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Tutorial 02 – System Fundamentals
Operating Systems Principles and Programming [18ECSC202]

Semester: IV   Batch: C   Slot: Week 02

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Note:
- This assignment needs to be done in a team of 2
- The submission needs to made to prakash.hegade@kletech.ac.in with the subject line: OSPP Tutorial 02 Submission
- The submitted file must contain name and roll number of both teammates
- Include appropriate screenshots wherever necessary
- Programs must also include output screenshots as necessary

PART I

1. Imagine a graph that consists of directional links between nodes identified by small non-negative integers $< 2^{16}$. We define a "cycle" in the graph as a nonempty set of links that connect a node to itself. Imagine an application that allows insertion of links, but wants to prevent insertion of links that close cycles in the graph.

For example, starting from an empty graph, inserting a link $1 \to 2$ succeeds, but inserting a second link $2 \to 1$ would fail, since it would close the cycle $1 \to 2 \to 1$.

In the programming language of your choice, declare data structures to represent your graph, and write a code for an "insert_link" function that fails if a new link would close a cycle.

What, roughly, is the space- and time-complexity of your solution?   **10 Points**

2a. Write a function that returns a node in a tree given two parameters:
- Pointer to the root node
- The in-order traversal number of the node that must be returned

The only information stored in the tree is the number of children for each node.

2b. Write a function that given a list of items and weights, returns a random item in the list, taking the weights into account.   **10 Points**

3. Function calls are typically implemented by an instruction or an instruction sequence (the calling sequence) that pushes certain information on the stack. Calls to interrupt handlers typically begin with the hardware's interrupt transfer mechanism followed by some instructions to push certain information on the stack.

3a. What is the difference between the information pushed on the stack by a typical function call and by response to a typical interrupt?

3b. Is it possible to checkpoint or save the state of a running Linux process, and then resume the same process on a Windows system? Discuss how this could be done, or what factors make this not possible. **10 Points**

4. Implement the following file related programs. Read and explore the "dirent.h" header file for file APIs.

4a. List all files in the current directory.

4b. Modify a <filename>.<ext> to <filename>-<ISODATE>.<ext>, where <ISODATE> is the current date (read from the system) in ISO 8601 format.
Example: hello.c would become hello-20210429 if the program is invoked on April 29, 2021. **10 Points**

5. There are around 98.1 million prime numbers less than 2×10^9 and a standard ASCII file containing all of them, separated by spaces is about 639 MB in size. Write a C program to compute and output to a file all the prime numbers less than 2×10^9, using the standard "sieve" method.

How much time did it take to generate the output file?

Cross-compile the program on Windows to obtain a binary for Linux OS using appropriate GCC. Mention and write in detail on what steps did you follow for the cross-compiling. What is the size of your binary? Submit appropriate proofs to validate that you have generated the cross-compiled binary. **10 Points**

PART II

6. Download and install the Gnu PG application from http://gnupg.org. You can find windows version here https://www.gpg4win.org/.

Create a 2048-bit ELG-E key pair for yourself giving your e-mail address, and submit the public key to the MIT key server pgp.mit.edu. Also submit the same key in your assignment. Use this question pdf (os-tute-02.pdf) and make an ASCII detached signature of that file using your own key. Submit this detached signature as well.   **10 Points**

7. What do the following sites talk about?
   * http://gcc.gnu.org/install/test.html
   * http://coremark.org/home.php

What are GCC standard test suites and why are they important? What is CoreMark benchmarking software? Prepare a report of what you understood after going through the websites.   **10 Points**

PART III

8. Look up the technical data sheet and other published information for your laptop's battery. If not visible, get the specs from the internet for the battery you have. Then, assuming that the battery is in fairly good condition (so that the specs apply), do the following:

Measure the discharge rate of the battery carefully while executing a given type of program (you can consider running assignment 5 question to generate and output primes) over a range of input values. Note that it is better to take the average of multiple observations, rather than a single observation.

Now, based on the published technical data as well as your experimental data, compute a parameter which we may call the specific energy consumption for your laptop, giving the amount of energy consumed per unit task.   **20 Points**

9. The pwgen program is a small and useful password generating program, available from http://sourceforge.net/projects/pwgen/.

Download it and inspect its source code. Does the pwgen source code adhere to the ISO/IEC 9899:2018 (aka C17) standard? Prepare a report.

Note: You can refer to standards in the pdf here:
http://www.open-std.org/jtc1/sc22/wg14/www/docs/n2310.pdf   **20 Points**

"Break a Leg"
- Prakash Hegade