Sample Problems for Exam 1

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1 Some Hints

Your professor suggests the following preparation strategies:

- The problems in this set should be doable by you in about 100 minutes total, time yourself.
- The number of minutes you are expected to use per problem is posted next to it (to indicate the difficulty level).
- Practice writing neat clean answers, since if the grader cannot understand you on the real exam, it will go badly for you.
- Show your work, if you are guessing the grader will not give much credit (even if you get lucky and guess right).
- Define your notation (you can use tables like the lecture notes if you like).
- Set up the solution symbolically and simplify before plugging numbers in, it is easier to follow for the grader.
- These exercises are meant to be done alone with an open book and notes and a calculator.
- You can solve problems out of order, but keep the work for each problem in one place, and mark it clearly.

2 The Problems

1. CRC (10 Minutes): Given a generator polynomial $P(x) = x^2 + x + 1$ and a message frame 101110, what is the corresponding CRC?

2. Signal Processing (15 Minutes):

   (a) Suppose a signal has a strength of 100 milliwatts and has 10 milliwatts of noise, what is the signal to noise ratio (5 minutes)?

   (b) Suppose a (complex) signal, $S(t)$ is defined as:

   $$S(t) = c_1 \times \sin(t) + c_2 \times \sin(9t) + c_3 \times \sin(11t) \quad (1)$$

   where t is time measured in seconds.

      i. What is the fundamental frequency of $S(t)$ (5 minutes)?

      ii. What is the minimum frequency of sampling needed to accurately reconstruct $S(t)$ (5 minutes)?

3. Information Theory (15 Minutes): Suppose that an information link transmits a 4 bit messages (3 bits of user data and a 1 bit header). Suppose that the header always contains the value of 1, and each bit of the user data has a probability of 0.5 of being set to 1. What is the entropy of this link?

4. Channel Performance Analysis (15 minutes): Suppose that a satellite has 100 gigabits per second of band width, and is 40000 kilometers from two ground stations. Assume that the signals transmitted to and from the satellite travel at approximately the speed of light (about 300000 kilometers per second). How long will it take to send 1 kilobyte of data from one station to the other?

5. Overhead analysis (10 Minutes):

   (a) Suppose that a packet can hold 1484 bytes of user data and has a 16 byte header. What is the header overhead (5 minutes)?

   (b) If the ATM forum had adopted 64 byte cells, what would the the header overhead of an ATM packet be (5 minutes)?

6. Short answer (10 minutes):

   (a) Why does the US have echo cancellation widely installed, but not Japan or Europe (5 minutes)?

   (b) If using layering in protocol design removes complexity at each layer, why not use say 100 layers, or say 2 layers (5 minutes)?

7. Queueing Theory (10 minutes):

(a) Suppose that a router receives (on average) 800 packets per second and takes 1 millisecond to forward a packet, what is the utilization assuming interarrival and service times are exponentially distributed (5 minutes)?

(b) What is the mean time to route a packet (5 minutes)?

8. Network Systems programming (15 minutes):

(a) Why does Unix sometimes return from a read or write systems call if only part of the data could be transferred? (5 minutes)

(b) What functionality does the gethostbyname system call provide (5 minutes)?

(c) Describe the functionality of the listen system call (5 minutes).