Please answer each question with a written response (no code required). Feel free to use whatever software you want for your write-up. However, you should convert it to a `pdf` file for your submission upload.

Question 1: Shared Medium Protocol

Below are 4 nodes that have different bandwidth requirements b on a shared medium:

- **node a:** $b_a = \frac{1}{2}$
- **node b:** $b_b = \frac{1}{4}$
- **node c:** $b_c = \frac{1}{8}$
- **node d:** $b_d = \frac{1}{16}$

Here, b_b being set to $\frac{1}{4}$ means that **node b** wants to send a frame $\frac{1}{4}$ of the time on average. Assume that the nodes agree beforehand on when frames can be sent (similar to slotted ALOHA) so that they would always try to send at the same time. Two or more nodes sending at the same time means a collision (no data gets through). Based on this, please determine the utilization of the shared link (medium) under the following protocols:

(a) **Chaos Protocol**: Each node attempts to transmit a frame whenever one is available. The probability of a frame being available is the same as the bandwidth requirement above (e.g., **node a** sends $\frac{1}{4}$ of the time). For simplicity, assume that collisions do not change the probabilities of node sending rates. What is the utilization of the link?

(b) **Time-Division Multiplexing**: Each node gets to send in one of every four time windows. Use the bandwidth requirements above to determine how frequently a node will send in its time slot. Specifically, assume that **node a** would send each time slot (as $\frac{1}{2}$ is larger than $\frac{1}{4}$) and **node c** would send every 2nd of its reserved time slots (as $\frac{1}{8}$ is $2\times$ smaller than $\frac{1}{4}$). What is the utilization of the link?

Question 2: Local Area Networks

You have been tasked with setting up a new Local Area Network (LAN) that will sit behind a single router. Your network will need to support 200 users with wired Ethernet connections. You need to place a bulk order for a bunch of 40-port switches that you will use to provision the network. Assume that the router can only be connected to a single switch.

(a) Draw out (or explain in text) how you will set up your LAN to support these 200 users.

(b) How many 40-port switches do you need?