

NAME: _____

COLLABORATOR(S): _____

8/6/3/0 1. Match the following socket system calls to their description:

- | | |
|----------------|--|
| socket() ____ | (a) A client routine to pair a socket to a remote host. |
| bind() ____ | (b) A routine to associate the socket with a given local address |
| accept() ____ | (c) Clean up a socket after all operations are complete |
| listen() ____ | (d) Create a new socket |
| connect() ____ | (e) Specify the socket as willing to accept incoming connections |
| close() ____ | (f) Create a new socket for an incoming connection for further communication |

5/3/1/0 2. Explain why when accepting an incoming connection a new socket is created?

5/3/1/0 3. Explain the second argument to **listen()**, the **backlog**.

4. Below is an output of the hello_server program from the course notes, can you explain the change in ports from client to server?

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```
#> ./hello_server
Listening On: 127.0.0.1:1845
Connection From: 127.0.0.1:42555
Read from client: hello
Sending: Hello 127.0.0.1:42555
Go Navy! Beat Army
Closing socket
```

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5. Consider the code loop for handling client sockets: Can this program handle multiple clients simultaneously? That is, if multiple clients are connected, will the server be able to services all sockets when data is available? Explain.

```
char buf[BUF_SIZE];
int sockets[NUMSOCKS], i,n;

//iterate over all open sockets
for(i=0;i < NUMSOCKS; i++){
    if(i>0){
        //read from socket
        n = read(sockets[i], buf, BUF_SIZE);

        //socket closed
        if(n<0){
            close(sockets[i]);
            sockets[i] = -1;
        }

        //echo back
        write(sockets[i], buf, n);
    }
}
```

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6. What does a **select()** procedure do? And, how does **select()** and multi-threading avoid the problem above?

7. Match the programming unit to its description.

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- | | |
|------------------|---|
| FD_ZERO() _____ | (a) Check if a file descriptor in the fd_set is actionable, e.g., can be read/write from. |
| select() _____ | (b) Type for storing select information for a set of file descriptors |
| fd_set _____ | (c) Set a file descriptor to be tested as actionable by select() |
| FD_ISSET() _____ | (d) Given a set of file descriptors, test if any are actionable |
| FD_SET() _____ | (e) Remove a file descriptor from the testing set |
| FD_CLR() _____ | (f) Completely clear the set of file descriptors |

8. For each of the statements, indicate if the statement is True or False. You must provide an additional brief statement in support of your selection:

- 5/3/1/0 (a) Threads are created just like processes by calling `fork()` except instead of checking the return value of `fork()` a specified function is executed.

<p>TRUE / FALSE</p>

- 5/3/1/0 (b) Threads are scheduled just like other processes because POSIX threads are treated like individual process by the OS.

<p>TRUE / FALSE</p>

- 5/3/1/0 (c) Like multiple processes, threads provide resource isolation. Two threads from the same program do not share memory or other resources.

<p>TRUE / FALSE</p>

5/3/1/0 9. What are the equivalent thread commands for system call **fork()** and **wait()**?

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10. Match the identifier to its description:

- | | |
|---|--|
| <p>10/8/6/3/0</p> <p style="padding-left: 100px;"><code>tid</code> ____</p> <p style="padding-left: 100px;"><code>pid</code> ____</p> <p style="padding-left: 100px;"><code>pid_t</code> ____</p> <p style="padding-left: 100px;"><code>pthread_t</code> ____</p> <p style="padding-left: 100px;"><code>syscall (SYS_gettid);</code> ____</p> <p style="padding-left: 100px;"><code>getpid()</code> ____</p> <p style="padding-left: 100px;"><code>pthread_self()</code> ____</p> | <p>(a) Retrieve the POSIX thread identifier for the calling thread</p> <p>(b) The process identifier, shared by all threads of a multi-threaded program</p> <p>(c) Retrieve the Unix OS thread identifier of the calling thread</p> <p>(d) Retrieve the Unix OS process identifier of the calling process</p> <p>(e) The type of a POSIX thread identifier</p> <p>(f) The type of the Unix OS thread identifier</p> <p>(g) The thread identifier, unique to each thread and equal to the pid for the main thread</p> |
|---|--|

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11. Fill in the following program that prints the first command line argument from the thread. For each line of code you add, provide a brief comment describing the purpose/function:

```

void * startup( void * args){
    char * str; //variable to reference string to print

    printf(
    return NULL;
}

int main(int argc, char * argv[]){

    pthread_t thread; //POSIX thread identifier

    //create a thread to run startup with argument argv[1]
    pthread_create(&thread, NULL, startup, argv[1]);

    return 0;
}

```

12. Answer the following questions about the program to the left, assume the program was run on the lab machines:

```

#include <stdio.h>
#include <stdlib.h>
#include <pthread.h>

```

```

void * foo(void * args){
    pthread_t thread;

    if(args == NULL){
        pthread_create(&thread, NULL,
            foo, (void *) 1);
    }

    while(1);
}

int main(int argc, char * argv[]){
    pthread_t threads[4];
    int i;

    for(i=0;i<4;i++){
        pthread_create(&threads[i], NULL,
            foo, NULL);
    }

    while(1);
}

```

(a) Based on the code, what are the two possible values for the argument to foo()?

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(b) When you run this program, how many threads are running. Use ps -L to count:

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(c) According to top what percent CPU does the program consume? Is this more or less than you expect? Explain.

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