EE319K Homework Manual

Univ of Texas at Austin

Do not print the entire document; we will be making changes.

Spring 2017 (2/13/17 version)

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This lab manual is updated each semester. If you find a mistakes, please email your instructor.
Grading policies: All homeworks are "submission only", which implies that the we trust you will use the homework to learn the material but we will not be grading it by looking at the correctness of your answers. You turn in your work in class to a TA and the TA gives you credit for the homework.

You are allowed to work in groups of 2 on homework. Each student must turn in their own solution. If you will miss class you are allowed to turn in homework to your professor before class. If you are uncertain about your answers go to an Instructor's their office hours to check your answers. We will not post the answers.

Homework 1. Basics from Intro to Computing and first week's lecture

Due: Wednesday 1/25 Thursday 1/26 in Class
(turn in this paper to the TA during class)

Read all Chapter 2 from the E-Book(you can skim section 2.8)
http://users.ece.utexas.edu/~valvano/Volume1/E-Book/C2_FundamentalConcepts.htm

Problem 1.1: Fill in the letter that specifies the definition for each word. (Definitions on next page)

Computer	ROM	microcontroller
Arithmetic logic unit (ALU)	Instruction set architecture (ISA)	ADC
basis	embedded computer system	Hardware port
bus	Real time	Halfword
R13	R14	R15
byte	Big endian	Little endian
Serial port	Parallel Port	Device driver

Problem 1.2: Compare memory on LC3 and on the ARM. Fill in this table

	How many memory locations are there?	How many bits are stored at each address?
LC3		
ARM Cortex M		

Problem 1.3: Each row of the following table is to contain an equal value expressed in binary, hexadecimal, and decimal. Complete the missing values. Assume the decimal values are unsigned. The first row illustrates the process.

binary	hexadecimal	Decimal
2_01101001	0x69	105
	0x48	
		49
2_11001110		
	0xF5	

Problem 1.4: Each row of the following table is to contain an equal value expressed in binary, hexadecimal, and decimal. Complete the missing values. Assume each value is 8 bits and the decimal numbers are signed. The first row illustrates the process.

binary	hexadecimal	decimal
2_01011110	0x5E	94
	0xB2	
		-76

2_11000011		

Problem 1.5 . What is Ohm's Law?

Problem 1.6: Fill in this table with the equivalent resistance (all values are in ohms)

R1	R2	R1 in series with R2	R1 in parallel with R2
1000	2000		
2000	10000		
1000		4000	
2000			1600

Problem 1.7. What is the range of voltages that represent logic low?

Problem 1.8. What is the range of voltages that represent logic high?

Definitions for assignment 1.1 (please do not turn this page in)

A Memory that is nonvolatile and contains machine instructions (code)

B Component of the processor that performs arithmetic and logic operations.

C Mechanism for storing multiple byte numbers such that the least significant byte exists first (in the smallest memory address).

D Mechanism for storing multiple byte numbers such that the most significant byte exists first (in the smallest memory address).

E Link register containing the return address when calling a function (subroutine).

F A set of digital signals that connect the CPU, memory and I/O devices, consisting of address signals, data signals and control signals. See also address bus, control bus and data bus.

G A register in the processor that points to the memory containing the instruction to execute next.

H Digital information containing 8 bits.

I A single chip microcomputer like the Texas Instruments TM4C123, Freescale 9S12, Intel 8051, Intel 8096, PIC16, or the Texas Instruments MSP430.

J A physical/electrical mechanism for data to flow into or out of the microcontroller

K Stack pointer.

L A description of a processor that details the machine code, the instruction set, addressing modes, and how data are accessed.

M A system that performs a specific dedicated operation where the computer is hidden inside the machine.

N Input/output with many bits sent at the same time.

O Input/output that sends one bit at a time.

P Digital information containing 32 bits.

Q An electronic device that converts analog signals (e.g., voltage) into digital form (i.e., integers).

R Digital information containing 64 bits.

S Includes a processor, RAM, ROM, and I/O ports.

T Digital information containing 16 bits.

U A system can guarantee a worst case upper bound on the response time between when the new input information becomes available and when that information is processed..

