



UTM
UNIVERSITI TEKNOLOGI MALAYSIA

**SECR1033-01: COMPUTER ORGANIZATION
& ARCHITECTURE
SEMESTER 2 2023/2024**

**GROUP PROJECT
(Benchmarking of Computer Performance)**

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- CPU-Z : <https://youtu.be/DSIQOzu0Ii0>
GeekBench : <https://youtu.be/AXq53vSJmPY>
MiniTool Partition Wizard : <https://youtu.be/x5g1iffmHOs>
Task Manager : <https://youtu.be/BpxG0sfvdRY>
ASM Coding Explanation : <https://youtu.be/0keUp5RwgmA>
Final Presentation Video : <https://youtu.be/ODPPbS4G5Vw>
Submitted date : 15 July 2024

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1.0 Introduction

1.1 Research and basics of CPU benchmarking

In the world of computing, the central processing unit (CPU) is a critical component that influences overall system performance. Therefore, evaluating the capabilities and efficiency of CPUs is essential for users to optimize their hardware for various tasks, such as gaming and performing complex computational work.

CPU benchmarking is a crucial process used to assess the performance of the CPU of a computer. This involves running standardized tests and applications to measure how well a CPU performs under different conditions. The primary goals of CPU benchmarking are to evaluate performance, facilitate comparisons, and identify potential bottlenecks for optimization.

Key metrics in benchmarking include clock speed, core and thread count, instructions per cycle (IPC), and cache size. The benchmarking process involves preparing the system, running benchmarks, and analyzing results, while considering factors such as hardware configuration, software environment, and cooling solutions.

1.2 Aim

The purpose of this project is to compare the CPU benchmarking of three different computers using three different benchmarking tools. We also run a simple Assembly programme on three different computers and use functions to calculate the difference in CPU running time between them.

1.3 Objectives

- Learn the fundamental concepts behind benchmarking including different types of benchmarks
- Use selected benchmarking tools to measure and compare the performance of CPUs from different computers
- Run assembly programme using three different computers to examine it's efficiency

1.4 Scopes

The computers we used to do the benchmarking step are Asus Vivobook(1), Asus Vivobook(2) ,Victus by HP Laptop 16-d0xxx and HP Laptop 15-fd0xxx.

Specifications	Computer Type			
	Asus Vivobook(1)	Asus Vivobook(2)	HP Victus by HP laptop 16-d0xxx	HP Laptop 15-fd0xxx
Processor Type	Intel Core i5 1135G7	Intel Core i5 8250U	Intel Core i7 11800H	Intel Core i5-1335U
RAM Size	8 GBytes	12 GBytes	8 Gbytes	12 GBytes
Cache Type	L1 x 4 L2 x 4 L3 x 1	L1 x 4 L2 x 4 L3 x 1	L1 x 8 L2 x 8 L3 x 1	L1 x 6 L2 x 1 L3 x1
Memory Type	DDR4	DDR4	DDR4	DDR4
Motherboard	ASUSTeK COMPUTER INC.X513EAN	ASUSTeK COMPUTER INC.X542UF	HP 88F9	HP 8BB6
Single-Core Score	1781	1236	1249	1822
Multi-Core Score	4354	3803	4298	7195

In this project, we use CPU-Z, GeekBench, Task Manager and MiniTool Partition Wizard to benchmark the computers.

1. CPU-Z

CPU-Z is a well-known utility software that offers detailed information about the hardware components of a computer system. It is primarily used to gather information

about the CPU (Central Processing Unit), but it also provides information regarding other system components like:

- Processor name and number, codename, process, package, cache levels.
- Mainboard and chipset.
- Memory type, size, timings, and module specifications (SPD).
- Real-time frequency measurement of each core's internal frequency, memory frequency.
- CPU-Z is fully supported on Windows® 11.
- Its type of Benchmark is synthetic which helps to measure CPU performance using artificial workloads.

2. Geekbench

GeekBench is a cross-platform benchmarking tool that measures the performance of CPUs and GPUs using a combination of synthetic and real-world tests. It is intended to offer a thorough and accurate performance score. It consists of:

- Integer, floating-point, and memory performance tests.
- Assessing both single-core and multi-core performance.
- Real-world scenarios such as image processing and machine learning tasks.
- Cross-platform comparisons to measure performance across different devices (Windows, macOS, iOS, and Android.)

3. Task Manager

Task Manager is a built-in Windows utility that monitors the performance and activity of system components in real-time. It comprises:

- Detailed statistics on CPU, memory, disk, network usage and GPU.
- Information on running processes and applications.
- Real-time performance graphs and historical data.
- Tools to manage startup programs and system services.
- Fully integrated with Windows operating systems, including Windows® 11.
- It tracks system performance during typical user workloads.

4. MiniTool Partition Wizard

MiniTool Partition Wizard is a disk management utility that includes various features for managing disk partitions and measuring storage device performance. It offers:

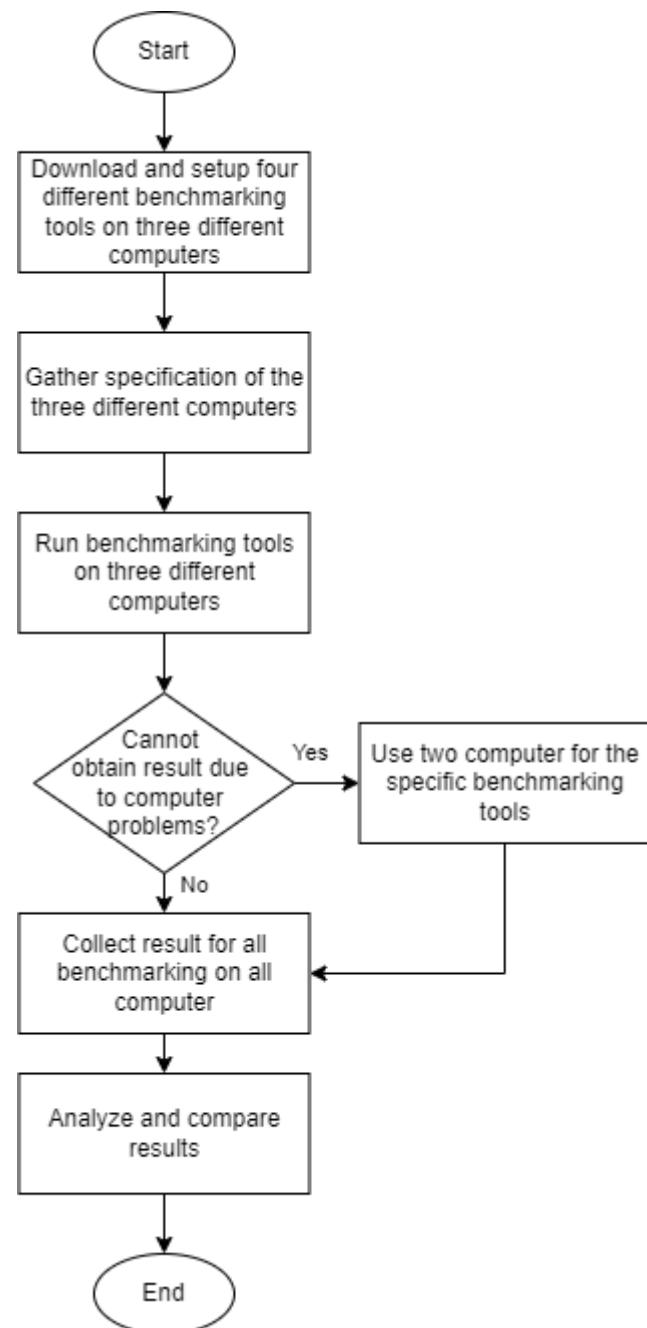
- Tasks such as creating, resizing, deleting partitions, converting disk types, and recovering lost partitions.
- Disk copying, SSD alignment, file system integrity checks.
- Optimization of disk space, management of startup programs and services.
- Measuring storage device read and write speeds.
- It is an application benchmark that measures storage performance using actual disk operations.

2.0 Part 1

2.1 Overview

In this project, benchmarking tools will be used to test three computer performance, which are HP Victus by HP Laptop 16-d0xxx, HP Laptop 15-fd0xxx, Asus Vivobook (1) and Asus Vivobook (2). By collecting data results from benchmarking, the data will be compared and analyzed between three of the CPUs.

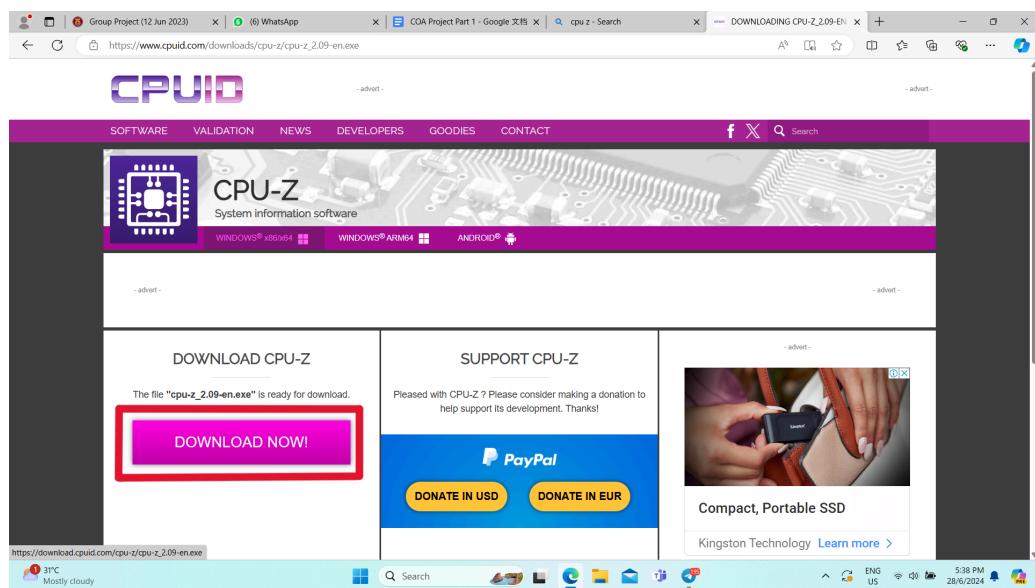
2.2 Flowchart



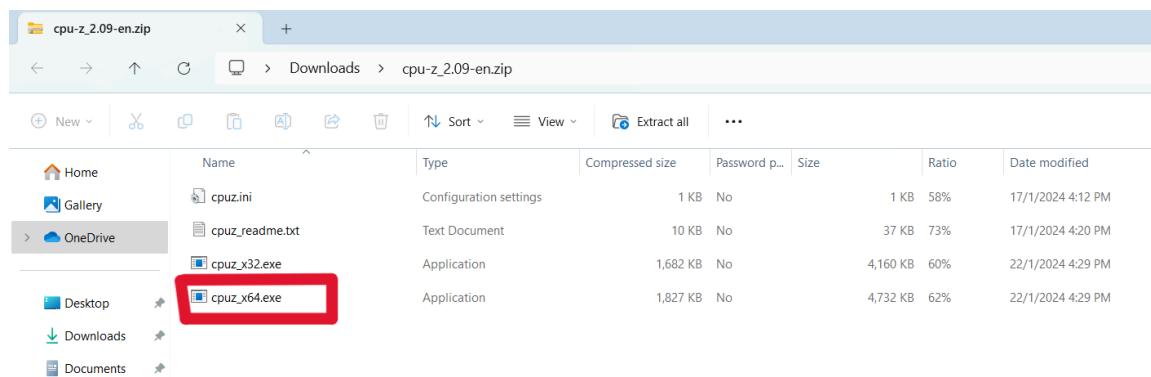
2.3 Setup & Installation

CPU-Z

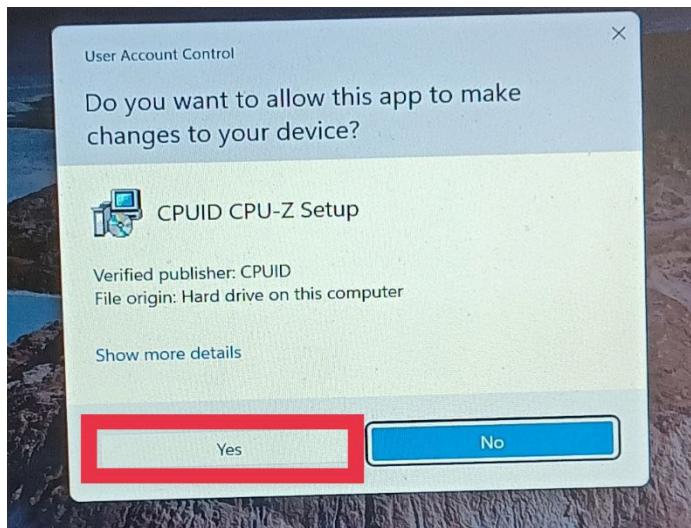
Step 1: Click on “DOWNLOAD NOW!”



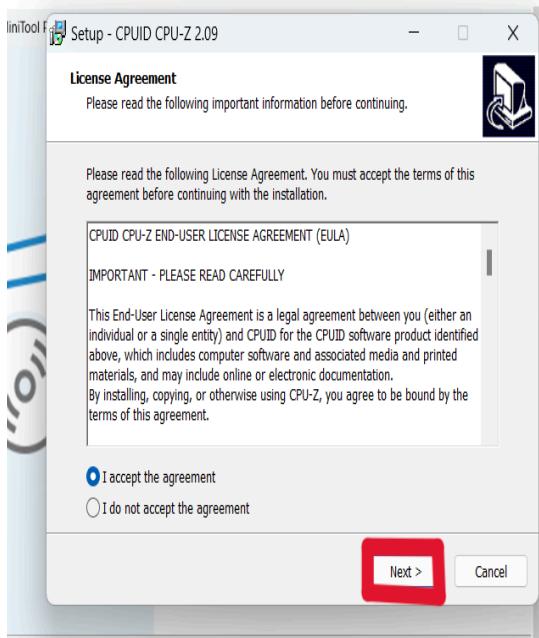
Step 2: After finish downloading, open the file and click on “cpuz_x64.exe”



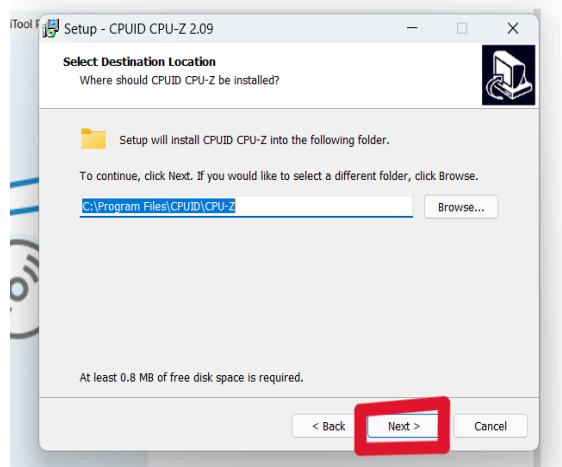
Step 3: Press “Yes” to allow CPU-Z to make changes to the device



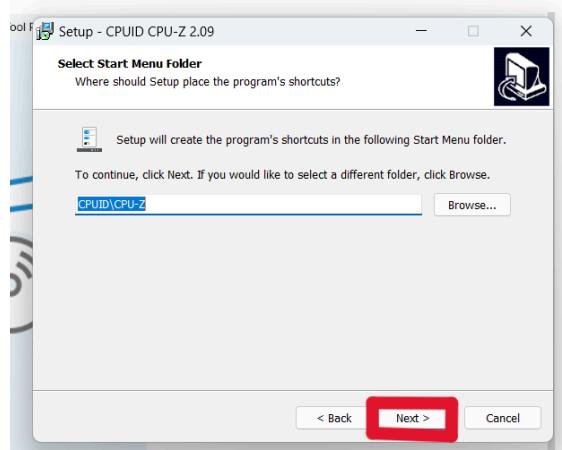
Step 4: Accept the agreement and click on the “Next” button



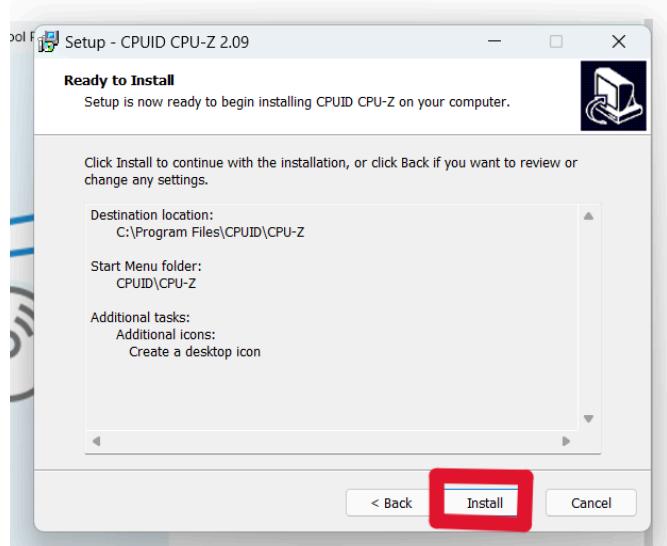
Step 5: Select Destination Location and click on the “Next” button



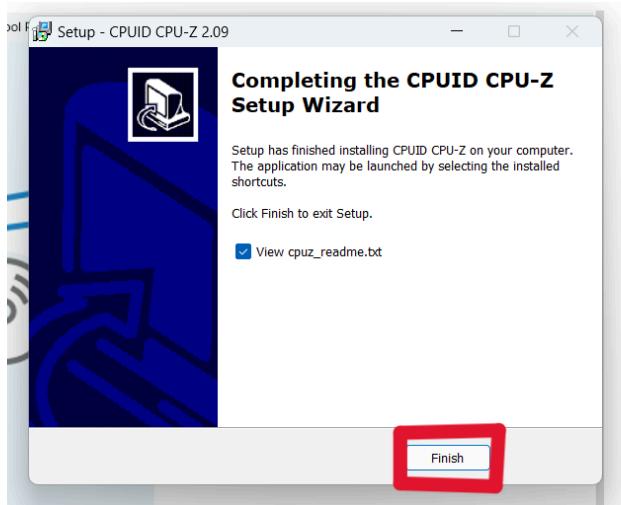
Step 6: Select Start Menu Folder and click on the “Next” button



Step 7: Click on the “Install” button



Step 8: Click on the “Finish” button and the setup is done

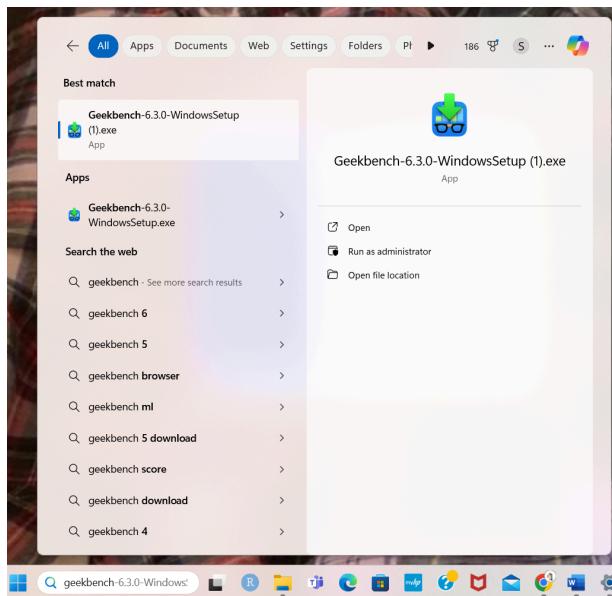


Geekbench

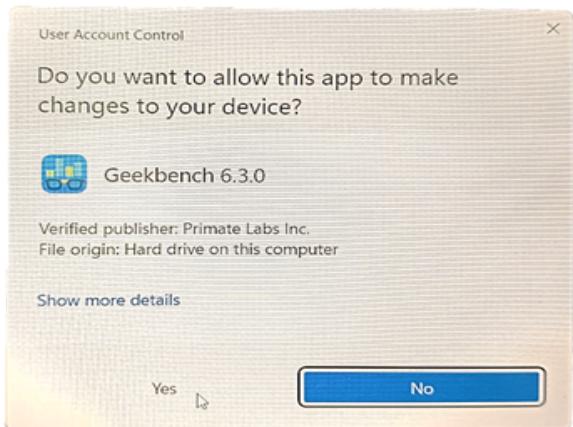
Step 1: Click the “Download for Windows” button

A screenshot of the Geekbench 6 download page. The top navigation bar includes links for Home, Browser, Store, Blog, and Support. The main heading is "Download Geekbench 6". Below this, there are three download options: "macOS" (with a blue circular icon), "Windows" (with the Windows logo), and "Linux" (with the Linux logo). Each option has a green "Download for [platform]" button. Under each button, there are "System Requirements" and "Processor Requirements" sections. For macOS, requirements are macOS 11 or later and 4GB of RAM. For Windows, requirements are Windows 10 (64-bit) or later and 4GB of RAM. For Linux, requirements are Ubuntu 18.04 LTS (64-bit) or later and 2GB of RAM.

