# DATA COMMUNICATION – EDA340

Solution to Final Exam 14 December 2000

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## Problem 1

(a). False.

(b). False.

(c). False.

(d). True.

(e). True.

(f). False.

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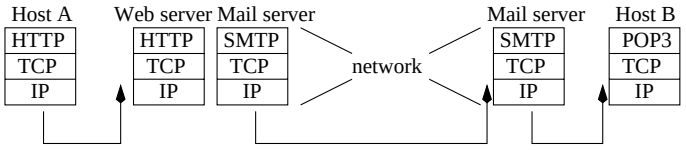
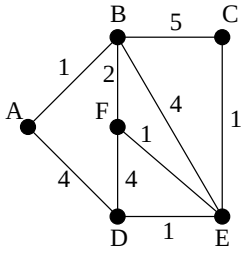
## Problem 2

(a). Lecture 1, slides 19 and 22.

(b).




(c).




| | | | | | | |
|---|---|---|---|---|---|---|
| A | 0 | - | | | | |
| B | 1 | B | | | | |
| C | 5 | B | | | | |
| D | 4 | D | | | | |
| E | 4 | B | | | | |
| F | 3 | B | | | | |

| Step | N | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 0 | A | 1,A | $\infty$ | 4,A | $\infty$ | $\infty$ |
| 1 | AB | 1,A | 6,B | 4,A | 5,B | 3,B |
| 2 | ABD | 1,A | 6,B | 4,A | 5,B | 3,B |
| 3 | ABDF | 1,A | 6,B | 4,A | 4,F | 3,B |
| 4 | ABDFE | 1,A | 5,E | 4,A | 4,F | 3,B |
| 5 | ABDFEC | 1,A | 5,E | 4,A | 4,F | 3,B |

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## Problem 3

(a). Lecture 3, slide 3.

(b). Rate = 1/3

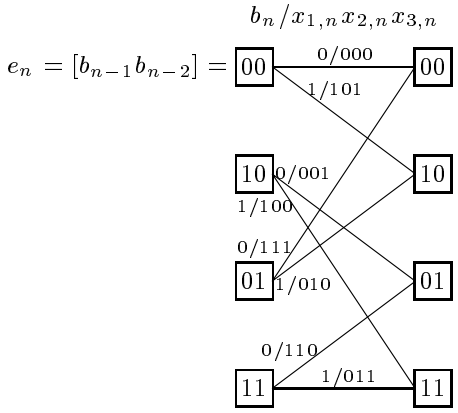
$g_1 = 101 = 5$

$g_2 = 001 = 1$

$g_3 = 111 = 7$

(c).

| $b_n$ | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
|---|---|---|---|---|---|---|---|---|
| $e_n$ | 00 | 00 | 10 | 10 | 01 | 01 | 11 | 11 |
| $\mathbf{x}_n$ | 000 | 101 | 001 | 100 | 111 | 010 | 110 | 011 |
| $e_{n+1}$ | 00 | 10 | 01 | 11 | 00 | 10 | 01 | 11 |




## Problem 4

(a). Lecture 5, slides 10–12.

(b).

$$
\begin{array}{l}
x^6 + x^3 + x^2 + x + 1 : x^2 + x + 1 = x^4 + x^3 + 1 \\
\underline{x^6 + x^5 + x^4} \\
\qquad x^5 + x^4 + x^3 + x^2 + x + 1 \\
\qquad \underline{x^5 + x^4 + x^3} \\
\qquad\qquad\qquad x^2 + x + 1 \\
\qquad\qquad\qquad \underline{x^2 + x + 1} \\
\qquad\qquad\qquad\qquad 0
\end{array}
$$

No errors detected.

(c). Lecture 6, slides 4–5.

## Problem 5

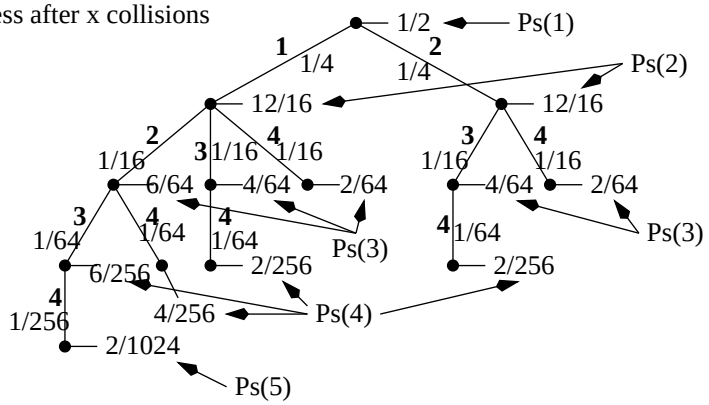
(a). Lecture 7, slides 14, 20

(b). Lecture 7, slides 21, 24

(c). After the initial collision, we have success with probability 1/2 and with probability 1/4 we have collision either in slot 1 or slot 2. After a second collision, we have success with probability $(1/4) \cdot (12/16) \cdot 2$ and we can have collision in slots 3, 4, 5 or 6. With collision in slots 5 or 6 we can no longer have success. With collision in slot 4, we have 2 outcomes with success, collision in slot 3 leads to 6 possible outcomes with success. Following this direction of arguments, we can build up the following tree.

initial collision in slot 0 | 0 1 2 3 4 5 6 | real timeslots
X

Ps(x)= Prob success after x collisions




The probability of success is then the sum of all paths in the tree, where the branch probabilities are multiplied together.

## Problem 6

(a). 110 -90 bytes = 20 bytes
Ack # 90

(b). Lecture 13, slide 26

(c). Known-plaintext attack

| | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| k=8 | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | A | B | C | D | E | F | G | H |
| k=24 | Y | Z | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X |

Decrypted to read

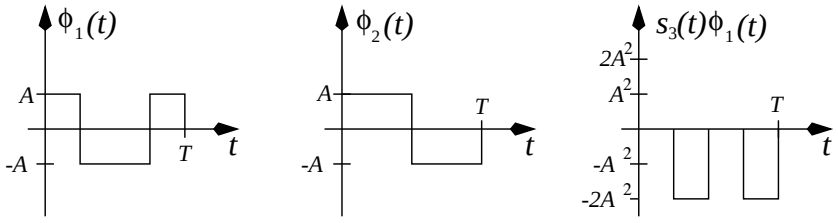
**are you able to get two points for this**

## Problem 7

(a). Lecture 2, slide 5.

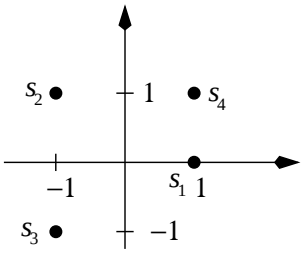
(b). Dimension = 2.

(c).




We have $\int_0^T s_2(t)\phi_1(t)dt = -1$.
So $\phi_1(t) = s_2(t) - \phi_1(t)$.

It follows that $s_1 = (1, 0)$, $s_2 = (-1, 1)$, $s_3 = (-1, -1)$, $s_4 = (1, 1)$.




(d). Lecture 2, slide 24 with $\sqrt{E_b}$ exchanged with $\frac{\sqrt{2E_b}}{2}$

$$P_b = Q\left(\sqrt{\frac{E_b}{N_0}}\right)$$

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