

COMP4336/9336 Mobile data networking
W9 Quiz: RF Sensing

1. A 77-81 GHz FMCW radar system supports four 1 GHz radar channels, allowing dynamic channel switching to avoid interference from nearby radars. What is the range resolution for each of these radar channels?
- a) 7.5cm
 - b) 3.75cm
 - c) 15cm
 - d) 60cm
 - e) 90cm

Sol: Correct answer is c) 15 cm

Bandwidth (B) for each radar channel is 1 GHz.

Resolution: $c/2B = (3 \times 10^8)/(2 \times 10^9) = 15 \text{ cm}$

2. What would be the pulse width of a pulsed radar that achieves a resolution of 30 meters?
- a) 100ns
 - b) 10ns
 - c) 20ns
 - d) 200ns
 - e) 30ns

Sol: The correct answer is d) 200ns

Resolution = R meter = 30 meter

Speed of light, $c = 3 \times 10^8$

Pulse width (sec) = $(2 \times R)/c = 60/(3 \times 10^8) = 200 \text{ ns}$

3. A 24GHz radar
- a) has a resolution of 6.25 mm.
 - b) is expected to operate in the 24 GHz ISM band with a bandwidth much smaller than 24 GHz.
 - c) is expected to achieve finer resolution than a 77GHz radar.
 - d) has a bandwidth 10 times higher than 2.4GHz WiFi .

Sol: The correct answer is b).

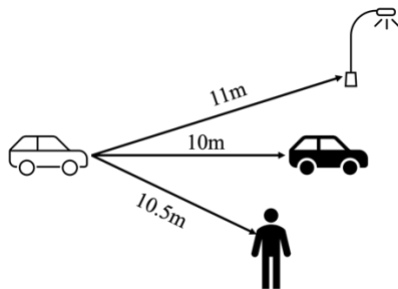
These radars usually have a bandwidth of up to **250 MHz** (ranging from 24.00 GHz to 24.25 GHz).

4. For a $CSI = 3 + 4j$, the amplitude response is
- a) 4
 - b) 6

- c) 5
- d) 7
- e) None of these

Sol: Amplitude = $\sqrt{3^2+4^2} = 5$

5. Autonomous vehicles must unequivocally detect all objects in their proximity to ensure safe operation. The diagram illustrates three distinct objects positioned in front of a car, which necessitates their detection using an FMCW radar. What minimum sweep bandwidth would be required for the radar to unambiguously detect all three objects? You can assume that light travels at the speed of 3×10^8 m/s.



- a) 100MHz.
- b) 200MHz.
- c) 300MHz.
- d) 400MHz.
- e) 500MHz.

Sol. The correct answer is c) 300MHz.

The minimum distance between the objects is 0.5 m. Hence, the range resolution must be better than 0.5m to detect all three objects unambiguously.

B = sweep bandwidth

Range resolution, $R = c/2B$

$$B = c/2R = 3 \times 10^8 / 2 \times 0.5 = 0.3 \text{ GHz} = 300\text{MHz}$$

6. What is the estimated range to the target if an FMCW radar, using a chirp with a sweep rate of 40 GHz/s, detects a beat frequency (i.e., the frequency difference between the transmitted and received signals) of 20 kHz?
- a) 15m.
 - b) 75m.
 - c) 150m.
 - d) 15cm.
 - e) 100m.

Sol: The correct answer is b) 75m.

Chirp slope, $S = 40\text{GHz/sec}$. $C = 3 \times 10^8 \text{ m/s}$. Beat frequency, $\Delta f = 20\text{kHz}$.
Distance (Range) = $(\Delta f c) / (2S) = (20 \times 10^3 \times 3 \times 10^8) / (2 \times 40 \times 10^9) = 75\text{m}$

7. A UWB radar operating in the 1.5 GHz to 2 GHz band can distinguish between two objects along the same bearing if the difference in their distances from the radar is at least:

- a) 10cm
- b) 20cm
- c) 30cm
- d) 40cm
- e) 50cm

Sol: The correct answer is c) 30cm

Bandwidth, $B = 2\text{GHz} - 1.5\text{GHz} = 500\text{MHz}$
 $R = c/2B = (3 \times 10^8) / (2 \times 500 \times 10^6) = 0.3\text{m} = 30\text{cm}$

8. Can radar signals be used to carry data?

- a) No, radar signals are strictly used for detecting and measuring distance, speed, and direction of objects.
- b) Yes, radar signals can carry data by modulating the transmitted signal, similar to how communication systems transmit information.
- c) Only high-frequency radar systems, such as those above 100 GHz, can carry data.
- d) Radar signals can carry data, but only if they are using pulse modulation techniques.

Sol: The correct answer is b).

9. Which of the following statements correctly compares Wi-Fi sensing with radar sensing?

- a) Wi-Fi sensing is generally more accurate than radar sensing for detecting small movements and gestures.
- b) Radar sensing can operate effectively in low or no-light conditions, while Wi-Fi sensing relies on the presence of light.
- c) Wi-Fi sensing has higher range resolution than radar sensing due to the wider bandwidth of Wi-Fi signals.
- d) Radar sensing provides better accuracy for detecting distance and speed due to its dedicated signal design and higher frequency range.

Sol: The correct answer is d)

10. Which of the following statements correctly compares RSS-based sensing with CSI-based sensing?

- a) RSS-based sensing provides detailed information about the channel, including phase and amplitude changes, while CSI-based sensing only measures signal strength.
- b) CSI-based sensing offers higher granularity and sensitivity to small movements compared to RSS-based sensing, which only captures overall signal strength variations.
- c) RSS-based sensing is more effective for fine-grained motion detection than CSI-based sensing due to its high resolution.
- d) CSI-based sensing is limited to short-range applications, whereas RSS-based sensing can operate effectively over longer distances.

Sol. b)

End of W9 Quiz