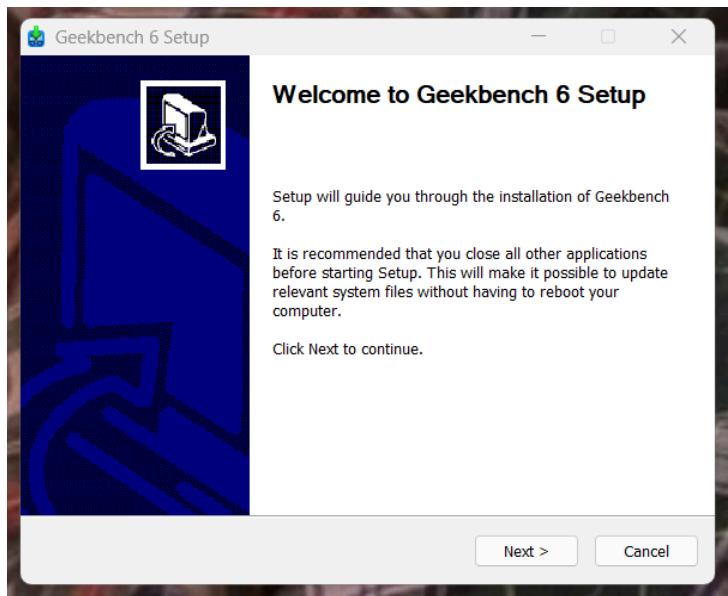
Step 2: After finished downloading, search and click to open GeekBench 6



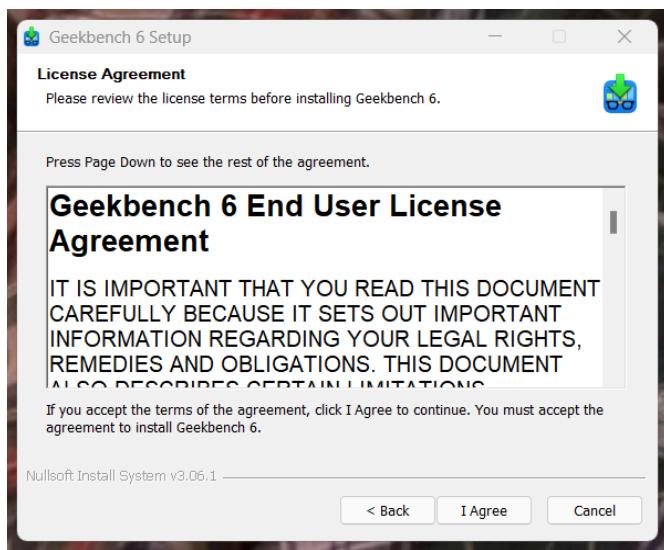
Step 3: Click the “Yes” button to allow Geekbench 6.3.0 to make changes to the device



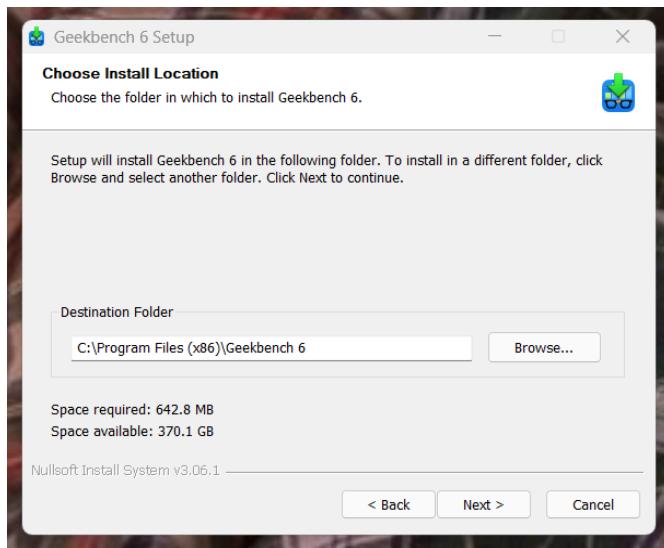
Step 4: Click “Next >” button to further the installation



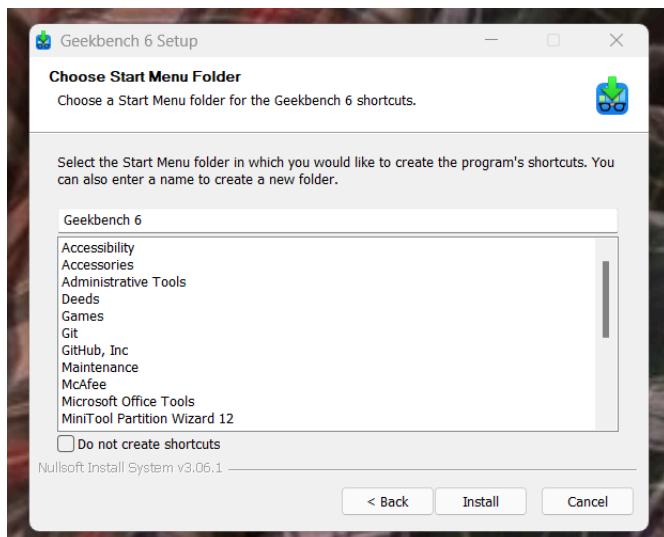
Step 5: Click the “ I Agree” button to move to the next step



Step 6: Choose the Destination Location and click the “Next >” button



Step 7: Choose Start Menu and click the “Install” button

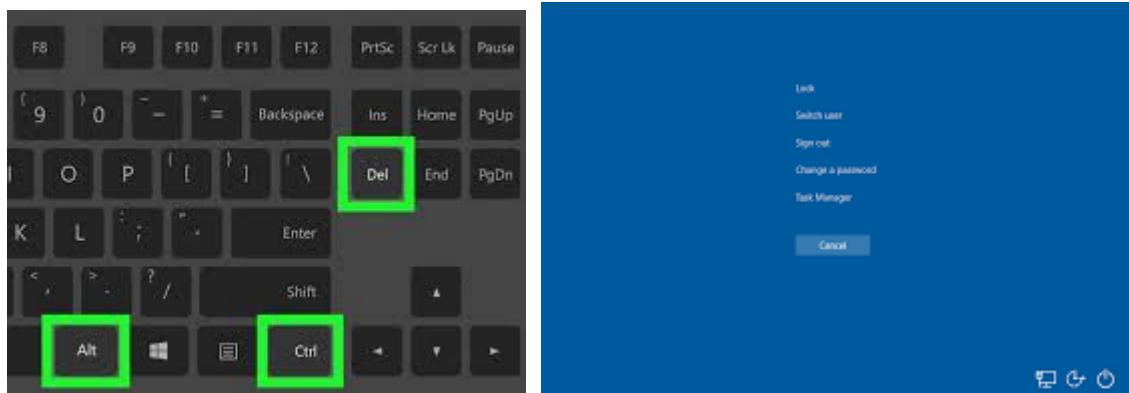


Task Manager

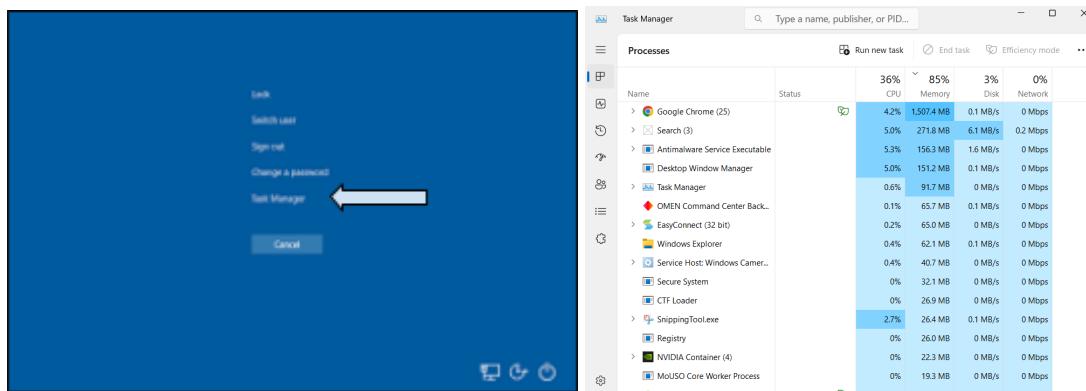
Task manager basically is a system tool that is used to access the information for the process and performances of the computer, for us to identify the machine's overall performance. Thus, we do not need to install any application to run Task Manager. It can be used through steps below:

Step 1: Open computer

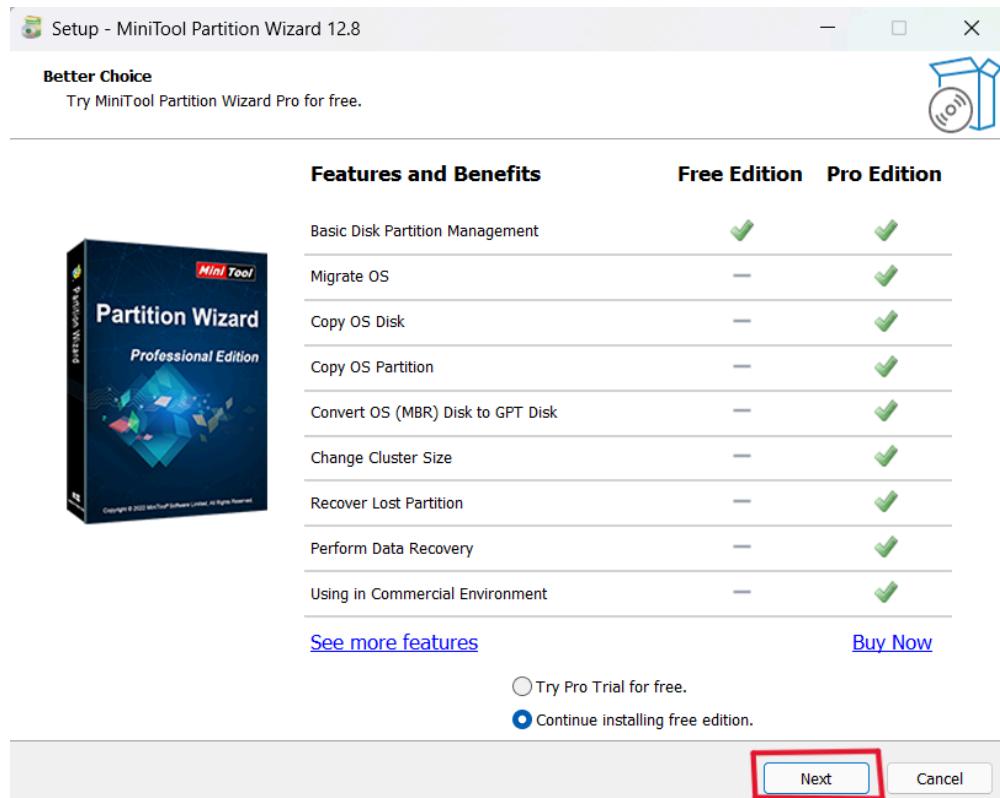
Step 2: Press “Ctrl + Alt + Delete” together on the keyboard. You will see a few options.



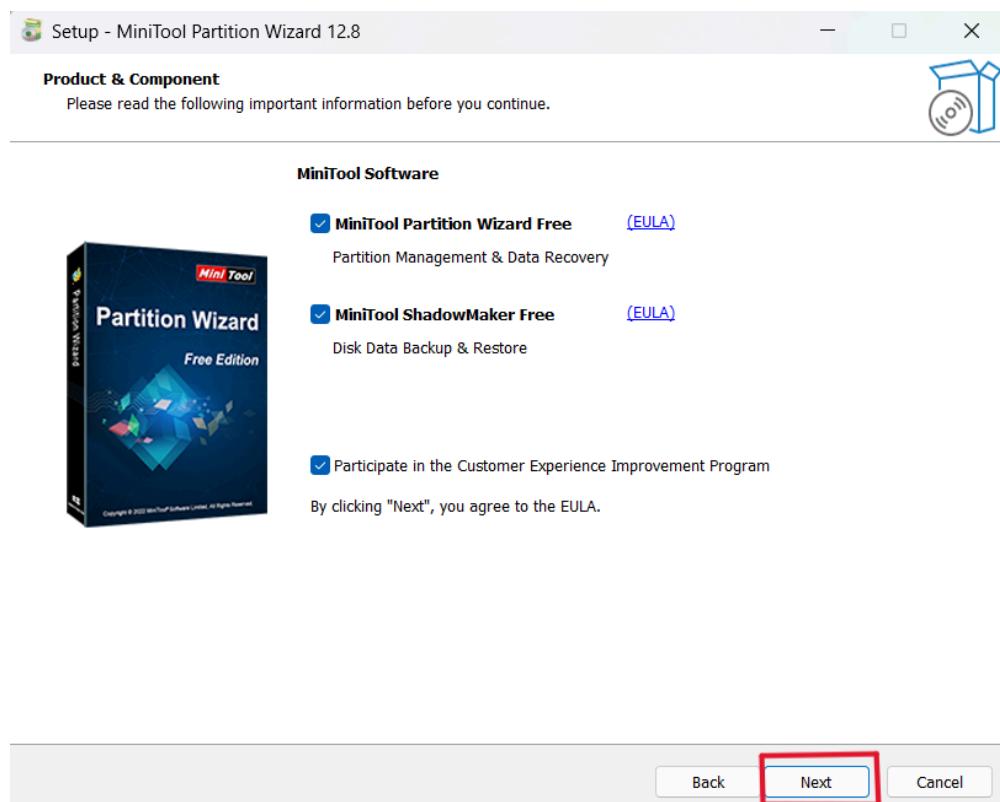
Step 3: Click on Task Manager and the Task Manager is open now.



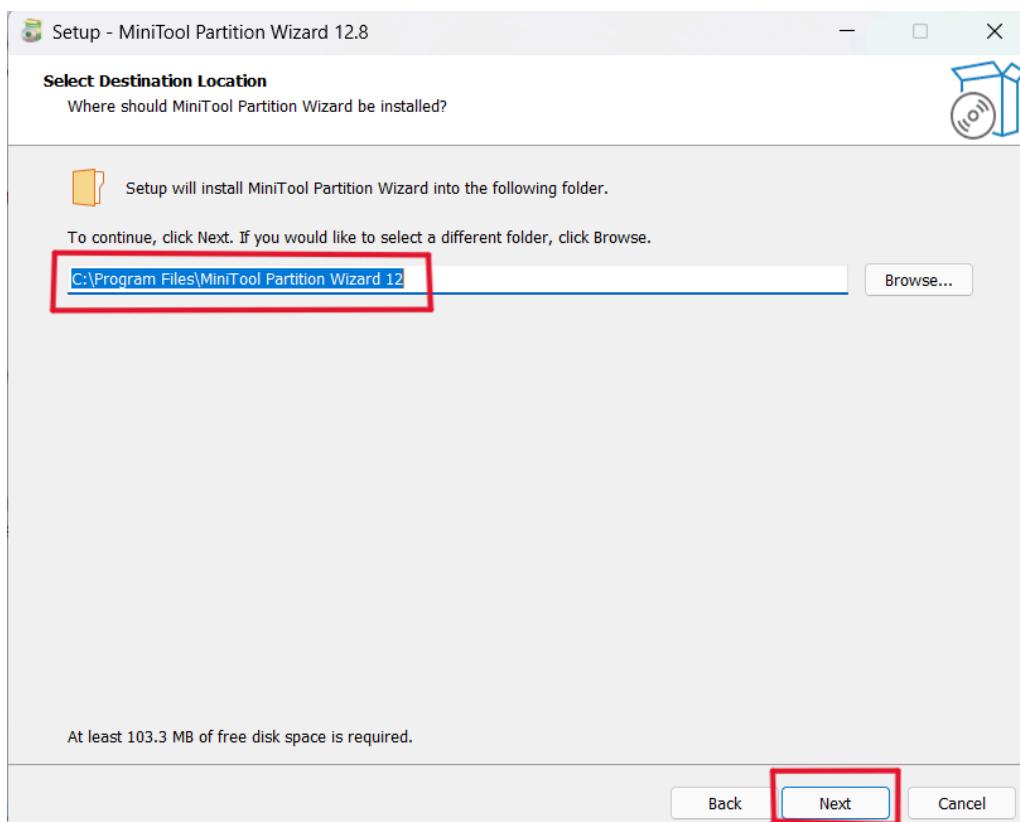
MiniTool Partition Wizard



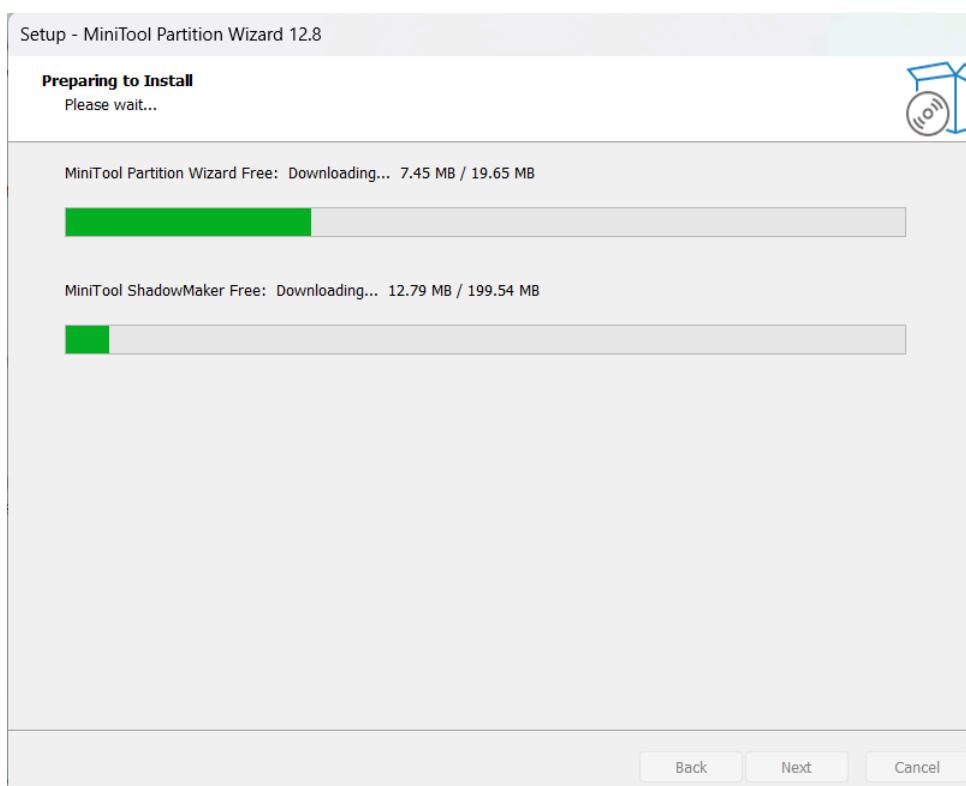
Step 1 : Press NEXT button to continue



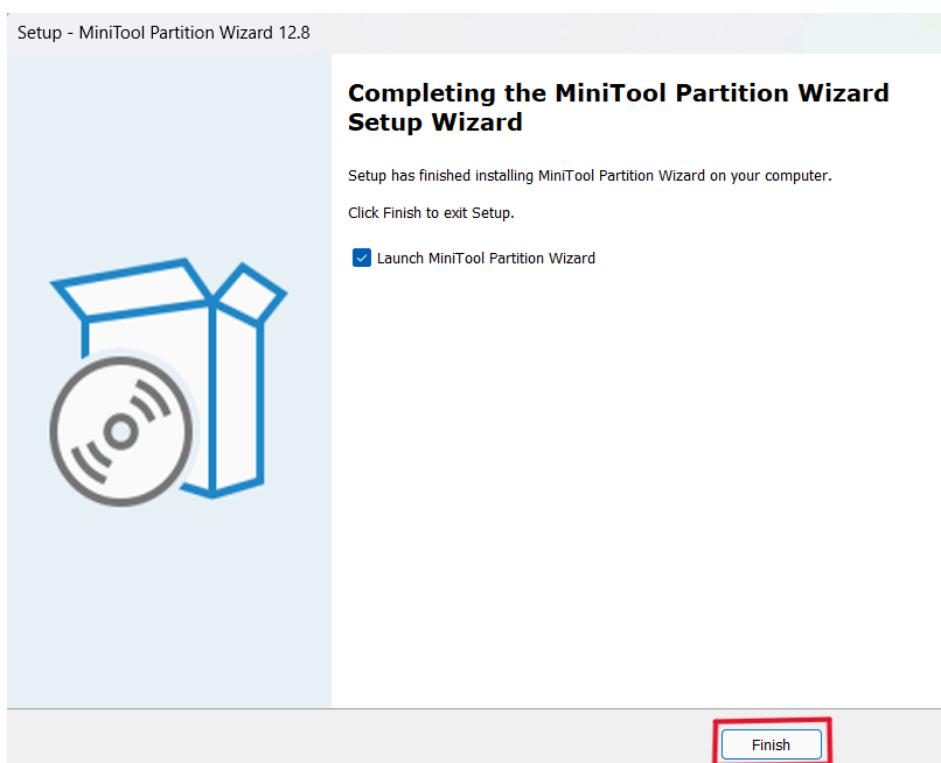
Step 2 : Press NEXT button to continue



Step 3 : Check the location to install the MiniTool Partition Wizard and press NEXT to continue



