

A network card on a machine is receiving packets at an average rate of 100 packets per second. If we assume that each packet causes the network Interrupt Service Routine (ISR) to execute for 0.2 millisecond, what percentage of the CPU time is used in handling network packets? [4 pts]

$$\text{CPU \%} = \frac{\text{CPU time}}{\text{total time}}$$

$$\frac{100 \text{ packets}}{\text{sec}} \cdot \frac{0.2 \text{E-3 CPU Secs}}{\text{packet}} = \boxed{0.02 \cdot 100\% = 2\%}$$

Some architectures are designed so that processors have multiple register sets. Describe what happens when a context switch occurs if the new context (of the next process selected by the scheduler) is already loaded into one of the register sets. What happens if the new context is in memory rather than in a register set and all the register sets are in use? [4 pts]

- a) ① Save previous to PCB
② exe

- b) ① Save the registers & ^{stack}PC in the process control buffer
② Load next process (register, PC, + stack) into registers from PCB
③ turn/update

Consider a program that performs the following steps repeatedly:

1. Use the CPU for 4 milliseconds.
2. Issue an I/O to disk for 14 milliseconds.
3. Use the CPU for 10 milliseconds.
4. Issue an I/O to the network for 18 milliseconds.

Assume that each step depends on data obtained from the previous step. Also, assume that it takes 2 milliseconds to execute the device driver code on the CPU for both the disk and the network at the beginning of the I/O. Answer the following questions:

(a) Draw 3 time-line diagrams (time on the x-axis and utilization on the y-axis) that illustrate the utilizations of the CPU, disk, and network over the execution of two iterations of the program above. [3 pts]

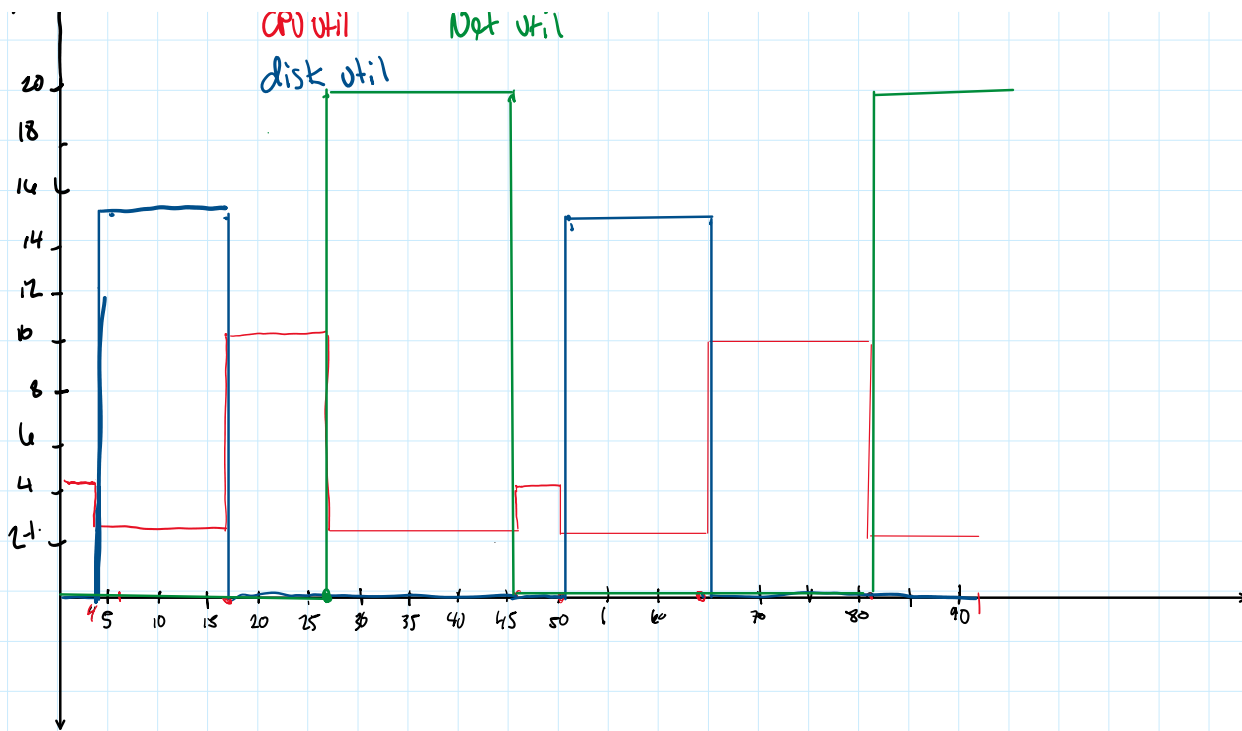
(b) What are the average utilizations of the CPU, disk and network over these two iterations? [3 pts]