V A condition where information is lost when power is removed.
W A subset from which linear combinations of the elements can be used to construct the entire set.
Y a set of software functions that facilitate the use of an I/O port.
Z 1024 bytes or 8192 bits, abbreviated KiB.

Homework 2. Assembly and C Programming

Due: Wednesday 2/1 Thursday 2/2 in Class

1) Read all of the E-Book Chapters 3 and 4,
http://users.ece.utexas.edu/~valvano/Volume1/E-Book/
2) Read the textbook sections 1.1, 1.2, 1.3, 3.1, 3.2 and 3.3

3) Review Lec1 and Lec2

If you will miss class you are allowed to turn in homework to your professor before class. To get credit for homework you must complete all questions, but the official score will be completion. i.e., we will not check the answers. However, the professors have answers to the homework, so if you are uncertain about your answers go to their office hours to check your answers against the solution key. We will NOT post the answers.

When writing assembly code you can use the following directives

```
GPIO_PORTB_DATA_R       EQU   0x400053FC
GPIO_PORTB_DIR_R        EQU   0x40005400
GPIO_PORTB_AFSEL_R      EQU   0x40005420
GPIO_PORTB_DEN_R        EQU   0x4000551C
SYSCTL_RCGC2_R          EQU   0x400FE108
```

Problem 2.1. Write assembly code to set the Port B direction register so PB7-PB4 are output and PB3-0 are inputs.

Problem 2.2. Assume Port B is initialized and PB5 is an output pin. Write assembly code to set PB5 high. It will take three steps 1) read the data register; 2) perform a logical operation to set bit 5; and then 3) write the new value back to the data register. Hint: this is similar to Example 3.1.

Problem 2.3: Give the correct sequence of assembly instructions and a single line of equivalent C code, to perform the following operations.
a) Read a 16-bit signed number named *icount*, increment it and write it back.

b) Read an 8-bit unsigned number named *bcount* decrement it and write it back.

Problem 2.4: Assume N is a 32-bit global variable defined in RAM. Write assembly code to set bit 3 and clear bit 29 of N (Note: bits are numbered from 0:LSB to 31:MSB).

Homework 3. Interfacing and more C

Due: Wednesday 2/10 / Thursday 2/11 in Class

1) Read the textbook sections 3.3.1- 3.3.5, and 3.3.7
2) Review Lec3.ppt

Problem 3.1: Draw the circuits that interface a positive logic switch to Port A pin 7 and, a negative logic switch to Port A pin 0.

Problem 3.2: Draw the circuit that interfaces a positive-logic LED to Port A pin 6. The LED parameters are 1.2V 1mA. Assume the microcontroller output voltage V_{OH} is 3.2V.

Problem 3.3: Solve Lab0 in C and submit a screenshot showing your Simulator with two cases as you did for the Lab checkout. You will find the starter code on the course website as part of the C tutorial.

Homework 4: Conditional statements and loops in C

Due: Friday 2/17 on Canvas (Midnight)

1) Read EdX Chapter 5: sections 5.1, 5.2 and 5.3

http://users.ece.utexas.edu/~valvano/Volume1/E-Book/

2) Write the following two functions. The second function calls the first.

```
/* Function called when Alice makes a monthly payment
* or defaults on the monthly payment.
* Returns nothing, updates global variable credit_rating_Alice.
*/
int credit_rating_Alice = 750;
void credit_rating_for_Alice (int opcode, /* 0 if default, 1 if paid */)

{
    // each monthly payment increments rating by 10 points all the way up to 800

    // every default decrements rating by 10 points down to 700.









}
/* Function that raises an alarm when Alice's rating is 700 for 2 consecutive months,
* or rewards her if she has maintained a rating of 800 for 2 consecutive months.
* Reads PORTA_DATA_Reg for Alice's input.
* Returns 0 if alarm, 1 if reward, loops endlessly otherwise.
*/

int rewards_or_alarm ()
{
   // read port A in a loop. Assume port has been initialized in main().

       // call credit_rating_for_Alice() with input from PortA.

       // return (optional). Based on return value of credit_rating_for_Alice
```

}

Homework 5 – Practice Exam

Due: Friday 2/24 on Canvas (Midnight)

UT EID:

Printed Name:

