

Task 1:

```
[02/10/21]seed@VM:~$ cd ./Desktop/CSCE465/HW1
[02/10/21]seed@VM:~/HW1$ gcc myprintenv.c
[02/10/21]seed@VM:~/HW1$ a.out
SHELL=/bin/bash
SESSION_MANAGER=local/VM:@/tmp/.ICE-unix/2627,unix/VM:/tmp/.ICE-unix/2627
QT_ACCESSIBILITY=1
COLORTERM=truecolor
XDG_CONFIG_DIRS=/etc/xdg/xdg-ubuntu:/etc/xdg
XDG_MENU_PREFIX=gnome-
GNOME_DESKTOP_SESSION_ID=this-is-deprecated
GNOME_SHELL_SESSION_MODE=ubuntu
SSH_AUTH_SOCK=/run/user/1000/keyring/ssh
XMODIFIERS=@tn=ibus
DESKTOP_SESSION=ubuntu
SSH_AGENT_PID=2567
GTK_MODULES=gail:atk-bridge
PWD=/home/seed/Desktop/CSCE465/HW1
LOGNAME=seed
XDG_SESSION_DESKTOP=ubuntu
XDG_SESSION_TYPE=x11
GPG_AGENT_INFO=/run/user/1000/gnupg/S.gpg-agent:0:1
XAUTHORITY=/run/user/1000/gdm/Xauthority
GJS_DEBUG_TOPICS=JS ERROR;JS LOG
WINDOWPATH=2
HOME=/home/seed
USERNAME=seed
IM_CONFIG_PHASE=1
LANG=en_US.UTF-8
LS_COLORS=rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33;01:cd=40;33;01:or=40;31;01:mi=00:su=37;41:sg=30;43:ca=30;41:tw=30;42:ow=34;42:st=37;44:ex=01;32:*.tar=01;31:*.tgz=01;31:*.arc=01;31:*.arj=01;31:*.taz=01;31:*.lha=01;31:*.lzh=01;31:*.lzn=01;31:*.tlz=01;31:*.txz=01;31:*.tzo=01;31:*.t7z=01;31:*.zip=01;31:*.z=01;31:*.dz=01;31:*.gz=01;31:*.lrz=01;31:*.lzo=01;31:*.xz=01;31:*.zst=01;31:*.tzt=01;31:*.bz2=01;31:*.bz=01;31:*.tbz2=01;31:*.tbz=01;31:*.tz=01;31:*.deb=01;31:*.rpm=01;31:*.jar=01;31:*.war=01;31:*.ear=01;31:*.sar=01;31:*.rar=01;31:*.alz=01;31:*.ace=01;31:*.zoo=01;31:*.cpio=01;31:*.7z=01;31:*.rz=01;31:*.cab=01;31:*.wim=01;31:*.swm=01;31:*.dwm=01;31:*.esd=01;31:*.jpg=01;35:*.jpeg=01;35:*.mjpg=01;35:*.mjpeg=01;35:*.gif=01;35:*.bmp=01;35:*.pbm=01;35:*.pgm=01;35:*.ppm=01;35:*.tga=01;35:*.xbm=01;35:*.xpm=01;35:*.tif=01;35:*.tiff=01;35:*.png=01;35:*.svg=01;35:*.svgz=01;35:*.mng=01;35:*.pcx=01;35:*.mov=01;35:*.mpg=01;35:*.mpeg=01;35:*.m2v=01;35:*.mkv=01;35:*.webm=01;35:*.ogm=01;35:*.mp4=01;35:*.m4v=01;35:*.mp4v=01;35:*.vob=01;35:*.qt=01;35:*.nuv=01;35:*.wmv=01;35:*.asf=01;35:*.rm=01;35:*.rmvb=01;35:*.flc=01;35:*.avi=01;35:*.fli=01;35:*.flv=01;35:*.gl=01;35:*.dl=01;35:*.xcf=01;35:*.xwd=01;35:*.yuv=01;35:*.cgm=01;35:*.emf=01;35:*.ogv=01;35:*.ogx=01;35:*.aac=00;36:*.au=00;36:*.flac=00;36:*.n4a=00;36:*.mid=00;36:*.midi=00;36:*.mka=00;36:*.mp3=00;36:*.mpc=00;36:*.ogg=00;36:*.ra=00;36:*.wav=00;36:*.oga=00;36:*.opus=00;36:*.spx=00;36:*.xspf=00;36:
XDG_CURRENT_DESKTOP=ubuntu:GNOME
VTE_VERSION=6003
ls GNOME TERMINFO SCRFNM=/usr/share/terminfo/Screen/h687cfr? 49ra 4d6d h753 e38ah15Ba3f5
```

All that was done in this task was compile and run the provided text to show the results of printing environment variables, along with the use of export/unset in such.

