Name:_____

ESPTR 2012 – Exam 1, **version A**

Try to write the answer in the provided space. If you need it, put your calculations on an additional sheet.
If there are multiple answers for a problem - give one to have full score, give all to have +1 bonus point.

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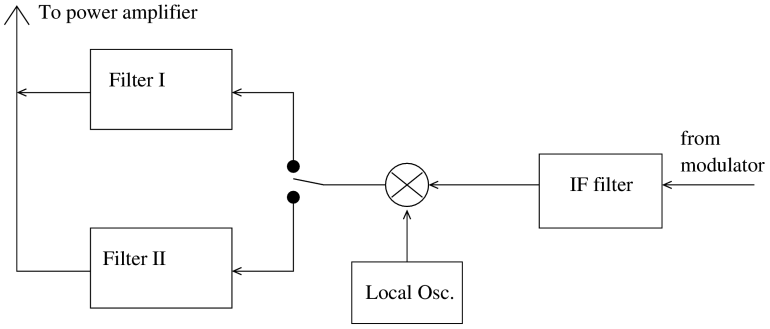


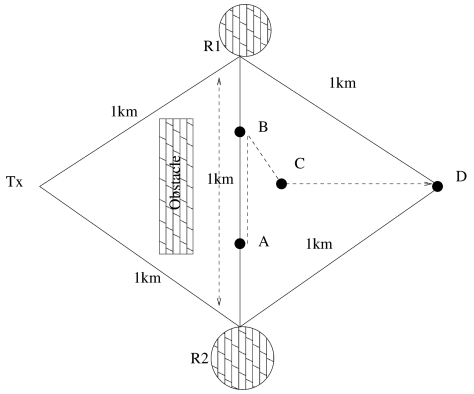
1. A dualband transmitter (sketched above) is to work in UMTS-FDD standard in two USA uplink channels with frequencies 1850-1910 MHz (band II) and 1710-1755 MHz (band IV) .

   (a) (4 p.) Propose the values of filter passbands and LO frequency ranges so that the same LO and IF may be used for both bands: $F_I =$ [ ], $F_{II} =$ [ ], $f_{LO} =$ [ ], $f_{IF} =$ [ ] .....

   (b) (2 p.) Are the filters "Filter I" and "II" necessary? yes:[ ] or no:[ ] explain why:.....
   .....

2. (2 p.) What are the pros and cons of a balanced mixer vs. unbalanced one?
   Pro: .....
   .....
   Con: .....
   .....

3. A transmitter with a carrier frequency of 1.8 GHz is located in p. "Tx". A receiver moves from "A" to "B" then "C" and "D" with constant linear velocity of 36 km/h. The straight path is totally blocked by large building, only signals reflected by R1 and R2 can be received.



   (a) (3 p.) Calculate the frequencies that are seen at the receiver in points A [ ] and D [ ]. .....

   (b) (2 p.) Where on the receiver trajectory will we see strongest constructive interference? .....
   .....

   (c) (3 p.) Describe where the minimum of the received power due to destructive intereference will be observed. Will it be a total zero? .....
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   Calculations: .....
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4. (6 p.) For a given pulsed radar with 4 kW transmitter, and pulse width of 2 us the smallest detectable object at the distance of 20 km has 1 square meter of effective radar cross-section. If the pulse width were 32 us, at what maximum distance could the 1 sq.m object be detected, assuming optimal processing of pulse compression in the receiver? [ ] .....
.....
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5. (4 p.) With optimal processing - which radar would give stronger detections: pulsed with 20 μs pulse, 1kHz PRF and 500 W power, or FMCW with 1 kHz modulation period and 20 W power? (assume the same bandwidth). Answer: [ ] calculations: .....
.....

6. (3 p.) A PAM transmitter emits gaussian-shaped impulses. What should be the impulse response of the matched filter in the receiver? [ ] What shape will be the pulse at the output signal of the matched filter? .....

7. (5 p.) Describe the working principle of SAR imaging. Start from the changing distance from antenna to the object and describe the phase change of the received signal
Answer: .....
.....
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8. (9 p.) In an OFDM modulation system with bandwidth of 15 MHz at 4.8 GHz carrier, two design conditions must be fulfilled:

   - The system must tolerate the multipath reception with 5 km of path length difference
   - The system must tolerate the movement of a receiver with max speed of 360 km/h.

   The subcarrier modulation used is 16QAM. We assume that a limit of good reception is when subcarrier is shifted by 5% of the subcarrier spacing.

   Calculate:

   - Number of possible subcarriers. Answer: [ ]
   - Minimum cyclic prefix length. Answer: [ ]
   - Resulting total limit on system bitrate (reserve 10% for pilots etc.). Answer: [ ]

   .....
   .....
   .....

9. (3 p.)Does the near-far problem occur in CDMA uplink (user$\longrightarrow$base) or downlink (base$\longrightarrow$user) transmission? [ ] Describe this problem closer. .....
.....
.....

10. (4 p.) A guard interval in the uplink of GSM system is to solve two problems. Name them.
problem with the channel: .....
problem with many mobile stations: .....

11. (3 p.) How many transmitter-receiver pairs do we need in a passive radar system to locate the object in 3D? [ ] Why? .....