Last, First

Your signature is your promise that you have not cheated and will not cheat on this exam, nor will you help others to cheat on this exam:

Signature:

Instructions:

- Closed book and closed notes. No books, no papers, no data sheets (other than the last two pages of this Exam)
- No devices other than pencil, pen, eraser (no calculators, no electronic devices), please turn cell phones off.
- Please be sure that your answers to all questions (and all supporting work that is required) are contained in the space (boxes) provided. *Anything outside the boxes/blanks will be ignored in grading*. You may use the back of the sheets for scratch work.
- You have 75 minutes, so allocate your time accordingly.
- For all questions, unless otherwise stated, find the most efficient (time, resources) solution.
- Unless otherwise stated, make all I/O accesses friendly.
- *Please read the entire exam before starting.*

Problem 1	10	
Problem 2	6	
Problem 3	4	
Problem 4	10	
Problem 5	20	
Problem 6	10	
Problem 7	10	
Problem 8	15	
Problem 9	15	
Total	100	

(10) Question 1. State the term, symbol, or expression that is best described by each definition.

Part a) A property of memory that describes the fact that when power is removed and subsequently restored, the contents of the memory is lost.

Part b) A debugging instrument or tool that measures voltage versus time for multiple digital signals.

Part c) A drawing that describes how information is passed from one module to another in a system. An arrow from circle A to circle B means information is passed from software module A to software module B.

Part d) A collection of wires in a computer that allows data to travel from one module to another within the computer.

Part e) A processor in which the operands to ALU instructions are never a memory location uses what type of generic architecture? (Hint: the answer to this question is not ARM, THUMB, or Cortex-M, but rather the general architecture type.)

Part f) The electrical property that specifies the number of electrons per second that are traveling down a wire.

Part g) This C operator will perform the exclusive or of two numbers in a bit-wise fashion.

Part h) A C program calls an assembly subroutine. When the assembly subroutine returns, where can the return value be found? (Hint: AAPCS)

Part i) This declaration is used to create a variable in C that can take on the values from -20 to +200. Pick the most efficient format.

Part j) A debugging feature that causes execution to halt, and control returns to the debugger when your software executes an instruction at a specific location in your code.

(6) Question 2. Octal means base 8 in the same way binary means base 2, decimal means base 10, and hexadecimal means base 16. This means each octal digit can be 0, 1, 2, 3, 4, 5, 6, or 7. What is the value of the unsigned four-digit octal number 1036? Give your answer as a decimal number. Show your work.

(4) Question 3 Consider the following 8-bit addition (assume registers are 8 bits wide, and assume the condition code bits are set in a way similar to the Cortex M4)

```
Load   0x80 into R1
Load   0x20 into R2
Adds   R3 = R1+R2, setting the condition codes
```

a. What is the 8-bit result in Register R3 (as an unsigned decimal)?

b. What is the 8-bit result in Register R3 (as a signed decimal)?

c. What will be the value of the carry (C) bit?

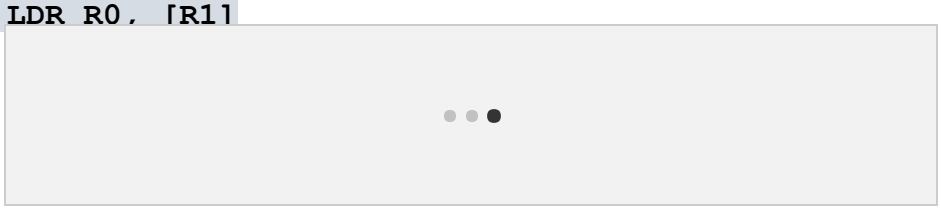
d. What will be the value of the overflow (V) bit?

(10) Question 4. Complete the assembly subroutine that initializes **Port D**, making **PD4** an output, and making **PD3**, **PD2**, **PD1**, **PD0** inputs. This subroutine is called once at the start of execution of the system. **All accesses to I/O registers must be friendly.** Your *subroutine* will set the *clock*, *direction*, and *enable* registers (in this question do not worry about AFSEL, PUR, PDR, AMSEL, or PCTL). You must fill in the instruction or instructions for the following five boxes. Boxes may contain 0, 1, or 2 instructions. Do not assume DIR, DEN or DATA registers have been cleared by the reset operation. Comments are not needed.