Step 4 : Wait for the downloading process. When done, press NEXT to continue



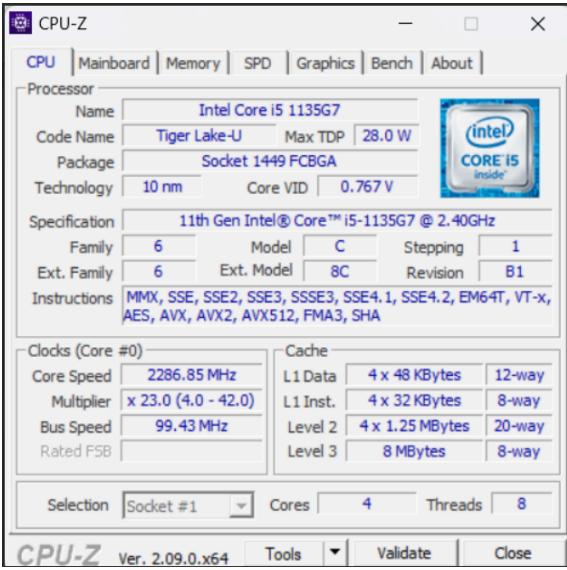
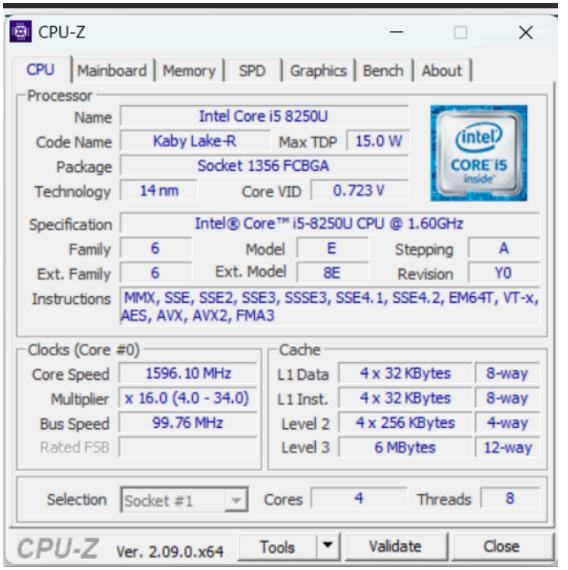
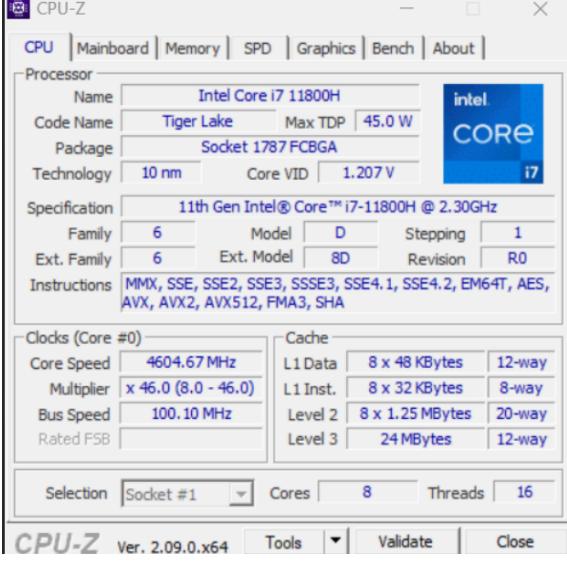
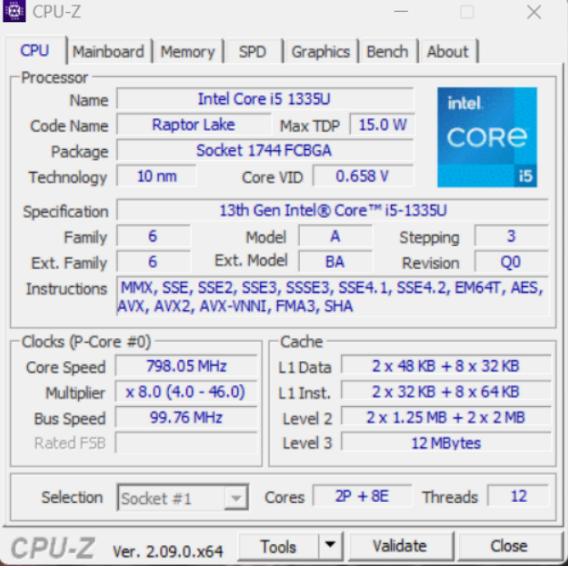
Step 5 : Press FINISH to finish the setup process.

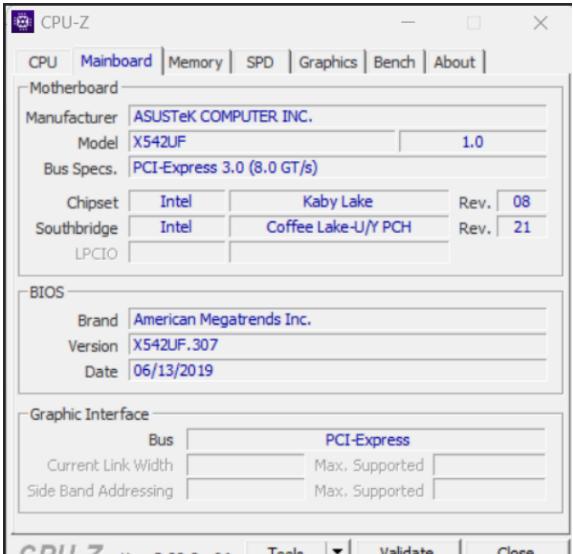
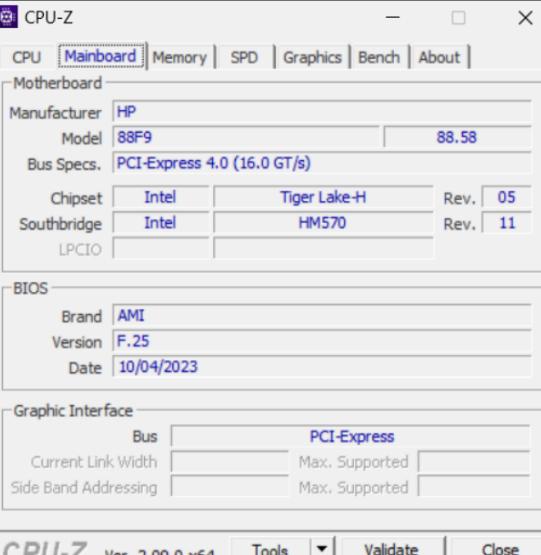
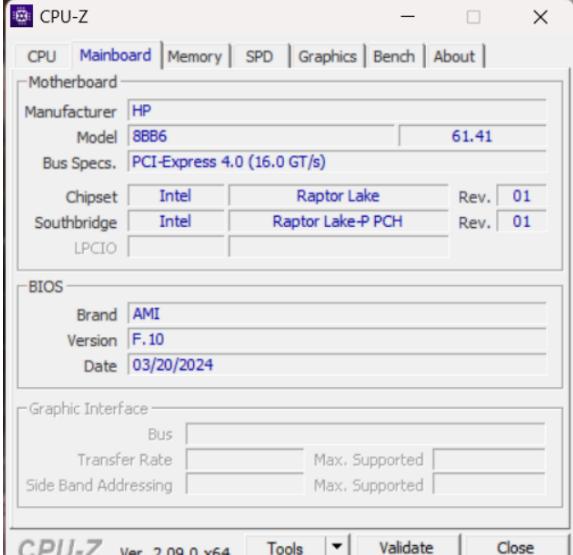
2.4 Benchmarking result

CPU-Z

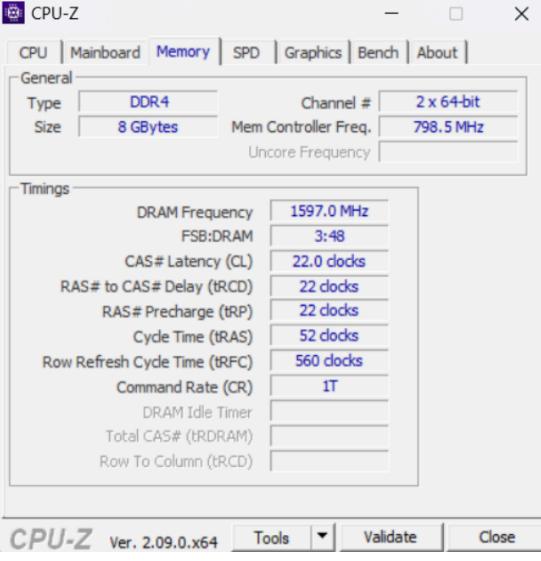
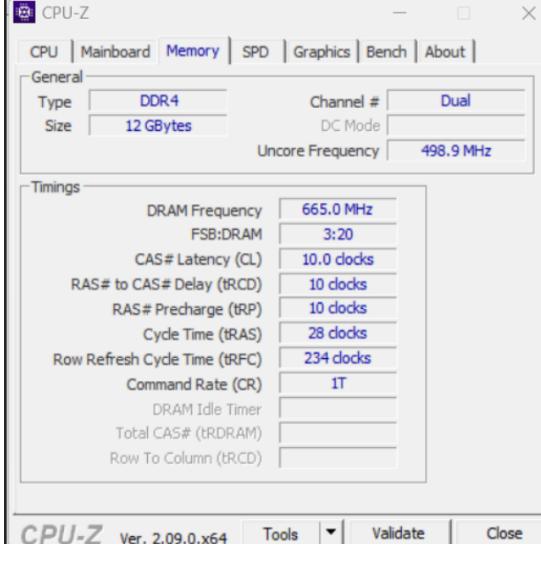
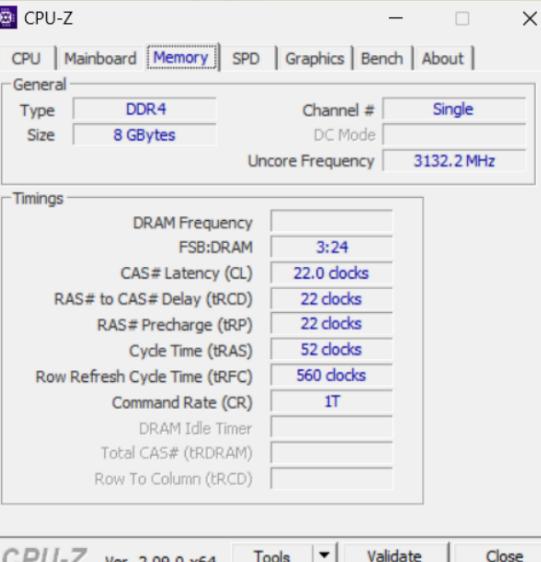
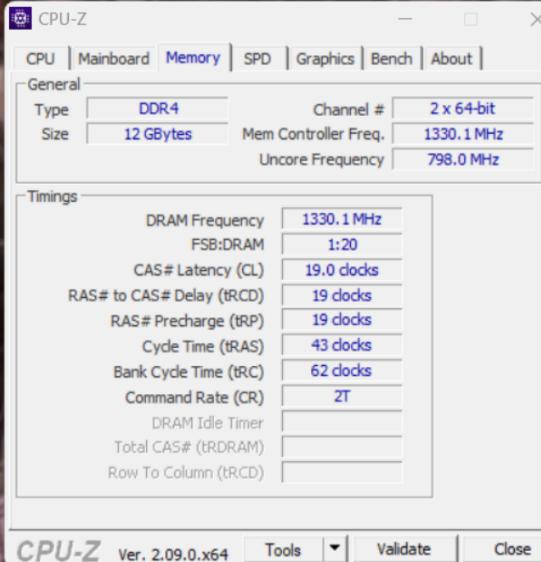
Benchmark	Computer Type			
	Asus VivoBook (1)	Asus VivoBook (2)	Victus by HP Laptop 16	HP Laptop 15
Core Speed	2286.85 MHz	1596.10 MHz	4604.67 MHz	798.05 MHz
Bus Speed	99.43 MHz	99.76 MHz	100.10 MHz	99.76 MHz
RAM Size	8 GB	12 GB	8 GB	12 GB
L1 Data Cache	192 KB	128 KB	384 KB	352 KB
L1 Instruction Cache	128 KB	128 KB	256 KB	576 KB
L2 Cache	5 MB	1 MB	10 MB	6.5 MB
L3 Cache	8 MB	6 MB	24 MB	12 MB
Total Cache Size	10.361 MB	7.25 MB	34.625 MB	19.406 MB
Chipset Revision	Revision 1	Revision 8	Revision 5	Revision 1

CPU

Asus VivoBook (1)	Asus VivoBook (2)																																																																																										
 <p>CPU-Z Ver. 2.09.0.x64 Tools Validate Close</p> <p>Processor</p> <table border="1"> <tr><td>Name</td><td>Intel Core i5 1135G7</td></tr> <tr><td>Code Name</td><td>Tiger Lake-U</td></tr> <tr><td>Package</td><td>Socket 1449 FCBGA</td></tr> <tr><td>Technology</td><td>10 nm</td></tr> <tr><td>Core VID</td><td>0.767 V</td></tr> <tr><td>Max TDP</td><td>28.0 W</td></tr> </table> <p>Specification</p> <table border="1"> <tr><td>Family</td><td>6</td></tr> <tr><td>Model</td><td>C</td></tr> <tr><td>Stepping</td><td>1</td></tr> <tr><td>Ext. Family</td><td>6</td></tr> <tr><td>Ext. Model</td><td>8C</td></tr> <tr><td>Revision</td><td>B1</td></tr> </table> <p>Instructions</p> <table border="1"> <tr><td>MMX, SSE, SSE2, SSE3, SSSE3, SSE4.1, SSE4.2, EM64T, VT-x, AES, AVX, AVX2, AVX512, FMA3, SHA</td></tr> </table> <p>Clocks (Core #0)</p> <table border="1"> <tr><td>Core Speed</td><td>2286.85 MHz</td></tr> <tr><td>Multiplier</td><td>x 23.0 (4.0 - 42.0)</td></tr> <tr><td>Bus Speed</td><td>99.43 MHz</td></tr> <tr><td>Rated FSB</td><td></td></tr> </table> <p>Cache</p> <table border="1"> <tr><td>L1 Data</td><td>4 x 48 KBytes</td><td>12-way</td></tr> <tr><td>L1 Inst.</td><td>4 x 32 KBytes</td><td>8-way</td></tr> <tr><td>Level 2</td><td>4 x 1.25 MBytes</td><td>20-way</td></tr> <tr><td>Level 3</td><td>8 MBytes</td><td>8-way</td></tr> </table> <p>Selection Socket #1 Cores 4 Threads 8</p>	Name	Intel Core i5 1135G7	Code Name	Tiger Lake-U	Package	Socket 1449 FCBGA	Technology	10 nm	Core VID	0.767 V	Max TDP	28.0 W	Family	6	Model	C	Stepping	1	Ext. Family	6	Ext. Model	8C	Revision	B1	MMX, SSE, SSE2, SSE3, SSSE3, SSE4.1, SSE4.2, EM64T, VT-x, AES, AVX, AVX2, AVX512, FMA3, SHA	Core Speed	2286.85 MHz	Multiplier	x 23.0 (4.0 - 42.0)	Bus Speed	99.43 MHz	Rated FSB		L1 Data	4 x 48 KBytes	12-way	L1 Inst.	4 x 32 KBytes	8-way	Level 2	4 x 1.25 MBytes	20-way	Level 3	8 MBytes	8-way	 <p>CPU-Z Ver. 2.09.0.x64 Tools Validate Close</p> <p>Processor</p> <table border="1"> <tr><td>Name</td><td>Intel Core i5 8250U</td></tr> <tr><td>Code Name</td><td>Kaby Lake-R</td></tr> <tr><td>Package</td><td>Socket 1356 FCBGA</td></tr> <tr><td>Technology</td><td>14 nm</td></tr> <tr><td>Core VID</td><td>0.723 V</td></tr> <tr><td>Max TDP</td><td>15.0 W</td></tr> </table> <p>Specification</p> <table border="1"> <tr><td>Family</td><td>6</td></tr> <tr><td>Model</td><td>E</td></tr> <tr><td>Stepping</td><td>A</td></tr> <tr><td>Ext. Family</td><td>6</td></tr> <tr><td>Ext. Model</td><td>8E</td></tr> <tr><td>Revision</td><td>Y0</td></tr> </table> <p>Instructions</p> <table border="1"> <tr><td>MMX, SSE, SSE2, SSE3, SSSE3, SSE4.1, SSE4.2, EM64T, VT-x, AES, AVX, AVX2, FMA3</td></tr> </table> <p>Clocks (Core #0)</p> <table border="1"> <tr><td>Core Speed</td><td>1596.10 MHz</td></tr> <tr><td>Multiplier</td><td>x 16.0 (4.0 - 34.0)</td></tr> <tr><td>Bus Speed</td><td>99.76 MHz</td></tr> <tr><td>Rated FSB</td><td></td></tr> </table> <p>Cache</p> <table border="1"> <tr><td>L1 Data</td><td>4 x 32 KBytes</td><td>8-way</td></tr> <tr><td>L1 Inst.</td><td>4 x 32 KBytes</td><td>8-way</td></tr> <tr><td>Level 2</td><td>4 x 256 KBytes</td><td>4-way</td></tr> <tr><td>Level 3</td><td>6 MBytes</td><td>12-way</td></tr> </table> <p>Selection Socket #1 Cores 4 Threads 8</p>	Name	Intel Core i5 8250U	Code Name	Kaby Lake-R	Package	Socket 1356 FCBGA	Technology	14 nm	Core VID	0.723 V	Max TDP	15.0 W	Family	6	Model	E	Stepping	A	Ext. Family	6	Ext. Model	8E	Revision	Y0	MMX, SSE, SSE2, SSE3, SSSE3, SSE4.1, SSE4.2, EM64T, VT-x, AES, AVX, AVX2, FMA3	Core Speed	1596.10 MHz	Multiplier	x 16.0 (4.0 - 34.0)	Bus Speed	99.76 MHz	Rated FSB		L1 Data	4 x 32 KBytes	8-way	L1 Inst.	4 x 32 KBytes	8-way	Level 2	4 x 256 KBytes	4-way	Level 3	6 MBytes	12-way
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Geekbench

