Home Work Assignment -1

1) a) given $RTT = 50ms$

$\text{initial time} = 2 \times RTT = 100ms$

$\text{bandwidth} = 1.5 mbps$

$\text{packet size} = 1KB = 1 \times 1024 \times 8 \text{ bits} = 8192 \text{ bits}$

$$\text{transmission time per packet} = \frac{\text{packet size}}{\text{bandwidth}} = \frac{8192}{1.5 \times 10^6}$$

$$\text{total transmission time} = \frac{\text{file size}}{\text{bandwidth}}$$

$$= \frac{8192 \times 1000}{1.5 \times 10^6}$$

$$= 5.46 \text{ secs}$$

total time required = initial time + transmission time + Propagation delay

$$= 2 \times RTT + 5.46 \text{ secs} + RTT/2$$

$$= 100 \text{ ms} + 5.46 \text{ secs} + 25 \text{ ms}$$

$$= 5.585 \text{ secs}$$

→ hence total time required = 5.585 secs

b) given case is similar to a but we need to wait for RTT time between two packets

here we have 1000 packets so to send 1000 packets we need to wait 999 RTT.

total transmission time = $\frac{8192 \times 1000}{1.5 \times 10^6} + 999(RTT)$

$= 5.46$ secs $+ 999(50$ msec$)$

$= 5.46$ sec $+ 49.95$ sec

$= 55.41$ secs

total time required = initial time + transmission time + Propagation

$= 2RTT + 55.41 + RTT/2$

$= 100$ ms $+ 55.41$ sec $+ 25$ msec

$= 55.535$ secs

→ here total time required = 55.535 secs

c) here we can send 20 packets per RTT so.
no of RTT required is

no of RTT required = $1000/20$ = 50 RTT

but for the last RTT we only require $RTT/2$

so total no of RTT required to transfer 1000 packets = 49.5 RTT

total time required = initial time + transmission time

= 2 × RTT + 49.5 RTT

= 51.5 RTT

= 51.5 × 50 ms

= 2.575 secs

→ hence total time required = 2.575 secs

d) no of packets sent in a RTT follows the series
$1+2+4 \cdots \cdots$
sum of the series $= 2^n - 1$

to transfer 1000 packets we have $2^n - 1 = 1000$

so we require 10 RTT to transfer 1000 Packets
for the last RTT we only require RTT/2

→ hence total no of RTT required for transmission = 9.5 RTT

total time required = Initial time + transmission time

$= 2 \times RTT + 9.5\ RTT$

$= 11.5\ RTT$

$= 11.5 \times 50$ msec

$=$

$= 0.575$ secs

→ hence total time required = 0.575 secs

2) given propogation delay = 5us/Km
data rate between A to B = 100 KbPS
data frames are 1000 bits long

Between A to B :-

propogation delay = 4000 x 5 us/km
= 20 msec

Transmission time of 1000 bits = $\frac{1000}{100 \times 10^3}$ = 10msec

since A and B follow sliding window protocol of size 3
In one cycle it transfers 3 data frames = 3000 bits

time required to transfer 3000 bits = $2T_p + 3T_n$
= 2 x 20 msec + 3 x 10 msec
= 50 msec

Between B to C :-

Propagation delay = 1000 x 5 us/KM
= 5msec

Transmission time of 1000 bits = $\frac{1000}{R}$

Where R is ~~bandwidth~~ transmission rate to be found out

Since B and C uses stop and wait to send 3000 bits time required = $3(2T_p + T_n)$

$$= 3\left(2 \times 5\text{msec} + \frac{1000}{R}\right)$$

In order not to flood the buffer of B the time required to send 3000 bits must be equal for A to B and B to C, when we do that we have

$$50\ msec = 3\left(10\ msec + \frac{1000}{R}\right)$$

$$= 30\ msec + \frac{3000}{R}$$

$$20\ msec = \frac{3000}{R}$$

$$R = \frac{3000\ bits}{20\ msec}$$

$$\rightarrow R = 150\ Kbps$$

→ Hence required transmission rate between B & C = 150 Kbps

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3 A) codewords = {111, 100, 001, 010}

here $n = 3$, since there are 4 code words no of data bits is 2 hence $K = 2$ and minimum hamming distance $d = 2$

$$(n, K, d) = (3, 2, 2)$$

→ ~~data~~ coding rate $= K/n = 2/3 = \underline{0.66}$

A code is said to K error detecting if its satisfies $K = d_{min} - 1$ where d_{min} = minimum hamming distance

