(20) 1) a) Prove that the excessive degree distribution follows the following equation

$$q_k = \frac{(k+1)p_{k+1}}{\langle k \rangle}$$

where k is a random variable showing a node degree (links), p_k is the probability that the node we are studying has k links and q_k is the probability that the neighbor of the node we are studying has k excessive links (i.e. k+1 links). $\langle k \rangle = E\{k\}$ and is the expected (average) number of links a node in the network has.

b) Briefly explain why a degree-based approximation is better than a fully-mixed model?

c) Briefly explain at least one problem with the degree-based approximation.

(30) 2) Imagine you have been called to give advice as a security expert on a virus outbreak in a network. When you get there, they tell you that according to the rate of infection, $\beta/n = 0.00002$. But some of the nodes die as a result of virus infection. You notice that out of the 100 infected nodes at the time of your arrival, 8 recover in 24 hours (i.e. in 1 unit of time). But in the same 24 hours, 30 new cases of infection are reported in the network.

a) write the fully mixed differential equation for this phenomenon.

b) Can you guess how many susceptible nodes have remained at this stage (based on the differential equation you obtained and the information given above)?

c) Can you say how long does a node that catches virus remains infected?

d) When the infection reaches its climax (i.e. its highest value), how many susceptible nodes will we have in the network?

(30) 3) If you ever work on intrusion detection systems (IDSs), you will have to learn about Support Vector Machine (SVM) classifiers. This problem serves as a tutorial for you to learn how SVM works.

Imagine that you have been given a single instance of good behaviour in 2-dimensional feature space (i.e. (x1,x2)) by { (2,0) } and an instance of bad behaviour in the same space by { (0,0) }. You want to find a linear line to set as the border of good and bad behaviours. Watching Patrick Winston's lecture on SVMs at MIT is highly recommended. The link is:

https://www.youtube.com/watch?v=_PwhiWxHK8o

and the mirror is :

http://www.anslab.org/videos/assignment

We want to make it easy for you. You can follow the same steps in the tutorial to get to Lagrange maximization, and then insert the above points in the equations to find the support

vectors (guard lines) as well as the classifier boundary equation. This specific problem does not require numerical solution. It can be solved manually.

(20) 4- Suppose that in Crowds anonymizing algorithm p_f is probability of forwarding (upon receiving a relay request) and $1 - p_f$ is the probability of sending it to the real destination.

a) what's the average number of forwards? (do not count the final request to the destination)

b) If there are n proxies in the network and c of them are malicious, calculate the probability that none of the malicious nodes find the real destination of a packet (i.e. the probability that none of them be part of the route to the destination). You don't need to write the closed form formula.