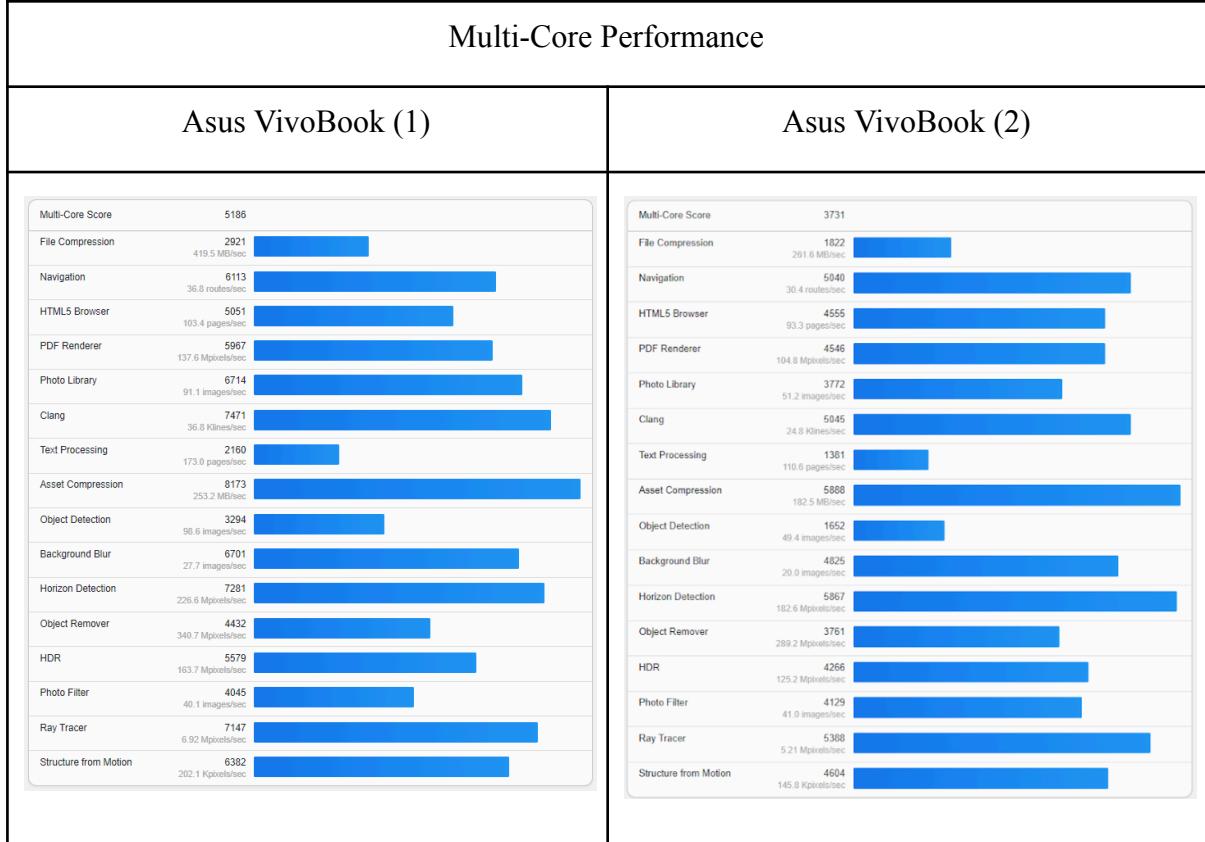
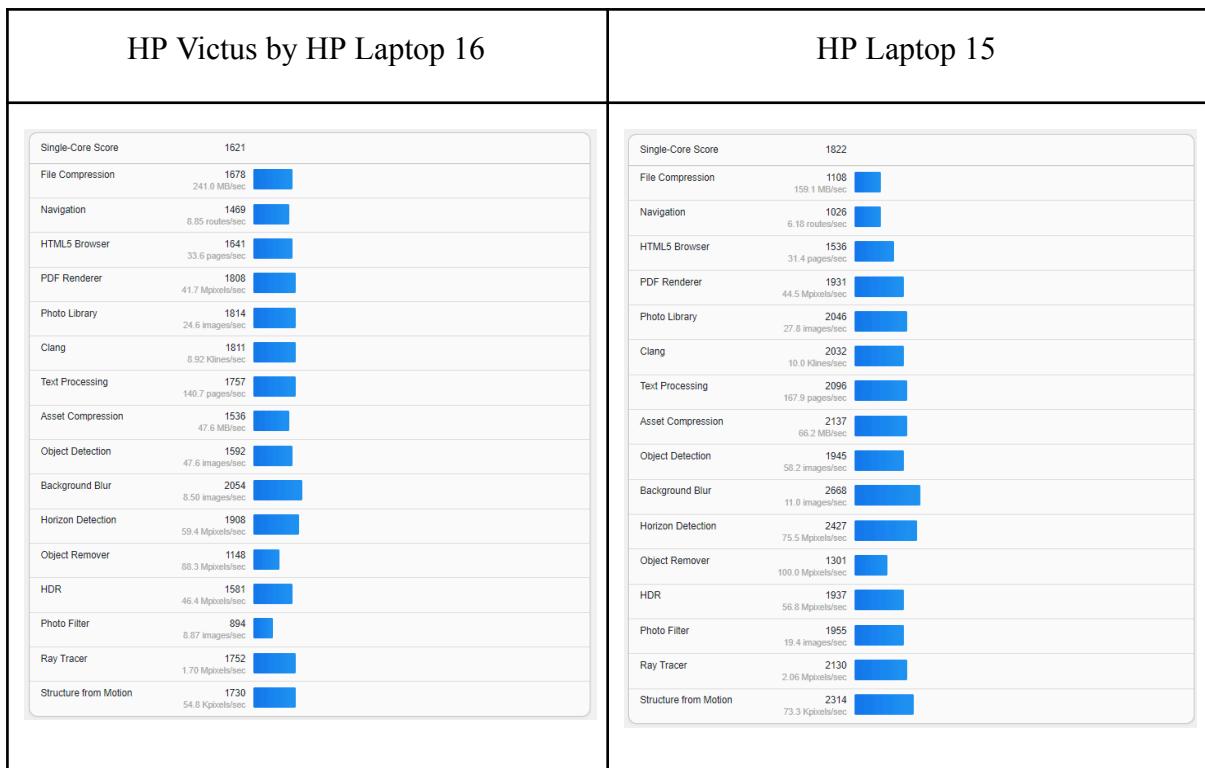
Benchmark	Computer Type			
	Asus VivoBook (1)	Asus VivoBook (2)	Victus by HP Laptop 16	HP Laptop 15
CPU				
Name	Intel Core i5-1135G7	Intel Core i5-8250U	Intel Core-i7-11800H	Intel Core i5-1335U
Topology	1 Processor, 4 Cores, 8 Threads	1 Processor, 4 Cores, 8 Threads	1 Processor, 8 Cores, 16 Threads	1 Processor, 10 Cores, 12 Threads
Base Frequency	2.39 GHz	1.80 GHz	2.30 GHz	1.30 GHz
Maximum Frequency	4186 MHz	3392 MHz	4588 MHz	4588 MHz
Single-core Score	1697	1228	1621	1822
Multi-core Score	5186	3731	4963	7195
Codename	Tiger Lake-U	Kaby Lake-R	Tiger Lake	Raptor Lake
L1 Instruction Cache	32.0 KB x 4	32.0 KB x 4	32.0 KB x 8	64.0 KB x 6
L2 Data Cache	48.0 KB x 4	32.0 KB x 4	48.0 KB x 8	32.0 KB x 6
L2 Cache	1.25 MB x 4	256 KB x 4	1.25 MB x 8	2.00 MB x 1
L3 Cache	8.00 MB x 1	6.00 MB x 1	24.0 MB x 1	12.0 MB x 1

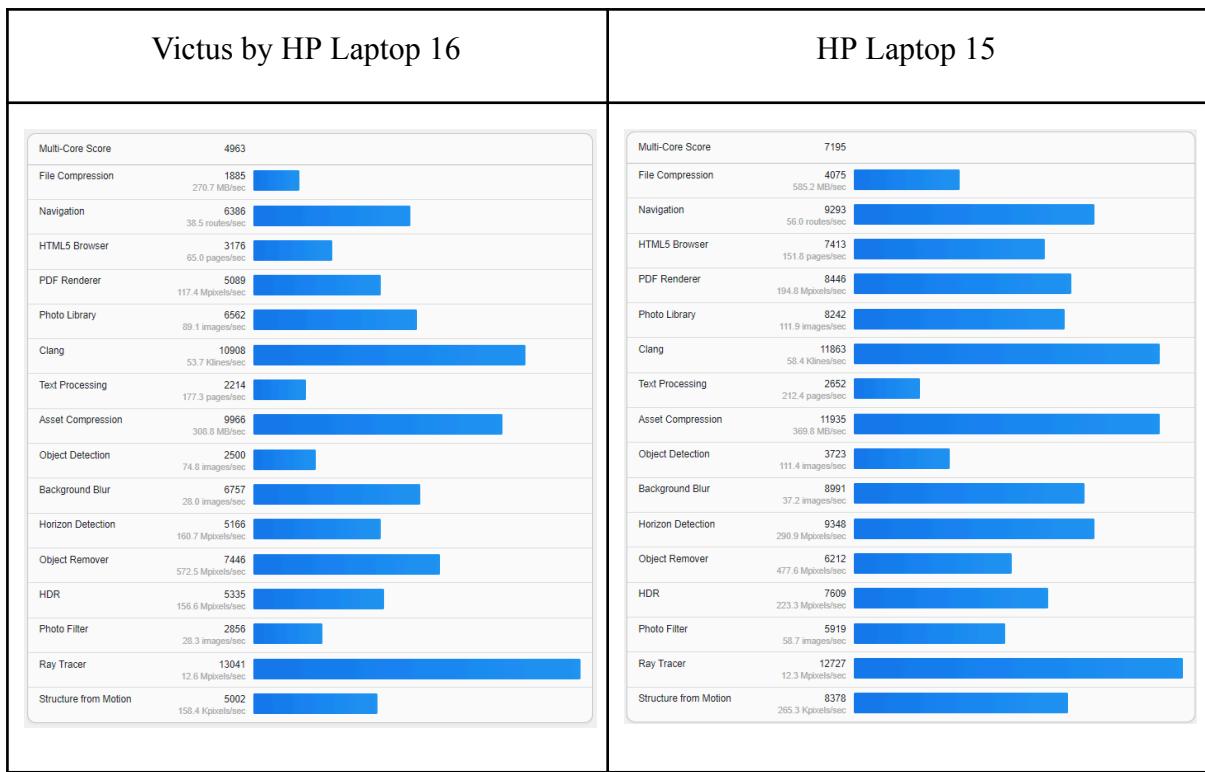
Memory				
Size	7.70 GB	12.00 GB	8.00 GB	12.00 GB
Transfer Rate	3192 MT/s	2392 MT/s	1596 MT/s	2926 MT/s
Type	DDR4 SDRAM	DDR4 SDRAM	DDR4 SDRAM	DDR4 SDRAM
Channels	2	2	1	2

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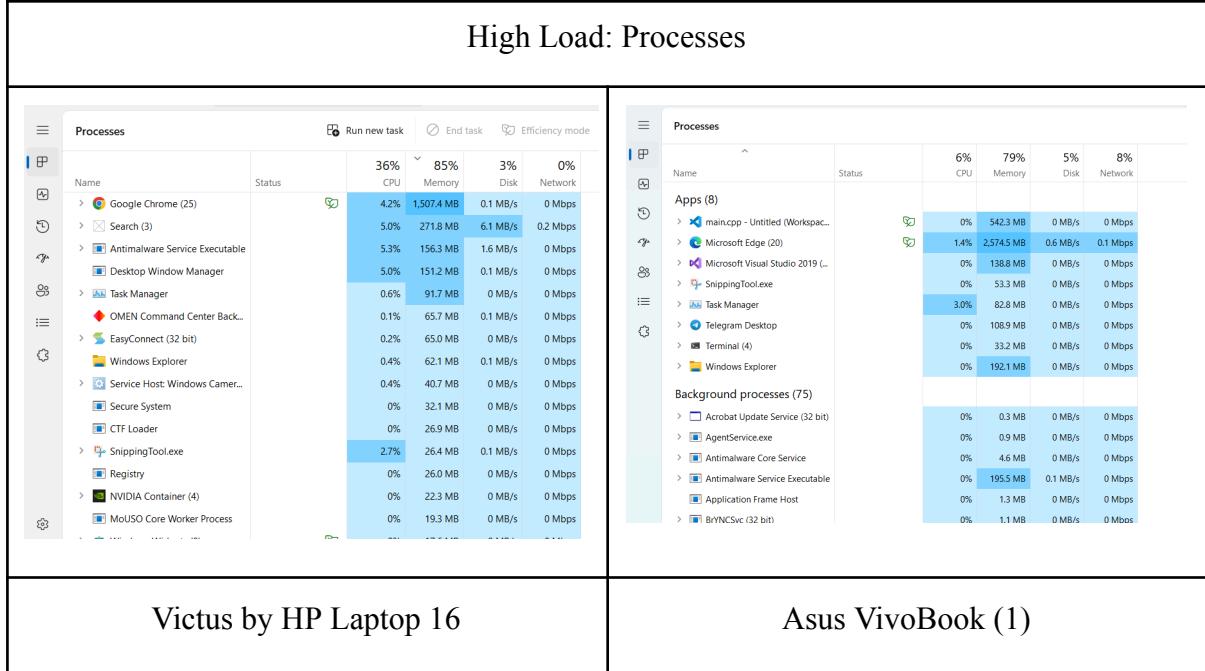
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File Compression	1125 161.5 MB/sec.																																																																																																
Navigation	1407 8.47 routes/sec.																																																																																																
HTML5 Browser	1340 27.4 pages/sec.																																																																																																
PDF Renderer	1344 31.0 Mpixels/sec.																																																																																																
Photo Library	1007 13.7 images/sec.																																																																																																
Clang	1321 6.51 Klines/sec.																																																																																																
Text Processing	1160 92.9 pages/sec.																																																																																																
Asset Compression	1334 41.3 MB/sec.																																																																																																
Object Detection	549 16.4 images/sec.																																																																																																
Background Blur	1707 7.06 images/sec.																																																																																																
Horizon Detection	1758 54.7 Mpixels/sec.																																																																																																
Object Remover	1110 85.4 Mpixels/sec.																																																																																																
HDR	1285 37.7 Mpixels/sec.																																																																																																
Photo Filter	1722 17.1 images/sec.																																																																																																
Ray Tracer	1066 1.03 Mpixels/sec.																																																																																																
Structure from Motion	1426 45.0 Kpixels/sec.																																																																																																





Task Manager



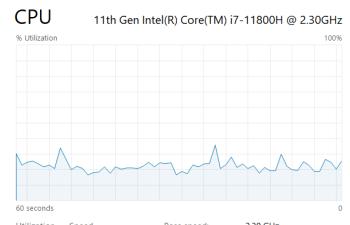
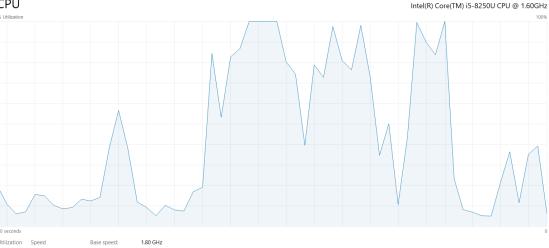
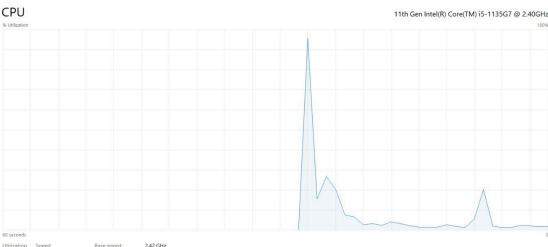
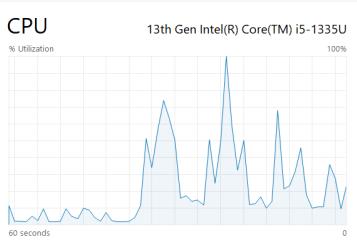
Processes		Processes								
Name	Status	7% CPU	80% Memory	3% Disk	0% Network	11% CPU	72% Memory	4% Disk	0% Network	
> Google Chrome (10)	Running	0%	845.9 MB	0.1 MB/s	0.1 Mbps	0.5%	1,573.5 MB	0.1 MB/s	0.1 Mbps	
> Windows Widgets (8)	Running	4.8%	226.9 MB	0.2 MB/s	0 Mbps	0.3%	352.0 MB	0.1 MB/s	0.1 Mbps	
> bdservicehost	Running	0.2%	195.5 MB	0.1 MB/s	0 Mbps	0.8%	108.6 MB	0 MB/s	0 Mbps	
> Task Manager	Running	0.9%	141.2 MB	0 MB/s	0 Mbps	1.1%	95.0 MB	0 MB/s	0 Mbps	
> Desktop Window Manager	Running	0.2%	134.0 MB	0 MB/s	0 Mbps	0.1%	258.4 MB	0.1 MB/s	0 Mbps	
> Intel® Graphics Command Ce...	Running	0%	111.3 MB	0 MB/s	0 Mbps	0.9%	163.9 MB	0 MB/s	0 Mbps	
> Windows Shell Experience Ho...	Running	0.6%	101.0 MB	0.1 MB/s	0 Mbps					
> Search (3)	Running	0%	95.9 MB	0 MB/s	0 Mbps					
> Start (2)	Running	0%	57.9 MB	0 MB/s	0 Mbps					
Windows Explorer	Running	0.3%	54.3 MB	0 MB/s	0 Mbps					
> Service Host: DCOM Server Pr...	Running	0%	25.6 MB	0.1 MB/s	0 Mbps					
> bdservicehost	Running	0%	17.5 MB	0 MB/s	0 Mbps					
> Service Host: State Repository ..	Running	0%	17.4 MB	0.1 MB/s	0 Mbps					
> Service Host: Diagnostic Policy...	Running	0%	16.3 MB	0 MB/s	0 Mbps					
> Service Host: Remote Procedu...	Running	0%	13.5 MB	0 MB/s	0 Mbps					

Asus VivoBook (2)

HP Laptop 15

High Load: Memory																																																	
<p>Memory</p> <p>Memory usage 60 seconds Memory composition</p> <table border="1"> <tr> <td>In use (Compressed)</td> <td>Available</td> <td>Speed:</td> <td>3200 MHz</td> </tr> <tr> <td>6.8 GB (57.0 MB)</td> <td>892 MB</td> <td>Slots used:</td> <td>1 of 2</td> </tr> <tr> <td>Committed</td> <td>Cached</td> <td>Form factor:</td> <td>SODIMM</td> </tr> <tr> <td>10.9/20.1 GB</td> <td>577 MB</td> <td>Hardware reserved:</td> <td>362 MB</td> </tr> <tr> <td>Paged pool</td> <td>Non-paged pool</td> <td></td> <td></td> </tr> <tr> <td>597 MB</td> <td>862 MB</td> <td></td> <td></td> </tr> </table>	In use (Compressed)	Available	Speed:	3200 MHz	6.8 GB (57.0 MB)	892 MB	Slots used:	1 of 2	Committed	Cached	Form factor:	SODIMM	10.9/20.1 GB	577 MB	Hardware reserved:	362 MB	Paged pool	Non-paged pool			597 MB	862 MB			<p>Memory</p> <p>Memory usage 60 seconds Memory composition</p> <table border="1"> <tr> <td>In use (Compressed)</td> <td>Available</td> <td>Speed:</td> <td>2400 MHz</td> </tr> <tr> <td>8.5 GB (417 MB)</td> <td>3.3 GB</td> <td>Slots used:</td> <td>2 of 2</td> </tr> <tr> <td>Committed</td> <td>Cached</td> <td>Form factor:</td> <td>SODIMM</td> </tr> <tr> <td>10.6/15.0 GB</td> <td>2.5 GB</td> <td>Hardware reserved:</td> <td>111 MB</td> </tr> <tr> <td>Paged pool</td> <td>Non-paged pool</td> <td></td> <td></td> </tr> <tr> <td>635 MB</td> <td>450 MB</td> <td></td> <td></td> </tr> </table>	In use (Compressed)	Available	Speed:	2400 MHz	8.5 GB (417 MB)	3.3 GB	Slots used:	2 of 2	Committed	Cached	Form factor:	SODIMM	10.6/15.0 GB	2.5 GB	Hardware reserved:	111 MB	Paged pool	Non-paged pool			635 MB	450 MB		
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Asus VivoBook (2)	HP Laptop 15																																																