Task 2:

```
[02/10/21]seed@VM:~/HW1$ gcc myprintenv.c
[02/10/21]seed@VM:~/HW1$ a.out > file
[02/10/21]seed@VM:~/HW1$ gcc myprintenv.c
[02/10/21]seed@VM:~/HW1$ a.out > file2
[02/10/21]seed@VM:~/HW1$ diff file file2
[02/10/21]seed@VM:~/HW1$
```



```
myprintenv.c
~/Desktop/CSCE465/HW1

1#include <unistd.h>
2#include <stdio.h>
3#include <stdlib.h>
4
5extern char **environ;
6
7void printenv()
8{
9    int i = 0;
10   while (environ[i] != NULL) {
11       printf("%s\n", environ[i]);
12       i++;
13   }
14}
15
16void main()
17{
18    pid_t childPid;
19    switch(childPid = fork()) {
20        case 0: /* child process */
21            //printenv();
22            exit(0);
23        default: /* parent process */
24            printenv();
25            exit(0);
26    }
27}
```

From the results of the “diff” command, it is evident that the output of the program is identical regardless of if the parent or child is executing such. As a result, this goes to show both that

programs execute commands the same way, it is merely the course by which the execution occurs that changes between the parent and child accordingly.

Task 3:

```
[02/10/21]seed@VM:~/.../HW1$ gcc myenv.c
[02/10/21]seed@VM:~/.../HW1$ a.out
[02/10/21]seed@VM:~/.../HW1$ gcc myenv.c
[02/10/21]seed@VM:~/.../HW1$ a.out
SHELL=/bin/bash
SESSION_MANAGER=local/VM:@/tmp/.ICE-unix/2627,unix/VM:/tmp/.ICE-unix/2627
QT_ACCESSIBILITY=1
COLORTERM=truecolor
XDG_CONFIG_DIRS=/etc/xdg/xdg-ubuntu:/etc/xdg
XDG_MENU_PREFIX=gnome-
GNOME_DESKTOP_SESSION_ID=this-is-deprecated
GNOME_SHELL_SESSION_MODE=ubuntu
SSH_AUTH_SOCK=/run/user/1000/keyring/ssh
XMODIFIERS=@ln=ibus
DESKTOP_SESSION=ubuntu
SSH_AGENT_PID=2567
GTK_MODULES=gail:atk-bridge
PWD=/home/seed/Desktop/CSCE465/HW1
LOGNAME=seed
XDG_SESSION_DESKTOP=ubuntu
XDG_SESSION_TYPE=x11
GPG_AGENT_INFO=/run/user/1000/gnupg/S.gpg-agent:0:1
XAUTHORITY=/run/user/1000/gdm/Xauthority
GJS_DEBUG_TOPICS=JS ERROR;JS LOG
WINDOWPATH=2
HOME=/home/seed
USERNAME=seed
IM_CONFIG_PHASE=1
LANG=en_US.UTF-8
LS_COLORS=rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33;01:cd=40;33;01:or=40;31;01:mi=00:su=37;41:sg=30;43:ca=30;41:tw=30;42:ow=34;42:st=37;44:ex=01;32:*.tar=01;31:*.tgz=01;31:*.arc=01;31:*.arj=01;31:*.taz=01;31:*.lha=01;31:*.lz4=01;31:*.lzh=01;31:*.lzma=01;31:*.tlz=01;31:*.txz=01;31:*.tzo=01;31:*.t7z=01;31:*.zip=01;31:*.z=01;31:*.dz=01;31:*.gz=01;31:*.lrz=01;31:*.lz=01;31:*.lzo=01;31:*.xz=01;31:*.zst=01;31:*.tzst=01;31:*.bz2=01;31:*.bz=01;31:*.tbz=01;31:*.tbz2=01;31:*.tz=01;31:*.deb=01;31:*.rpm=01;31:*.jar=01;31:*.war=01;31:*.ear=01;31:*.sar=01;31:*.rar=01;31:*.alz=01;31:*.ace=01;31:*.zoo=01;31:*.cpt=01;31:*.7z=01;31:*.rz=01;31:*.cab=01;31:*.wlm=01;31:*.swm=01;31:*.dwm=01;31:*.esd=01;31:*.jpg=01;35:*.jpeg=01;35:*.njpg=01;35:*.mjpeg=01;35:*.gif=01;35:*.bmp=01;35:*.pbm=01;35:*.pgm=01;35:*.ppm=01;35:*.tga=01;35:*.xbm=01;35:*.xpm=01;35:*.tif=01;35:*.tiff=01;35:*.png=01;35:*.svg=01;35:*.svgz=01;35:*.mng=01;35:*.pcx=01;35:*.mov=01;35:*.mpg=01;35:*.mpeg=01;35:*.m2v=01;35:*.mkv=01;35:*.webm=01;35:*.ogm=01;35:*.mp4=01;35:*.m4v=01;35:*.mp4v=01;35:*.vob=01;35:*.qt=01;35:*.nuv=01;35:*.wmv=01;35:*.asf=01;35:*.rm=01;35:*.rmvb=01;35:*.flc=01;35:*.avi=01;35:*.fli=01;35:*.flv=01;35:*.gl=01;35:*.dl=01;35:*.xcf=01;35:*.xwd=01;35:*.yuv=01;35:*.cgm=01;35:*.emf=01;35:*.ogv=01;35:*.ogx=01;35:*.aac=00;36:*.au=00;36:*.flac=00;36:*.m4a=00;36:*.m4=00;36:*.m4d=00;36:*.mka=00;36:*.mp3=00;36:*.mpc=00;36:*.ogg=00;36:*.ra=00;36:*.wav=00;36:*.oga=00;36:*.opus=00;36:*.spx=00;36:*.xspf=00;36:
XDG_CURRENT_DESKTOP=ubuntu:GNOME
VTF_VFSSTN=KARR
```

As evidenced in the picture above, the original code has no environment variables as it is pathed to “NULL”, while the edited code prints out the environment variables associated with “environ”. As such, it is clear that the program will explicitly print out the environment variables associated with the file provided, appended to the directory provided.

