**Topic 2C: Install and Configure System Memory Notes:**

**System RAM:** Volatile memory. Speed measured in GB. When a program is executed, it is first loaded into the System RAM.

**Virtual Memory:** Helps when physical RAM is insufficient. But slower than RAM. It is the combination of swap space and RAM.

**Pages:** Pages are small fixed-size chunks of memory used by OS to manage and organize virtual memory. Typically, of 4KB size and can vary according to the system architecture. When RAM gets full, inactive or less frequently used pages are moved to **swap space** on the disk.

**Swap Space:** Disk area (like SSDs or HDDs) used to extend the RAM.

**Address Space:** total amount of memory locations that CPU can work with. Depends on two factors: **address bus width** and **data bus width.** 32-bit address bus can track 4GB of memory whereas 64-bit can address upto 16 exabytes. 64-bit CPU often uses 48-bit address bus which can address upto 256TB of memory.

**RAM Types:** Modern computer uses **DDR SDRAM**.

**DRAM:** Stores data using tiny electrical charges in capacitor (1 for charged and 0 for no charge). Read and write is done through **transistors.** Since DRAM lose electrical charges over time, constant **charge refresh** is required. It is not required in SRAM.

**SDRAM:** Synchronizes with system clock for better performance. Means CPU knows exactly how much time it will take to read or write data. If CPU knows exactly the time, it is not required to wait until that job is done.

**DDR SDRAM:** Transfers data **twice** per clock cycle that doubles the speed.

**Max capacity:** DDR3 => **8GB**, DDR4=> **32GB**, DDR5=**128GB**

**Memory Modules:** A slot or circuit board that holds the RAM in the motherboard. In PC, we call is **Dual Inline Memory Module (DIMM)** slots. In laptops we call it **SODIMM** (Small Outline DIMMs).

**Multi-Channel System Memory:** **Dual-channel memory** that can use two 64-bits paths, doubling the speed to **128bits** per cycle.

**Error Correcting Code (ECC) RAM:** It is a special type of memory used in **servers** and **workstations** where reliability is critical. It calculates special code (**checksums**) for each piece of data and stores it alongside the data. It can fix **single** bit errors but for **multi-bit** errors (such as 2, 3, or 4bits), it will stop the system and shows an error message. It uses 72-bit bus, 64bit for data and extra 8bit for extra checksum data.

**Types of ECC RAM:** **RDIMM** => includes extra hardware to reduce electrical load on the memory controller. Slightly slower than regular RAM because of additional processing. **UDIMM**=>Common in consumer PCs and does not include ECC in most cases.

**RDIMM** and **EDIMM** cannot be mixed. That means you cannot use **RDIMM** in the **EDIMM** slots.