

NYU, Tandon School of Engineering

Bridge to Computer Science Program

4th Exam

Thursday 29 October 2021

- You have two hours
- There are 100 points total.
- Note that there are longer problems at the end. Be sure to allow enough time for these.
- We supplied you with a file, named 'solutions.txt', where you should type all your answers.
- Write your name, netID and NYU ID at the head of the solutions file.
- For editing this file, you are allowed to use only plain text editors (Notepad for Windows users, or textEdit for Mac users).
- You are permitted to use Visual Studio (C++), CLion or XCode as compilers. And Textedit/Notepad for text editing
- Calculators are not allowed.
- This is a closed-book exam. No additional resourced are allowed.
- Pay special attention to the style of your code. Indent your code correctly, choose meaningful names for your variables, define constants where needed, choose most suitable control statements, etc.
- In all questions you may assume that the users enter inputs as they are asked. For example, if the program expects a positive integer, you may assume that users will enter positive integers.
- No need to document your code in this exam, but you may add comments if you think they are needed for clarity.
- Read every question completely before answering it.
- When done, please upload your answer file to Brightspace.nyu.edu, Gradescope and email to dkatz@nyu.edu

- 1) (3 pts) Given `int* ptr = new int(100);` What number is stored in `ptr` after that code executes?
 - a. An integer (100)
 - b. A virtual memory address
 - c. A physical memory address
 - d. A register
- 2) (3 pts) Linux's Kernel slab memory allocator works by taking "chunks" of 4MB of physical memory and allocating 4MB, 2MB, 1MB, 0.5MB or 0.25MB (or smaller in the pattern) whenever the kernel needs internal memory allocation. What kind of memory allocation system would this be classified as?
 - a. Buddy System
 - b. Fixed Partitioning
 - c. Dynamic partitioning
 - d. Paging
- 3) (3 pts) A new protocol will be designed which will provide a unique identifier for every machine in the world and a mechanism for grouping those machines. This would, most likely be classified as which layer in OSI?
 - a. Application (7)
 - b. Presentation (6)
 - c. Transport (4)
 - d. Network (3)
- 4) (3 pts) A TCP connection begins with a packet sent from the client to the server with the _____ flag set to 1.
- 5) (3 pts) In DNS, the slave servers know when it's time to re-download the domain from the master when they detect a change in the _____ field in the domain's SOA record.
- 6) (15 pts) Persistent HTTP connections tend to perform better than non-persistent connections since they minimize the amount of traffic. Explain why this is true in a scenario where 5 files will be downloaded from the same website.
- 7) (10 points) In designing an application with multiple threads, explain how you, as the programmer, would identify critical sections in your code and what you could do to protect those sections.
- 8) (15 pts) An operating system has recognized that it is severely running out of free frames of memory. To try to help, the OS has decided it will suspend a process. The OS will either suspend the largest process (measuring the resident set size), the smallest process or the one which most recently faulted. List and explain the benefits and disadvantages associated with each of those three options.
- 9) (10 pts) In a system which uses paging and a page size of 10000 bytes. Provide the physical memory address calculated in the MMU if the process is accessing virtual address 23741 and the Page Map table is "[17, 82, 3, 5, 7, 18]". (NB: I've tried to make the math easy so you do not need a calculator)

- 10) (15 pts) OpenSSL is a library of code which provides easy to use encryption functions for programs to use when communicating on the network. The library is so popular that virtually every program running on a UNIX machine will incorporate it and use some of its features. Occasionally bugs are found in the library and so a new version is released. The new version, once installed on the machine, is updated for all of the programs that use that library. The library is small, 5MB, but is incorporated in some way or another to hundreds of running processes. How does a modern operating system allow lots of processes to use that code, allow updates to a single location (rather than hundreds of programs having to be updated individually) and save memory space?
- 11) (20 pts) Heating and Cooling in buildings is done with large system that are complex to manage and maintain. Sometimes, multiple large, individual, units have to be combined to provide sufficient heating or cooling for a given space. The amount of heating and cooling that one of these systems can produce is measured in British Thermal Units (BTUs) and known for each unit individually. We would like to design classes for both Heating and Cooling and allow for units of like type to be “added” together (i.e. Heating+Heating or Cooling+Cooling but not differing types). However, when two units are combined, the total BTU measurement is 10% less than the sum of their two, individual, measurements as a result of lost efficiency.

Design three classes: System, Heating and Cooling and allow for addition of two similar systems using the addition operator. Create one vector which stores three Cooling units and two Heating units.