Task 4:

```
[02/10/21]seed@VM:~/.../HW1$ touch systentest.c
[02/10/21]seed@VM:~/.../HW1$ gcc systentest.c
[02/10/21]seed@VM:~/.../HW1$ a.out
sh: 1: /user/bin/env: not found
[02/10/21]seed@VM:~/.../HW1$ gcc systentest.c
[02/10/21]seed@VM:~/.../HW1$ a.out
GJS_DEBUG_TOPICS=JS ERROR;JS LOG
LESSOPEN=| /usr/bin/lesspipe %s
USER=seed
SSH_AGENT_PID=2567
XDG_SESSION_TYPE=x11
SHLVL=1
HOME=/home/seed
OLDPWD=/home/seed
DESKTOP_SESSION=ubuntu
GNOME_SHELL_SESSION_MODE=ubuntu
GTK_MODULES=gail:atk-bridge
MANAGERPID=2350
DBUS_SESSION_BUS_ADDRESS=unix:path=/run/user/1000/bus
COLORTERM=truecolor
IM_CONFIG_PHASE=1
LOGNAME=seed
JOURNAL_STREAM=9:39020
_=/a.out
XDG_SESSION_CLASS=user
USERNAME=seed
TERM=xterm-256color
GNOME_DESKTOP_SESSION_ID=this-is-deprecated
WINDOWPATH=2
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin:
SESSION_MANAGER=local/VM:@/tmp/.ICE-unix/2627,unix/VM:/tmp/.ICE-unix/2627
INVOCATION_ID=73c3a8cb9772458193cdd8dd61b244cf
XDG_MENU_PREFIX=gnome-
GNOME_TERMINAL_SCREEN=/org/gnome/Terminal/screen/b687cfc2_49ca_4d64_b253_e38ab150a3f5
XDG_RUNTIME_DIR=/run/user/1000
DISPLAY=:0
LANG=en_US.UTF-8
XDG_CURRENT_DESKTOP=ubuntu:GNOME
XMODIFIERS=@im=ibus
XDG_SESSION_DESKTOP=ubuntu
```

As expected, the program provided matches up with its planned results, printing out environment variables of the provided file accordingly.