(c & d) Assume that there are two processes of the program above running in a multiprogramming system (i.e., when a process blocks for I/O, another process can get the CPU), answer parts (a) and (b) for this case showing which part belong to which process. You can ignore the time spent in context switching. [6 pts]

Resource time		CPU Util	Disk Util	Net Util
A1 = CPU 4ms	0	$\frac{4}{92} = 4.35\%$	0	0
A2 = CPU 2ms + disk 14ms	4	$\frac{2}{92} = 2.17\%$	$\frac{14}{92} = 15.22\%$	0
A3 = CPU 10ms	18	$\frac{10}{92} = 10.87\%$	0	0
A4 = CPU 2ms + 18ms Network	28	$\frac{2}{92} = 2.17\%$	0	$\frac{18}{92} = 19.57\%$
B1 = CPU 4ms	46	$\frac{4}{92} = 4.35\%$	0	0
B2 = CPU 2ms + disk 14ms	50	$\frac{2}{92} = 2.17\%$	$\frac{14}{92} = 15.22\%$	0
B3 = CPU 10ms	64	$\frac{10}{92} = 10.87\%$	0	0
B4 = CPU 2ms + 18ms Network	82	$\frac{2}{92} = 2.17\%$	0	$\frac{18}{92} = 19.57\%$

%.
20

CPU Util
Disk Util
Net Util



$$B) \text{ avg CPU util} = \frac{(dur_1)(util_1) + dur_2u_2 + \dots + dur_nu_n}{dur_{tot}}$$

$$= \frac{4(4.35) + 14(2.17) + 10(10.87) + 18(2.17) + 4(4.35) + 14(2.17) + 10(10.87) + 18(2.17)}{92}$$

