

# Final Exam

## System Programming

### Spring 2012

Throughout this exam, note that:

- A digit is any one of these: 01234456789
- A lower-case letter is any one of these: abcdefghijklmnopqrstuvwxyz
- An upper-case letter is any one of these: ABCDEFGHIJKLMNOPQRSTUVWXYZ
- A letter is any one of these: abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ
- A character is any single ASCII byte
- All commands are typed within the C shell.
- Whenever a file is show, you are to assume that the lines have no trailing spaces and that each line (including the last) ends in a `\n`, but has nor `\r`.
- If an answer is blank, write "BLANK"
- If a command causes an error, write "Error"
- You cannot use commands or flags that we did not teach in the course

#### Part 1.

Consider the following 3-line file:

```
% cat t
3
1
5
```

What is the answer for each of the following?

To make it clear what is being asked for, I have done the first one for you:

```
0. cat t | cat | tr "\n" ", "
```

```
3,1,5,
```

- |  |              |
|--|--------------|
| 1. cat t   sed -n '/2/p'               | tr "\n" ", " |
| 2. cat t   awk '/3/'                   | tr "\n" ", " |
| 3. cat t   sed '2\!d'                  | tr "\n" ", " |
| 4. cat t   sed 'G;s/\n//g'             | tr "\n" ", " |
| 5. cat t   sed 'x'                     | tr "\n" ", " |
| 6. cat t   sed 'h'                     | tr "\n" ", " |
| 7. cat t   sed -n 'H;\${x;p}'          | tr "\n" ", " |
| 8. cat t   sed 'd'                     | tr "\n" ", " |
| 9. cat t   sed 'q'                     | tr "\n" ", " |
| 10. cat t   sed 'n;d'                  | tr "\n" ", " |
| 11. cat t   sed -n '\$x;p'             | tr "\n" ", " |
| 12. cat t   sed -n 'x;H;\${x;P}'       | tr "\n" ", " |
| 13. cat t   awk '{print \$( \$0 )}'    | tr "\n" ", " |
| 14. cat t   awk '{print \$A}'          | tr "\n" ", " |
| 15. cat t   awk 'END{print \$0}'       | tr "\n" ", " |
| 16. cat t   awk 'i%2{i++}END{print i}' | tr "\n" ", " |
| 17. cat t   awk '/[15]/{print \$i++}'  | tr "\n" ", " |

Consider the following 1-line file:

```
% cat stuff
~ ` ! @ # $ % ^ & * ( ) _ - + = { [ ] \ | ; : " ' < , > . ? /
```

What is the answer for each of the following?

- 18. `cat stuff | tr " " "\n" | grep '\.'` | `tr "\n" ", "`
- 19. `cat stuff | tr " " "\n" | grep '[.]'` | `tr "\n" ", "`
- 20. `cat stuff | tr " " "\n" | grep '[[ ]'` | `tr "\n" ", "`
- 21. `cat stuff | tr " " "\n" | grep '\$'` | `tr "\n" ", "`
- 22. `cat stuff | tr " " "\n" | grep '"'` | `tr "\n" ", "`
- 23. `cat stuff | tr " " "\n" | grep '!'` | `tr "\n" ", "`
- 24. `cat stuff | grep -on '\\.*>'` | `tr "\n" ", "`
- 25. `cat stuff | sed 's/. . . . . /&\n/g' | sed '$\!d'` | `tr "\n" ", "`
- 26. `cat stuff | awk '{print $3}'` | `tr "\n" ", "`
- 27. `cat stuff | awk '{print $(\$0)}'` | `tr "\n" ", "`
- 28. `cat stuff | awk '{print $A}'` | `tr "\n" ", "`
- 29. `cat stuff | awk 'END{print $0}'` | `tr "\n" ", "`
- 30. `cat stuff | awk 'i%2{i++}END{print i}'` | `tr "\n" ", "`
- 31. `cat stuff | awk '/[15]/{print $i++}'` | `tr "\n" ", "`
- 32. `cat stuff | awk '{L[$2]=$3}{for (i in L) print L[i}]'` | `tr "\n" ", "`

Consider the following 1-line file:

```
% cat alph
abcdefghijklmnopqrstuvwxy
```

What is the answer for each of the following?