Task 5:

```
[02/10/21]seed@VM:~/.../HW1$ export ANY_NAME=$ANY_NAME:testing
[02/10/21]seed@VM:~/.../HW1$ export
declare -x ANY_NAME=:testing"
declare -x COLORTERM=:truecolor"
declare -x DBUS_SESSION_BUS_ADDRESS=:unix:path=/run/user/1000/bus"
declare -x DESKTOP_SESSION=:ubuntu"
declare -x DISPLAY=:0"
declare -x GDMSESSION=:ubuntu"
declare -x GJS_DEBUG_OUTPUT=:stderr"
declare -x GJS_DEBUG_TOPICS=:JS ERROR;JS LOG"
declare -x GNOME_DESKTOP_SESSION_ID=:this-is-deprecated"
declare -x GNOME_SHELL_SESSION_MODE=:ubuntu"
declare -x GNOME_TERMINAL_SCREEN=:/org/gnome/Terminal/screen/b687cfc2_49ca_4d64_b253_e38ab150a3f5"
declare -x GNOME_TERMINAL_SERVICE=:1.117"
declare -x GPG_AGENT_INFO=:/run/user/1000/gnupg/S.gpg-agent:0:1"
declare -x GTK_MODULES=:gail:atk-bridge"
declare -x HOME=:/home/seed"
declare -x IM_CONFIG_PHASE=:1"
declare -x INVOCATION_ID=:73c3a8cb9772458193cdd8dd61b244cf"
declare -x JOURNAL_STREAM=:9:39020"
declare -x LANG=:en_US.UTF-8"
declare -x LD_LIBRARY_PATH"
declare -x LESSCLOSE=:/usr/bin/lesspipe %s %s"
declare -x LESSOPEN=:| /usr/bin/lesspipe %s"
declare -x LOGNAME=:seed"
declare -x LS_COLORS=:rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33;01:cd=40;33;01:or=40;31;01:mi=00:su=37;41:sg=30;43:ca=30;41:tw=30;42:ow=34;42:st=37;44:ex=01;32*:tar=01;31*:tgz=01;31*:arc=01;31*:arj=01;31*:taz=01;31*:lha=01;31*:lzh=01;31*:lzma=01;31*:tlz=01;31*:txz=01;31*:tzo=01;31*:t7z=01;31*:zip=01;31*:z=01;31*:dz=01;31*:gz=01;31*:lrz=01;31*:lz=01;31*:lzo=01;31*:xz=01;31*:zst=01;31*:tzt=01;31*:bz2=01;31*:bz=01;31*:tbz2=01;31*:tbz=01;31*:deb=01;31*:rpm=01;31*:jar=01;31*:war=01;31*:ear=01;31*:sar=01;31*:rar=01;31*:alz=01;31*:ace=01;31*:zoo=01;31*:cpio=01;31*:7z=01;31*:rz=01;31*:c
ab=01;31*:wlm=01;31*:swm=01;31*:dwm=01;31*:esd=01;31*:jpg=01;35*:jpeg=01;35*:mjpg=01;35*:mjpeg=01;35*:gif=01;35*:bmp=01;35*:pbm=01;35*:pgm=01;35*:ppm=01;35*:tga=01;35*:xbm=01;35*:xpm=01;35*:tif=01;35*:tiff=01;35*:png=01;35*:svg=01;35*:svgz=01;35*:mng=01;35*:pcx=01;35*:mov=01;35*:mpg=01;35*:mpeg=01;35*:n2v=01;35*:nkv=01;35*:webm=01;35*:ogm=01;35*:mp4=01;35*:m4v=01;35*:mp4v=01;35*:vob=01;35*:qt=01;35*:nuv=01;35*:wmv=01;35*:asf=01;35*:rm=01;35*:rmvb=01;35*:flc=01;35*:avi=01;35*:fli=01;35*:flv=01;35*:gl=01;35*:gl=01;35*:d=01;35*:xcf=01;35*:xwd=01;35*:yuv=01;35*:cgm=01;35*:enf=01;35*:ogv=01;35*:ogx=01;35*:aac=00;36*:au=00;36*:flac=00;36*:m4a=00;36*:mid=00;36*:midi=00;36*:nka=00;36*:mp3=00;36*:mpc=00;36*:ogg=00;36*:ra=00;36*:wav=00;36*:oga=00;36*:opus=00;36*:spx=00;36*:xspf=00;36*:
0;36:"
declare -x MANAGERPID=:2350"
declare -x OLDPWD=:/home/seed"
declare -x PATH=:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin:."
declare -x PWD=:/home/seed/Desktop/CSCE465/HW1"
declare -x QT_ACCESSIBILITY=:1"

[02/10/21]seed@VM:~/.../HW1$ a.out
SHELL=:bin/bash
SESSION_MANAGER=:local/VM:@/tmp/.ICE-unix/2627,unix/VM:/tmp/.ICE-unix/2627
QT_ACCESSIBILITY=:1
COLORTERM=:truecolor
XDG_CONFIG_DIRS=:/etc/xdg/xdg-ubuntu:/etc/xdg
XDG_MENU_PREFIX=:gnome-
GNOME_DESKTOP_SESSION_ID=:this-is-deprecated
ANY_NAME=:testing
GNOME_SHELL_SESSION_MODE=:ubuntu
SSH_AUTH_SOCK=:/run/user/1000/keyring/ssh
XMODIFIERS=:@im=ibus
DESKTOP_SESSION=:ubuntu
SSH_AGENT_PID=:2567
GTK_MODULES=:gail:atk-bridge
PWD=:/home/seed/Desktop/CSCE465/HW1
LOGNAME=:seed
XDG_SESSION_DESKTOP=:ubuntu
XDG_SESSION_TYPE=:x11
GPG_AGENT_INFO=:/run/user/1000/gnupg/S.gpg-agent:0:1
XAUTHORITY=:/run/user/1000/gdm/Xauthority
GJS_DEBUG_TOPICS=:JS ERROR;JS LOG
WINDOWPATH=:2
HOME=:/home/seed
USERNAME=:seed
IM_CONFIG_PHASE=:1
LANG=:en_US.UTF-8
LS_COLORS=:rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33;01:cd=40;33;01:or=40;31;01:mi=00:su=37;41:sg=30;43:ca=30;41:tw=30;42:ow=34;42:st=37;44:ex=01;32*:tar=01;31*:tgz=01;31*:arc=01;31*:arj=01;31*:taz=01;31*:lha=01;31*:lzh=01;31*:lzma=01;31*:tlz=01;31*:txz=01;31*:tzo=01;31*:t7z=01;31*:zip=01;31*:z=01;31*:dz=01;31*:gz=01;31*:lrz=01;31*:lz=01;31*:lzo=01;31*:xz=01;31*:zst=01;31*:tzt=01;31*:bz2=01;31*:bz=01;31*:tbz2=01;31*:tbz=01;31*:deb=01;31*:rpm=01;31*:jar=01;31*:war=01;31*:ear=01;31*:sar=01;31*:rar=01;31*:alz=01;31*:ace=01;31*:zoo=01;31*:cpio=01;31*:7z=01;31*:rz=01;31*:cab=01;31*:w
lm=01;31*:swm=01;31*:dwm=01;31*:esd=01;31*:jpg=01;35*:jpeg=01;35*:mjpg=01;35*:mjpeg=01;35*:gif=01;35*:bmp=01;35*:pbm=01;35*:pgm=01;35*:ppm=01;35*:tga=01;35*:xbm=01;35*:xpm=01;35*:tif=01;35*:tiff=01;35*:png=01;35*:svg=01;35*:svgz=01;35*:mng=01;35*:pcx=01;35*:mov=01;35*:mpg=01;35*:mpeg=01;35*:n2v=01;35*:nkv=01;35*:webm=01;35*:ogm=01;35*:mp4=01;35*:m4v=01;35*:mp4v=01;35*:vob=01;35*:qt=01;35*:nuv=01;35*:wmv=01;35*:asf=01;35*:rm=01;35*:rmvb=01;35*:flc=01;35*:avi=01;35*:fli=01;35*:flv=01;35*:gl=01;35*:gl=01;35*:d=01;35*:xcf=01;35*:xwd=01;35*:yuv=01;35*:cgm=01;35*:enf=01;35*:ogv=01;35*:ogx=01;35*:aac=00;36*:au=00;36*:flac=00;36*:m4a=00;36*:mid=00;36*:midi=00;36*:nka=00;36*:mp3=00;36*:mpc=00;36*:ogg=00;36*:ra=00;36*:wav=00;36*:oga=00;36*:opus=00;36*:spx=00;36*:xspf=00;36*:
XDG_CURRENT_DESKTOP=:ubuntu:GNOME
VTE_VERSION=:6003
GNOME_TERMINAL_SCREEN=:/org/gnome/Terminal/screen/b687cfc2_49ca_4d64_b253_e38ab150a3f5
TMUX=:session:TMUX-727220a-b07774504022a4d04d41b344a-f
```