High Load: CPU

 <p>CPU 11th Gen Intel(R) Core(TM) i7-11800H @ 2.30GHz % Utilization</p> <table border="1"> <thead> <tr> <th>Utilization</th> <th>Speed</th> <th>Base speed:</th> <th>Cores</th> <th>Sockets:</th> <th>Logical processors:</th> </tr> </thead> <tbody> <tr> <td>26%</td> <td>2.30 GHz</td> <td>2.30 GHz</td> <td>8</td> <td>1</td> <td>16</td> </tr> <tr> <td>Processes</td> <td>Threads</td> <td>Handles</td> <td></td> <td></td> <td>Virtualization: Enabled</td> </tr> <tr> <td>248</td> <td>3660</td> <td>123326</td> <td></td> <td></td> <td>L1 cache: 640 KB</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td>L2 cache: 10.0 MB</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td>L3 cache: 24.0 MB</td> </tr> <tr> <td colspan="6">Up time: 2:20:51:20</td> </tr> </tbody> </table>	Utilization	Speed	Base speed:	Cores	Sockets:	Logical processors:	26%	2.30 GHz	2.30 GHz	8	1	16	Processes	Threads	Handles			Virtualization: Enabled	248	3660	123326			L1 cache: 640 KB						L2 cache: 10.0 MB						L3 cache: 24.0 MB	Up time: 2:20:51:20						 <p>CPU Intel(R) Core(TM) i5-8250U CPU @ 1.60GHz % Utilization</p> <table border="1"> <thead> <tr> <th>Utilization</th> <th>Speed</th> <th>Base speed:</th> <th>Cores</th> <th>Sockets:</th> <th>Logical processors:</th> </tr> </thead> <tbody> <tr> <td>0%</td> <td>1.45 GHz</td> <td>1.45 GHz</td> <td>4</td> <td>1</td> <td>8</td> </tr> <tr> <td>Processes</td> <td>Threads</td> <td>Handles</td> <td></td> <td></td> <td>Virtualization: Enabled</td> </tr> <tr> <td>255</td> <td>3320</td> <td>148803</td> <td></td> <td></td> <td>L1 cache: 128 KB</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td>L2 cache: 4.0 MB</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td>L3 cache: 6.0 MB</td> </tr> <tr> <td colspan="6">Up time: 21:04:59:06</td> </tr> </tbody> </table>	Utilization	Speed	Base speed:	Cores	Sockets:	Logical processors:	0%	1.45 GHz	1.45 GHz	4	1	8	Processes	Threads	Handles			Virtualization: Enabled	255	3320	148803			L1 cache: 128 KB						L2 cache: 4.0 MB						L3 cache: 6.0 MB	Up time: 21:04:59:06					
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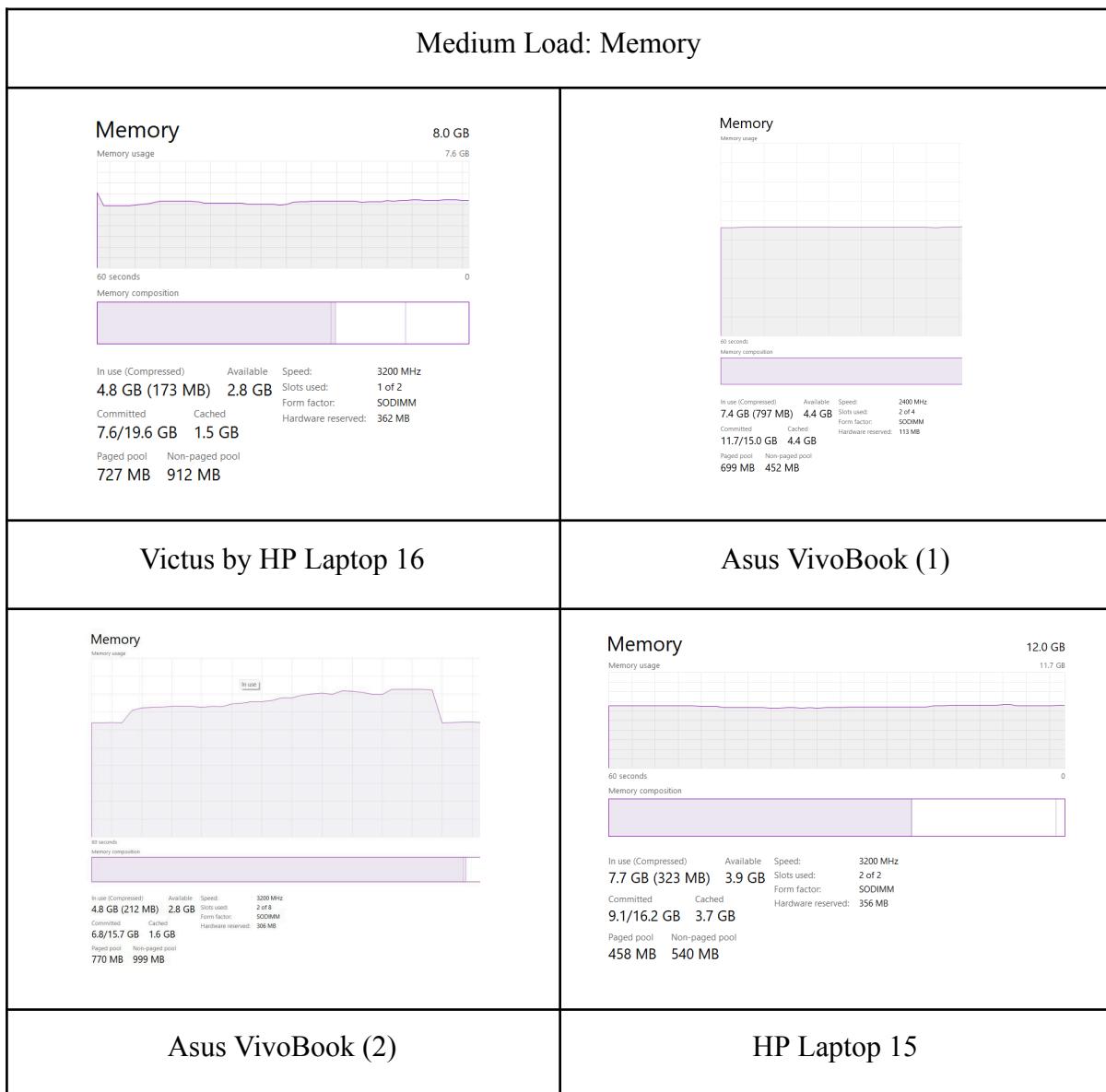
Medium Load: Processes

Processes Run new task End task Efficiency mode	Name	Status	12% CPU	63% Memory	32% Disk	0% Network		--------------------------------------	--------	---------	------------	----------	------------		> Search (3)		0%	226.9 MB	0 MB/s	0 Mbps		Desktop Window Manager		4.4%	207.7 MB	0.1 MB/s	0 Mbps		> Antimalware Service Executable		0.6%	159.4 MB	0.2 MB/s	0 Mbps		> Windows Explorer		1.8%	157.0 MB	0.2 MB/s	0 Mbps		> NVIDIA Share (3)		0%	98.1 MB	0.8 MB/s	0 Mbps		Task Manager		0.5%	86.1 MB	0.1 MB/s	0 Mbps		> SnippingTool.exe		2.8%	68.5 MB	0.7 MB/s	0 Mbps		Secure System		0%	31.1 MB	0 MB/s	0 Mbps		MoUSO Core Worker Process		0%	20.6 MB	0 MB/s	0 Mbps		> Microsoft Windows Search Ind...		0.2%	19.0 MB	0.1 MB/s	0 Mbps		> Service Host: State Repository ...		0%	14.4 MB	0 MB/s	0 Mbps		> Windows Widgets (8)		0%	14.1 MB	0 MB/s	0 Mbps		> NVIDIA Container (2)		0%	14.0 MB	0.1 MB/s	0 Mbps		> Service Host: UtcSvc		0%	13.5 MB	0 MB/s	0 Mbps		NVIDIA Web Helper Service (3...)		0%	13.5 MB	3.1 MB/s	0 Mbps		**Processes**	Name	Status	6% CPU	62% Memory	1% Disk	0% Network		-------------------------------------	--------	--------	------------	----------	------------		Apps (7)		0%	229.2 MB	0 MB/s	0 Mbps		exercise 18.cpp - pt2 - Visual S...		0%	10.4 MB	0 MB/s	0 Mbps		Media Player (2)		0%	763.0 MB	0.1 MB/s	0 Mbps		Microsoft Edge (5)		0.2%	466.5 MB	0.1 MB/s	0 Mbps		RStudio (7)		1.7%	87.6 MB	0 MB/s	0 Mbps		Task Manager		0%	11.6 MB	0 MB/s	0.1 MBps		Telegram Desktop		0.2%	184.1 MB	0 MB/s	0 Mbps		Background processes (62)		0%	0.1 MB	0 MB/s	0 Mbps		Acrobat Update Service (32 bit)		0%	0.2 MB	0 MB/s	0 Mbps		AgentService.exe		0%	3.8 MB	0 MB/s	0 Mbps		Antimalware Core Service		0.2%	159.2 MB	0 MB/s	0 Mbps		Application Frame Host		0%	6.8 MB	0 MB/s	0 Mbps		Background Task Host		0%	0 MB	0 MB/s	0 Mbps		BvNCSvc (32 bit)		0%	0.2 MB	0 MB/s	0 Mbps	
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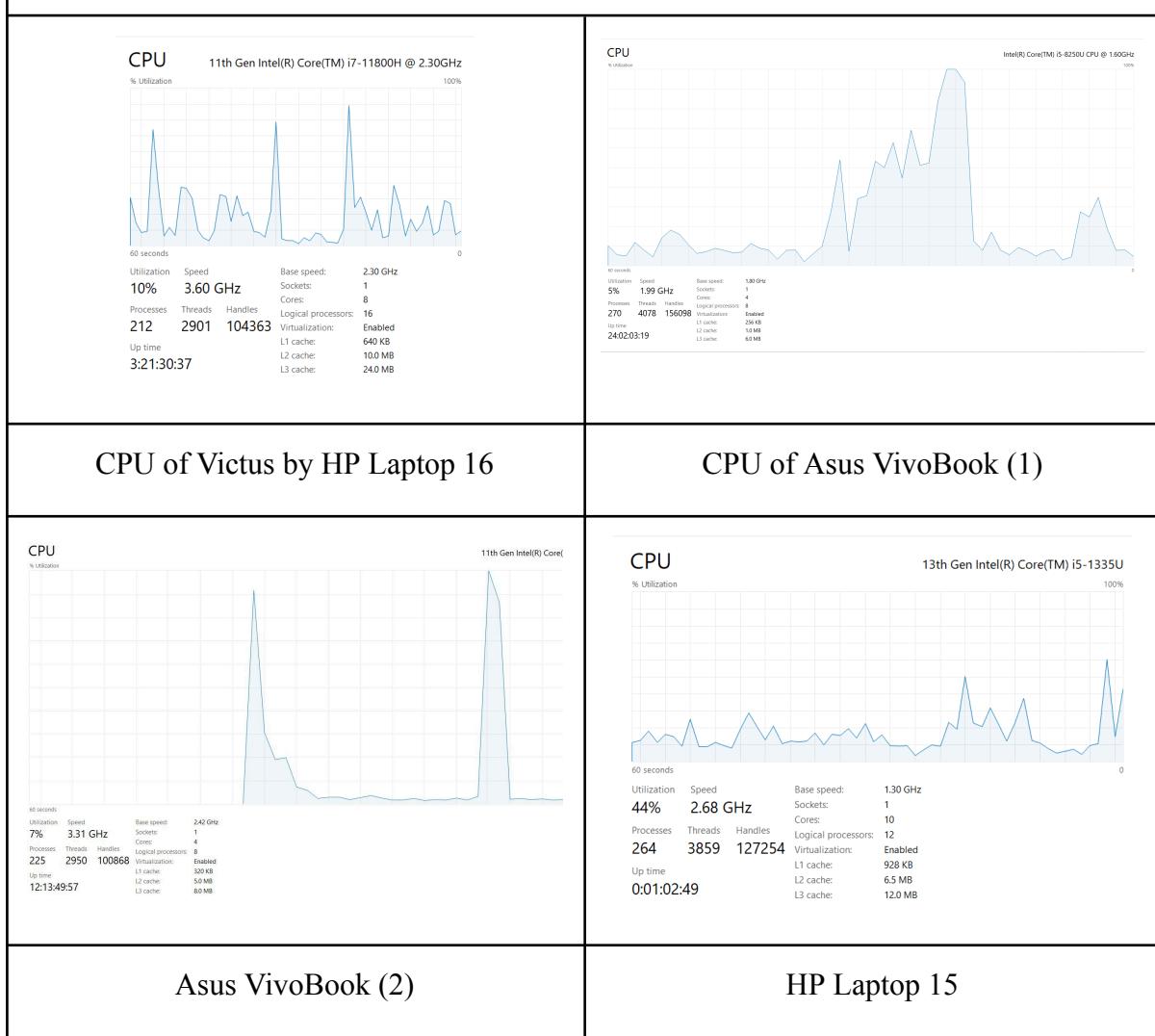
Processes						Processes					
Name	Status	5%	64%	1%	0%	Name	Status	42%	67%	2%	0%
> bdservicehost		0%	202.7 MB	0.1 MB/s	0 Mbps	Apps (4)		2.7%	1,554.5 MB	0.1 MB/s	0 Mbps
Windows Explorer		0%	150.5 MB	0.1 MB/s	0 Mbps	> SnippingTool.exe		0.8%	57.3 MB	0.1 MB/s	0 Mbps
Desktop Window Manager		0%	145.9 MB	0 MB/s	0 Mbps	> Task Manager		3.6%	85.5 MB	0.1 MB/s	0 Mbps
> Task Manager		1.7%	139.8 MB	0 MB/s	0 Mbps	> Windows Explorer		0.5%	163.4 MB	0.1 MB/s	0 Mbps
> Start (2)		0%	120.6 MB	0 MB/s	0 Mbps	Background processes (88)					
> Intel® Graphics Command Ce...		0%	111.8 MB	0.1 MB/s	0 Mbps	> 64-bit Synaptics Pointing Enh...		0%	0.8 MB	0 MB/s	0 Mbps
> Search (3)		0%	96.7 MB	0 MB/s	0 Mbps	> AgentService		0%	4.2 MB	0 MB/s	0 Mbps
SnippingTool.exe		0%	87.2 MB	0 MB/s	0 Mbps	> Antimalware Core Service		0%	1.0 MB	0 MB/s	0 Mbps
experience.exe		0%	39.1 MB	0 MB/s	0 Mbps	> Antimalware Service Executable		4.1%	193.8 MB	0 MB/s	0 Mbps
> Service Host: DCOM Server Pr...		0%	26.6 MB	0.1 MB/s	0 Mbps	> AppHelpCap		0%	4.3 MB	0 MB/s	0 Mbps
> Service Host: State Repository ...		0%	21.6 MB	0.1 MB/s	0 Mbps	> Application Frame Host		0%	1.9 MB	0 MB/s	0 Mbps
> Service Host: Diagnostic Policy...		0%	20.9 MB	0 MB/s	0 Mbps	> COM Surrogate		0%	3.2 MB	0 MB/s	0 Mbps
						> CommRecovery		0%	2.2 MB	0.1 MB/s	0 Mbps
								0%	2.7 MB	0 MB/s	0 Mbps

Asus VivoBook (2)

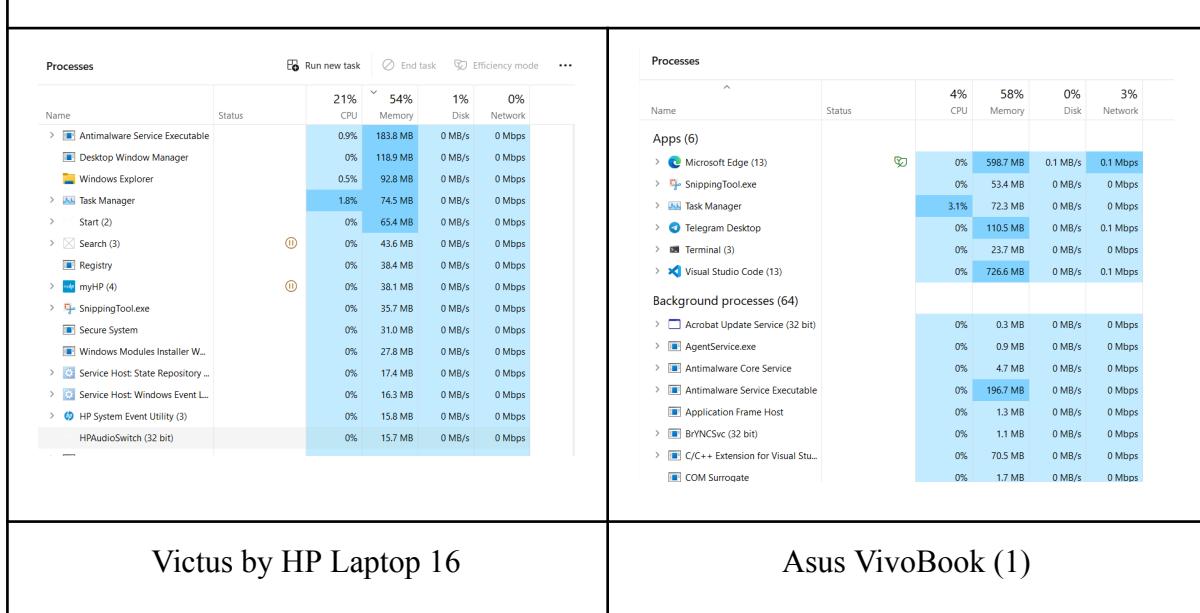
HP Laptop 15



Medium Load: CPU



Low Load: Processes

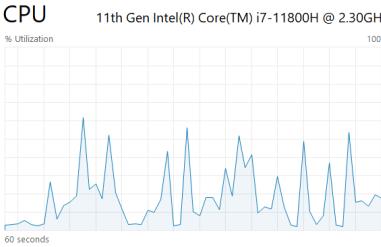
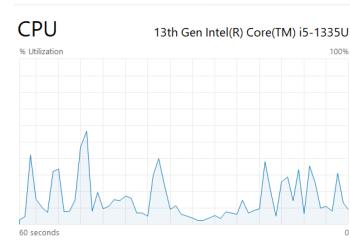


Processes		Processes			
Name	Status	1% CPU	59% Memory	0% Disk	0% Network
> bdservicehost		0%	221.8 MB	0 MB/s	0 Mbps
Desktop Window Manager		0%	143.3 MB	0 MB/s	0 Mbps
> Task Manager		0%	139.6 MB	0 MB/s	0 Mbps
> Intel® Graphics Command Ce...		0%	111.6 MB	0 MB/s	0 Mbps
> Search (3)		0%	100.0 MB	0 MB/s	0 Mbps
> Service Host: DCOM Server Pr...		0%	25.9 MB	0 MB/s	0 Mbps
> Service Host: State Repository -		0%	20.5 MB	0 MB/s	0 Mbps
> Service Host: Diagnostic Policy...		0%	18.9 MB	0 MB/s	0 Mbps
> bdservicehost		0%	16.6 MB	0 MB/s	0 Mbps
Bitdefender agent		0%	14.8 MB	0 MB/s	0 Mbps
> LocalServiceNoNetworkfirewa...		0%	14.3 MB	0 MB/s	0 Mbps
> Service Host: Remote Procedu...		0%	13.9 MB	0 MB/s	0 Mbps
		0%	13.0 MB	0 MB/s	0 Mbps

Name	Status	12% CPU	53% Memory	1% Disk	0% Network
Apps (2)					
> SnippingTool.exe		0.5%	106.0 MB	0 MB/s	0 Mbps
> Task Manager		2.0%	99.2 MB	0 MB/s	0 Mbps
Background processes (88)					
> 64-bit Synaptics Pointing Enh...		0%	0.8 MB	0 MB/s	0 Mbps
Agent for EasyConnect (32 bit)		0%	4.2 MB	0.1 MB/s	0 Mbps
> AgentService		0%	1.0 MB	0 MB/s	0 Mbps
> Antimalware Core Service		0%	7.2 MB	0 MB/s	0 Mbps
> Antimalware Service Executable		0.8%	181.9 MB	0 MB/s	0 Mbps
> AppHelperCap		0%	4.3 MB	0 MB/s	0 Mbps
Application Frame Host		0%	1.9 MB	0 MB/s	0 Mbps
COM Surrogate		0%	3.1 MB	0 MB/s	0 Mbps

Asus VivoBook (2)

HP Laptop 15

Low Load: CPU	
<p>CPU 11th Gen Intel(R) Core(TM) i7-11800H @ 2.30GHz</p>  <p>Utilization: 8% Speed: 2.55 GHz Base speed: 2.30 GHz Sockets: 1 Cores: 8 Logical processors: 16 Processes: 196 Threads: 3118 Handles: 79796 Virtualization: Enabled Up time: 0:00:02:01 L1 cache: 640 KB L2 cache: 10.0 MB L3 cache: 24.0 MB</p>	<p>CPU % Utilization</p>  <p>Utilization: 4% Speed: 1.74 GHz Base speed: 1.80 GHz Sockets: 1 Cores: 4 Logical processors: 8 Processes: 233 Threads: 2985 Handles: 133810 Virtualization: Enabled Up time: 21:04:55:32 L1 cache: 256 KB L2 cache: 1.0 MB L3 cache: 6.0 MB</p>
Victus by HP Laptop 16	Asus VivoBook (1)
<p>CPU % Utilization</p>  <p>Utilization: 2% Speed: 1.70 GHz Base speed: 2.42 GHz Sockets: 1 Cores: 4 Logical processors: 4 Processes: 216 Threads: 2744 Handles: 96364 Virtualization: Enabled Up time: 12:13:53:40 L1 cache: 320 KB L2 cache: 5.0 MB L3 cache: 1.0 MB</p>	<p>CPU 13th Gen Intel(R) Core(TM) i5-1335U</p>  <p>Utilization: 9% Speed: 1.32 GHz Base speed: 1.30 GHz Sockets: 1 Cores: 10 Logical processors: 12 Processes: 234 Threads: 3288 Handles: 110699 Virtualization: Enabled Up time: 0:01:13:04 L1 cache: 928 KB L2 cache: 6.5 MB L3 cache: 12.0 MB</p>
Asus VivoBook (2)	HP Laptop 15