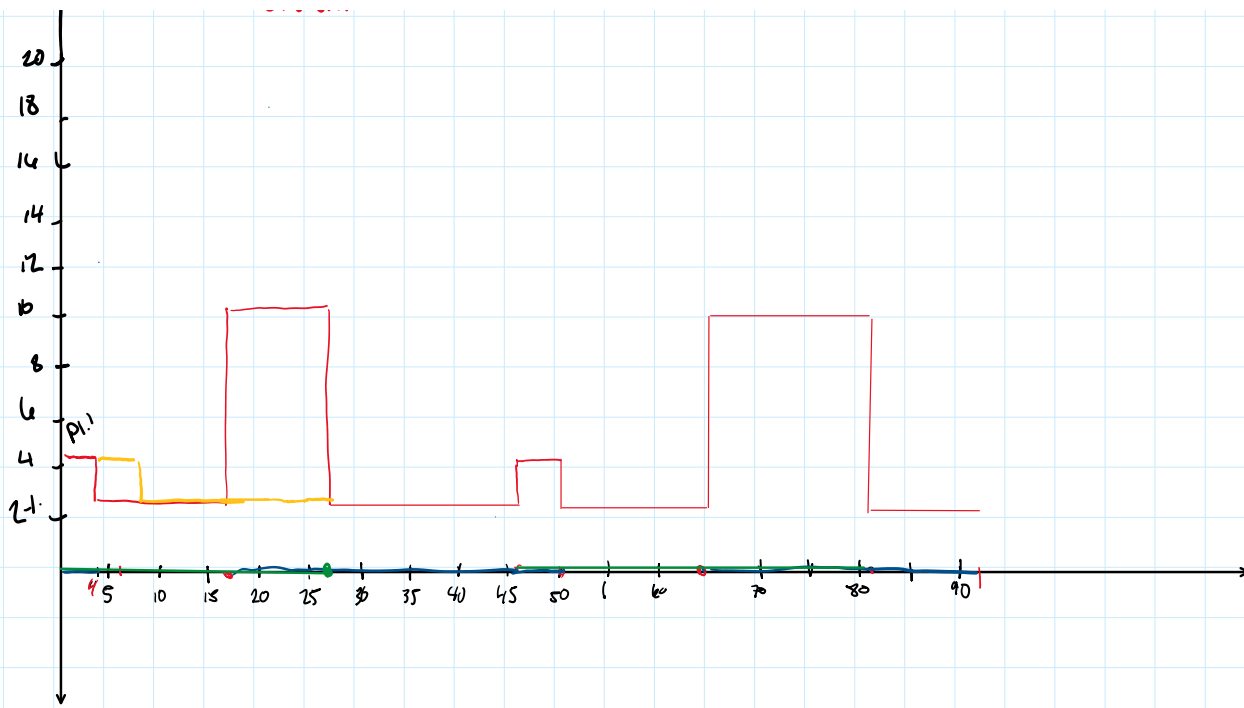
$$= 4.25\%$$

C) P_i

- A 1. Use the CPU for 4 milliseconds.
 B 2. Issue an I/O to disk for 14 milliseconds.
 C 3. Use the CPU for 10 milliseconds.
 D 4. Issue an I/O to the network for 18 milliseconds.

- E 1. Use the CPU for 4 milliseconds.
 F 2. Issue an I/O to disk for 14 milliseconds.
 G 3. Use the CPU for 10 milliseconds.
 H 4. Issue an I/O to the network for 18 milliseconds.

%
 20
 18
 CPU util



Problem 4

Consider a multiprogramming system with 4 processes, A, B, C, and D that arrived at the same time. Processes A and B are CPU-bound ones, while processes C and D are I/O-bound ones. Their resource requirements are given in the table below. Assume that process A uses 80% of the CPU while running, process B uses 90% of the CPU while running, process C uses 10% of the CPU while executing I/O, and process D uses 10% of the CPU while executing I/O. Assume processes C and D use their respective I/O

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Page 2 of 3

CNS220 (Miss Gargate) - Homework #1

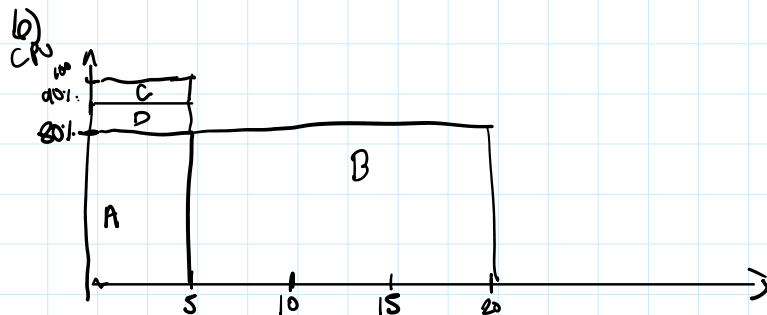
devices 80% of the time while executing their I/O. The total amount of time that the system is to be used for all jobs is 250000 (assume no initial or final overheads).

	Process A	Process B	Process C	Process D
Duration	5 min	15 min	5 min	10 min
Memory	40M	80M	20M	40M
Need Disk	No	No	Yes	Yes
Need printer	No	No	No	Yes

Answer the following questions:

- How long would it take until all the processes are done? [4 pts]
- Draw the utilization of the CPU, memory, disk and printer over time? [4 pts]
- What are the average utilizations of the CPU, memory, disk and printer? [4 pts]
- What is the overall system throughput (in jobs/hr)? [4 pts]
- What is the average turnaround time for all processes? [4 pts]

a) 15 minutes BC multiprog



$$c) \frac{5(.8) + 15(.9) + 5(.1) + 10(.1)}{26} \text{ min} = 86.5\%$$

$$\text{dist} = \frac{0 + 0 + 3 + 16}{20} = 75\%$$

Print 30-1.

