

Name: _____

GTID: _____

ECE 6390: Satellite Communications and Navigation Systems
TEST 2 (Fall 2007)

- Please read all instructions before continuing with the test.
- This is a **closed** notes, **closed** book, **closed** friend, **open** mind test. On your desk you should only have writing instruments and a calculator.
- Show all work. (It helps me to give partial credit.) Work all problems in the spaces below the problem statement. If you need more room, use the back of the page. DO NOT use or attach extra sheets of paper for work.
- Work intelligently – read through the exam and do the easiest problems first. Save the hard ones for last.
- All necessary mathematical formulas are included either in the problem statements or the last page of this test.
- You have 80 minutes to complete this examination. When the proctor announces a “last call” for examination papers, he will leave the room in 5 minutes. The fact that the proctor does not have your examination in hand will not stop him.
- I will not grade your examination if you fail to 1) put your name and GTID number in the upper left-hand blanks on this page or 2) sign the blank below acknowledging the terms of this test and the honor code policy.
- Have a nice day!

Pledge Signature: _____

I acknowledge the above terms for taking this examination. I have neither given nor received unauthorized help on this test. I have followed the Georgia Tech honor code in preparing and submitting the test.

Short Answer Section (2 points/blank)

1. _____
Rain attenuation is strongest for polarization.

2. _____ (1) _____ (2)
Lucille Ball's braces act like a(n) , which is a very type of receiver in commercial radio practice.

3. _____
True or False: It is possible to use SSB and QAM to multiplex 4 signals into the same overlapping bandwidth.

4. _____
The most bandwidth-efficient form of amplitude modulation is .

5. _____
Using a more complicated signal constellation trades-off higher for increased bit-error rate.

6. _____ (1) _____ (2)
Due to low , deep space satellites send data mostly using digital modulation.

7. _____ (highest) _____ (lowest)
Rank the following scenarios in terms of in terms of highest to lowest possible Doppler shift in (Hz):
 - (a) geostationary satellite to an Earth station dish in Atlanta at 12 GHz
 - (b) 900 MHz cell-phone on a bus traveling 65 m.p.h. on the highway
 - (c) SARSAT satellite receiving an EPIRB signal
 - (d) NASA space probe orbiting Neptune close to the atmospheric layer, communicating back to Earth at 16 GHz
 - (e) 2.45 GHz WiMax link to a pedestrian wireless PDA user

8. _____ lat _____ lon
A SARSAT satellite riding down the 85.70° W longitude line estimates the coordinates of an EPIRB to be at 25.70° latitude and 89.70° longitude. What lat/lon on the earth might also result in an ambiguous location estimate for the EPIRB?

9. _____
 If carrier frequency on an existing satellite link increases, which of the following 4 elements in the link will *always* increase:
- (a) dish antenna gain
 - (b) LNA gain
 - (c) rain attenuation
 - (d) free space path loss
 - (e) noise bandwidth
 - (f) Doppler shift
 - (g) FM processing gain
 - (h) tropospheric delay
10. _____
 [Answer] is the empirical relationship between FM bandwidth and the baseband properties of the signal to be modulated.
11. _____
 The magnetic field of the Earth in conjunction with the charged particles of the ionosphere work together to cause [Answer] in a satellite link.
12. _____ (1) _____ (2) _____ (3)
 In an ideal world, the [Answer 1] pulse would be the best digital symbol, because it satisfies the [Answer 2] interference criterion with the minimum [Answer 3].
13. _____ (lowest) _____ (highest)
 Rank the following based on which location would result in the lowest received C/N for a radio Comlink:
- (a) the ice world of Hoth
 - (b) a small asteroid in deep space
 - (c) the swamp world of Degobah
14. _____ (1) _____ (2)
 Using a higher [Answer 1] factor increases the [Answer 2] but allows truncated pulses to fit within a tighter out-of-band spectral constraint.

15. _____
True or False: Cloud cover can be a factor in a satellite communication link.
16. _____
When out-of-band harmonics appear in a receiver RF chain, this may be a sign of Answer amplifier effects.
17. _____
The most critical component in an RF chain for reducing system noise is the Answer.
18. _____ (1) _____ (2)
A higher Answer 1 factor in FM results in higher Answer 2 at the output of a receiver – at the expense of larger occupied RF bandwidth.
19. _____ (1) _____ (2)
The Answer 1 and Answer 2 channels are 90° out-of-phase with one another.
20. _____ (1) _____ (2)
Name 2 types of dish antenna geometries that use sub-reflectors.
21. _____
Uniform Answer introduces $6N$ dB of signal-to-noise ratio to an otherwise perfect signal.
22. _____ Msamples/sec _____ (2)
An analog television signal with 5 MHz of baseband bandwidth must be sampled by at least Answer 1 to avoid Answer 2.

23. A pair of signals is analog-modulated using the following format:

$$x_p(t) = A \cos \left(2\pi f_c t + 2\pi k_m \int_0^t [x_1(t) \cos(2\pi f_o t) + x_2(t) \sin(2\pi f_o t)] dt \right)$$

Using block diagrams, sketch the complete structure of a receiver that would demodulate and separate these 2 signals. The components available to you are: band-pass filters, low-pass filters, high-pass filters, capacitors and diodes, antennas, LNA, mixers, oscillators, phase-shifters, and differentiators. You may assume ideal oscillators. Label the outputs clearly. (**18 points**)