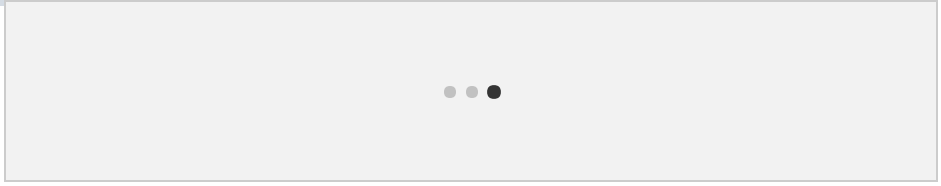
```
GPIO_PORTD_DATA_R  EQU 0x400073FC
GPIO_PORTD_DIR_R   EQU 0x40007400
GPIO_PORTD_DEN_R   EQU 0x4000751C
SYSCTL_RCGCGPIO_R  EQU 0x400FE608
PortD_Init
    LDR R1, =SYSCTL_RCGCGPIO_R
    LDR R0, [R1]
```

```
    STR R0, [R1]
```

```
    LDR R1, =GPIO_PORTD_DIR_R
    LDR R0, [R1]
```



```
    STR R0, [R1]
    LDR R1, =GPIO_PORTD_DEN_R
    LDR R0, [R1]
```



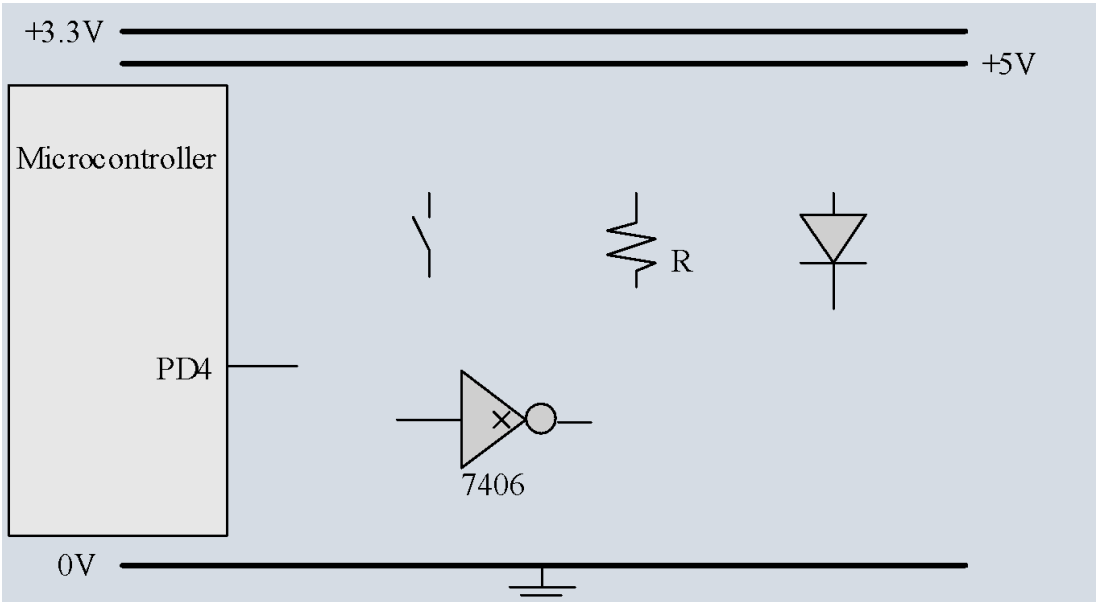
```
    STR R0, [R1]
```

(20) Question 5. The inputs are on **Port D** pins 3,2,1,0. The output is **PD4**. Design a detector that reads a 4-bit number on **PD3** – **PD0** and activates a positive-logic detection light on **PD4**. First, read the 4-bit input and count the number of input pins, **PD3** – **PD0**, that are high. If the count is odd, set **PD4** high; if the count is even, clear **PD4** low. For example, if **PD3** – **PD0** is 1011 then there are an odd number of pins that are high, the pattern is detected, and the **PD4** should be set high. When such a pattern is detected turn ON the light otherwise turn it off. You will design pieces of the solution in two parts. You may assume the subroutine in Question 4 has been called making **PD4** an output and making **PD3** – **PD0** inputs.

