3203 A3 – Shalin L – 101036399

1. Q1
    a. Compass Routing: S->3->14->21->19->T
    b. Left Hand Facing: S->3->(10)14->(13,31,21)20->27->(28)29->T
    c. Right Hand Facing: S->4->5->8->(10)12->(13)23->(31)22->(21,28)19->T
2. Q2

Example: Range = r.

Center has access to all external nodes.

All other nodes have access Center Only.

Therefore:

for all nodes, dist to C = r, dist to next node > r

As an example, say dist to node = r.

This means that any two adjacent nodes on exterior form an equilateral triangle with the center.

This in turn means that you can fit exactly 6 nodes on the exterior.

Now, say we want dist to next node to be > r

This means we need to make space on the exterior. Changing the dist to center will make no difference, therefore we must remove at least one

node from exterior, which means k must be <= 5.

3. Q3

S_height = S's distance from W1 = 4

x = x coord of first collision

tan(angle)=S_height/(x)

tan(angle)=4/(x)

x = 4/tan(angle)

x' = dist from collision to T = 10-x

angle remains the same (angle of reflection = angle of incident)

T_height = T's distance from W1 = 3

Tan(angle) = T_height / (10-x)

10-x = T_height / tan(angle)

X = 10-3/tan(angle)

X = 4/tan(angle) = 10-(3/tan(angle))

10=7/tan(angle)

Tan(angle)=10/7

angle =atan(10/7)

angle = 34.9 degrees

Therefore, the angle must be 34.9 degrees to ensure the ray leaving from S reaches T after one reflection.

4. Q4

the center is furthest from all three corners. It's an equilateral triangle.

If the point is any distance from the center, then it will be distancing from at most two edges, and approaching all other edges.

Halfway point = a/2

angle to halfway point = 30 degrees

cos 30 = (adj/hyp)

hyp = adj/(cos 30)

hyp = a/(2 cos 30)

hyp = a/sqrt(2)

therefore dist = a/sqrt(2)

5. Q5
   a) P(contains at least 1 error) = 1-(P (0 errors))

      P(0 errors) = $(1\text{-p(error)})^{\text{num bits}}$

      = $(1\text{-p})^{n}$

      Therefore, P(contains at least 1 error) = $1\text{-}(1\text{-p})^{n}$

   b) Given P(contains at least 1 error) and Probability e:
      Want n.
      $1\text{-}(1\text{-p})^{n}$ = e
      $(1\text{-p})^{n}$ = 1-e
      n log(1-p)=log(1-e)
      n = log(1-e)/log(1-p)

$n = \log_{(1-p)}\log(1-e)$

can't send a half packet, therefore $n=\text{floor}(\log_{(1-p)}\log(1-e))$

6. Q6

Pseudocode:

Request coords of A

Request coords of B

Request coords of C

Construct the following system of equations:

(x+a)^2 + (x'+a')^2 = 4

(x+b)^2 + (x'+b')^2 = 9

(x+c)^2 + (x'+c')^2 = 4

Solve the system for x, x'.

7. Q7

a)

Buffer overflows if $C < C_0 + tr$

$C = C_0 + t*r$

$C-C_0 = t*r$

$t = (C-C_0)/r$

therefore after $(C-c_0)/r$ time units the buffer will overflow

b)

Send message if: $C_0 + tr > p*C$

$tr + C_0 = p*C$

$tr = pC – C_0$

$t = (pC – C_0)/r$

Therefore, message will be sent after $(pC – C_0)/r$ time units.

8. Q8

Each of the n/2 nodes is sending out a packet to each of the n/2 end packets.

Therefore there at lease (n^2)/4 packets being sent, which is Omega(n^2) given the $(n^2)/4$ packets being sent, and the knowledge that there are $(n+1)$ possible nodes along line L.

Assuming a completely uniform distribution of nodes, (The best possible case), each node is forced to take $1/(n+1) * (n^2)/4$ packets.

$1/(n+1)*(n^2)/4$

$<= (1/n)(n^2)/4$

$<= n/4$

$= \Omega(n)$

Applying the same logic as before, now there are at most l possible nodes. Therefore it is $(1/l)*(n^2)/4 <= (n^2)/(4*l) = \Omega((n^2)/l)$

9. Q9

a)

Total size of headers = nh (# header * size of each header)

Ratio = Total size headers / (Total size headers + size of initial packet)

= nh / (nh + p), where p = the initial size of the packet

b) 3p = p + nh

2p = nh

n = 2p/h

Therefore after 2p/h applications the packet will be at least triple the length of the intitial packet.

10. Q10

E(change) = I(w)(1-p) + (-D(w))p

if given p, a congestion window with I(w)(1-p) = D(w)p will result in an equilibrium

more precisely,

I(w) = w + 1/w

D(w) = w/2

want

I(w)(1-p)-D(w)p = 0

I(w)(1-p) = D(w)p

(1/w)(1-p) = (w/2)p

(w/2)(1/(1/w)) = (1-p)/p

w/(1/w) = 2*(1-p)/p

$$(1/w)/w = p/(2*(1-p))$$

$$1/w^2 = p/(2*(1-p))$$

$$w = \sqrt{2(1-p)/p}$$

Sorry about the awful formatting, I don't have the time to make decent pictures and write it up in latex.