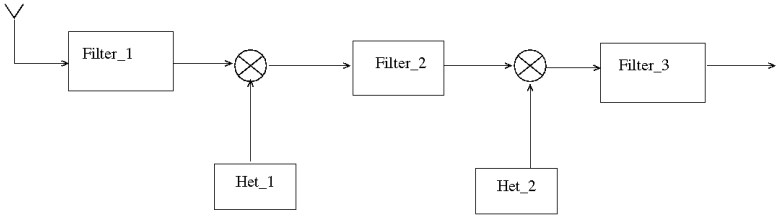
Name:_____

ESPTR 2011 – Final Exam 1, **version A** 16.06.2011

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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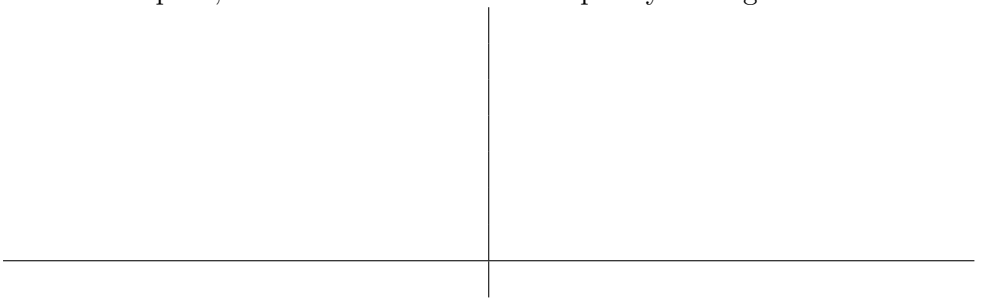
1. (4 p.) A dual conversion receiver idea is sketched above. $F_{RF} = 970\ MHz$, $F_{het1} = 920\ MHz$, $F_{Filter3} = 10.7\ MHz$ Choose the missing LO frequencies (or middle frequencies of filter passband) properly. Answer: $F_{Filter1} =$[ ], $F_{Filter2} =$[ ], $F_{het2} =$[ ]
   .....

2. (3 p.) Find the intermediate frequency (IF) and LO frequency when $F_{RF} = 2.1\ GHz$ and $F_{image} = 1.9\ GHz$? Answer: $F_{IF} =$[ ] $F_{LO} =$[ ]. Calculation: .....

3. (2 p.) The signal propagates from the transmitter (Tx) to the receiver (Rx) along two paths. One path is straight and has length of 3000 m, the other is a bounce off the ground. Both Tx and Rx are 30 m over the flat earth surface. (In case of any doubt, ask the teacher for a sketch on the blackboard). At which signal frequencies will there be the strongest constructive interference? Answer:[ ] Calculations: .....

4. (8 p.) A 6 GHz radar is located on an airplane, which flies at 1 km altitude along a straight trajectory passing exactly over a radar reflector (assume this moment as t=0). Airplane linear velocity is 100 m/s. Calculate the frequency received by radar at some (e.g. 5) chosen points of the aircraft path, and then sketch the Rx frequency vs. flight time.



5. (5 p.) For a given pulsed radar with 2 kW (peak) transmitter, the smallest detectable object at the distance of 100 km has 16 square meters of effective radar cross-section. If the object had 1 square meter, at what maximum distance could it be detected?[ ] .....
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6. (4 p.) A signal expected at the digital receiver input is a $N = 32$-sample Gaussian pulse.

   - Describe the impulse response of a filter required to detect this signal in the presence of white noise. 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:
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7. (6 p.) Describe the working principle of ISAR radar system. Hint: start from the idea of Doppler frequency, describe the radar or object movement. Answer: .....
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8. (5 p.) An OFDM system is designed to be used for communication in multipath environment with maximum path difference of 1 km. Carrier frequency is $F_c = 2.4\ GHz$, QPSK is used in subchannels.

   - Calculate the possible number of subcarriers in 7 MHz band, if the guard intervals occupy 25% of total transmission time. Answer: .....
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   - Calculate the bit rate in the system (Hint: add 10% overhead for pilots and synchronization). Answer: .....
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9. (4 p.) Two users are transmiting 1 W each in an OFDM system at 2.4 GHz carrier. One is stationary and is using even subcarriers, second moves at 72 km/h towards the base station and he is using odd subcarriers.

   (a) Calculate relative frequency error at the reception of the second user signal (in % of subcarrier spacing which is equal to 1 kHz). Answer: .....
   .....

   (b) Calculate the amount (power) of ICI caused by this effect (approximate the slope of sin(x) at zero crossing linearly). Answer: .....
   .....