The first image provided is the result of the regular export command, with the following image being of the results after running my Set-UID program. As evidenced by the ANY_NAME environment variable I altered, the change did go through the Set-UID child process. This therefore indicates that, since the original file is set to root permissions, any forked process resulting from external users opening the file will have these same permissions accordingly and the export command also serves to update all processes with the updated variables.

Task 6:

```
[02/10/21]seed@VM:~/.../HW1$ export PATH=/home/seed:$PATH
[02/10/21]seed@VM:~/.../HW1$ export
declare -x COLORTERM="truecolor"
declare -x DBUS_SESSION_BUS_ADDRESS="unix:path=/run/user/1000/bus"
declare -x DESKTOP_SESSION="ubuntu"
declare -x DISPLAY=":0"
declare -x GDMSESSION="ubuntu"
declare -x GJS_DEBUG_OUTPUT="stderr"
declare -x GJS_DEBUG_TOPICS="JS ERROR;JS LOG"
declare -x GNOME_DESKTOP_SESSION_ID="this-is-deprecated"
declare -x GNOME_SHELL_SESSION_MODE="ubuntu"
declare -x GNOME_TERMINAL_SCREEN="/org/gnome/Terminal/screen/b038d00a_f716_405a_b979_b997494f9359"
declare -x GNOME_TERMINAL_SERVICE=":1.238"
declare -x GPG_AGENT_INFO="/run/user/1000/gnupg/S.gpg-agent:0:1"
declare -x GTK_MODULES="gail:atk-bridge"
declare -x HOME="/home/seed"
declare -x IM_CONFIG_PHASE="1"
declare -x INVOCATION_ID="73c3a8cb9772458193cdd8dd61b244cf"
declare -x JOURNAL_STREAM="9:39020"
declare -x LANG="en_US.UTF-8"
declare -x LESSCLOSE="/usr/bin/lesspipe %s %s"
declare -x LESSOPEN="| /usr/bin/lesspipe %s"
declare -x LOGNAME="seed"
declare -x LS_COLORS="rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33:cd=40;33:or=40;31:mi=00:su=37;41:sg=30;43:ca=30;41:tw=30;42:ow=34;42:st=37;44:ex=01;32:*.tar=01;31:*.tgz=01;31:*.arc=01;31:*.arj=01;31:*.taz=01;31:*.lha=01;31:*.lz4=01;31:*.lzh=01;31:*.lzma=01;31:*.tlz=01;31:*.txz=01;31:*.tzo=01;31:*.t7z=01;31:*.zip=01;31:*.z=01;31:*.dz=01;31:*.gz=01;31:*.lrz=01;31:*.lzo=01;31:*.xz=01;31:*.zst=01;31:*.tzst=01;31:*.bz2=01;31:*.bz=01;31:*.tbz=01;31:*.tbz2=01;31:*.tzt=01;31:*.deb=01;31:*.rpm=01;31:*.jar=01;31:*.war=01;31:*.ear=01;31:*.sar=01;31:*.rar=01;31:*.alz=01;31:*.ace=01;31:*.zoo=01;31:*.cpt=01;31:*.7z=01;31:*.rz=01;31:*.cab=01;31:*.wlm=01;31:*.swm=01;31:*.dwm=01;31:*.esd=01;31:*.jpg=01;31:*.jpeg=01;31:*.mjpg=01;31:*.mjpeg=01;31:*.gif=01;31:*.bmp=01;31:*.pbm=01;31:*.pgm=01;31:*.ppm=01;31:*.tga=01;31:*.xbm=01;31:*.xpm=01;31:*.tif=01;31:*.tiff=01;31:*.png=01;31:*.svg=01;31:*.svgz=01;31:*.mng=01;31:*.pcx=01;31:*.mov=01;31:*.mpg=01;31:*.mpeg=01;31:*.m2v=01;31:*.mkv=01;31:*.webm=01;31:*.ogm=01;31:*.mp4=01;31:*.m4v=01;31:*.mp4v=01;31:*.vob=01;31:*.qt=01;31:*.nuv=01;31:*.wmv=01;31:*.asf=01;31:*.rm=01;31:*.rmvb=01;31:*.flc=01;31:*.avi=01;31:*.fli=01;31:*.flv=01;31:*.gl=01;31:*.dl=01;31:*.xcf=01;31:*.xwd=01;31:*.yuv=01;31:*.cgm=01;31:*.emf=01;31:*.ogv=01;31:*.ogx=01;31:*.aac=00;36:*.au=00;36:*.flac=00;36:*.m4a=00;36:*.mid=00;36:*.midi=00;36:*.mka=00;36:*.mp3=00;36:*.mpc=00;36:*.ogg=00;36:*.ra=00;36:*.wav=00;36:*.oga=00;36:*.opus=00;36:*.spx=00;36:*.xspf=00;36:"
declare -x MANAGERPID="2350"
declare -x OLDPWD="/home/seed"
declare -x PATH="/home/seed:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin:."
declare -x PWD="/home/seed/Desktop/CSC465/HW1"
declare -x QT_ACCESSIBILITY="1"
declare -x QT_IM_MODULE="ibus"
declare -x SESSION_MANAGER="local/VM:@/tmp/.ICE-unix/2627,unix/VM:/tmp/.ICE-unix/2627"
declare -x USER="seed"
[02/10/21]seed@VM:~/.../HW1$ touch setuidtest3.c
[02/10/21]seed@VM:~/.../HW1$ gcc setuidtest3.c
[02/10/21]seed@VM:~/.../HW1$ a.out
a.out cap_leak.c catall.c file file2 Labsetup myenv.c myrintenv.c setuidtest2.c setuidtest3.c setuidtest.c systemtest.c
[02/10/21]seed@VM:~/.../HW1$ █
[02/10/21]seed@VM:~/.../HW1$ sudo chown root setuidtest2.c
[02/10/21]seed@VM:~/.../HW1$ sudo chmod 4755 setuidtest2.c
[02/10/21]seed@VM:~/.../HW1$ a.out
a.out cap_leak.c catall.c file file2 Labsetup myenv.c myrintenv.c setuidtest2.c setuidtest.c systemtest.c
[02/10/21]seed@VM:~/.../HW1$ █
```