$$d) \frac{4}{15} = \frac{x}{60} \quad \frac{60(4)}{15} = x \quad 16 \text{ jobs/hr}$$

e) $\frac{5+10+5+5}{4} = 8.75$ mins

For this problem, you are allowed to research the correct parameters/commands to use.

```
PS C:\Users\evanw> ssh ers131@eros.cs.txstate.edu
Warning: Permanently added 'ers131@eros.cs.txstate.edu' (RSA) to the list of known hosts.
WARNING: REMOTE HOST IDENTIFICATION HAS CHANGED! 0
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
IT IS POSSIBLE THAT SOMEONE IS DOING SOMETHING NASTY!
Someone could be eavesdropping on you right now (man-in-the-middle attack)!
It is also possible that a host key has just been changed.
The fingerprint for the ED25519 key sent by the remote host is
SHA256:RIU0G5SF4KwZLUknX7Pwpa7oJaTqcdQvbyiAag.
Please contact your system administrator.
Add correct host key in C:\Users\evanw\ssh\known_hosts to get rid of this message.
Resending ED25519 public key for authentication. (fingerprint=C:\Users\evanw\ssh\known_hosts:1)
Host key for eros.cs.txstate.edu has changed and you have requested strict checking.
Host key verification failed.
PS C:\Users\evanw> ssh ers131
PS C:\Users\evanw> ssh ers131@zeus.cs.txstate.edu
Warning: Permanently added 'ers131@zeus.cs.txstate.edu' (RSA) to the list of known hosts.
WARNING: REMOTE HOST IDENTIFICATION HAS CHANGED! 0
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
IT IS POSSIBLE THAT SOMEONE IS DOING SOMETHING NASTY!
Someone could be eavesdropping on you right now (man-in-the-middle attack)!
It is also possible that a host key has just been changed.
The fingerprint for the ED25519 key sent by the remote host is
SHA256:RIU0G5SF4KwZLUknX7Pwpa7oJaTqcdQvbyiAag.
Please contact your system administrator.
Add correct host key in C:\Users\evanw\ssh\known_hosts to get rid of this message.
Resending ED25519 public key for authentication. (fingerprint=C:\Users\evanw\ssh\known_hosts:2)
Host key for zeus.cs.txstate.edu has changed and you have requested strict checking.
Host key verification failed.
PS C:\Users\evanw>
```

This is on leap2.txstate.edu

```

top - 16:24:53 up 117 days, 2:51, 2 users, load average: 0.00, 0.02, 0.01
Tasks: 995 total, 1 running, 994 sleeping, 0 stopped, 0 zombie
%Cpu(s): 0.1 us, 0.2 sy, 0.0 ni, 99.7 id, 0.0 wa, 0.0 hi, 0.0 si, 0.0 st
MiB Mem : 2597373.7 total, 147292.7 free, 12269.9 used, 97811.3 buff/cache
MiB Swap : 16394.0 total, 16141.7 free, 242.2 used, 242766.5 avail Mem

  PID USER      PR  NI    TSD      RSP      SHR   S  CPU    WMEM    TIME+ COMMAND
26556286 ersl31   20   0 68664    5740  SR8   R   0.0   0.0  0:00.04 top
26556311 ersl31   20   0 89080    9500  8110   S   0.0   0.0  0:00.06 systemd
26556792 ersl31   20   0 313116   3560   S   0.0   0.0  0:00.00 csh-pam
26557091 ersl31   20   0 152124   5108  3852   S   0.0   0.0  0:00.03 sshd
26557171 ersl31   20   0 29768    564    3436   S   0.0   0.0  0:00.14 bash

```

```
(base) [ers131@login2 ~]$ pstree -u ers131
sshd--bash--pstree
systemd--(sd-pam)
(base) [ers131@login2 ~]$ |
```