- 33. `cat alph | sed ':L;s/\([^\.]\)\([^\.]*)\)/\2.\1/;tL'` | `tr "\n" ", "`
- 34. `cat alph | awk '{for (i=NF;i>=0;i--) printf("%c", $i)}'` | `tr "\n" ", "`
- 35. `cat alph | awk -F '[cfilorux]' '{OFS="\n"}'` | `tr "\n" ", "`
- 36. `cat alph | awk -F '[cfilorux]' '{OFS="\n"}|awk 'END{print $NR}' | tr "\n" ", "`

## Part 2. Short answer

If your answers for the following are significantly longer than necessary then they will be counted wrong:

37 A `tr` command to remove all digits from the input stream

... | `tr _____` | ...

38 A `sed` command to remove all non-letters from the input stream

... | `sed _____` | ...

39 An `awk` command to remove all lower-case letters from the input stream

... | `awk _____` | ...

40. Write a program which asks the user for 2 numbers and then returns their sum as the `$?` value.

41. Write a program to list arguments in reverse order, on one line, with a `\n` at the end.

For example:

```
% ./myprog A B C D
./myprog D C B A
%
```

Note that there might be any number of arguments, including zero:

```
% ./myprog
./myprog
% ./myprog A B C D E F G H I J K L M N O P Q R S T
% ./myprog T S R Q P O N M L K J I H G F E D C B A
```

Note also that you do not know that the name of the program is necessarily myprog. After all, we would expect this to work, right?

```
% cp myprog prog2
% chmod u+x prog2
% ./prog2 A B C D
./prog2 D C B A
%
```

### Part 3. Matching (Write your answer for this part on this exam paper)

Consider the following

```
% head -15 a.txt
ALICE'S ADVENTURES IN WONDERLAND
Lewis Carroll
```

```
THE MILLENNIUM FULCRUM EDITION 3.0
```

```
CHAPTER I. Down the Rabbit-Hole
```

Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do; once or twice she had peeped into the book her sister was reading, but it had no pictures or conversations in it, 'and what is the use of a book,' thought Alice 'without pictures or conversation?'

So she was considering in her own mind (as well as she could, for the

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Now, for each of the commands shown below, decide what the proper output should be. Then look for that output in the list of choices attached at the end of this exam paper. If you find it, write the pair of letters for that choice into the space to the right of the question.

- If you don't find it, choose the option "BW". If there is no output, then choose "BV"
- More than one command may produce the same output. So you might use the same letter-pair in several places. I have intentionally put some incorrect choices into the output. So some letter-pairs will never be used.
- Spaces matter, as do blank lines. **The output only matches if it is a perfect match.**
- To make your searching faster, you can see that I have grouped the choices. They are kind of in alphabetical order – based on the first output line, and also based on shorter outputs going first.
- Some problems will be worth more points than others.

