CS 354.
Assembly Worksheet -1

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x86 general-purpose registers

```
(most significant)                        (least)
      [........ ........ ........ ........] eax        32 bits
                        [........ ........]  ax        16 bits
                        [........]           ah         8 bits
                                 [........]  al         8 bits

      [........ ........ ........ ........] ebx
                        [........ ........]  bx
                        [........]           bh
                                 [........]  bl

      [........ ........ ........ ........] ecx
                        [........ ........]  cx
                        [........]           ch
                                 [........]  cl

      [........ ........ ........ ........] edx
                        [........ ........]  dx
                        [........]           dh
                                 [........]  dl

      [........ ........ ........ ........] esi
      [........ ........ ........ ........] edi
```

Referred to as %eax, %ebx, %ecx, %edx, %esi, %edi, etc.

INSTRUCTION: **mov SOURCE, DESTINATION**

definition: moves "SOURCE" into "DESTINATION"

commonly has trailing character that indicates size of move, e.g.,
- movb - move a byte
- movl - move "long" or 4 bytes (that's an L after mov, not a one)
- movq - quad or 8 bytes

movw - move 2 bytes.

our focus: movl (mostly)

Initial (limited) usage
- source=number ("immediate") destination=register
  e.g., mov $10, %eax

- source=register destination=register
  e.g., mov %eax, %ebx

Later, we will add different types of operands for mov

```
INSTRUCTION: addl SOURCE, DESTINATION

  definition: adds SOURCE and DESTINATION, puts result into DESTINATION
              i.e., DESTINATION = DESTINATION + SOURCE

  limited usage (for now):
  - source=number ("immediate")   destination=register
  - source=register               destination=register
```

```
INSTRUCTION: subl SOURCE, DESTINATION

  definition: DESTINATION = DESTINATION - SOURCE

  limited usage (for now):
  - source=number ("immediate")   destination=register
  - source=register               destination=register
```

```
INSTRUCTION: imull SOURCE, DESTINATION

  definition: DESTINATION = DESTINATION * SOURCE

  alternate:
    imull AUX, SOURCE, DESTINATION
    definition: DESTINATION = AUX * SOURCE

  limited usage (for now):
  - source=number ("immediate")   destination=register
  - source=register               destination=register
  - (aux=immediate)
```

```
INSTRUCTION: idivl DIVISOR

  definition: contents of %edx:%eax (64 bit number) divided by DIVISOR
    quotient  -> %eax
    remainder -> %edx

  limited usage (for now):
  - divisor=register

  Notes: A bit weird in its usage of VERY SPECIFIC registers!
```

Problem #1

Write assembly to:

- move value 1 into %eax
- add 10 to it and put result into %eax

Problem #2

Expression: 3 + 6 * 2

Use one register (%eax), and 3 instructions to compute this piece-by-piece

Problem #3

```
movl $0, %edx
movl $7, %eax
movl $3, %ebx
idivl %ebx
movl %eax, %ecx
movl $0, %edx
movl $9, %eax
movl $2, %ebx
idivl %ebx
movl %edx, %eax
addl %ecx, %eax
```

Write simple C expression that is equivalent to these instructions

Many x86 instructions can refer to **memory addresses;**
these addresses take on many different forms.

ABSOLUTE/DIRECT addressing
  definition: just use a number as an address

  movl 1000, %eax
    gets contents (4 bytes) of memory at address 1000, puts into %eax

  NOTE: DIFFERENT than movl $1000, %eax
  (which just moves the VALUE 1000 into %eax)

INDIRECT addressing
  definition: address is in register

  movl (%eax), %ebx
    treat contents of %eax as address, get contents from that address,
    put into %ebx

BASE + DISPLACEMENT addressing
  definition: address in register PLUS displacement value (an offset)

  movl 8(%eax), %ebx
    address = 8 + contents of eax
    get contents from that address, put into %ebx

INDEXED addressing
  definition: use one register as base, other as index

  movl 4(%eax, %ecx), %ebx
    address = 4 + contents[eax] + contents[ecx]
    get contents from that address, put into %ebx

SCALED INDEXED addressing (most general form)
  definition: use one register as base, other as index, scale index by
              constant (e.g., 1, 2, 4, 8)

  movl 4(%eax, %ecx, 8), %ebx
    address = 4 + contents[eax] + 8*contents[ecx]
    get contents from that address, put into %ebx

Problem #4 (from CSAPP 3.1)

Memory

Address	Value
0x100	0xFF
0x104	0xAB
0x108	0x13
0x10C	0x11

Registers	
%eax	0x100
%ecx	0x1
%edx	0x3

Value of:

%eax _____

0x104 _____

$0x108 _____

(%eax) _____

4(%eax) _____

9(%eax, %edx) _____

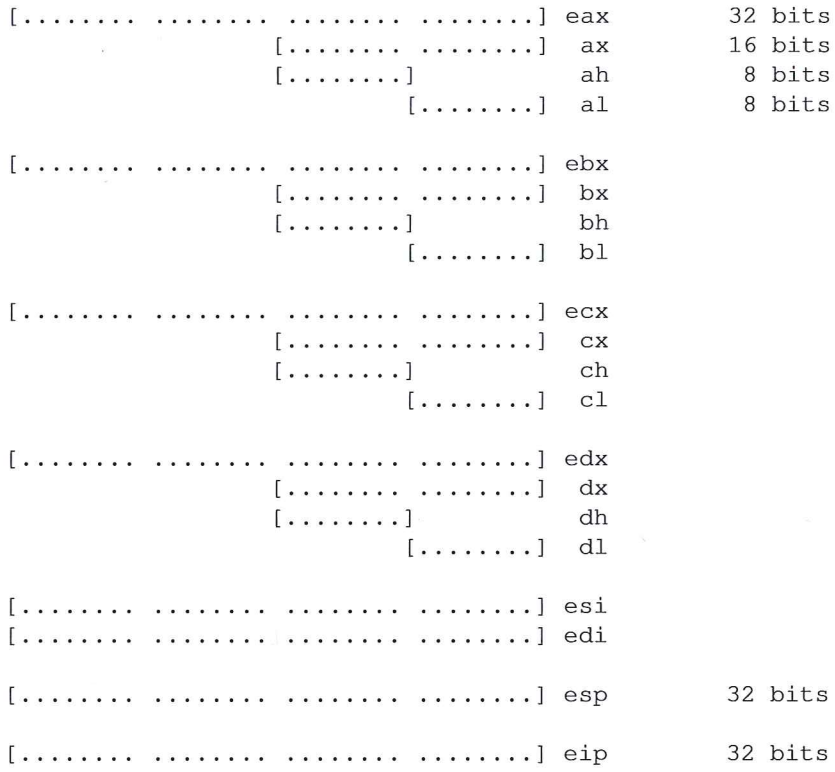
260(%ecx, %edx) _____

0xFC(,%ecx, 4) _____

(%eax, %edx, 4) _____

New register to help with stack: esp (extended stack pointer)

Referred to as %esp



Points to "top of stack" when program is running
Changes often (room for local variables, function call/return, etc.)

Can use normal instructions to interact with it, e.g., addl, subl
Can also use special instructions (we'll see this later)

Problem #5

Use instructions to:

- Increase size of stack by 4 bytes
- Store an integer value 10 into the top of the stack
- Retrieve that value and put it into %ecx
- Add 5 to it
- Put final value into %eax

-Decrease size of stack by 4 bytes.

Edited by: Gerald.