5 a) Today ‘s commodity processors have 1 to 32 cores, with some exotic processors boasting 72 cores, and specialized GPUs having 5000+ CUDA cores.

About how many cores/ threads are expected to be in future commodity processors in the next five years?

Ans: Number of Core/Threads are not expected to increase significantly in future commodity processors in the coming years for the following reasons-

1. Operating Systems: The available operating systems in the market for use in PCs are not Capable of handling a greater number of Processors. Most of the algorithms in these operating systems cannot use the added computing resources efficiently.

2. Memory management: Multiple cores offer very high processing speed, but the accessing speed of memory will not match the demand. The added computing resources will be underutilized.

3. Programs: The advantage of more Processors can be had with suitable programs which have parallel structure. But the software programmes are predominantly sequential due to which the advantage of multiple Processors is not utilized.

4. Cost: The cost will increase in proportion to the number of processors in the system, however the performance gain is very less. Multiple cores used in GPU are useful and offers advantage of very good graphics performance

5. Power consumption: Energy consumption also limits number of cores that can be used on a system for protecting it from overheating.

   As the number of cores in the system are limited by above factors, the increase in number of processors depends up on specific application demand other wise significant increase is not expected.

b) Describe what a core and hardware thread is on a modern processor, **and the difference between them?**

Core: A core is a part of CPU which performs tasks according to the received instructions. A processor can have a single core or a multicore. The increase in number of cores betters the performance of the system as they can receive more set of instructions and can process at the same time.

A hardware thread is a physical CPU or a core. If we have a four core CPU system, we can run four hardware threads at the same time.

Performance: A core can process one hardware thread at a time. However, a hardware thread can run multiple software threads. For example, consider a quad-core processor. Here, the four cores can execute four hardware threads whereas the hardware thread can process multiple software threads.

c) Compare GPU and CPU Chips in terms of their strength and weakness. Discuss trade-offs between power efficiency, Programmability and performance.

The CPU is a microprocessor used for executing the instructions given by a program according to the operations.

The GPU is devised to render images in computer games. The CPU emphasis on low-latency while in GPU the importance is given to the high throughputs.

Power efficiency: GPU is more power efficient than CPU because CPU send data through much longer path. When it is needed to make all cores have the same data at a given time, CPU does read from all cores. Which consumes more power. GPU on the other hand, uses its broadcasting ability to clone same data to all cores in a single cycle. Broadcasting ability of GPU consumes less power than CPU as it does not have Broadcasting ability.

Programmability:

The CPU provides more effective results when processing of serial instructions. On the other hand, the GPU process parallel instructions in a more effective way.

Performance:

The GPU can achieve a high-speed comparative to the CPU because of its immense parallel processing.

The CPU requires more memory for processing while comparatively, GPU needs less memory.

A CPU is comprised of a smaller number of powerful cores. In contrast, the GPU is constructed through many weak cores.

In CPU's the priority is given to the low-latency whereas in the GPU, the number of calculations performed in a time interval must be high or as much as possible.

d)Why do we not have processors running at 100GHZ today (as might have been predicted in the year 2000?

Ans: According to Moore's Law, the number of transistors on a chip was to double every 24 months. Processors had to become smaller to accommodate more transistors. It would mean better performance. However, the resultant increase in temperature would require massive cooling. Therefore, the race for speed ended up being the fight against the laws of physics.

In fact, if it was possible to develop a 100 GHz single-core unit, it would be a perfect machine. However, silicon chips can't be clocked up that fast due to the laws of physics.