Part 3 – Written exercises

1. Describe each of the tools we used in this lab:
   - **gcc -c** is used to tell GCC to compile the code or source file into an object file (.o file). If we don't specify the -c, GCC will compile the code and link it together into a complete executable program which only works if it includes every .c files at the same time. In short, -c allows us to execute the sources file to generate a .o file that could be used to link later.
   - **objdump** is used to display information about one for more object files (.o file). The -t (objdump -t) is one of the objdump options that output the symbol table.
   - **man** command is used to generate the manual of a particular function. For example, man objdump will give us the manual of objdump.
   - **file libsecret.so**: this command tells the type of a file.
   - gcc -fPIC is used to generate a position-independent code (PIC) that is appropriate for shared library. The -shared allows to make the shareable library instead of the static one. Therefore, when we use the **gcc -fPIC -shared secret.c -o libsecret.so**, we tell the compiler to create a shared library.
   - nm command is sued to lists symbols from the object file. Without the -g flag, it will shows use the symbol value, symbol type, and symbol name. nm -g displays only the external symbols.
   - **readelf** shows the information about ELF format object files. It is similar to objdump but it is more detail.
   - **gcc lottery.o** libsecret.so -o lotto we compile this two files together and name it lotto. We do this because in case there is a file change, like lotter.c change, we can just compile lottery itself and get the .o file then linking the two together just like what we did. Linker helps us with compilation time.
   - **ldd** is enables users to view the executable file's shared object dependencies.

   ```
   linux-vdso.so.1 =>  (0x00007ffeec3df000)
   libsecret.so => not found
   libc.so.6 => /lib64/libc.so.6 (0x00007ffb2b93c000)
   /lib64/ld-linux-x86-64.so.2 (0x00007ffb2bd18000)
   ```

   The first session here shows virtual dynamic shared object (VDSO). The second lines is supposed to show the ELF interpreter but it is not found right now. The final part show the memory place that the library is loaded.
   - **LD_LIBRARY_PATH**=. ./lotto the . infront of the ./ will allow us to go the the directory above the current directory.
   - LD_PRELOAD is used to load specific shared libraries. Before loading any library, the dynamic loader will load the shared libraries that is located in the LD_PRELOAD. **export LD_PRELOAD=$PWD/libhack.so** lotto means we are passing the full-path to LD_PRELOAD environment variable before other libraries and we set it as our environment variable.
     i. export command is used to creating an environment variable.

- Echo is sued to display a line of text/string on an output or a file. ==echo $LD_PRELOAD== is used to print out the environment variable that we have set.
- unset LD_PRELOAD is used to reset the environment variable and default it back to the environment.

2. The advantages and disadvantages of linking libraries into the program is:
- Advantages:
    i. Helps reduce the size of the executable file as some files could be shared in the library; hence, saving the memory and disk space
    ii. Individuals shared modules could updated and recompiled. This would help save recompiling time as we only recompile the modules or files that get changed
    iii. People from different team could use the same library so it creates a more collaborative environment
- Disadvantages:
    i. Creates more complications as some files are in the shared folder, so we need to access it and add it to the environment variable
    ii. Could be slower as we have to load the external shared library into the program then bind those shared library dynamically to the program
    iii. Compatibility is questionable as if a library is changed like new compiler is released or something then it could cause the compatibility issue. Also, if the library is deleted or removed, then program will not work