number of channels available per cell} = 100/4 = \mathbf{25}$$

Q3. Which of the following cannot be a valid cluster size in cellular networks?

- a) 25
- b) 26
- c) 27
- d) 28
- e) All are valid

A3.

Valid cluster size satisfies: $i^2 + j^2 + i \times j$

25 ($i=5;j=0$); 27 ($i=3;j=3$); 28 ($i=4;j=2$); **26 not possible.**

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. In LTE, the longer the Cyclic Prefix is, the smaller the number of symbols that can be transmitted within the 0.5ms UL/DL slot.

- A. **True**
- B. False

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

Q6. Serving multiple users over the same frequency at the same time is facilitated by which of the following technology?

- a) NOMA
- b) Full duplex
- c) mmWave
- d) Edge Computing
- e) Massive MIMO

A6. NOMA uses *successive interference cancellation* to achieve this.

Q7. What types of antennas are better suited to serve user equipment in 3D space?

- a) Sector antenna
- b) Planar array antenna
- c) Dish antenna
- d) Dipole antenna
- e) All of these

A7

Planar antenna, which is expected to be used in 5G and beyond networks.

Q8. Which of the following scenarios can benefit from NOMA?

- a) There is always one user associated with the base station.
- b) When users are experiencing different channel gains.
- c) When all users experience identical channels.
- d) When users are outside the coverage of the base station.
- e) When users are highly mobile.

A8

Correct answer is (b). Different channels gains result in different power allocations to individual user signals, which is used by success interference cancellation to extract individual signals from the combined signal.

Q9. Assume that a 5G base station is located at (0,0) while serving four users with the following locations: $U1=(0,1)$, $U2=(0,2)$, $U3=(0,3)$, and $U4=(0,4)$. Which user will be required to do the most computations to decode its packets if NOMA is used?

- a) U1
- b) U2
- c) U3
- d) U4
- e) Both U1 and U4

A9

U1 is closest to the base station, which means its signal will be allocated the lowest power and hence it will do the most success interference cancellation computations.

Q10. For self-interference cancellation, the Tx signal goes through an attenuation and delay circuit in the full duplex radio before being combined with the Rx signal because

- a) The Tx signal uses higher frequency than that used in Rx signal.
- b) The Tx signal is attenuated and delayed by the time it reaches to the Rx antenna.
- c) The Tx and the Rx signals use different waveforms.
- d) The Rx signal is stronger than the Tx signal.
- e) The Rx signal is attenuated and delayed by the time it reaches to the Tx antenna.

A10

Correct answer is (b). Interference happens at the Rx antenna, which is caused by the Tx signal.

End of W7 Quiz
