**MATH233 Unit 1 Individual Project**

**NAME (Required): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

To communicate most effectively, network administrators attempt to maximize bandwidth and throughput speeds to achieve high data transmission rates within the building’s CAT5e cables. These performance data transfer rates are given in multiples of unit bits per second (bps). In the table below, the school’s IT department estimates the network throughput that is required in the near future. The network manager has asked you to use these data to analyze the current traffic load and the network's overall capacity.

Estimates given in the table below suggest that your network throughput can transfer $y$ Gigabits (Gb) of data in $x$ seconds for each user.

**For each question, be sure to show all your work details for full credit.** **Round all numerical answers to three decimal places.**

1. Research and define the concepts of maximum theoretical throughput, channel capacity, and bandwidth. Next, explain the similarities and differences between CAT5e and CAT6 Ethernet cables. What specific speeds can each of these cables handle? Listing credible cited resources, please answer these below.
2. In the table below, based on the first letter of your last name, please select one number from each of the ranges in the x and y columns.

Table A: Estimates of bit-transmissions and times

|  |  |  |
| --- | --- | --- |
| First Letter of Your LastName |  $x$Seconds | $y$ Gigabits (Gb) |
| A – D | 2 to 3.99 | 2 to 3.99 |
| E – H | 4 to 7.99 | 4 to 7.99 |
| I – L | 8 to 15.99 | 8 to 15.99 |
| M – P | 16 to 31.99 | 16 to 31.99 |
| Q – T | 32 to 63.99 | 32 to 63.99 |
| U – Z | 64 to 79.99 | 64 to 79.99 |

Given that the throughput is the table’s Gigabits per seconds (Gbps), calculate and record this transfer rate for your chosen values with the formula:

$$Throughput=\frac{y Gigabits}{x Seconds}$$

1. Your school’s CAT5e network has a maximum bandwidth of 1 Gbps. Does your answer from above exceed that or not? Based strictly on your value, do you think the maximum bandwidth should be raised? If you think the network needs to be upgraded, will the network infrastructure need to be upgraded to support CAT6 cables? How did you arrive at this conclusion? Include the factors that influenced your decision.

**NOTE: The questions below do not specifically use the calculations in questions #2.**

1. It has been found that the school’s network throughput speed ***R*(*t*)** in Gbps, with respect to time in seconds, is best modeled with the rational function:

$$R\left(t\right)=\frac{2t^{2}+t}{t^{2}+4t}$$

Generate a graph of this function using Excel or another graphing utility. (There are free downloadable programs like [Graph 4.4.2](http://www.padowan.dk/) or [Mathematics 4.0](http://microsoft-mathematics.en.uptodown.com/); or, there are also online utilities such as [this site](https://www.desmos.com/) and many others.) Insert both the function and the graph into the Word document containing your answers and work details. Be sure to label and number the axes appropriately.

### Peak Measured Throughput (PT): Peak or instantaneous throughputs (PT) measure values useful for systems that rely on bursts of data in a CAT5e cable. Unlike continuous streaming, information travels in short bursts. For example, during in-class demonstrations, a computer lab’s user experiences high traffic usage spikes on a very high-bandwidth that are transmitted over a relatively short period of time. Activity is important during these in-use peak times. Peak rates are measured limits taken with respect to throughput as time approaches zero. So for the above function, use algebraic techniques and limit theorems to show the work details for calculating the following limit:

### $$PT=\lim\_{ t\to 0^{+}}R(t)=\lim\_{t\to 0^{+}}\frac{2t^{2}+t}{t^{2}+4t}$$

Based strictly on this result, do you think your school should raise its current network’s bandwidth of 1 Gbps? How did you arrive at this conclusion?

### Maximum Sustained Throughput (ST): One of the most accurate indicators of system performance for high duty cycle networks is the maximum sustained throughput (ST) averaged over a long period of time. This value measures the network capacity fully utilized over its entire existence. Essentially, high volumes of continuously streamed transmissions max out the amounts of data being transferred in because the network is busy processing current data and unable to efficiently enter the cable. This builds up the delivery time causing latency instabilities. In this case, sustained rates are measured limits taken with respect to throughput as time increases towards infinity. So for the above function, use algebraic techniques and limit theorems to show the work details for calculating the following limit:

$$ST=\lim\_{t\to \infty }R\left(t\right)= \lim\_{t\to \infty }\frac{2t^{2}+t}{t^{2}+4t}$$

Based strictly on this result, do you think your school should raise its current network’s bandwidth of 1 Gbps? How did you arrive at this conclusion?

**References**

*Desmos*. (n.d.). Retrieved from https://www.desmos.com/

*Graph 4.4.2*. (n.d.). Retrieved from the Graph Web site: http://www.padowan.dk/

*Mathematics 4.0*. (n.d.). Retrieved from the Microsoft Web site: http://microsoft-mathematics.en.uptodown.com/