Low Load: Memory

<p>Memory</p> <p>Memory usage</p> <p>Memory composition</p> <table border="1"> <thead> <tr> <th>In use (Compressed)</th> <th>Available</th> <th>Speed:</th> <th>Slots used:</th> </tr> </thead> <tbody> <tr> <td>4.4 GB (52.3 MB)</td> <td>3.1 GB</td> <td>3200 MHz</td> <td>1 of 2</td> </tr> <tr> <td>Committed</td> <td>Cached</td> <td>Form factor:</td> <td>SODIMM</td> </tr> <tr> <td>5.0/20.1 GB</td> <td>3.0 GB</td> <td>Hardware reserved:</td> <td>362 MB</td> </tr> <tr> <td>Paged pool</td> <td>Non-paged pool</td> <td></td> <td></td> </tr> <tr> <td>430 MB</td> <td>653 MB</td> <td></td> <td></td> </tr> </tbody> </table>	In use (Compressed)	Available	Speed:	Slots used:	4.4 GB (52.3 MB)	3.1 GB	3200 MHz	1 of 2	Committed	Cached	Form factor:	SODIMM	5.0/20.1 GB	3.0 GB	Hardware reserved:	362 MB	Paged pool	Non-paged pool			430 MB	653 MB			<p>Memory</p> <p>Memory usage</p> <p>Memory composition</p> <table border="1"> <thead> <tr> <th>In use (Compressed)</th> <th>Available</th> <th>Speed:</th> <th>Slots used:</th> </tr> </thead> <tbody> <tr> <td>6.6 GB (348 MB)</td> <td>5.1 GB</td> <td>2400 MHz</td> <td>2 of 4</td> </tr> <tr> <td>Committed</td> <td>Cached</td> <td>Form factor:</td> <td>SODIMM</td> </tr> <tr> <td>8.2/15.0 GB</td> <td>1.8 GB</td> <td>Hardware reserved:</td> <td>113 MB</td> </tr> <tr> <td>Paged pool</td> <td>Non-paged pool</td> <td></td> <td></td> </tr> <tr> <td>625 MB</td> <td>424 MB</td> <td></td> <td></td> </tr> </tbody> </table>	In use (Compressed)	Available	Speed:	Slots used:	6.6 GB (348 MB)	5.1 GB	2400 MHz	2 of 4	Committed	Cached	Form factor:	SODIMM	8.2/15.0 GB	1.8 GB	Hardware reserved:	113 MB	Paged pool	Non-paged pool			625 MB	424 MB		
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	Victus by HP Laptop 16	Asus Vivobook (1)	Asus Vivobook (2)	HP Laptop 15
CPU Base speed	2.30 GHz	1.80 GHz	2.42 Ghz	1.30 GHz
CPU Sockets	1	1	1	1
CPU Cores	8	4	4	10
CPU Logical processors	16	8	8	12

CPU Virtualization	Enabled	Enabled	Enabled	Enabled
CPU L1 cache	640 KB	256 KB	320 KB	928 KB
CPU L2 cache	10.0 MB	1.0 MB	5.0 MB	6.5 MB
CPU L3 cache	24.0 MB	6.0 MB	8.0 MB	12.0 MB
Memory Speed	3200 MHz	2400 MHz	3200 MHz	3200 MB
Memory Slots used	1 of 2	2 of 4	2 of 8	2 of 2
Memory Form factor	SODIMM	SODIMM	SODIMM	SODIMM
Memory Hardware reserved	362 MB	113 MB	306 MB	356 MB

Load	Low Load			
Computer type	Victus by HP Laptop 16	Asus Vivobook (1)	Asus Vivobook (2)	HP Laptop 15
CPU Usage	21%	4%	1%	12%
CPU Utilization	8%	4%	2%	9%
CPU Speed	2.55 GHz	1.74 GHz	1.70 GHz	1.32 GHz
CPU Processes	196	233	216	234
CPU Threads	3118	2985	2744	3288
CPU Handles	79796	133810	96364	110699

CPU Up time	0:00:02:01	21:04:55:32	12:13:53:40	0:01:13:04
Memory Usage	54%	58%	59%	53%
Memory In use (Compressed)	4.4 GB (52.3 MB)	6.6 GB (348 MB)	4.8 GB (209 MB)	6.0 GB (238 MB)
Memory Available	3.1 GB	5.1 GB	2.9 GB	5.6 GB
Memory Committed	5.0/20.1 GB	8.2/15.0 GB	6.7/25.7 GB	7.1/16.2 GB
Memory Cached	3.0 GB	1.8 GB	1.6 GB	3.3 GB
Memory Paged pool	430 MB	625 MB	772 MB	461 MB
Memory Non-paged pool	653 MB	424 MB	1002 MB	542 MB

Load	Medium Load			
Computer type	Victus by HP Laptop 16	Asus Vivobook (1)	Asus Vivobook (2)	HP Laptop 15
CPU Usage	12%	6%	5%	42%
CPU Utilization	10%	5%	7%	44%
CPU Speed	3.60 GHz	2.99 GHz	3.31 GHz	2.68 GHz
CPU Processes	212	270	225	264
CPU Threads	2901	4078	2950	2859

CPU Handles	104363	156098	200868	127254
CPU Up time	3:21:30:37	24:02:03:19	12:13:49:57	0:01:02:49
Memory Usage	63%	62%	64%	67%
Memory In use (Compressed)	4.8 GB (173 MB)	7.4 GB (797 MB)	4.8 GB (212 MB)	7.7 GB (323 MB)
Memory Available	2.8 GB	4.4 GB	2.8 GB	3.9 GB
Memory Committed	7.6/19.6 GB	11.7/15.0 GB	6.8/15.7 GB	9.1/16.2 GB
Memory Cached	1.5 GB	4.4 GB	1.6 GB	3.7 GB
Memory Paged pool	727 MB	699 MB	770 MB	458 MB
Memory Non-paged pool	912 MB	452 MB	999 MB	540 MB

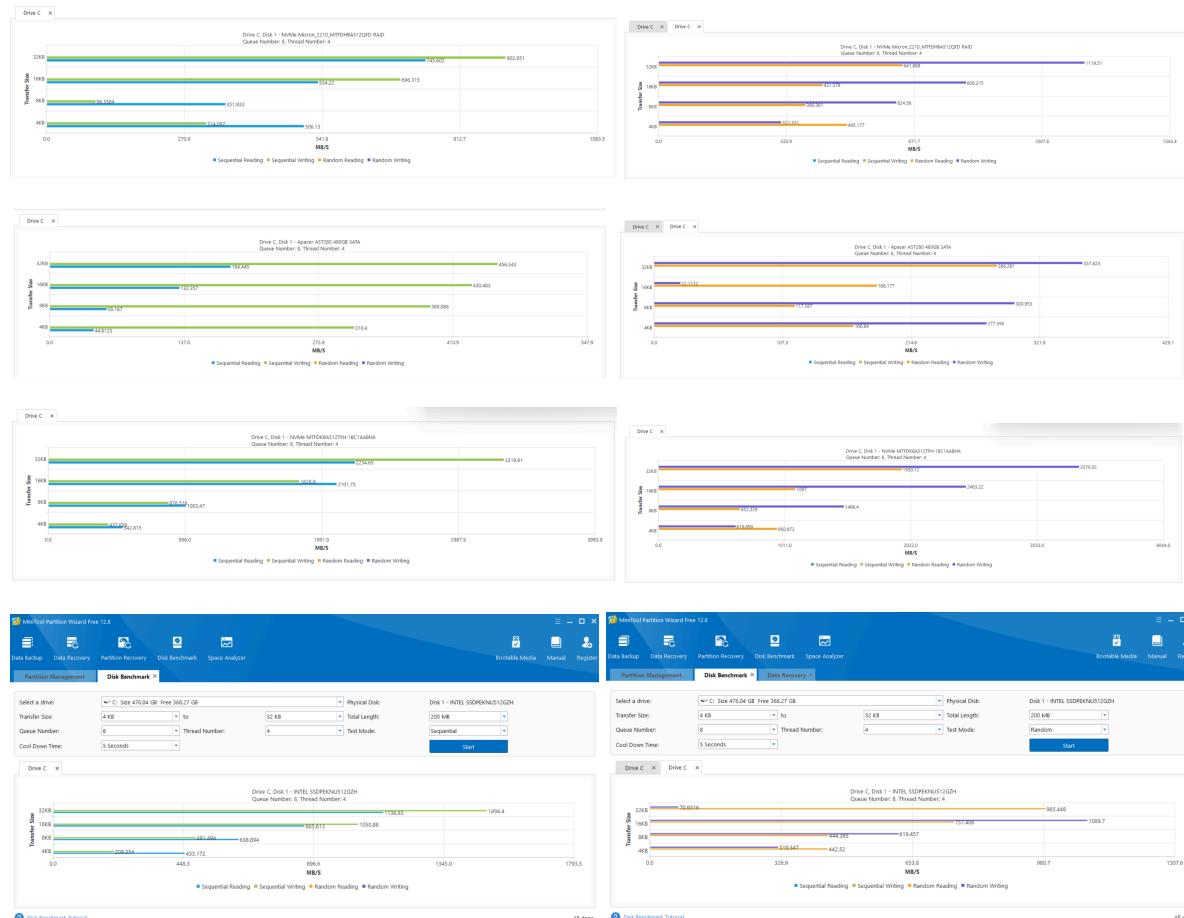
Load	High Load			
Computer type	Victus by HP Laptop 16	Asus Vivobook (1)	Asus Vivobook (2)	HP Laptop 15
CPU Usage	36%	6%	7%	11%
CPU Utilization	26%	6%	2%	23%
CPU Speed	2.30 GHz	1.45 GHz	2.24 GHz	2.31 GHz
CPU Processes	248	255	238	276

CPU Threads	3660	3320	3279	4169
CPU Handles	123326	148803	106722	132352
CPU Up time	2:20:51:20	21:04:59:06	12:13:33:16	0:01:09:02
Memory Usage	85%	79%	80%	72%
Memory In use (Compressed)	6.8 GB (57.0 MB)	8.5 GB (417 MB)	6.3 GB (250 MB)	8.5 GB (285 MB)
Memory Available	892 MB	3.3 GB	1.4 GB	3.0 GB
Memory Committed	10.9/20.1 GB	10.6/15.0 GB	8.3/15.7 GB	10.1/16.2 GB
Memory Cached	577MB	2.5 GB	1.2 GB	3.1 GB
Memory Paged pool	597 MB	635 MB	773 MB	463 MB
Memory Non-paged pool	862 MB	450 MB	1003 MB	544 MB

MiniTool Partition Wizard

Specification	Computer Type			
	Asus Vivobook(1)	Asus Vivobook(2)	HP Victus by HP laptop 16-d0xxx	HP Laptop 15-fd0xxx
Sequential Reading (MB/s)				
4KB	506.13 MB/s	44.8125 MB/s	542.815 MB/s	453.172
8KB	351.933 MB/s	58.167 MB/s	1003.47 MB/s	638.894
16KB	534.22 MB/s	132.357 MB/s	2101.75 MB/s	865.613
32KB	745.602 MB/s	184.445 MB/s	2234.65 MB/s	1136.83
Sequential Writing (MB/s)				
4KB	314.097 MB/s	310.4 MB/s	437.639 MB/s	209.354
8KB	96.3584 MB/s	388.086 MB/s	876.516 MB/s	491.494
16KB	696.315 MB/s	430.483 MB/s	1828.9 MB/s	1050.88
32KB	902.951 MB/s	456.543 MB/s	3319.91 MB/s	1494.4
Random Reading (MB/s)				
4KB	495.177 MB/s	166.64 MB/s	950.972 MB/s	442.52
8KB	386.361 MB/s	117.587 MB/s	652.329 MB/s	444.385
16KB	431.379 MB/s	186.177 MB/s	1097 MB/s	757.406

32KB	641.888 MB/s	286.291 MB/s	1950.12 MB/s	985.448
Random Writing (MB/s)				
4KB	322.331 MB/s	277.595 MB/s	618.899 MB/s	319.347
8KB	624.56 MB/s	300.953 MB/s	1486.4 MB/s	619.457
16KB	808.215 MB/s	22.1172 MB/s	2463.22 MB/s	1089.7
32KB	1119.51 MB/s	357.623 MB/s	3370.02 MB/s	70.9316



2.5 Result Analysis, Comparison and Discussion

CPU-Z

1. Core Speed

- Asus VivoBook (1) : 2286.85 MHz
- Asus VivoBook (2) : 1596.10 MHz
- Victus by HP Laptop 16 : 4604.67 MHz
- HP Laptop 15 : 798.05 MHz

Higher core speed indicates a faster processor capable of executing more instructions per second. The Victus by HP Laptop 16 has the highest core speed compared to the other three laptops indicates that the Victus by HP Laptop 16 has a more powerful processor, and is suitable for complicated tasks such as gaming and video editing. The Asus VivoBook (1) has the second highest core speed followed by the Asus VivoBook (2), and is suitable for everyday use and some demanding tasks. The HP Laptop 15 has the lowest core speed, which means it's not as powerful and may have trouble with complicated tasks such as gaming but is fine for basic activities.

2. Bus Speed

- Asus VivoBook (1) : 99.43 MHz
- Asus VivoBook (2) : 99.76 MHz
- Victus by HP Laptop 16 : 100.10 MHz
- HP Laptop 15 : 99.76 MHz

Higher bus speed allows faster data transfer between the CPU and other components such as RAM and the motherboard. The bus speeds of all four laptops are very similar. The Victus by HP Laptop 16 is slightly faster than the other three laptops. However, the small difference will not affect overall performance. Since the bus speeds are almost the same, data transfer rates will be quite consistent for all three laptops. Therefore, factors like core speed and RAM will be more important in affecting performance.

3. RAM Size

- Asus VivoBook (1) : 8 GB
- Asus VivoBook (2) : 12 GB

- Victus by HP Laptop 16 : 8 GB
- HP Laptop 15 : 12 GB

Higher RAM size allows a computer to handle more tasks simultaneously without slowing down. The Asus VivoBook (2) and the HP Laptop 15 have the biggest RAM which is 12 GB, making it better for multitasking and running memory-intensive applications without slowing down. Both the Victus by HP Laptop 16 and the Asus VivoBook (1) have 8 GB of RAM, which is enough for everyday tasks and moderate multitasking but may struggle with more demanding applications compared to the Asus VivoBook (2) and the HP Laptop 15. The extra RAM in the Asus VivoBook (2) and the HP Laptop 15 gives them a clear advantage when using multiple or heavy applications.

4. Cache

Computer	Asus VivoBook (1)	Asus VivoBook (2)	Victus by HP Laptop 16	HP Laptop 15
L1 Data Cache	192 KB	128 KB	384 KB	352 KB
L1 Instruction Cache	128 KB	128 KB	256 KB	576 KB
L2 Cache	5 MB	1 MB	10 MB	6.5 MB
L3 Cache	8 MB	6 MB	24 MB	12 MB
Total Cache Size	10.361 MB	7.25 MB	34.625 MB	19.406 MB

L1 Data Cache: The Victus by HP Laptop 16 has the largest L1 data cache which is 384 KB, followed by the HP Laptop 15 with 352 KB. The Asus VivoBook (1) has 192 KB, and the Asus VivoBook (2) has the smallest with 128 KB. A larger L1 data cache means more immediate data can be stored close to the CPU for quick access, improving performance in data-heavy tasks.

L1 Instruction Cache: The HP Laptop 15 has the largest L1 instruction cache which is 576 KB, which allows it to store more instructions close to the CPU, enhancing its ability to handle complex computations quickly. The Victus by HP Laptop 16 follows with 256 KB, while both Asus VivoBooks have 128 KB.

L2 Cache: The Victus by HP Laptop 16 also has the largest L2 cache size with 10 MB, indicating better performance for storing and accessing large datasets compared to the other laptops. The HP Laptop 15 follows with 6.5 MB, the Asus VivoBook (1) has 5 MB, and the Asus VivoBook (2) has the smallest L2 cache with 1 MB.

L3 Cache: The Victus by HP Laptop 16 has the largest size of L3 Cache at 24 MB, showing it can handle larger sets of instructions and data effectively, leading to improved performance in demanding applications. The HP Laptop 15 has 12 MB, the Asus VivoBook (1) has 8 MB, and the Asus VivoBook (2) has the smallest L3 cache with 6 MB.

Total Cache Size: The larger cache size is able to store more instructions that the CPU needs to execute. The Victus by HP Laptop 16 has the largest size of cache which is 34.625 MB, followed by the HP Laptop 15 which has 19.406 MB of cache. This allows the two laptops to perform well for tasks that require fast and frequent data access. The Asus VivoBook (1) has moderate cache size which is 10.361 MB, followed by the Asus VivoBook (2) which has 7.25 MB of cache. These two laptops might not perform well in heavy computational tasks but are able to fulfill the basic computing needs.

5. Chipset Revision

- Asus VivoBook (1) : Revision 1
- Asus VivoBook (2) : Revision 8
- Victus by HP Laptop 16 : Revision 5
- HP Laptop 15 : Revision 1

A higher chipset revision indicates newer technology and improvements in the motherboard's design and capabilities. The Asus VivoBook (2) with a revision 8 chipset has the best stability and features among the three laptops. The Victus by HP Laptop 16 with a revision 5 chipset also has many improvements and is a stable and reliable option. The Asus VivoBook (1) and the HP Laptop 15, with a revision 1 chipset, might be less stable and reliable, which could affect its performance.

Summary for CPU-Z

In conclusion, the Asus VivoBook (1) has a high core speed of 2286.85 MHz, making it good for moderate tasks. Besides, it also has moderate cache size, which helps with fast data access and processing.

Next, the Asus VivoBook (2) has 12 GB of RAM, which is good for multitasking and running memory-intensive applications. Moreover, it also has the latest chipset revision, which means it works better with newer hardware and has improved system features.

The following is the Victus by HP Laptop 16. This laptop has the highest core speed at 4604.67 MHz, making it ideal for CPU-intensive tasks like gaming and video editing. Its large cache size also improves processing speed and efficiency, meeting high-performance needs.

Lastly, the HP Laptop 15 has a large RAM size, which makes it good for multitasking. Besides, it also has a large cache size, which ensures quick instruction fetching and execution, improving performance for applications that need frequent instruction retrieval.

Geekbench

1. Add system info as complement /conformation to CPU-Z

GeekBench provides valuable system information that complements the detailed hardware insights offered by CPU-Z. Together, these tools enhance our understanding of each laptop's hardware configuration, including critical components such as the processor (CPU), memory (RAM), cache memory, and chipset codename. This combined approach allows a comprehensive assessment of performance metrics, spanning from single-core and multi-core performance to specific optimizations tailored to different chipset architecture.

The Asus VivoBook (1) features an 11th Gen Intel Core i5-1135G7 processor and 8GBBytes of DDR4 RAM. This configuration is well-suited for everyday computing

tasks such as web browsing, email, and other basic productivity applications. Its processor offers efficient performance and power management, while its 8GB of RAM provides sufficient memory for multitasking and handling multiple applications simultaneously.

The Asus VivoBook (2) is powered by an 8th Gen IntelCore i5-8250U processor paired with 12 GBytes of DDR4 RAM. This combination offers reliable performance for general productivity tasks and moderate multitasking. The 8th Gen Intel Core i5 processor provides decent computing power suitable for everyday applications too, while its size of RAM ensures smoother operation when running multiple applications concurrently.

The HP Victus by HP laptop 16 is equipped with an 11th Gen Intel Core i7-11800H processor with 8 GBytes of DDR4 RAM. While this configuration is geared towards users requiring higher processing power for intensive applications and gaming. The processor offers superior performance with its higher core count and clock speeds, making it suitable for running highly demanding tasks smoothly.

The HP Laptop 15 features a 13th Gen Intel Corei5-1335U processor and 12 GBytes of DDR4 RAM. Among the four laptops, it has the newest generation processor, which is intended to deliver improved efficiency and performance compared to old models. With 12 GB of RAM, the laptop provides ample memory for multitasking and handling more intensive workloads effectively. This configuration is ideal for users looking for a balance between performance and efficiency in everyday computing tasks and light multimedia editing.

To sum up, the Asus VivoBook (1) and (2) provide balanced performance for everyday tasks, with the latter offering more RAM for enhancing multitasking. In contrast, the HP Victus by HP Laptop 16 excels in processing power and is ideal for intensive applications, while the HP Laptop 15 showcases newer generation efficiency for light multimedia tasks. GeekBench adds system information as a complement to CPU-Z because it assists to deliver a comprehensive validation of hardware performance and specifications across different computing platforms.

2. CPU test with variation of technique or method used, either single-core or multi-core performance

When evaluating CPU performance, it is essential to consider both single-core and multi-core performance, as each offers distinct insights. Single-core performance measures the capability of an individual CPU core, providing crucial information on how well a processor could handle tasks that rely predominantly on a single thread. This metric is particularly significant for applications that do not take advantage of multiple cores simultaneously. A higher single-core score generally means better performance in tasks such as web browsing, basic productivity software, and older applications that are not optimized for multi-threading.

On the other hand, the multi-core score evaluates how well a processor can manage tasks across all its cores at the same time. This metric is vital for activities that benefit from parallel processing, such as video editing, virtualization, data analysis and running multiple applications concurrently. A higher multi-core score indicates superior performance in these types of tasks, where the workload can be divided among multiple-cores effectively.