→ so here since $d_{min} = 2$, this code is $\underline{1}$ error detecting

A code is said to K error correcting if it satisfies $K = \frac{d_{min} - 1}{2}$ where d_{min} = minimum hamming distance

$$K = \frac{2-1}{2} = \underline{1/2}$$

→ error correcting capability of code $= 1/2$

→ $(n, K, d) = (3, 2, 2)$

→ error detecting capability $= 1$

→ error correcting capability $= 1/2$

→ coding rate $= 0.66$

B) codewords = { 00000, 01111, 10100, 11011 }

here $n = 5$, since no of code words = 4 we have message bits = 2 hence $k = 2$ and $d = 2$

$(n, k, d) = (5, 2, 2)$

→ coding rate = $k/n = 2/5 = 0.4$

A code is said to be k error detecting if it satisfies $k = d_{min} - 1$, where d_{min} = minimum hamming distance

$k = 2 - 1 = \underline{1}$

A code is said to k error ~~detect~~ correcting if it satisfies $k = \frac{d_{min} - 1}{2}$, where d_{min} = minimum hamming distance

$k = \frac{2-1}{2} = \underline{1/2}$

→ $(n, k, d) = (5, 2, 2)$

→ coding rate = 0.4

→ error detecting capability = 1

→ error correcting capability = 1/2

4) given $(n, k, d) = (n, 20, 3)$

now for a code word having n bits · with k message bits no of parity check bits is $n-k$, so no of code words possible is 2^{n-k}. a no of ways in which we can have 0 errors or 1 bit errors $= {}^{n}C_0 + {}^{n}C_1 = 1 + n$
for a code to correct all single bit errors the no of patterns should be greater than no of ways in which error can be obtained. i.e

$$2^{n-k} \geq n+1$$

so if this criteria $2^{n-k} \geq n+1$ than we can say that code can correct all single bit errors.

for our given problem we should have

$$2^{n-20} \geq n+1$$

if we have $n = 25$ then $2^{25-20} \geq 25+1$

$$32 \geq 26$$

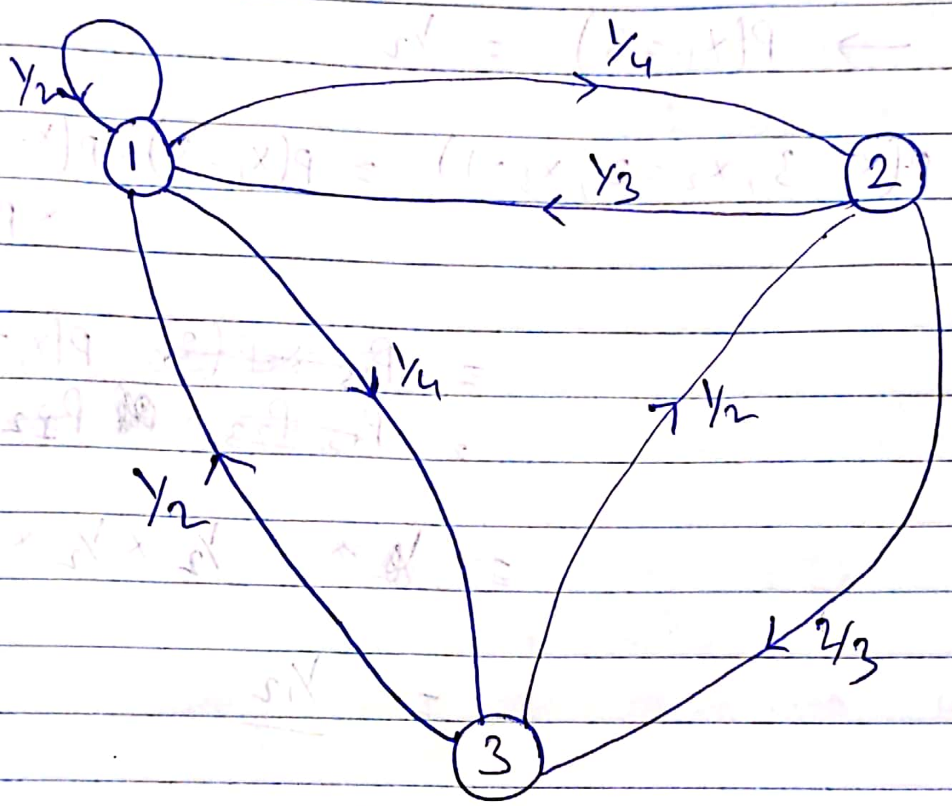
so $n = 25$ is the minimum value of n for which the above criteria is satisfied here.