- \_\_\_42: head a.txt | grep .
- \_\_\_43: head a.txt | egrep "^T|A|l"
- \_\_\_44: head a.txt | awk 'NF{print \$0 "\n"}'
- \_\_\_45: head a.txt | awk 'NF{\$0=++a " " \$0};1'
- \_\_\_46: head a.txt | awk '{for (i=1; i<=NF; i++) s=s+\$i}; END{print s}'
- \_\_\_47: head a.txt | awk '/the/{ total = total + NF }; END {print total}'
- \_\_\_48: head a.txt | awk '{i=NF/2; print \$i, \$i+1 }'
- \_\_\_49: head a.txt | awk 'NF > 4'
- \_\_\_50: head a.txt | tail -2 | awk '{print \$2, \$1}'
- \_\_\_51: head a.txt | tail -2 | awk '{ \$2 = ""; print }'
- \_\_\_52: head a.txt | tail -1 | awk '{for (i=NF; i>0; i--) printf("%s ",\$i);print ""}'
- \_\_\_53: head a.txt | tail -1 | tr " " "\n" | cat -n | sort -gr | sed 's/[^\t]\*[\t]//'

```

tr "\n" " "
__54: head a.txt | awk 'NR>2{exit};1'
__55: head a.txt | awk '{y=x "\n" $0; x=$0};END{print y}'
__56: head a.txt | awk '/the/'
__57: head a.txt | sed '/the/ p'
__58: head a.txt | sed 's/the/the/p'
__59: head a.txt | awk '$7 ~ /^[t]/'
__60: head a.txt | awk '/do/{print x};{x=$0}'
__61: head a.txt | tail -5 | awk 'NR==2,NR==4'
__62: head a.txt | awk NF
__63: head a.txt | awk '/./'
__64: head a.txt | awk 'BEGIN{FS="\n";OFS=" ";RS=".";ORS=".\n"}{$1=$1;print}'
__65: head a.txt | sed G
__66: head a.txt | sed '/^$/d;G'
__67: head a.txt | sed '/^$/d;G'| sed 'n;d'
__68: head a.txt | sed '/the/{x;p;x;}'
__69: head a.txt | sed '/the/G'
__70: head a.txt | grep '.'
__71: head a.txt | sed = | sed 'N;s/\n/\t/'
__72: head a.txt | sed '=;N;s/\n/\t/'
__73: head a.txt | sed '/./=' | sed '/./N; s/\n/ /'
__74: head a.txt | sed -n '$='
__75: head a.txt | sed 's/[A-Z]/[a-z]/g'
__76: head a.txt | sed -n 's/\(.*\) o\(..* o\)/\1 O\2/p'
__77: head a.txt | sed '/was/s/the//p'
__78: head a.txt | sed -n '1\!G;h;$p'
__79: head a.txt | sed '1\!G;h;$!d'
__80: head a.txt | sed -e :a -e '/D$/N; s/\n//; ta'
__81: head a.txt | sed q
__82: head a.txt | sed -e :a -e '$q;N;5,$D;ba'
__83: head a.txt | sed '/the/\!p'
__84: head a.txt | sed -n '/WONDER/{n;p;}'
__85: head a.txt | sed '2\!d'
__86: head a.txt | sed '/^$/,/the/d'
__87: head a.txt | sed '$\!N; /\^(.*\) \n\1$/\!P; D'
__88: head a.txt | sed -e :a -e '$d;N;2,5ba' -e 'P;D'
__89: head a.txt | sed 'n;n;n;n;d;'
__90: head a.txt | sed -n '/^$/ {p;h;}; /./ {x; /./p;}'
__91: set the = "the" ; head a.txt | grep '$the'
__92: head a.txt | grep -ni "the" | sed -e 's_\([0-9]*\) :.*_1_' | tr "\n" " "
__93: head a.txt | sed '1 p; 3p; 5p'
__94: head a.txt | sed -n '1 p; 3p; 5p'

```

Here is the input file:

```
% head -15 a.txt
ALICE'S ADVENTURES IN WONDERLAND
Lewis Carroll

THE MILLENNIUM FULCRUM EDITION 3.0
```

CHAPTER I. Down the Rabbit-Hole

Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do: once or twice she had peeped into the book her sister was reading, but it had no pictures or conversations in it, 'and what is the use of a book,' thought Alice 'without pictures or conversation?'

So she was considering in her own mind (as well as she could, for the %

And here are the choices:

---

AA:

ALICE'S ADVENTURES IN WONDERLAND  
Lewis Carroll

---

AB:

ALICE'S ADVENTURES IN WONDERLAND

---

AC:

ALICE'S ADVENTURES IN WONDERLAND  
Lewis Carroll

---

AD:

ALICE'S ADVENTURES IN WONDERLAND

---

AE:

ALICE'S ADVENTURES IN WONDERLAND  
Lewis Carroll

bank, and of having nothing to do: once or twice she had peeped into the

---

AF:

ALICE'S ADVENTURES IN WONDERLAND  
Lewis Carroll

THE MILLENNIUM FULCRUM EDITION 3.0

---

AG:

ALICE'S ADVENTURES IN WONDERLAND  
Lewis Carroll

THE MILLENNIUM FULCRUM EDITION 3.0

CHAPTER I. Down the Rabbit-Hole

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AH:

ALICE'S ADVENTURES IN WONDERLAND Lewis Carroll THE MILLENNIUM FULCRUM EDITION 3.  
0 CHAPTER I.