10. (3 p.) The duration of 148 bits transmitted in a GSM time slot is equal to 0.546ms while the time slot lasts for 0.577ms (so some part of the slot is wasted). What is the reason of this duration difference? .....
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11. (3 p.)Does the near-far problem occur in CDMA uplink (userbase) or downlink (baseuser) transmission? Describe this problem closer. .....
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12. (3 p.) What are the roles of two antennas in a passive (parasitic) radar? .....
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13. (3 p.) How can all users in an ideal TDMA system share the same band? Answer: .....
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version A , $\Sigma = 53p$ $T = 90\ min$

Name:_____

ESPTR 2011 – Final Exam 1, **version B** 16.06.2011

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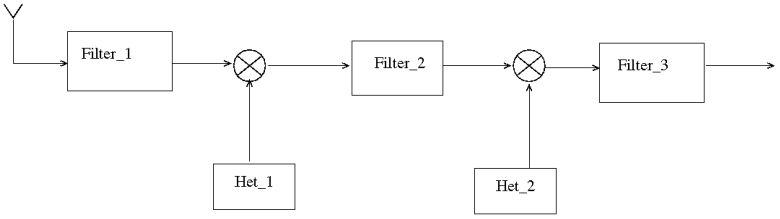

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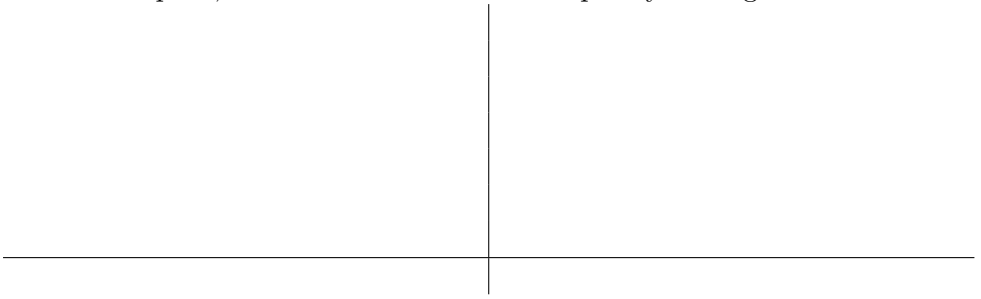
1. (4 p.) A dual conversion receiver idea is sketched above. $F_{RF} = 970\ MHz$, $F_{het1} = 820\ MHz$, $F_{Filter3} = 30.7\ MHz$ Choose the missing LO frequencies (or middle frequencies of filter passband) properly. Answer: $F_{Filter1}$ =[ ], $F_{Filter2}$ =[ ], F_{het2} =[ ]
   .....

2. (3 p.) Find the intermediate frequency (IF) and LO frequency when $F_{RF} = 1.9\ GHz$ and $F_{image} = 2.1\ GHz$? Answer: F_{IF} =[ ] F_{LO} =[ ]. Calculation: .....

3. (2 p.) The signal propagates from the transmitter (Tx) to the receiver (Rx) along two paths. One path is straight and has length of 6000 m, the other is a bounce off the ground. Both Tx and Rx are 30 m over the flat earth surface. (In case of any doubt, ask the teacher for a sketch on the blackboard). At which signal frequencies will there be the strongest constructive interference? Answer:[ ] Calculations: .....

4. (8 p.) A 9 GHz radar is located on an airplane, which flies at 1 km altitude along a straight trajectory passing exactly over a radar reflector (assume this moment as t=0). Airplane linear velocity is 100 m/s. Calculate the frequency received by radar at some (e.g. 5) chosen points of the aircraft path, and then sketch the Rx frequency vs. flight time.



5. (5 p.) For a given pulsed radar with 2 kW (peak) transmitter, the smallest detectable object at the distance of 100 km has 16 square meters of effective radar cross-section. What size (RCS) object would be detected at 25 km?[ ] .....
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   .....

6. (4 p.) A signal expected at the digital receiver input is a $N = 64$-sample raised cosine $1/2 \cdot (1 + cos(2\pi n/N))$ pulse.

   - Describe the impulse response of a filter required to detect this signal in the presence of white noise. 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:
.
.
.
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7. (6 p.) Describe the working principle of ISAR radar system. Hint: start from the idea of Doppler frequency, describe the radar or object movement. Answer: .....
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8. (5 p.) An OFDM system is designed to be used for communication in multipath environment with maximum path difference of 2 km. Carrier frequency is $F_c = 2.4\ GHz$, QPSK is used in subchannels.

   - Calculate the possible number of subcarriers in 7 MHz band, if the guard intervals occupy 25% of total transmission time. Answer: .....
   .....
   .....
   - Calculate the bit rate in the system (Hint: add 10% overhead for pilots and synchronization). Answer: .....
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9. (4 p.) Two users are transmiting 1 W each in an OFDM system at 2.4 GHz carrier. One is stationary and is using even subcarriers, second moves at 108 km/h towards the base station and he is using odd subcarriers.

   (a) Calculate relative frequency error at the reception of the second user signal (in % of subcarrier spacing which is equal to 1 kHz). Answer: .....
   .....

   (b) Calculate the amount (power) of ICI caused by this effect (approximate the slope of sin(x) at zero crossing linearly). Answer: .....
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10. (3 p.) The duration of 148 bits transmitted in a GSM time slot is equal to 0.546ms while the time slot lasts for 0.577ms (so some part of the slot is wasted). What is the reason of this duration difference? .....
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12. (3 p.) What are the roles of two antennas in a passive (parasitic) radar? .....
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13. (3 p.) How can all users in an ideal FDMA system share the same time slot? Answer: .....
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version B , $\Sigma = 53p\ T = 90\ min$