Week 13. Final exam review

1. True or false?

A. I claim that linked lists have the following advantages over the arrays:
- ✓ They allow insertion in the middle in a constant time
- They allow access to the element at position *k* in a constant time
- They use less memory
- The search is faster because we are following the pointers

B. I claim that for the following variables:

```
char *a;  int *b;
```

- a and b store values of different types
- sizeof(a) ≠ sizeof(b)
- ✓ sizeof(*a) ≠ sizeof(*b)

C. I claim that for the following declarations:

```
char a [] = "abc";  char *b="abc";
```

- sizeof(a)=sizeof(b)
- a and b both are variables that store an address
- we can do both a=b and b=a
- the amount of memory used is the same for both declarations
- we can do both a[1] = 'd'; and b[1]='d';
- ✓ we can pass both a and b as parameters to a function *func (char *c)*

2. What is legal?

```
int x, y;
int *px, *py, *p;
float *pf;

px = &x;              /**  legal assignment  **/
py = &y;              /**  legal assignment  **/
p = px + py;          /**  addition is illegal  **/
p = px * py;          /**  multiplication is illegal  **/
p = px + 10.0;        /**  addition of float is illegal  **/
pf = px;      /**  assignment of different types is illegal  **/
```

3. Linked lists

Given new data type *node*:

```
typedef struct node{
   int data;
   struct node * next;
}node;
```

- How do we declare a list of nodes? `node * head;`

- How do we insert a new node *new_node* after the second element of the list?

```
int counter = 1;
node *current = head;
while (current!=NULL && counter<2) {
   current=current->next;
   counter++;
}
if (counter == 2 && current != NULL) {
   new_node->next = current->next;
   current->next = new_node;
}
```

- How do we make a circular list of nodes?
  We find the last element of the list and set its next to point to the head
- How can we reverse the order of elements in the list in one iteration?

Move each next node on top of a reversed list

```
node *headOfReverse = NULL;
node * current = head;
node * next = NULL:
while (current != NULL)    {
     next = current->next;
       //store pointer to the next node – to continue iteration
     current->next = headOfReverse; //push on top of reverse list
     headOfReverse = current;

     current = next; //advance in the original list
}
head = headOfReverse ;
```

- How can we add new element on top of the list in a void function?
  We need to pass an address of a head pointer:

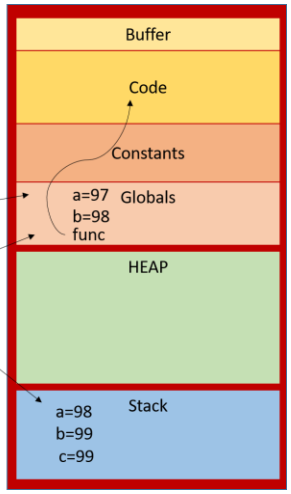
```
void addOnTop (node ** head,  int value)
{
    node * d = (node *)calloc (1, sizeof(node));
    d->data = value;
    if (*head == NULL)
        *head = d;
    else
    {
        d->next = *head->next;
        *head = d;
    }
}

int main (){
    addOnTop (&head, 1);

    return 0;
}
```

4. Memory segments

Draw memory diagram and say where each variable is stored and to which memory segment it points to (in case it is a pointer):

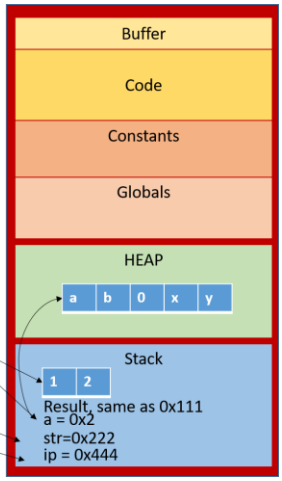
A. Fun

```
int fun (char a, char b) {
        a++;
        b++;
        return b;
}
char a='a'; //value 97
char b='b';
int (*func) (char, char);
int main () {
        func = fun;
        char c = (char) func (a, b);
        printf ("%c %c %c\n", a, b, c);
//what is printed by the way?
}
```



B. More fun

```
int * more_fun (char *a) {
        a = malloc (5);
        *a = 'a';
        *(a+1) = 'b';
        *(a+2) = 0;
        int result[] = {1,2};
        return result;
}

int main () {
        char *str;
        int *ip = more_fun (str);
        printf ("%d %s\n", *ip, str);
}
```



5. Pass by value (even pointer variables)

```
void init_array2 (char ** a, int size) {
    *a = (char *) malloc (size);
    strncpy(*a, "new value", size-1);
    (*a)[size-1] = '\0';
}

int main () {
    char * y = "abba";
    init_array2 (&y, 8);
    fprintf (stdout, "Array after init1 - %s\n", y);
}
```

6. File descriptors

A. If you want a parent process to read from a pipe and a child process to write to a pipe, which file descriptors do you leave open?

Parent: fds[0] or ~~fds[1]~~

Child: ~~fds[0]~~ or fds[1]

B. You want to implement the following shell pipe in a C program

```
sort file1 | head
```

- Which process should be the parent and which one the child? Head is the parent, sort is the child
- How would you use *dup2* to set standard output of a child process to the writing end of a pipe, and standard input of a parent process to the reading end of the pipe?

Parent file descriptors: 0, 1, 2, fds[0], fds[1]

dup2(____fds[0]____, ___0_____)

Child file descriptors: 0, 1, 2, fds[0], fds[1]

dup2(__fds[1]_____, ___1_____)

C. Sockets

Server code:

```
int a= socket(family, type, protocol);
int b= accept(a, &clientAddr, &addrLen);
```

Client code:

```
int c= socket(family, type, protocol);
int d=connect(c, &foreignAddr, addrlen);
```

Which of the file descriptors a,b,c (or d) are used for sending data between server and client?

b and c

7. Handling signals

- How can we make our program to ignore an interrupt signal?

```
struct sigaction action;
action.sa_handler = SIG_IGN;
sigaction (SIGINT, &action, NULL);
```

- How can we make sure that our signal handler is not interrupted in the middle by an interrupt signal?

By adding this signal to the mask argument of sigaction:

```
struct sigaction action;
action.sa_handler = &my_handler;
sigemptyset(&action.sa_mask);
sigaddset(&action.sa_mask, SIGINT);
sigaction(SIGINT, &action, NULL);
```

- How can we make sure that the important section of code gets uninterrupted by any signal?

Using sigprocmask with BLOCK and then with UNBLOCK:

```
sigset_t sigset;
sigemptyset(&sigset);
sigaddset(&sigset, SIGINT);

printf("Blocking signals...\n");
sigprocmask (SIG_BLOCK, &sigset, NULL);
 // Critical section
sigprocmask (SIG_UNBLOCK, &sigset, NULL);
```