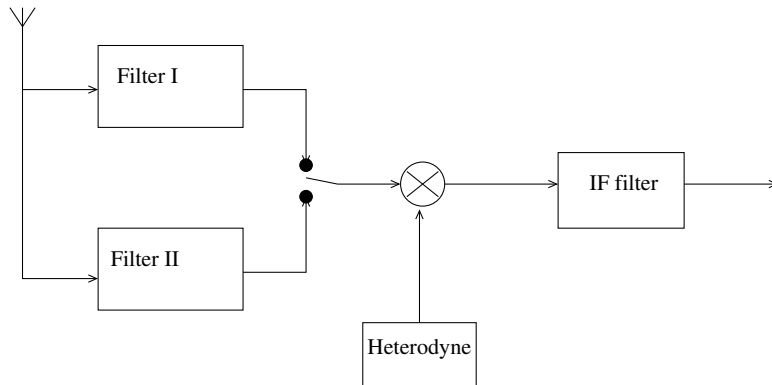


Name: _____

ESPTR 2008 – Exam 1, **version A** 18.06.2008

Try to write the answer in the provided space. If you need it, put your calculations on an additional sheet.



1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
Σ	

1. A dualband receiver idea is sketched above. The heterodyne frequency is 120 MHz and IF frequency is 15 MHz with ± 0.5 MHz bandwidth.

(a) (3 p.) What are the center frequencies of the receive bands? Answer: $F_I =$, $F_{II} =$

(b) (1 p.) What is the input bandwidth of the receiver? Answer: $BW_I =$, $BW_{II} =$.

(c) (1 p.) What is the type and role of the filters “Filter I” and “II”?

Type: , Role:.....

2. (2 p.) Why are the pros and cons of a balanced mixer vs. unbalanced one?

Pro:

Con:

3. (5 p.) A 2.0 GHz transmitter is located at (0, 0) point on a kilometre grid. A large building is located at (10, 10) and a receiver at (0, 10) (when $t = 0$). The receiver is moving towards the transmitter at 10 km/h. Calculate the Doppler frequency of a straight path (answer:) and of a building echo path (answer:). Calculate the delay difference between both paths at $t = 0$. (Answer:).

4. (6 p.) For a given pulsed radar with 2 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 4 us, at what maximum distance could the 1 sq.m object be detected, assuming optimal processing of pulse compression in the receiver?

5. (6 p.) A signal at the digital receiver input has the shape of 25 samples of windowed sine wave.

- Sketch the impulse response of a filter required to detect this signal in the presence of white noise. What is the filter order? Answer:

.....

- Sketch the output signal of this filter when the above signal is present at the input (no noise). What is the response length? Answer:

.....

6. (5 p.) Describe the working principle of SAR radar system. Hint: start from the idea of Doppler frequency, describe the radar or object movement. Answer:

.....

7. (8 p.) In an OFDM modulation system with bandwidth of 0.5 MHz at 1 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 3% in subcarrier frequency error is a limit of good reception.

Calculate:

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

.....

8. (3 p.) Why are the bursts transmitted in the Random Access Channel (RACH) in GSM much shorter than the time slot duration?

.....

9. (4 p.) Which modulation techniques require highly linear amplifiers and why?

.....

10. (6 p.) Describe the purpose and working principle of a RAKE receiver.

.....

11. (2 p.) What is the purpose of interleaving? Answer:

.....

12. (2 p.) How can all users in an ideal CDMA system use the same band at the same time? Answer:

.....

$\Sigma = 54p \quad T = 105 \text{ min}$