→ The minimum value of n for which code can correct all single bit errors $= \underline{25}$

5) given transition Matrix

$$P = \begin{bmatrix} 1/2 & 1/4 & 1/4 \\ 1/3 & 0 & 2/3 \\ 1/2 & 1/2 & 0 \end{bmatrix}$$

a) transition diagram is as follows



b) given $P(X_1=1) = P(X_1=2) = 1/4$

we know that

$$P(X_1=3, X_2=2, X_3=1) = P(X_1=3) \times P(X_2=2/X_1=3) \times P(X_3=1/X_2=2)$$

$$= P(X_1=3) \times P_{32} \times P_{21}$$

we have $P(X_1=1) + P(X_1=2) + P(X_1=3) = 1$

so $P(X_1=3) = 1 - P(X_1=1) - P(X_1=2) = 1 - 1/4 - 1/4$

$= 1/2$

from table $P_{32} = 1/2$, $P_{21} = 1/3$

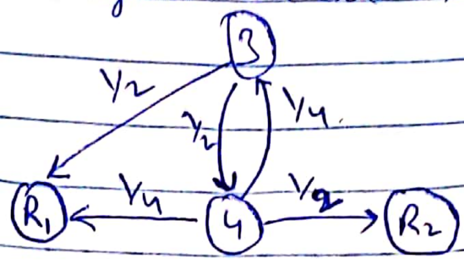
$$P(X_1=3, X_2=2, X_3=1) = P(X_1=3) \times P_{32} \times P_{21}$$

$$= 1/2 \times 1/2 \times 1/3$$

$$= 1/12$$

$\rightarrow P(X_1=3, X_2=2, X_3=1) = \underline{1/12} = 0.0833$

6) The given diagram can be redrawn as



where $R_1 = \{1,2\}$, $R_2 = \{5,6,7\}$ are recurrent and absorbable.

Let us have $b_i = P(\text{absorbtion in } R_1 / X_0 = i)$

. from this we can have $b_{R_1} = 1$ and $b_{R_2} = 0$

we can also have $b_i = \sum_K b_K P_{Ki}$

we obtain the equation

$$b_3 = \frac{1}{2} b_{R_1} + \frac{1}{2} b_4 = \frac{1}{2} + \frac{1}{2} b_4 \quad -(1)$$

$$b_4 = \frac{1}{4} b_{R_1} + \frac{1}{2} b_{R_2} + \frac{1}{4} b_3 = \frac{1}{4} + \frac{1}{4} b_3 \quad -(2)$$

solving (1) and (2) we have

$\underline{b_3 = 5/7}$, $b_4 = 3/7$

→ hence Probability that chain gets absorbed in R_1 given initial state $X_0 = 3$ is $b_3 = \underline{5/7}$

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