*This exam is **closed book**. You can have **one page** of notes. Please answer every part of every question.*

**1.** Match each of the following features with the ***single sentence*** that describes it best: (10×3 points) (***Hint:*** *Several of the choices offered are **plain wrong**.*)

| | | | |
|---|---|---|---|
| ***pipe*** | __o__ | ***fork*( )** | __d__ |
| ***thread*** | __k__ | ***execve*( )** | __i__ |
| ***microkernel*** | __e__ | ***kill*( )** | __j__ |
| ***ready state*** | __c__ | ***signal*( )** | __l__ |
| ***privileged mode*** | __a__ | **DMA** | __f__ |

**a)** Allows the CPU to execute input/output instructions.

**b)** Contains all processes that are ready to access a peripheral.

**c)** Contains all the processes waiting for the CPU.

**d)** Creates a new process.

**e)** Delegates most of its duties to user-level servers.

**f)** Gives a disk controller direct access to the main memory.

**g)** Gives real-time processes faster access to the CPU.

**h)** Grants user processes direct access to BIOS routines.

**i)** Loads in memory the program to be executed by a given process.

**j)** Sends a signal to another process.

**k)** Shares the address space of its parent.

**l)** Specifies what a process should do when it receives a signal.

**m)** Specifies a superuser process.

**n)** Terminates the process making that system call.

**o)** Used to send the standard output of a process to the standard input of another one**.**

**2.** Complete the following program fragment to redirect **stdout** to the file **mydata.txt**. (2×5 points)

```
int fd;
fd = open("mydata.txt", O_RDWR | O_CREAT, 0640);
```

close(1) _____

dup(fd) _____

3. **Advantage and disadvantages:** *you will get no credit if you mention a disadvantage when an advantage is asked and vice versa.* (6×5 points)

a) What is the major advantage of **symmetric multiprocessing**?

Since the kernel can run on any processor, it will never constitute a bottleneck.

b) What is the major disadvantage of **not having timer interrupts**?

We would have no way to prevent a process from monopolizing the CPU.

c) What is the major disadvantage of **user-level threads**?

Programmers cannot use blocking system calls without blocking all threads in the same address space.

d) What is the major disadvantage of **delayed writes**?

Data will be lost if the system crashes before the data are written to disk.

e) What is the major advantage of **dual-mode CPUs**?

We can prevent users from accessing directly the disk drive.

f) What is the major advantage of **multithreaded servers**?

They can process several user requests at the same time.

4. **Complete the following sentences.** (6×5 points)

a) _ fork() _ is one of the most expensive system calls.

b) Memory protection is always implemented in hardware because _ any other solution would be too slow. _____.

c) The process playing a DVD on your laptop has _ soft _ deadlines.

d) The UNIX operating system is mostly written in _ C _____.

e) There is no direct transition from the waiting state to the _ running _ state.

f) The first personal workstations with a graphical user interface were developed at _ Xerox Palo Alto Research Center (Xerox PARC) _____