As provided above, the first picture evidences the addition of the “/home/seed” directory to the PATH variable from its original state using the “export” command, while the other two images pertain to the output of the new Set-UID program before and after being given root ownership and made into a Set-UID program. Given the results, it is clear that the program functions identically regardless of its ownership in this case, listing out the relative directory in which the program is located in the file system. Likewise, the program is evidenced to run with the root privilege due to the fact that a normal user is unable to edit the file after being given root ownership and changed to a Set-UID program.

Task 7:

```
[02/10/21]seed@VM:~/.../HW1$ ls -l
total 100
-rwxr-xr-x 1 root root 16696 Feb 10 18:42 a.out
-rw-rw-r-- 1 seed seed 761 Dec 27 13:07 cap_leak.c
-rw-rw-r-- 1 seed seed 451 Dec 27 13:05 catall.c
-rw-rw-r-- 1 seed seed 2964 Feb 10 16:36 file
-rw-rw-r-- 1 seed seed 2964 Feb 10 16:36 file2
drwxrwxr-x 2 seed seed 4096 Dec 27 13:13 Labsetup
-rwxrwxr-x 1 seed seed 18704 Feb 10 18:14 libmylib.so.1.0.1
-rw-rw-r-- 1 seed seed 183 Feb 10 17:04 myenv.c
-rw-rw-r-- 1 seed seed 75 Feb 10 18:06 mylib.c
-rw-rw-r-- 1 seed seed 5960 Feb 10 18:14 mylib.o
-rw-rw-r-- 1 seed seed 418 Feb 10 16:28 myprintenv.c
-rwsr-xr-x 1 seed seed 58 Feb 10 18:41 myprog.c
-rwsr-xr-x 1 root seed 81 Feb 10 17:53 setuidtest2.c
-rw-rw-r-- 1 seed seed 81 Feb 10 17:55 setuidtest3.c
-rwsr-xr-x 1 root seed 160 Feb 10 17:19 setuidtest.c
-rw-rw-r-- 1 seed seed 91 Feb 10 17:14 systemtest.c
[02/10/21]seed@VM:~/.../HW1$ a.out
[02/10/21]seed@VM:~/.../HW1$ a.out
[02/10/21]seed@VM:~/.../HW1$ sudo chown root myprog.c
[02/10/21]seed@VM:~/.../HW1$ sudo chmod 4755 myprog.c
[02/10/21]seed@VM:~/.../HW1$ a.out
[02/10/21]seed@VM:~/.../HW1$ sudo su
root@VM:/home/seed/Desktop/CSCE465/HW1# export LD_PRELOAD=./libmylib.so.1.0.1
root@VM:/home/seed/Desktop/CSCE465/HW1# exit
exit
[02/10/21]seed@VM:~/.../HW1$ a.out
[02/10/21]seed@VM:~/.../HW1$ sudo su
root@VM:/home/seed/Desktop/CSCE465/HW1# export LD_PRELOAD=./libmylib.so.1.0.1
root@VM:/home/seed/Desktop/CSCE465/HW1# ./a.out
I am not sleeping!
root@VM:/home/seed/Desktop/CSCE465/HW1# exit
exit
[02/10/21]seed@VM:~/.../HW1$ sudo chown seed myprog.c
[02/10/21]seed@VM:~/.../HW1$ sudo chmod 4755 myprog.c
[02/10/21]seed@VM:~/.../HW1$ export LD_PRELOAD=./libmylib.so.1.0.1
[02/10/21]seed@VM:~/.../HW1$ a.out
I am not sleeping!
```