12. (3 p.) Name few causes why CDMA user codes are not exactly orthogonal in practice: .....
.....
Name the bad effect of this situation: .....

version A , $\Sigma = 56p$ $T = 90$ min

Name:_____

ESPTR 2012 – Exam 1, **version B**

Try to write the answer in the provided space. If you need it, put your calculations on an additional sheet.
If there are multiple answers for a problem - give one to have full score, give all to have +1 bonus point.

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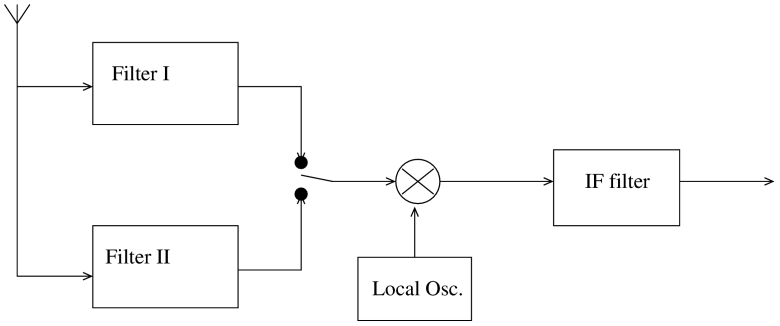


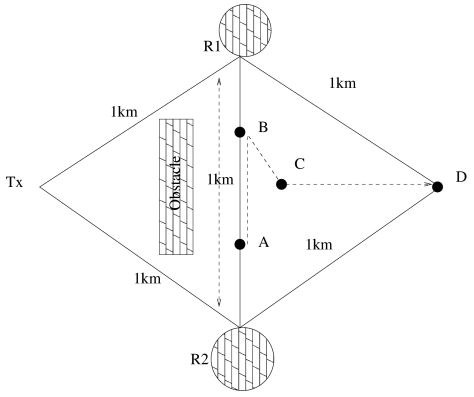
1. A dualband receiver (sketched above) is to work in UMTS-FDD standard in EU and USA downlink channels with frequencies 2110-2170 MHz (EU) 1930-1990 MHz (US).

   (a) (4 p.) Propose the values of filter passbands and LO frequency ranges so that the same LO and IF may be used for both bands: $F_I =$ [ ], $F_{II} =$ [ ], $f_{LO} =$ [ ], $f_{IF} =$ [ ] .....

   (b) (2 p.) Are the filters "Filter I" and "II" necessary? yes:[ ] or no:[ ] explain why:.....
   .....

2. (2 p.) What are the pros and cons of a unbalanced mixer vs. balanced one?
   Pro: .....
   .....
   Con: .....
   .....

3. A transmitter with a carrier frequency of 0.9 GHz is located in p. "Tx". A receiver moves from "A" to "B" then "C" and "D" with constant linear velocity of 72 km/h. The straight path is totally blocked by large building, only signals reflected by R1 and R2 can be received.



   (a) (3 p.) Calculate the frequencies that are seen at the receiver in points B [ ] and D [ ]. .....

   (b) (2 p.) Where on the receiver trajectory will we see strongest constructive interference? .....
   .....

   (c) (3 p.) Describe where the minimum of the received power due to destructive intereference will be observed. Will it be a total zero? .....
   .....

   Calculations: .....
   .....
   .....

4. (6 p.) For a given pulsed radar with 4 kW transmitter, and pulse width of 16 us the smallest detectable object at the distance of 20 km has 1 square meter of effective radar cross-section. If the pulse width were 1 us, at what maximum distance could the 1 sq.m object be detected, assuming optimal processing of pulse compression in the receiver? [ ] .....
.....
.....

5. (4 p.) With optimal processing - which radar would give stronger detections: pulsed with 10 μs pulse, 1kHz PRF and 500 W power, or FMCW with 1 kHz modulation period and 1 W power? (assume the same bandwidth). Answer: [ ] calculations: .....
.....

6. (3 p.) A PAM transmitter emits gaussian-shaped impulses. What should be the impulse response of the matched filter in the receiver? [ ] What shape will be the pulse at the output signal of the matched filter? .....

7. (5 p.) Describe the working principle of SAR imaging. Start from the changing velocity of the antenna w.r.t the object and describe the changing Doppler shift in the received signal
Answer: .....
.....
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.....

8. (9 p.) In an OFDM modulation system with bandwidth of 15 MHz at 2.4 GHz carrier, two design conditions must be fulfilled:

   - The system must tolerate the multipath reception with 5 km of path length difference
   - The system must tolerate the movement of a receiver with max speed of 360 km/h.

   The subcarrier modulation used is 4QAM. We assume that a limit of good reception is when subcarrier is shifted by 10% of the subcarrier spacing.

   Calculate:

   - Number of possible subcarriers. Answer: [ ]
   - Minimum cyclic prefix length. Answer: [ ]
   - Resulting total limit on system bitrate (reserve 10% for pilots etc.). Answer: [ ]

   .....
   .....
   .....

9. (3 p.)Does the near-far problem occur in CDMA uplink (user$\longrightarrow$base) or downlink (base$\longrightarrow$user) transmission? [ ] Describe this problem closer. .....
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problem with many mobile stations: .....

11. (3 p.) How many transmitter-receiver pairs do we need in a passive radar system to locate the object in 3D? [ ] Why? .....

12. (3 p.) Name few causes why CDMA user codes are not exactly orthogonal in practice: .....
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Name the bad effect of this situation: .....

version B , $\Sigma = 56p$ $T = 90$ min