For single-core performance, the HP Laptop 15 tops the list with a score of 1822, trailed by the Asus VivoBook (1) with a commendable 1697, the HP Victus by HP Laptop 16 with a closely matched score of 1621, and lastly, the Asus VivoBook (2) with a modest 1228. Higher single-core scores indicate better performance in tasks that rely on the processing power of a single CPU core. There are several factors that may cause lower scores, including older or less advanced CPU architectures, thermal throttling inadequate, and so on.

Shifting focus to multi-core performance, the HP Laptop 15 maintains its lead with a score of 7195, followed by the Asus VivoBook (1) at 5186, the HP Victus by HP Laptop 16 with a moderate score of 4963, and the Asus VivoBook (2) achieving 3731. A higher multi-core score leads to smoother multitasking and faster responsiveness in demanding applications, as well as enhancing overall user experience and productivity.

Overall, considering both single-core and multi-core performance metrics is important for evaluating CPU capabilities. The HP Laptop 15 stands out with strong scores in both categories, reflecting its versatility and ability to deliver efficient performance across various computing tasks.

Task Manager

1. CPU Usage

Computer type	Victus by HP Laptop 16	Asus Vivobook (1)	Asus Vivobook (2)	HP Laptop 15
CPU Usage	Low Load			
	21%	4%	1%	12%
	Medium Load			
	12%	6%	5%	42%
	High Load			
	36%	6%	7%	11%

At low and high load, the Victus by HP Laptop 16 has the higher CPU Usage compared to all of the laptops. This indicates that under both high and low-load situations, Vicuts by HP Laptop 16 handles it more effectively, utilizing a large portion of its CPU to manage demanding tasks. However, HP Laptop 15 consists of a higher CPU Usage at the medium load. This suggests that it can manage more intensive applications effectively under medium load.

2. CPU Speed

Computer type	Victus by HP Laptop 16	Asus Vivobook (1)	Asus Vivobook (2)	HP Laptop 15
CPU Speed	Low Load			
	2.55 GHz	1.74 GHz	1.70 GHz	1.32 GHz
	Medium Load			
	3.60 GHz	2.99 GHz	3.31 GHz	2.68 GHz
	High Load			
	2.30 GHz	1.45 GHz	2.24 GHz	2.31 GHz

	Victus by HP Laptop 16	Asus Vivobook (1)	Asus Vivobook (2)	HP Laptop 15
CPU Base speed	2.30 GHz	1.80 GHz	2.42 Ghz	1.30 GHz

Under low and medium load, the Victus by HP Laptop 16 consist of the highest CPU speed at 2.55 GHz and 3.60 GHz, indicating its capability to maintain a high cpu speed even under minimal load (50% to 60% memory usage or 60% to 70% memory usage), which can show its good performance for light and medium tasks. However, under high load, although HP Laptop 15 consists of a lowest cpu base speed, it consists of a higher cpu speed which is 2.31 GHz. This might be because of the CPU's ability to use some dynamic frequency scaling to increase the clock speed under heavy load, to optimize performance for heavy tasks. The Asus Vivobook (1) shows only 1.45 GHz CPU speed at high load, showing that it might struggle with intensive tasks compared to other laptops.

3. Memory In Use (Compressed)

Computer type	Victus by HP Laptop 16	Asus Vivobook (1)	Asus Vivobook (2)	HP Laptop 15
Memory Usage	Low Load			
	54%	58%	59%	53%
	Medium Load			
	63%	62%	64%	67%
	High Load			
	85%	79%	80%	72%
Memory In use (Compressed)	Low Load			
	4.4 GB (52.3 MB)	6.6 GB (348 MB)	4.8 GB (209 MB)	6.0 GB (238 MB)
	Medium Load			
	4.8 GB (173 MB)	7.4 GB (797 MB)	4.8 GB (212 MB)	7.7 GB (323 MB)
	High Load			
	6.8 GB (57.0 MB)	8.5 GB (417 MB)	6.3 GB (250 MB)	8.5 GB (285 MB)

Under all load conditions, the Victus by HP Laptop 16 shows minimal or no compressed memory usage, but the Asus Vivobook (1), Asus Vivobook (2) and HP Laptop 15 shows some amounts of compressed memory usage (around 200 to 400 MB normally). This shows that the Victus by HP Laptop 16 manages its memory more efficiently without needing to compress memory as frequently as the other laptops.

4. Memory Available

Computer type	Victus by HP Laptop 16	Asus Vivobook (1)	Asus Vivobook (2)	HP Laptop 15
Memory Available	Low Load			
	3.1 GB	5.1 GB	2.9 GB	5.6 GB
	Medium Load			
	2.8 GB	4.4 GB	2.8 GB	3.9 GB
	High Load			
	892 MB	3.3 GB	1.4 GB	3.0 GB

Based on data provided, the available memory decreases with the increase in load for both laptops. However, the Victus by HP Laptop 16 has significantly less available memory high load (892 MB) compared to the Asus Vivobook (1) (3.3 GB), Asus Vivobook (2) (1.4 GB) and HP Laptop 15 (3.0 GB). This shows that the Victus by HP Laptop 16 uses more of its memory resources under high load, which may be beneficial in performance, but could also mean less memory available for additional tasks.

5. Memory Committed

Computer type	Victus by HP Laptop 16	Asus Vivobook (1)	Asus Vivobook (2)	HP Laptop 15
Memory	Low Load			
	5.0/20.1 GB	8.2/15.0 GB	6.7/25.7 GB	7.1/16.2 GB
	Medium Load			
	7.6/19.6 GB	11.7/15.0 GB	6.8/15.7 GB	9.1/16.2 GB

Committed	High Load			
	10.9/20.1 GB	10.6/15.0 GB	8.3/15.7 GB	10.1/16.2 GB

The memory committed significantly increased with load for both laptops. However, under high load, the Victus by HP Laptop 16 commits more memory (10.9/20.1GB) compared to the Asus Vivobook (1) (10.6/15.0 GB), Asus Vivobook (2) (8.3/15.7 GB) and HP Laptop 15 (10.1/16.2 GB). This indicates that the Victus by HP Laptop 16 is more capable in handling more intensive applications and tasks compared to all of the other laptops.

6. Memory Cached

Computer type	Victus by HP Laptop 16	Asus Vivobook (1)	Asus Vivobook (2)	HP Laptop 15
Memory Cached	Low Load			
	3.0 GB	1.8 GB	1.6 GB	3.3 GB
	Medium Load			
	1.5 GB	4.4 GB	1.6 GB	3.7 GB
	High Load			
	577MB	2.5 GB	1.2 GB	3.1 GB

The memory in cache significantly increases for all of the laptops in low and medium load. However, the Victus by HP Laptop 16 has a lower memory cache (577 MB) compared to other laptops such as the Asus Vivobook (1) (2.5 GB), Asus Vivobook (2) (1.2 GB) and HP Laptop 15 (3.1 GB). This indicates that at both low and medium load, both laptops rely more on the cached memory, but the Asus Vivobook (1), Asus Vivobook (2) and HP Laptop 15 more rely on cached memory at high load compared to Victus by HP Laptop 16, which can speed up access to the frequently used data.

7. Memory Paged Pool

Computer type	Victus by HP Laptop 16	Asus Vivobook (1)	Asus Vivobook (2)	HP Laptop 15
Memory Paged pool	Low Load			
	430 MB	625 MB	772 MB	461 MB
	Medium Load			
	727 MB	699 MB	770 MB	458 MB
	High Load			
	597 MB	635 MB	773 MB	463 MB

Under all load conditions, the Asus Vivobook (2) shows a higher memory paged pool compared to the Victus by HP Laptop 16, Asus Vivobook (1) and HP Laptop 15. For example, the Asus Vivobook (2) has 773 MB compared to the Victus by Hp Laptop 16 that has 597 MB. This suggested that more memory is being used for paged operations in Asus Vivobook.

8. Memory Non-paged Pool

Computer type	Victus by HP Laptop 16	Asus Vivobook (1)	Asus Vivobook (2)	HP Laptop 15
Memory	Low Load			
	653 MB	424 MB	1002 MB	542 MB
	Medium Load			
	912 MB	452 MB	999 MB	540 MB

Non-paged pool	High Load			
	862 MB	450 MB	1003 MB	544 MB

Under all load conditions, the Asus Vivobook (2) shows a highest memory non-paged pool compared to the Asus Vivobook (1), Victus by HP Laptop 16, and HP Laptop 15. For example, the memory non-paged pool is higher in the Asus Vivobook (2) under high load (1003 MB) compared to the Asus Vivobook (1) (450 MB). This could indicate that the Asus Vivobook (2) is allocating more memory for critical operations that cannot be paged, contributing to better performance under stress.

MiniTool Partition Wizard

1. Sequential mode stress test

The sequential mode stress test results for the four laptops reveal notable differences in their ability to handle continuous data streams. The HP Victus by HP laptop 16-d0xxx consistently shows the highest performance across various block sizes, with remarkable sequential read speeds such as 542.815 MB/s for 4KB and 2101.75 MB/s for 16KB, and write speeds reaching up to 3319.91 MB/s for 32KB. This indicates a strong capability for handling large, contiguous data transfers efficiently. The Asus Vivobook(1) performs moderately well, with a peak sequential read speed of 745.602 MB/s for 32KB and a write speed of 902.951 MB/s for the same block size, positioning it as a solid performer, albeit not at the top. The HP Laptop 15-fd0xxx shows competitive read speeds, especially in higher block sizes like 32KB where it reaches 1136.83 MB/s, and also performs decently in write operations. However, the Asus Vivobook(2) lags significantly behind, particularly in smaller block sizes, with a read speed of just 44.8125 MB/s for 4KB, indicating less efficiency in handling sequential data transfers. Overall, the HP Victus stands out as the best choice for tasks requiring high sequential read/write speeds, while the other models show varying levels of adequacy depending on the specific needs.

2. Random mode stress test

The random mode stress test results illustrate distinct performance disparities among the four laptops, highlighting their efficiency in handling non-contiguous data access

patterns. The HP Victus by HP laptop 16-d0xxx again emerges as the leader, delivering superior random read and write speeds across various block sizes. It achieves notable speeds such as 950.972 MB/s for 4KB random read and 2463.22 MB/s for 16KB random write, underscoring its capability for efficiently managing random data access, which is critical for multitasking and running complex applications. The HP Laptop 15-fd0xxx also performs well, particularly in random read operations, with speeds like 985.448 MB/s for 32KB, though it shows mixed results in write speeds, with a significant drop to 70.9316 MB/s for 32KB random write. The Asus Vivobook(1) maintains a balanced performance, showing good random read speeds such as 641.888 MB/s for 32KB and decent write speeds, though not at the top tier. The Asus Vivobook(2), however, struggles significantly in random operations, with lower speeds across all block sizes, particularly evident in its 22.1172 MB/s for 16KB random write. These results suggest that the HP Victus is the best suited for scenarios requiring high random read/write performance, followed by the HP Laptop 15-fd0xxx and Asus Vivobook(1), while the Asus Vivobook(2) may not be the ideal choice for such tasks.

3.0 Benchmarking Results

3.1 Overview

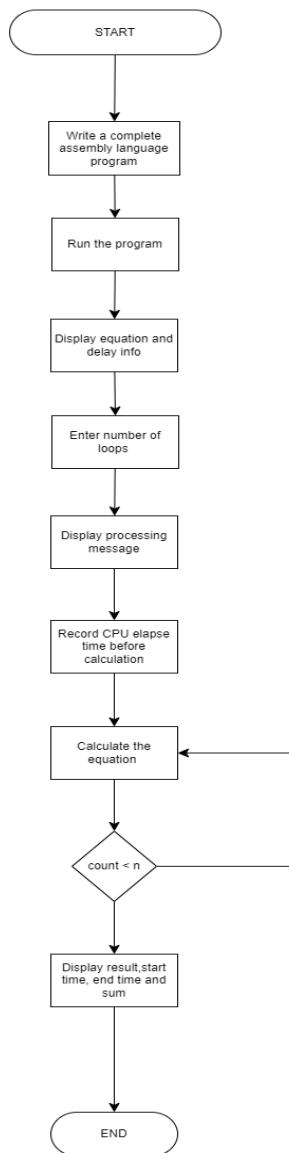
This project involves writing an assembly language program to benchmark the performance of a polynomial equation computation by measuring the execution time for different loops.

The polynomial equation used for benchmarking is:

$$y = (a * x^3) + (b * x^2) + c * x + d$$

where a,b,c and d are coefficients of delay and x is an integer input value.. The coefficients are derived from specific dates, such as birthdays, and are used to introduce a delay factor in milliseconds. The project aims to measure and compare the CPU execution time for different loop counts to evaluate performance under varying loads.

3.2 Flowchart of Execution



3.3 Coding and Implementation

TITLE Project COA

; Author: Group

; Group member :

; 1. Sabrina Heng Wei Qi

; 2. Chua Jia Lin

; 3. Goh Jiale

; 4. Gui Kah Sin

; Date: 29 June 2023

include Irvine32.inc

.data

welcomeMsg BYTE "Welcome to CPU Benchmark Program", 0

equationMsg BYTE "Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 +
11*x + 23", 0

delayMsg BYTE " (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)", 0

promptMsg BYTE "Enter Number of looping (N) = ", 0

processingMsg BYTE "CPU time Stress Test in progress...", 0

resultMsg BYTE "Result:", 0

startTimeMsg BYTE "First Capture Execution time in millisecond: ", 0

endTimeMsg BYTE "Second Capture Execution time in millisecond: ", 0

elapsedTimeMsg BYTE "Different Execution time in millisecond: ", 0

sumMsg BYTE "Value of Sum from the Stress Test (polynomial) = ", 0

N DWORD ? ; Number of Loop

sum WORD ? ; Sum of y

coef1 DWORD 27

coef2 DWORD 23

coef3 DWORD 11

coef4 DWORD 23

startTime DWORD ?

endTime DWORD ?

```
.code
main PROC
; Display welcome message
mov edx, OFFSET welcomeMsg
call WriteString
call Crlf
call Crlf

; Display equation and delay info
mov edx, OFFSET equationMsg
call WriteString
call Crlf
mov edx, OFFSET delayMsg
call WriteString
call Crlf
call Crlf

; Get number of loops from user
mov edx, OFFSET promptMsg
call WriteString
call ReadInt
mov N, eax

; Display processing message
mov edx, OFFSET processingMsg
call WriteString
call Crlf
call Crlf

; Capture start time
call GetMseconds
mov startTime, eax
```

; Main computation loop

mov ecx, 1

; Initialize sum to 0

mov sum, 0

L1:

; Calculate $y = 5 * x^3 + 8 * x^2 + 15 * x + 10$

mov eax, coef1

call Delay

mul cx ; $5 * x$

mul cx ; $5 * x^2$

mul cx ; $5 * x^3$

mov dx, ax ; store in dx first

mov eax, coef2

call Delay

mul cx ; $8 * x$

mul cx ; $8 * x^2$

add dx, ax ; $5 * x^3 + 8 * x^2$ and store in dx first

mov eax, coef3

call Delay

mul cx ; $15 * x$

add dx, ax ; add $5 * x^3 + 8 * x^2 + 11 * x$ and store inside dx

mov eax, coef4

call Delay

add dx, ax ; $27 * x^3 + 23 * x^2 + 11 * x + 23$

add sum, dx ; Add result(y) to sum

inc ecx ; Increase looping count by 1

cmp ecx, N ; Compare with max_loop to prevent over max_loop

```
jle L1
```

```
; Capture end time
```

```
call GetMseconds
```

```
mov endTime, eax
```

```
; Display results
```

```
mov edx, OFFSET resultMsg
```

```
call WriteString
```

```
call Crlf
```

```
call Crlf
```

```
; Display Start Time
```

```
mov edx, OFFSET startTimeMsg
```

```
call WriteString
```

```
mov eax, startTime
```

```
call WriteDec
```

```
call Crlf
```

```
; Display End Time
```

```
mov edx, OFFSET endTimeMsg
```

```
call WriteString
```

```
mov eax, endTime
```

```
call WriteDec
```

```
call Crlf
```

```
; Display Elapsed Time
```

```
mov edx, OFFSET elapsedTimeMsg
```

```
call WriteString
```

```
mov eax, endTime
```

```
sub eax, startTime
```

```
call WriteDec
```

```
call Crlf
```

```
; Display Sum of the y
mov edx, OFFSET sumMsg
call WriteString
mov ax, sum
call WriteDec
call Crlf

exit
main ENDP
```

END main

3.4 Implementation/Execution and Results

Screenshot of Output

When N=50 :

Asus VivoBook (1) :

```
Welcome to CPU Benchmark Program
Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
    (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 50
CPU time Stress Test in progress...

Result:
First Capture Execution time in millisecond: 50148119
Second Capture Execution time in millisecond: 50153569
Different Execution time in millisecond: 5450
Value of Sum from the Stress Test (polynomial) = 15175

C:\Users\Sabrina\Desktop\Year 1 Sem 2\COA\lab_template\lab_template\Debug\lab_template.exe (process 27440) exited with code 0.
To automatically close the console when debugging stops, enable Tools->Options->Debugging->Automatically close the console when debugging stops.
Press any key to close this window . . .
```

Asus VivoBook (2) :

```
Microsoft Visual Studio Debug X + ▾
Welcome to CPU Benchmark Program
Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
    (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 50
CPU time Stress Test in progress...

Result:
First Capture Execution time in millisecond: 81109082
Second Capture Execution time in millisecond: 81114602
Different Execution time in millisecond: 5520
Value of Sum from the Stress Test (polynomial) = 15175

C:\Users\Asus\source\repos\Project\Debug\Project.exe (process 20800) exited with code 0.
Press any key to close this window . . .
```

Victus by HP Laptop 16 :

```
Microsoft Visual Studio Debug X + ▾
Welcome to CPU Benchmark Program
Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
    (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 50
CPU time Stress Test in progress...

Result:
First Capture Execution time in millisecond: 61958643
Second Capture Execution time in millisecond: 61964116
Different Execution time in millisecond: 5473
Value of Sum from the Stress Test (polynomial) = 15175

C:\Users\Goh JiaLe\source\repos\Project COA\Debug\Project COA.exe (process 21340) exited with code 0.
Press any key to close this window . . .
```

HP Laptop 15 :

```
Microsoft Visual Studio Debug + ▾

Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
 (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 50
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 1410062
Second Capture Execution time in millisecond: 1415747
Different Execution time in millisecond: 5685
Value of Sum from the Stress Test (polynomial) = 15175

C:\Users\Stell\source\repos\projectSem2\Debug\projectSem2.exe (process 8368) exited with code 0.
Press any key to close this window . . .
|
```

When N=100 :

Asus VivoBook (1) :

```
Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
  (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 100
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 50224067
Second Capture Execution time in millisecond: 50234952
Different Execution time in millisecond: 10885
Value of Sum from the Stress Test (polynomial) = 57850

C:\Users\Sabrina\Desktop\Year 1 Sem 2\COA\lab_template\lab_template\Debug\lab_template.exe (process 6616) exited with code 0.
To automatically close the console when debugging stops, enable Tools->Options->Debugging->Automatically close the console when debugging stops.
Press any key to close this window . . .
|
```

Asus VivoBook (2) :

```
Microsoft Visual Studio Debug X + ▾

Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
  (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 100
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 81224822
Second Capture Execution time in millisecond: 81235844
Different Execution time in millisecond: 11022
Value of Sum from the Stress Test (polynomial) = 57850

C:\Users\Asus\source\repos\Project\Debug\Project.exe (process 13304) exited with code 0.
Press any key to close this window . . .
|
```

Victus by HP Laptop 16 :

```
Microsoft Visual Studio Debug X + ▾

Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
  (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 100
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 62043054
Second Capture Execution time in millisecond: 62053914
Different Execution time in millisecond: 10860
Value of Sum from the Stress Test (polynomial) = 57850

C:\Users\Goh JiaLe\source\repos\Project COA\Debug\Project COA.exe (process 21384) exited with code 0.
Press any key to close this window . . .
|
```

HP Laptop 15 :

```
Microsoft Visual Studio Debug + - 
Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
(with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 100
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 1435735
Second Capture Execution time in millisecond: 1447096
Different Execution time in millisecond: 11361
Value of Sum from the Stress Test (polynomial) = 57850

C:\Users\Stell\source\repos\projectSem2\Debug\projectSem2.exe (process 18944) exited with code 0.
Press any key to close this window . . .
```

When N=200 :

Asus VivoBook (1) :

```
Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
  (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 200
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 50275741
Second Capture Execution time in millisecond: 50297508
Different Execution time in millisecond: 21767
Value of Sum from the Stress Test (polynomial) = 29092

C:\Users\Sabrina\Desktop\Year 1 Sem 2\COA\lab_template\lab_template\Debug\lab_template.exe (process 27232) exited with code 0.
To automatically close the console when debugging stops, enable Tools->Options->Debugging->Automatically close the console when debugging stops.
Press any key to close this window . . .
```