Down the Rabbit-Hole Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do: once or twice she had peeped into the .

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AI:

ALICE'S ADVENTURES IN WONDERLAND  
Lewis Carroll  
THE MILLENNIUM FULCRUM EDITION 3.0  
CHAPTER I. Down the Rabbit-Hole

Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do: once or twice she had peeped into the

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**AJ:**

ALICE'S ADVENTURES IN WONDERLAND  
Lewis Carroll

THE MILLENNIUM FULCRUM EDITION 3.0

CHAPTER I. Down the Rabbit-Hole

Alice was beginning to get very tired of sitting by her sister on the  
bank, and of having nothing to do: once or twice she had peeped into the

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**AK:**

ALICE'S ADVENTURES IN WONDERLAND  
Lewis Carroll

THE MILLENNIUM FULCRUM EDITION 3.0

CHAPTER I. Down the Rabbit-Hole

Alice was beginning to get very tired of sitting by her sister on the

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**AL:**

ALICE'S ADVENTURES IN WONDERLAND

Alice was beginning to get very tired of sitting by her sister on the

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**AM:**

ALICE'S ADVENTURES IN WONDERLAND  
Lewis Carroll

THE MILLENNIUM FULCRUM EDITION 3.0

CHAPTER I. Down the Rabbit-Hole

Alice was beginning to get very tired of sitting by her sister on the  
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**AN:**

ALICE'S ADVENTURES IN WONDERLAND  
Lewis Carroll

THE MILLENNIUM FULCRUM EDITION 3.0

CHAPTER I. Down the Rabbit-Hole

Alice was beginning to get very tired of sitting by her sister on the  
bank, and of having nothing to do: once or twice she had peeped into the

---

**AO:**

1 ALICE'S ADVENTURES IN WONDERLAND  
2 Lewis Carroll

4 THE MILLENNIUM FULCRUM EDITION 3.0

7 CHAPTER I. Down the Rabbit-Hole

9 Alice was beginning to get very tired of sitting by her sister on the  
10 bank, and of having nothing to do: once or twice she had peeped into the

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**AP:**

ALICE'S ADVENTURES IN WONDERLAND  
Lewis Carroll

THE MILLENNIUM FULCRUM EDITION 3.0

CHAPTER I. Down the Rabbit-Hole  
CHAPTER I. Down the Rabbit-Hole

Alice was beginning to get very tired of sitting by her sister on the  
Alice was beginning to get very tired of sitting by her sister on the  
bank, and of having nothing to do: once or twice she had peeped into the  
bank, and of having nothing to do: once or twice she had peeped into the

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**AQ:**

ALICE'S ADVENTURES IN WONDERLAND

Lewis Carroll

THE MILLENNIUM FULCRUM EDITION 3.0

CHAPTER I. Down the Rabbit-Hole

Alice was beginning to get very tired of sitting by her sister on the  
bank, and of having nothing to do: once or twice she had peeped into the

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**AR:**

ALICE'S ADVENTURES IN WONDERLAND  
Lewis Carroll

THE MILLENNIUM FULCRUM EDITION 3.0

CHAPTER I. Down the Rabbit-Hole

Alice was beginning to get very tired of sitting by her sister on the  
bank, and of having nothing to do: once or twice she had peeped into the

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**AS:**

ALICE'S ADVENTURES IN WONDERLAND  
Lewis Carroll

THE MILLENNIUM FULCRUM EDITION 3.0

CHAPTER I. Down the Rabbit-Hole

Alice was beginning to get very tired of sitting by her sister on  
Alice was beginning to get very tired of sitting by her sister on  
bank, and of having nothing to do: once or twice she had peeped into the

