Homework 6 solutions

1. ALOHA and Slotted ALOHA:

Problem 8:

a.

$$S = Np(1-p)^{N-1}$$

Taking the derivative, we have,

$$N(1-p)^{N-1} + Np(N-1)(1-p)^{N-2}(-1) = 0$$

$$1 = \frac{p(N-1)}{(1-p)}$$

$$p = \frac{1}{N}$$

//10 points.

b.

$$Np(1-p)^{N-1} = \left(1-\frac{1}{N}\right)^{N-1} = \frac{1}{e} = 0.37$$

//5 points.

Problem 9:

$$S = Np(1-p)^{2(N-1)}$$

taking the derivative, which yields

$$p = \frac{1}{2N-1}$$

plugging this back,

$$S = \frac{N}{2N-1}\left(1-\frac{1}{2N-1}\right)^{2(N-1)}$$

$$= \frac{1}{2e}$$

//10 points

2. Throughput of a Broadcast Channel with Polling

$$Throughput = \frac{Q}{t_{poll} + Q/R} \text{ bps}$$

//20 points

3. CSMA/CD design for 10 Mbps and 100 Mbps

RTPD:	46.4 us
Throughput:	100 Mbps

Minimum packet size:

46.4e-6 * 100*e6+48 = 4688 bits

//10 points

Throughput: 100 Mbps

Minimum packet size: 512 bits

Maximum RTPD: 464 / 100e6 = 4.64 us

//10 points

4. Concepts: CDMA

The data bits are –1 and 1. The CDMA code is (1, -1, 1, -1, 1, -1, 1, -1). Hence, the sender's output is (-1, 1, -1, 1,- 1, 1, -1, 1, 1, -1, 1, -1, 1, -1, 1, -1).

//15 points

5. Concept: ARP

ARP query is sent within a broadcast frame is because that within a LAN, the sender doesn't know which host, if any, has the LAN address for its corresponding destination IP address. Hence, it has to send to all of them and see who gives it a reply – MAC address, saying that it is the correct receiver.

// 5 points

When the receiver sends an ARP response, it has already known the LAN address of the sender via the packet it received. Hence, instead of sending the response to the others, who are not the sender, the receiver can just simply direct its LAN address to the sender.

//5 points

Because IP determines that the destination node is not directly connected to the same LAN as the sender is, the sender needs to know the LAN address of the router that can pass the packet to the correct receiver in another LAN. Hence, the sender still needs to invoke ARP to obtain the correct router's LAN address.

//5 points

6000 level problem

(a).

Let q= $Np(1-p)^{(N-1)}$,

Then we have

$$E(x)=\sum_{m=0}^{\infty} mq(1-q)^m$$

$$=\frac{1-q}{q}$$

Therefore,

The efficiency: $E = \frac{k}{k+E(x)}$

$$= \frac{k}{k + \frac{1-q}{q}}$$

$$= \frac{kq}{kq + 1 - q}$$

Where q= $Np(1-p)^{N-1}$

//20 points

(b). Take the derivative, we have.

$$\frac{\partial E}{\partial p} = \frac{\partial E}{\partial q} \cdot \frac{\partial q}{\partial p}$$

Let $\frac{\partial E}{\partial p} = 0$

We have p=1/N.

//10 points

(c) When p=1/N and N approaches infinity, $q = 1/e$

Therefore,

E= $\frac{k}{(k-1)+e}$

//10 points

(d) When the frame length becomes large, k is approaching infinity,

Therefore,

$$E = \lim_{k \to \infty} \frac{kq}{kq + 1 - q}$$

$$= \lim_{k \to \infty} \frac{1}{1 + \frac{1-q}{kq}}$$

Since the value of q is not depending on k,

We have E=1.

//10 points.