Answers for the questions below can be found in the *Universal Serial Bus Specification* Revision 2.0 (also known as the "USB standard").   The standard is available in hard-copy via the reserve collection at the Dordt Library.   It is also available for free downloading from the Web.   (A link is given on the Canvas homework page for this course.)

For each question below, provide an answer that is as complete as possible subject to the constraint that it is less than 100 words.

What is an **Isochronous Transfer**?   (Section 5.6)   (4/4 points)

> Certain types of data have moderate timing requirements that are more important than error correction. Examples are audio and video streaming.   It is more important that the data stream be maintained for real-time playback than that the data stream be perfect.   When this type of data is supported with guaranteed bandwidth and guaranteed bounds on latency, but little or no error correction or transmission retries, this is called an isochroous transfer.   USB supports isochroous transfers with guaranteed bounded latency and guaranteed bandwidth.   No transmission retries are permitted in this mode.

What is a **Bulk Transfer**?   (Section 5.8)   (4/4 points)

> A bulk transfer uses bandwidth as it is available to the extent that it is available.   It also supports error detection and transmission retries.   There is no guaranteed bound on latency.   The data will arrive, but when is unpredictable.

How many **microframes** are there in a **frame**?   (Section 8.4.3.1)   (4/4 points)

> A full-speed frame takes 1000 μs.   A high-speed frame microframe takes 125 μs.   Thus there are 8 microframes in a frame.

What is **Bus Enumeration**?   (Section 9.1.2)   (4/4 points)

> Bus enumeration is a process used by the host to configure the ports and the attached devices. Initially all ports are disabled and all devices respond only to address 0.   The host enables a port and uses address 0 to find out what type of device (if any) is attached.   It then assigns a non-zero address to the device and configures it.   Then it enables another port, etc. until all ports have been processed.

What is **Dynamic Attachment and Removal**?   (Section 9.2.1)   (4/4 points)

> USB is designed to support the attachment and removal of devices while the host is in operation and without rebooting or requiring any other specific action of the user, other than plugging and unplugging devices.   When a device is plugged in the hub reports this to the host, which then resets the device, queries it to find its capabilities, and configures the device as needed.   If a device is unplugged, the hub disables that port and reports this to the host.   The host must then respond accordingly.