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**AT:**

1 ALICE'S ADVENTURES IN WONDERLAND  
2 Lewis Carroll  
3  
4 THE MILLENNIUM FULCRUM EDITION 3.0  
5  
6  
7 CHAPTER I. Down the Rabbit-Hole  
8  
9 Alice was beginning to get very tired of sitting by her sister on the  
10 bank, and of having nothing to do: once or twice she had peeped into the

---

**AU:**  
ADVENTURES IN  
Lewis Carroll

MILLENNIUM FULCRUM

I. Down

tired of  
do: once

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**AV:**  
THE MILLENNIUM FULCRUM EDITION 3.0  
Alice was beginning to get very tired of sitting by her sister on the

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**AW:**  
THE MILLENNIUM FULCRUM EDITION 3.0  
CHAPTER I. Down the Rabbit-Hole  
Alice was beginning to get very tired of sitting by her sister on the  
bank, and of having nothing to do: once or twice she had peeped into the

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**AX:**  
CHAPTER I. Down the Rabbit-Hole

Alice was beginning to get very tired of sitting by her sister on the  
bank, and of having nothing to do: once or twice she had peeped into the

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**AY:**  
CHAPTER I. Down the Rabbit-Hole  
Alice was beginning to get very tired of sitting by her sister on the  
bank, and of having nothing to do: once or twice she had peeped into the

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**AZ:**  
CHAPTER I. Down the Rabbit-Hole

Alice was beginning to get very tired of sitting by her sister on 4  
bank, and 13 having nothing 9 do: once or twice she had peeped into 4

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**BA:**  
Alice was beginning to get very tired of sitting by her sister on the

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**BB:**  
Alice was beginning to get very tired of sitting by her sister on  
bank, and of having nothing to do: once or twice she had peeped into the

---

**BC:**  
Alice beginning to get very tired of sitting by her sister on the  
bank, of having nothing to do: once or twice she had peeped into the

---

**BD:**  
Alice was beginning to get very tired of sitting by her sister on the  
bank, and of having nothing to do: once or twice she had peeped into the

---

**BE:**  
Alice was beginning to get very tired Of sitting by her sister on the  
bank, and of having nothing to do: Once or twice she had peeped into the

---

**BF:**  
bank, and of having nothing to do: once or twice she had peeped into the

---

NYVPR'F NQIRAGHERF VA JBAQREYNAQ  
Yrjvf Pneeby

---

**BG:**  
bank, and of having nothing to do: once or twice she had peeped into the  
Alice was beginning to get very tired of sitting by her sister on the

---

**BH:**  
bank, and of having nothing to do: once or twice she had peeped into the  
Alice was beginning to get very tired of sitting by her sister on the

---

CHAPTER I. Down the Rabbit-Hole

THE MILLENNIUM FULCRUM EDITION 3.0

Lewis Carroll  
ALICE'S ADVENTURES IN WONDERLAND

---



**BI:**  
DNALREDNOW NI SERUTNEVDA S'ECILA  
llorraC siweL

0.3 NOITIDE MURCLUF MUINNELLIM EHT

eloH-tibbaR eht nwoD .I RETPAHC

eht no retsis reh yb gnittis fo derit yrev teg ot gninnigeb saw ecila  
eht otni depeep dah ehs eciwt ro ecno :od ot gnihton gnivah fo dna ,knab

---

**BJ:**  
Lewis Carroll

---

**BK:**  
the into peeped had she twice or once do: to nothing having of and bank,

---

**BL:**  
was Alice  
and bank,

---

**BM:**  
,

3.0

.

, :

---

**BN:**  
,

3.0

.

, :

---

**BO:**  
AL  
Le  
TH  
CH  
Al  
ba  
bo it  
co So ho of

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**BP:**  
AL  
Le  
TH  
CH  
Al ba  
bo  
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co  
So  
ho  
of

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**BQ:**  
10

---

**BR:**  
12

---

**BS:**  
32

---

**BT:**  
2

---

**BU:**

4 7 9 10

---

**BV:**

<No output>

---

**BW:**

Other (output is not listed)

---