In the above picture, all of the results of the requested commands are present. The first test shows that myprog simply executes using the regular sleep functionality when executed by a regular user without any preloading. Likewise, afterwards it is shown that the execution is identical when performed after updating myprog to root ownership and Set-UID functionality. However, after this the functionality changes to reflect the updated library function for sleep inside myprog's execution when the LD_PRELOAD variable is set to ownership in the root and in an alternate user account. This is therefore evidence of the LD_PRELOAD variable operating to update these standard library functions when updated itself with a corresponding input.

Note: I also ran the "other user" option with the LD_PRELOAD export in another terminal where preloading hadn't already occurred and witnessed the same result, further indicating the argument and proving its overall functionality.

Task 8:

```
[02/10/21]seed@VM:~/.../HW1$ touch test.txt
[02/10/21]seed@VM:~/.../HW1$ sudo chown root test.txt
[02/10/21]seed@VM:~/.../HW1$ sudo chmod 4755 test.txt
[02/10/21]seed@VM:~/.../HW1$ a.out "-rm test.txt"
/bin/cat: invalid option -- 'r'
Try '/bin/cat --help' for more information.
[02/10/21]seed@VM:~/.../HW1$ a.out | rm test.txt
[02/10/21]seed@VM:~/.../HW1$ touch test.txt
[02/10/21]seed@VM:~/.../HW1$ sudo chown root test.txt
[02/10/21]seed@VM:~/.../HW1$ sudo chmod 4755 test.txt
[02/10/21]seed@VM:~/.../HW1$ touch test.txt
[02/10/21]seed@VM:~/.../HW1$ sudo chown root test.txt
[02/10/21]seed@VM:~/.../HW1$ sudo chmod 4755 test.txt
[02/10/21]seed@VM:~/.../HW1$ rm test.txt
rm: remove write-protected regular empty file 'test.txt'? ^C
[02/10/21]seed@VM:~/.../HW1$ a.out "rm test.txt"
/bin/cat: 'rm test.txt': No such file or directory
[02/10/21]seed@VM:~/.../HW1$ a.out "test.txt"
[02/10/21]seed@VM:~/.../HW1$ gcc catall.c
[02/10/21]seed@VM:~/.../HW1$ a.out "| rm test.txt"
^C[02/10/21]seed@VM:~/.../HW1$ ls -l
total 100
-rwxrwxr-x 1 seed seed 16928 Feb 10 19:24 a.out
-rw-rw-r-- 1 seed seed 761 Dec 27 13:07 cap_leak.c
-rwsr-xr-x 1 root seed 450 Feb 10 19:16 catall2.c
-rwsr-xr-x 1 root seed 451 Dec 27 13:05 catall.c
-rw-rw-r-- 1 seed seed 2964 Feb 10 16:36 file
-rw-rw-r-- 1 seed seed 2964 Feb 10 16:36 file2
drwxrwxr-x 2 seed seed 4096 Dec 27 13:13 Labsetup
-rwxrwxr-x 1 seed seed 18704 Feb 10 18:14 libmylib.so.1.0.1
-rw-rw-r-- 1 seed seed 183 Feb 10 17:04 myenv.c
-rw-rw-r-- 1 seed seed 75 Feb 10 18:06 mylib.c
-rw-rw-r-- 1 seed seed 5960 Feb 10 18:14 mylib.o
-rw-rw-r-- 1 seed seed 418 Feb 10 16:28 myprintenv.c
-rwsr-xr-x 1 seed seed 58 Feb 10 18:41 pyprog.c
-rwsr-xr-x 1 root seed 81 Feb 10 17:53 setuidtest2.c
-rw-rw-r-- 1 seed seed 81 Feb 10 17:55 setuidtest3.c
-rw-rw-r-- 1 seed seed 91 Feb 10 17:14 systemtest.c
[02/10/21]seed@VM:~/.../HW1$

catall2.c:22:3: warning: implicit declaration of function 'execve' [-Wimplicit-function-declaration]
 22 |   execve(v[0], v, NULL);
    |   ^~~~~~
[02/10/21]seed@VM:~/.../HW1$ sudo chown root catall2.c
[02/10/21]seed@VM:~/.../HW1$ sudo chmod 4755 catall2.c
[02/10/21]seed@VM:~/.../HW1$ a.out
Please type a file name.
[02/10/21]seed@VM:~/.../HW1$ a.out setuidtest.c
#include <stdio.h>
#include <stdlib.h>

extern char **environ;
int main() {
    int i = 0;
    while (environ[i] != NULL) {
        printf("%s\n", environ[i]);
        i++;
    }
}
[02/10/21]seed@VM:~/.../HW1$ a.out "rm setuidtest.c"
/bin/cat: 'rm setuidtest.c': No such file or directory
[02/10/21]seed@VM:~/.../HW1$ a.out rm setuidtest.c
/bin/cat: rm: No such file or directory
[02/10/21]seed@VM:~/.../HW1$ a.out "-rm setuidtest.c"
/bin/cat: invalid option -- 'r'
Try '/bin/cat --help' for more information.
[02/10/21]seed@VM:~/.../HW1$ a.out "-rm setuidtest.c"
/bin/cat: invalid option -- 'r'
Try '/bin/cat --help' for more information.
[02/10/21]seed@VM:~/.../HW1$ a.out | rm setuidtest.c
[02/10/21]seed@VM:~/.../HW1$ a.out | rm test.txt
[02/10/21]seed@VM:~/.../HW1$ a.out "rm | test.txt"
/bin/cat: 'rm | test.txt': No such file or directory
[02/10/21]seed@VM:~/.../HW1$ a.out "rm test.txt"
/bin/cat: 'rm test.txt': No such file or directory
[02/10/21]seed@VM:~/.../HW1$ a.out "test.txt"
[02/10/21]seed@VM:~/.../HW1$ a.out "| rm test.txt"
/bin/cat: '| rm test.txt': No such file or directory
[02/10/21]seed@VM:~/.../HW1$
```

