

CS 555: Computer Networks and Data Communication
Spring 2005
Midterm Examination- Part 1/2
Points: 75
March 1, 2005 (3:00-4:15 PM)
Time allowed: 75 minutes
CLOSED BOOK, CLOSED NOTES, OPEN MIND
Answer All Questions
Solution

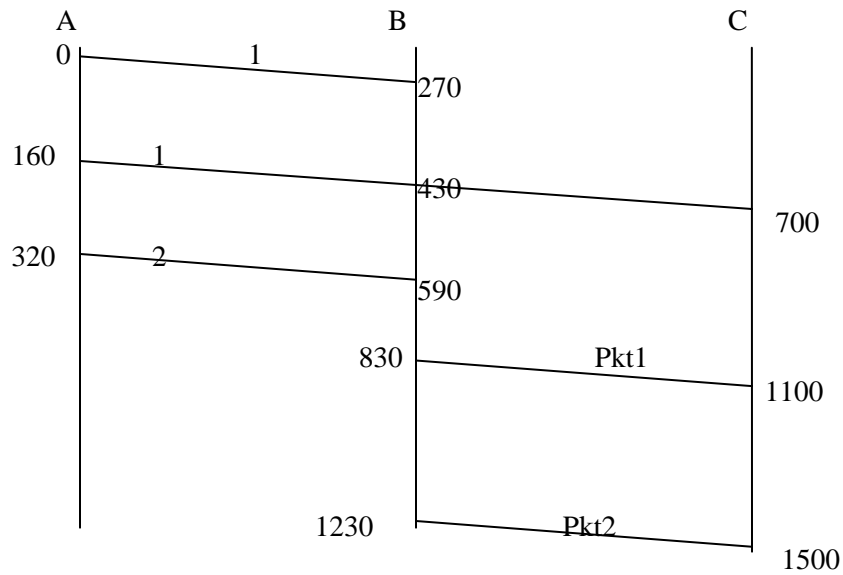
Question 1

- (i) $3^{\text{rd}} = 1.5\text{kHz}$; $1^{\text{st}} = 500\text{Hz}$, Period(milliseconds) = $T = 1/500 = 2\text{msec}$
- (ii) Bandwidth(kHz) = 10^{th} Harmonic = $10 * 0.5 = 5\text{ kHz}$
- (iii) Sampling rate (baud) = $2 * 5\text{ k} = 10,000\text{ baud}$
- (iv) Maximum data rate = $2H \log_2 V = 2 * 3 * \log_2 64 = 36\text{kbps}$
- (v) No, most significant harmonics 8^{th} and 10^{th} can't pass through.
- (vi) Maximum data rate (kbps) $S/N = 8\text{dB}$, $10 \log(S/N) = 8$, $S/N = 6.31$
 $H \log_2 (1+6.31) = 3 * \log_2 7.31 = 3 * 2.87 = 8.61\text{ kbps}$
- (vii) Output signal power (watts)
 $1.2 = 10 \log_{10} (\text{Input/Output})$
 $0.12 = \log_{10} (10/x)$
 $10/x = 10^{0.12} = 1.32$, $x = 7.59\text{ Watts}$

Question 2

- (i) There are 17 levels; so we need = 5bits/sample , Sampling rate = $2 * 10\text{ K} = 20\text{K}$ samples/sec; Maximum data rate (kbps) = $20 * 5 = 100\text{ kbps}$
- (ii) SRC1 = 70 kHz ; So sampling rate = 140 kbaud ; 16 levels so 4 bits/sample ;
Maximum data rate = $140 * 4 = 560\text{ kbps}$
SRC2 = 168 kbps
SRC3 = 42 kHz ; So sampling rate = 84 kbaud ; 64 levels so 6 bits/sample ;
Maximum data rate = $84 * 6 = 504\text{ kbps}$
SRC1 = $560/7 = 80/\text{sec}$, SRC2 = $168/7 = 24/\text{sec}$, SRC3 = $504/7 = 72/\text{sec}$
of channels; SRC1: 10, SRC2: 3, SRC3: 9
- (iii) It is 1 bit/sample for SRC1 and SRC3. So Combined data rate (kbps) = $140\text{ kbps} + 168\text{ kbps} + 84\text{ kbps} = 392\text{ kbps}$
- (iv) A → B: $(8 * 2000)/50 + 270 = 320 + 270 = 590$
B → C: $(8 * 2000)/20 + 270 = 800 + 270 = 1070$
Total Response time = $590 + 1070 = 1660\text{ msec}$

(v)



The 1st 1000 byte packet (transmission time $8000/50 = 160\text{msec}$; prop. Delay = 270msec) reaches B completely at 430 msec. B starts sending 1st packet from 430 msec onwards. Its last bit is received by C at 1100 msec. Similarly the last bit of the second packet is received by C at **1500 msec (Answer)**.

Question 3

(i) A 1010 B 1011
AB = 10101011

- - 1 - 0 1 0 - 1 0 1 1
c1 c2 d1 c4 d2 d3 d4 c8 d5 d6 d7 d8

$$c1 = d1 + d2 + d4 + d5 + d7 = 1$$

$$c2 = d1 + d3 + d4 + d6 + d7 = 1$$

$$c4 = d2 + d3 + d4 + d8 = 0$$

$$c8 = d5 + d6 + d7 + d8 = 1$$

Data sent (Hexadecimal string) 111001011011

(ii) **Checksum = 1111**

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10101) 101010110000 ( 10000011
        10101
        -----
                011000
                10101
                -----
                        11010
                        10101
                        -----
                                1111
    
```

- (iii) Transmission time = $8000/50 = 160$ msec
 $a = 270/160 = 27/16$
 $U = 1/(1+2*a) = 1/(1+2*27/8) = 8/35$

Throughput = $8/35 * 50 = 11.43$ kbps

- (iv) $0 \rightarrow 160$ ----- $270 \rightarrow 430$ Frame 1
 (ACK comes back to A at $430+270$ or 700 msec)
 $700 \rightarrow 860$ ---- $970 \rightarrow 1130$ Frame 2
Response time(milliseconds) = 1130

Question 4

- (i) 0,1,2 (Window size = 3 because we are using 2 bit sequence numbers)
 Transmission Time = 200 msec

F0: 0-200 \rightarrow 270-470 (F0 accepted) ACK sent at 470
 F1: 200-400 \rightarrow 470 – 670 (F1 error, ignored)
 F2: 400-600 \rightarrow 670 – 870 (F2 ignored)

Acknowledgement for F0 is received at $t = 470+270 = 740$ msec

F3: 740-940 \rightarrow 1010 – 1210 (F3 ignored)

At 1400, F1's timer timesout. Hence, the ones in the current window F1-F3 are sent again

F1: 1400-1600 \rightarrow 1670-1870 (F1 accepted)
 F2: 1600-1800 \rightarrow 1870-2070 (F2 accepted)
 F3: 1800-2000 \rightarrow 2070-2270 (F3 accepted)

Response time (milliseconds) = 2270 msec

- (ii) F0: 0-200 \rightarrow 270-470 (accepted) ACK sent at 470
 F1: 200-400 \rightarrow 470 – 670 (F1 error, ignored)

ACK for F0 received at 740.

F2: 740-940 \rightarrow 1010 – 1210 (F2 accepted)

F1 timesout at 1400; so F1 is retransmitted:

F1: 1400-1600 \rightarrow 1670 – 1870 (F1 accepted) ACK sent for F2

ACK received for F2 at $1870+270 = 2140$;

F3: 2140-2340 \rightarrow 2410-2610

Response time (milliseconds) = 2610 msec