Asus VivoBook (2) :

```
Microsoft Visual Studio Debug X + v

Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
  (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 200
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 81273659
Second Capture Execution time in millisecond: 81295719
Different Execution time in millisecond: 22060
Value of Sum from the Stress Test (polynomial) = 29092

C:\Users\Asus\source\repos\Project\Debug\Project.exe (process 18400) exited with code 0.
Press any key to close this window . . .
```

Victus by HP Laptop 16 :

```
Microsoft Visual Studio Debug X + v

Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
  (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 200
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 62086086
Second Capture Execution time in millisecond: 62107567
Different Execution time in millisecond: 21481
Value of Sum from the Stress Test (polynomial) = 29092

C:\Users\Goh JiaLe\source\repos\Project COA\Debug\Project COA.exe (process 7140) exited with code 0.
Press any key to close this window . . .
```

HP Laptop 15 :

```
Microsoft Visual Studio Debug + ▾
Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
  (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 200
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 1494318
Second Capture Execution time in millisecond: 1517254
Different Execution time in millisecond: 22936
Value of Sum from the Stress Test (polynomial) = 29092

C:\Users\Stell\source/repos\projectSem2\Debug\projectSem2.exe (process 14432) exited with code 0.
Press any key to close this window . . .
|
```

When N=500 :

Asus VivoBook (1) :

```
Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
(with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 500
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 50335931
Second Capture Execution time in millisecond: 50390352
Different Execution time in millisecond: 54421
Value of Sum from the Stress Test (polynomial) = 12994

C:\Users\Sabrina\Desktop\Year 1 Sem 2\COA\lab_template\lab_template\Debug\lab_template.exe (process 3516) exited with code 0.
To automatically close the console when debugging stops, enable Tools->Options->Debugging->Automatically close the console when debugging stops.
Press any key to close this window . . .
```

Asus VivoBook (2) :

```
Microsoft Visual Studio Debug x + ▾

Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
(with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 500
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 81407148
Second Capture Execution time in millisecond: 81462269
Different Execution time in millisecond: 55121
Value of Sum from the Stress Test (polynomial) = 12994

C:\Users\Asus\source\repos\Project\Debug\Project.exe (process 19528) exited with code 0.
Press any key to close this window . . .
```

Victus by HP Laptop 16 :

```
Microsoft Visual Studio Debug x + ▾

Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
(with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 500
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 62135026
Second Capture Execution time in millisecond: 62189970
Different Execution time in millisecond: 54944
Value of Sum from the Stress Test (polynomial) = 12994

C:\Users\Goh JiaLe\source\repos\Project COA\Debug\Project COA.exe (process 9880) exited with code 0.
Press any key to close this window . . .
```

HP Laptop 15 :

```
Microsoft Visual Studio Debug + ▾
Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
  (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 500
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 1542780
Second Capture Execution time in millisecond: 1599703
Different Execution time in millisecond: 56923
Value of Sum from the Stress Test (polynomial) = 12994

C:\Users\Stell\source/repos\projectSem2\Debug\projectSem2.exe (process 6456) exited with code 0.
Press any key to close this window . . .
|
```

When N=700 :

Asus VivoBook (1) :

```
Welcome to CPU Benchmark Program  
Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23  
    (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)  
Enter Number of looping (N) = 700  
CPU time Stress Test in progress...  
  
Result:  
First Capture Execution time in millisecond: 50423467  
Second Capture Execution time in millisecond: 50499641  
Different Execution time in millisecond: 76174  
Value of Sum from the Stress Test (polynomial) = 93510  
  
C:\Users\Sabrina\Desktop\Year 1 Sem 2\COA\lab_template\lab_template\Debug\lab_template.exe (process 29776) exited with code 0.  
To automatically close the console when debugging stops, enable Tools->Options->Debugging->Automatically close the console when debugging stops.  
Press any key to close this window . . .
```

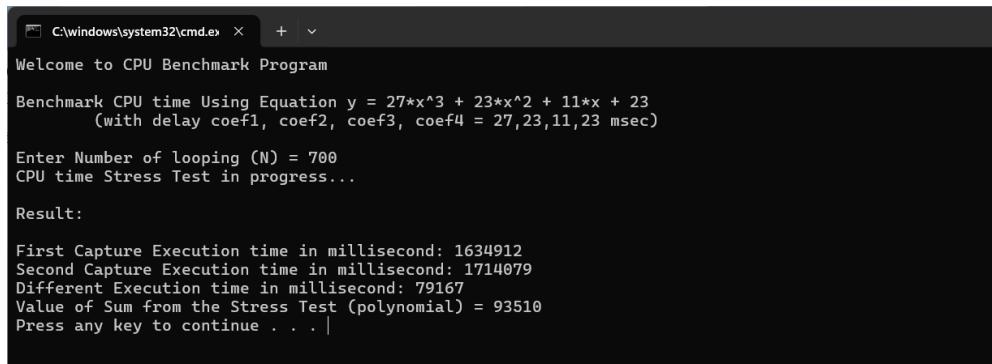
Asus VivoBook (2) :

```
Microsoft Visual Studio Debug X + ▾  
Welcome to CPU Benchmark Program  
Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23  
    (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)  
Enter Number of looping (N) = 700  
CPU time Stress Test in progress...  
  
Result:  
First Capture Execution time in millisecond: 81502502  
Second Capture Execution time in millisecond: 81579698  
Different Execution time in millisecond: 77196  
Value of Sum from the Stress Test (polynomial) = 93510  
  
C:\Users\Asus\source\repos\Project\Debug\Project.exe (process 7728) exited with code 0.  
Press any key to close this window . . .
```

Victus by HP Laptop 16 :

```
Microsoft Visual Studio Debug X + ▾  
Welcome to CPU Benchmark Program  
Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23  
    (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)  
Enter Number of looping (N) = 700  
CPU time Stress Test in progress...  
  
Result:  
First Capture Execution time in millisecond: 62213423  
Second Capture Execution time in millisecond: 62290431  
Different Execution time in millisecond: 77008  
Value of Sum from the Stress Test (polynomial) = 93510  
  
C:\Users\Goh JiaLe\source\repos\Project COA\Debug\Project COA.exe (process 13736) exited with code 0.  
Press any key to close this window . . .
```

HP Laptop 15 :



C:\windows\system32\cmd.exe + ^

Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation $y = 27*x^3 + 23*x^2 + 11*x + 23$
(with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 700
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 1634912
Second Capture Execution time in millisecond: 1714079
Different Execution time in millisecond: 79167
Value of Sum from the Stress Test (polynomial) = 93510
Press any key to continue . . . |

When N=1000 :

Asus VivoBook (1) :

```
Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
  (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 1000
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 50540278
Second Capture Execution time in millisecond: 50649128
Different Execution time in millisecond: 108850
Value of Sum from the Stress Test (polynomial) = 89012

C:\Users\Sabrina\Desktop\Year 1 Sem 2\COA\lab_template\lab_template\Debug\lab_template.exe (process 5948) exited with code 0.
To automatically close the console when debugging stops, enable Tools->Options->Debugging->Automatically close the console when debugging stops.
Press any key to close this window . . .
|
```

Asus VivoBook (2) :

```
Microsoft Visual Studio Debug X + ▾

Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
  (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 1000
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 81613702
Second Capture Execution time in millisecond: 81723960
Different Execution time in millisecond: 110258
Value of Sum from the Stress Test (polynomial) = 89012

C:\Users\Asus\source\repos\Project\Debug\Project.exe (process 20100) exited with code 0.
Press any key to close this window . . .
|
```

Victus by HP Laptop 16 :

```
Microsoft Visual Studio Debug X + ▾

Welcome to CPU Benchmark Program

Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23
  (with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)

Enter Number of looping (N) = 1000
CPU time Stress Test in progress...

Result:

First Capture Execution time in millisecond: 62317899
Second Capture Execution time in millisecond: 62428241
Different Execution time in millisecond: 110342
Value of Sum from the Stress Test (polynomial) = 89012

C:\Users\Goh JiaLe\source\repos\Project COA\Debug\Project COA.exe (process 21624) exited with code 0.
Press any key to close this window . . .
|
```

HP Laptop 15 :

```
C:\windows\system32\cmd.exe + - Welcome to CPU Benchmark Program  
Benchmark CPU time Using Equation y = 27*x^3 + 23*x^2 + 11*x + 23  
(with delay coef1, coef2, coef3, coef4 = 27,23,11,23 msec)  
Enter Number of looping (N) = 1000  
CPU time Stress Test in progress...  
Result:  
First Capture Execution time in millisecond: 1748232  
Second Capture Execution time in millisecond: 1860704  
Different Execution time in millisecond: 112472  
Value of Sum from the Stress Test (polynomial) = 89012  
Press any key to continue . . . |
```

Result:

Asus VivoBook (1) :

No of Loop (N)	Capture_msec (before)	Capture_msec (after)	CPU_msec (different)
50	50148119	50153569	5450
100	50224067	50234952	10885
200	50275741	50297508	21767
500	50335931	50390352	54421
700	50423467	50499641	76174
1000	50540278	50649128	108850

Asus VivoBook (2) :

No of Loop (N)	Capture_msec (before)	Capture_msec (after)	CPU_msec (different)
50	81109082	81114602	5520
100	81224822	81235844	11022
200	81273659	81295719	22060
500	81407148	81462269	55121
700	81502502	81579698	77196
1000	81613702	81723960	110258

Victus by HP Laptop 16 :

No of Loop (N)	Capture_msec (before)	Capture_msec (after)	CPU_msec (different)

50	61958643	61964116	5473
100	62043054	62053914	10860
200	62086086	62107567	21481
500	62135026	62189970	54944
700	62213423	62290431	77008
1000	62317899	62428241	110342

HP Laptop 15 :

No of Loop (N)	Capture_msec (before)	Capture_msec (after)	CPU_msec (different)
50	1410062	1415747	5685
100	1435735	1447096	11361
200	1494318	1517254	22936
500	1542780	1599703	56923
700	1634912	1714079	79167
1000	1748232	1860704	112472

3.5 Analysis, Comparison, Discussion

CPU elapsed time refers to the total time taken from the start to the end of a process. This includes the time the CPU spends actively processing the task and also any additional time spent waiting for resources such as I/O operations, other processes, or network responses.

After writing the assembly program completely, we run the program to observe the CPU elapsed time by looping the program for 50, 100, 200, 500, 700, and 1000 times using the "Start Without Debugging" function on the 4 laptops. By using the "call GetMseconds" function, we can get the number of milliseconds that have elapsed since midnight.

Computer	CPU Elapsed Time (msec) for N Loops					
	50	100	200	500	700	1000
Asus VivoBook (1)	5450	10885	21767	54421	76174	108850
Asus VivoBook (2)	5520	11022	22060	55121	77196	110258
Victus by HP Laptop 16	5473	10860	21481	54944	77008	110342
HP Laptop 15	5685	11361	22936	56923	79167	112472

At 50 loops :

- Asus VivoBook (1) : 5450 ms
- Asus VivoBook (2) : 5520 ms
- Victus by HP Laptop 16 : 5473 ms
- HP Laptop 15 : 5685 ms

At 50 loops, all four laptops have similar elapsed times, with only small differences. The Asus VivoBook (1) is faster than the Victus by HP Laptop 16 and the Asus VivoBook (2), whereas the HP Laptop 15 is the slowest. However, the difference is not significant.

At 100 loops :

- Asus VivoBook (1) : 10885 ms
- Asus VivoBook (2) : 11022 ms
- Victus by HP Laptop 16 : 10860 ms
- HP Laptop 15 : 11361 ms

At 100 loops, the Victus by HP Laptop 16 has the shortest elapsed time followed by Asus VivoBook (1), Asus VivoBook (2), and lastly HP Laptop 15. The HP Laptop 15 is still the slowest laptop at 100 loops.

At 200 loops :

- Asus VivoBook (1) : 21767 ms
- Asus VivoBook (2) : 22060 ms
- Victus by HP Laptop 16 : 21481 ms
- HP Laptop 15 : 22936 ms

At 500 loops, the performance differences become more obvious. The Victus by HP Laptop 16 again shows better performance compared to the two Asus VivoBooks, which have similar CPU elapsed times. The HP Laptop 15 has the longest elapsed time, indicating it gets slower as the workload increases.

At 500 loops :

- Asus VivoBook (1) : 54421 ms
- Asus VivoBook (2) : 55121 ms
- Victus by HP Laptop 16 : 54944 ms
- HP Laptop 15 : 56923 ms

At 500 loops, the Asus VivoBook (1) is faster than the Victus by HP Laptop 16 and the Asus VivoBook (2), whereas the HP Laptop 15 is the slowest indicating it struggles most with the heavy workloads.

At 700 loops :

- Asus VivoBook (1) : 76174 ms
- Asus VivoBook (2) : 77196 ms
- Victus by HP Laptop 16 : 77008 ms
- HP Laptop 15 : 79167 ms

At 700 loops, the Asus VivoBook (1) has the shortest elapsed time followed by the Victus by HP Laptop 16, Asus VivoBook (2), and lastly HP Laptop 15. The HP Laptop 15 is the slowest laptop at 700 loops.

At 1000 loops :

- Asus VivoBook (1) : 108850 ms
- Asus VivoBook (2) : 110258 ms
- Victus by HP Laptop 16 : 110342 ms
- HP Laptop 15 : 112472 ms

At 1000 loops, the performance differences become more significant. The Asus VivoBook (1) has the best performance, followed by Asus VivoBook (2), Victus by HP Laptop 16, and lastly HP Laptop 15.

In conclusion, the Asus VivoBook (1) and Victus by HP Laptop 16 perform well across all categories because they have the shortest or second shortest CPU elapsed time in all categories. The Asus VivoBook (2) has moderate performance in all categories whereas the HP Laptop 15 has the longest CPU elapsed time in all categories. It requires the longest time to perform the tasks, indicating it is less capable under heavy processing demands.

4.0 Conclusion and Reflection

4.1 Conclusion

In conclusion, the CPU benchmarking and performance comparison among the four laptops reveal distinct strengths and weaknesses. Based on the overall performance, the HP Victus by HP Laptop 16 stands out with the highest core speed, making it ideal for demanding tasks like video editing and data analysis due to its powerful i7 processor. It emerges as the best choice for those who need a high-performing machine capable of handling intensive tasks.

For users with more general productivity needs or who seek a balance between performance and cost, the HP Laptop 15 and Asus VivoBook (1) offer excellent versatility and efficiency. The Asus VivoBook (2) is a great choice for those who prioritize multitasking capabilities with its higher RAM capacity. Comparing the Asus VivoBook (1) and (2), both offer balanced performance suitable for everyday use, with the latter having an advantage in multitasking due to its higher RAM capacity. The HP Laptop 15, despite having the latest generation processor, shows lower core speed but compensates with a higher RAM capacity, making it better suited for multitasking and basic computing tasks.

In contrast to benchmarking performance, the analysis of the CPU elapsed durations reveals a slightly different result. The Asus VivoBook (1) performs exceptionally well in this section, defeating the best of previous benchmarking, the HP Victus by HP Laptop 16, with the lowest CPU elapsed times throughout five out of six loops. It is followed by the HP Victus by HP Laptop 16 and the Asus VivoBook (2), both slightly longer, with the former being shorter and having the lowest in one out of six loops. But of the four laptops in this section, the HP Laptop 15, which lags just behind the HP Laptop 16 in benchmarking performance, has the longest CPU elapsed time because of an accident that resulted in the loss of 4 GB of DDR4 RAM owing to water damage.

Overall, each laptop has its niche, with the HP Victus by HP Laptop 16 excelling in performance-intensive tasks and the Asus VivoBook (1) showing efficient CPU elapsed times. While the other two are more versatile for general productivity, multitasking, and light multimedia editing. Therefore, users must select the right laptop depending on their own needs, specific requirements, and use case.

4.2 Reflection

Throughout this project, our group has gained invaluable insights into CPU benchmarking and performance comparison. The collaborative effort involved in analyzing and comparing different laptop configurations has significantly enhanced our collective understanding of the factors influencing computing performance. This experience has not only improved our technical skills but also highlighted the importance of teamwork and thorough research in achieving comprehensive results.

We would like to express our sincere gratitude to Dr. Farkhana Binti Muchtar for her guidance and support throughout this project. Her prompt and insightful feedback has been instrumental in the progress and direction of our work. The constructive advice and step-by-step guidance by Dr. have helped us overcome challenges and enabled us to declutter our thoughts as well as a deeper understanding of the project matter. We are truly thankful for the opportunity to learn from such a friendly and dedicated lecturer, and we look forward to applying the lessons learned in future endeavors.

Sabrina Heng Wei Qi: From this final project for the Computer Organisation and Architecture course, I have learned about CPU benchmarking knowledge and more understandable for my computer spec such as processor, type of memory in computer and more. Otherwise, this is the first time I try using all of the benchmarking tools such as CPU-Z, Task Manager, Geekbench and Minitool Partition Wizard. It was a great experience for me! Moreover, as this project is done in a group, I felt glad to have helpful and kind teammates that teach me a lot of benchmarking theory. We have good communication and everyone gives their suggestions which make the process become more interesting. Lastly, I would like to thank my lecturer, Dr Farkhana Binti Muchtar who will always give us a response when we have any question during the project.

Chua Jia Lin: In this project, I have a great opportunity to learn about the computer hardware and performance evaluation using the benchmarking tools such as CPU-Z, Geekbench, MiniTool Partition Wizard and Task Manager. During the benchmarking process, I gained a better understanding of my laptop's hardware specifications. Besides, I also learn how different hardware components contribute to overall system performance from this project. Lastly, I am here deeply grateful to Dr. Farkhana Binti Muchtar for her guidance and support throughout this project.

Goh Jiale: Through this project, I have gained a more in-depth understanding of my computer and learned how to discover its specifications. Additionally, I learned to code in .asm format, including looping, declaring attributes, and using word types in assembly language. Furthermore, I realized that communication and teamwork are crucial to success through the collaboration with all my teammates on this project. Last but not least, we really appreciate the contribution and leadership of our lecturer, Dr. Farkhana Binti Muchtar, who provided full support not only academically but also mentally throughout this project. I have learned a lot through this project, and it has been a valuable experience in my study journey.

Gui Kah Sin: In my perspective, the project has gained me a deeper understanding of CPU benchmarking and the configurations of my own laptop. I have learned using distinct benchmarking performance such as CPU-Z, GeekBench, Task Manager, and MiniTool Partition Wizard testing on several laptop models. Besides, working collaboratively with my team has taught me the importance of communication, teamwork, and a leader in achieving a common goal. I am deeply grateful to Dr. Farkhana Binti Muchtar for her valuable guidance. Last but not least, I have understood what to consider when purchasing a laptop to meet the demands.

References

1. Benchmarks as Fast As Possible.
<https://youtu.be/cHtNJngtS1I>
2. Best CPU Benchmark Software For Windows.
<https://youtu.be/fgWGtWsDXmw>
3. First 5 Things I Do When Benchmarking.
<https://youtu.be/19eUZ0GwTxI>
4. What's the Difference Between a CPU and a GPU?
<https://blogs.nvidia.com/blog/2009/12/16/whats-the-difference-between-a-cpu-and-a-gpu/>

5. Download CPU-Z

<https://www.cpuid.com/softwares/cpu-z.html>

6. Download GeekBench

<https://www.geekbench.com/download/>

7. Download MiniTool Partition Wizard Free 12.8

<https://www.partitionwizard.com/free-partition-manager.html>

8. How To Fix High RAM/Memory Usage on Windows 10 [Complete Guide]

<https://www.youtube.com/watch?v=osKnDbHibig>

Appendices

1. Task Distribution

Person in Charge	Task
Chua Jia Lin	<ul style="list-style-type: none">• Intro (Research and basics of CPU benchmarking)• CPU Z (Setup, Data collection, benchmarking result, and result analysis)• Implementation/Execution and Results• Analysis, Comparison, Discussion
Gui Kah Sin	<ul style="list-style-type: none">• Intro (Scopes - Different Types of Benchmarks)• GeekBench (Setup, Data collection, benchmarking result, and result analysis)• Conclusion and Overall Reflection• Reference and Appendix
Sabrina Heng Wei Qi	<ul style="list-style-type: none">• Intro (Project aim, objectives and scopes) +• Minitool (Setup, Data collection, benchmarking result, and result analysis)• Overview

	<ul style="list-style-type: none"> • Flowchart of Execution
Goh Jiale	<ul style="list-style-type: none"> • Part 1 (Overview, Flowchart) • Task Manager (Setup, Data collection, benchmarking result, and result analysis) • Result Analysis, Comparison and Discussion • Coding and Implementation

2. Group Picture While Meeting

