* **(46p) Foundation**

Introduction to Parallel Computing and the Raspberry Pi.pdf)

* + **(5p) Identifying the components on the raspberry PI B+**
    - The Raspberry Pi Model B+ consist of a 1.4 GHz Quad-Core 64-bit ARM Cortex-A53 processor with 512 KB of shared L2 cache. It also contains 1 GB of SDRAM, which is shared with the GPU. For input/output functionalities, it has four USB 2.0 ports, a 15-pin MIPI camera interface connector, one HDMI port for video/audio out, a 3.5 mm phone jack for audio input/output, a (300 Mbit/s) Gigabit Ethernet port, built in 2.4/5 GHz dual band Wi-Fi technology, Bluetooth 4.2, a Micro-USB port for power input (5 V), a MicroSD slot, and a 40-pin GPIO for various functionalities. **(1)**
  + **(5p) How many cores does the Raspberry Pi’s B+ CPU have**
    - The Raspberry Pi B+ contains four ARMv7 Processors (4th Revision). **(2)**
  + **(8p) List four main differences between X86 (CISC) and ARM Raspberry PI (RISC).**
  + **Justify you answer and use your own words (do not copy and paste**

1. The Intel x86 supports a larger Instruction Set:
   * + - The Intel x86 is a CISC (Complex Instruction Set Computing) processor and its instruction set contains about 1000 different kinds of operation mnemonics that it can execute. **(3)** The Raspberry PI ARM processor is a RISC (Reduced Instruction Set Computing) processor and its instruction set contains less than 100 mnemonic instructions. **(4)** The CISC processors’ instructions are more complex and allow for more options in its instructions to manipulate data. CISC instruction set also contains a better support for memory access than its RISC counterpart.
2. CISC processors have less registers than RISC processors.
   * + - This is due to the fact that CISC processors’ have a more extensive instructions that support data management and does not need more registers to do this sort of tasks.**(4)** The ARM processor contains 16 integer registers and 32 floating point registers compared to the Intel x86 which only contains 8 General-Purpose registers, and 8 Special-Purpose registers. **(5)**
3. ARM processors provide conditional execution
   * + - The ARM processor also provides the capabilities for condition execution. This allows for an instruction to be executed or ignored based on the result of a status of a flag in the flag register. This option is not available in the Intel x86 processor. **(6)**
4. ARM processors provide Bi-Endian capabilities
   * + - ARM processors version 3 and above have BI-Endian capabilities. This allows for the processor to switch between little-endian and big-endian format when accessing information from memory. This option is controlled by either a hardware setting or software. **(7)** Intel x86 processors do not support this capabilities.
   * **(6p) what is the difference between sequential and parallel computation and identify the practical significance of each?**
     + Sequential or serial computing involves the process of breaking a problem into individual parts and executing them sequentially from start to finish. This process would be very similar to a factory assembly line where a complex problem can be executed one step at a time.
     + Parallel computation on the other hand, would also involve breaking the problem into individual parts. But unlike sequential computing, the parallel process would execute the instructions concurrently by coordinating and managing every aspect of the process.
   * **(5p) identify the basic form of data and task parallelism in computational problems.**
   * **(6p) Explain the differences between processes and threads.**
   * **(3p) what is OpenMP and what is OpenMP pragmas?**
   * **(4p) what applications benefit from multi-core (list four)?**
   * **(4p) Why Multicore? (why not single core, list four)**

**Citation:**

1. “Raspberry Pi.” *Wikipedia*, Wikimedia Foundation, 29 Sept. 2018, en.wikipedia.org/wiki/Raspberry\_Pi.
2. **Command Prompt: cat /proc/cpuinfo**
3. Heule, Stefan C. “Stefan c Heule.” *How Many x86-64 Instructions Are There Anyway?*, stefanheule.com/blog/how-many-x86-64-instructions-are-there-anyway/.
4. **“Arm Processor vs. Intel Processor” Handout**
5. “ARM Assembler in Raspberry Pi - RPi Labs.” *ARM Assembler in Raspberry Pi ·*, rpi.science.uoit.ca/lab/arm/#registers.
6. *ARM Information Center*, infocenter.arm.com/help/index.jsp?topic=%2Fcom.arm.doc.kui0100a%2Farmasm\_cegihjgh.htm.
7. “Endianness.” *Wikipedia*, Wikimedia Foundation, 30 Sept. 2018, en.wikipedia.org/wiki/Endianness.