The first of the images provided shows the various attempts I made at breaking the security of the “system()” version of the program, ultimately succeeding in deleting the file in question by providing “a.out” with the command “| rm test.txt”. This didn’t succeed in the “execve()” version of the program, however, as shown in the second image. Instead, the program returned an error stating “No such file or directory” regarding the argument, and wouldn’t be broken with any other command I provided it. To this extent, the results of these tests go to show the security flaws that can arise using the “system” argument in a program, as it is affected by the shell itself

and can be manipulated to this degree, therefore allowing commands passed through privileged programs to be executed as an argument for the shell accordingly.

Task 9:

```
[02/10/21]seed@VM:~/.../HW1$ a.out
Cannot open /etc/zzz
[02/10/21]seed@VM:~/.../HW1$ sudo su
root@VM:/home/seed/Desktop/CSC465/HW1# ./a.out
fd is 3
# exit
root@VM:/home/seed/Desktop/CSC465/HW1# exit
exit
[02/10/21]seed@VM:~/.../HW1$ ls -l
total 100
-rwxrwxr-x 1 seed seed 17008 Feb 10 20:52 a.out
-rwsr-xr-x 1 root seed 761 Dec 27 13:07 cap_leak.c
-rwsr-xr-x 1 root seed 450 Feb 10 19:16 catall2.c
-rwsr-xr-x 1 root seed 451 Dec 27 13:05 catall.c
-rw-rw-r-- 1 seed seed 2964 Feb 10 16:36 file
-rw-rw-r-- 1 seed seed 2964 Feb 10 16:36 file2
drwxrwxr-x 2 seed seed 4096 Feb 10 21:07 Labsetup
-rwxrwxr-x 1 seed seed 18704 Feb 10 18:14 libmylib.so.1.0.1
-rw-rw-r-- 1 seed seed 183 Feb 10 17:04 myenv.c
-rw-rw-r-- 1 seed seed 75 Feb 10 18:06 mylib.c
-rw-rw-r-- 1 seed seed 5960 Feb 10 18:14 mylib.o
-rw-rw-r-- 1 seed seed 418 Feb 10 16:28 myprintenv.c
-rwsr-xr-x 1 seed seed 58 Feb 10 18:41 myprog.c
-rwsr-xr-x 1 root seed 81 Feb 10 17:53 setuidtest2.c
-rw-rw-r-- 1 seed seed 81 Feb 10 17:55 setuidtest3.c
-rw-rw-r-- 1 seed seed 91 Feb 10 17:14 systemtest.c
[02/10/21]seed@VM:~/.../HW1$
```

When the program is run as a normal user, the file is not accessed due to the fact that the directory in question is routed through the “/etc” directory inside the root directory. However, when executed as a root user the program will execute as expected and provide the file descriptor for the “zzz” file accordingly. While this doesn’t completely evidence such, it still goes to show the functionality of lingering root user permissions for the function by the means of it still processing despite having relinquished privileges for its actions.

Note: Most code snippets were neglected as they were already provided in the setup files, were modified to such a slight extent (i.e. uncommenting/commenting), or were directly copied from the provided assignment text.