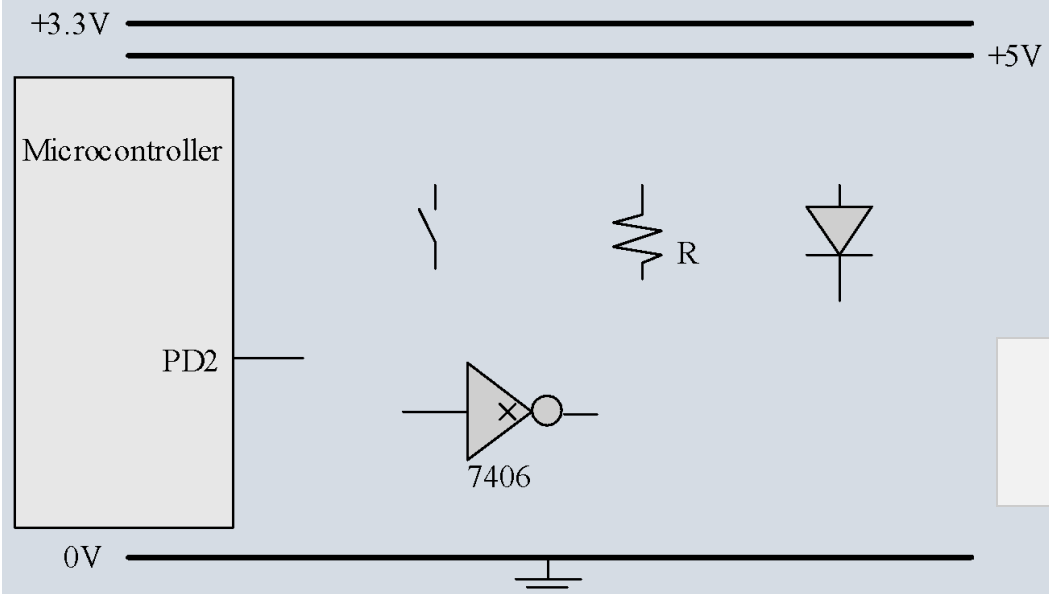
Part a) Write an assembly subroutine called *Detect* that takes a 4-bit input in a register (the remaining bits are zero). Returns a 1 if pattern is detected, 0 otherwise. *Detect* must be AAPCS compliant.

Part b) Complete the caller code loop in assembly that repeatedly reads the 4-bit number, calls *Detect* and appropriately manipulates the light. Execute these steps over and over.

(10) Question 6. You are to interface an **external LED** on Port D pin 4 that operates using positive logic. You have an LED whose desired brightness requires an operating point of (V_d , I_d) = (1.5V, 15mA). Given the TM4C microcontroller output low V_{OL} ranges between (0V,0.5V) and output high V_{OH} ranges between (2.4V,3.3V). The 7406 driver's V_{OL} is 0.5V. Show the calculation used to find the resistor value needed and draw the circuit below by connecting the needed elements:



(10) Question 7. You are to interface an **external Switch** on Port D pin 2 that operates using negative logic by using the needed elements in the following figure.
(8) Part a) Given the TM4C microcontroller limits the current flow into it to 2 μA calculate the voltage at Port D pin 2 when the switch is open. Choose a value for R and specify its value.



(2) Part b) If you were using an internal resistor (instead of an external one) what extra line(s) would you have to add to the initialization for port D. (C or Assembly is okay)

(15) Question 8. The right column shows Cortex M assembly for a function called **`Calc`**. You will write the corresponding C code in the left column. Think of the assembly as code generated by the C compiler. You must write the C code that corresponds to the functionality defined in the assembly code. Do not optimize, just translate the assembly into C. *Use comments in your C code for possible partial credit.*

```
#include <stdint.h> // C99
```

```
     AREA  Data,ALIGN=2
Num  SPACE 2
Cnt  SPACE 2


     AREA |.text|, CODE, ALIGN=2
     THUMB
     EXPORT  Calc
;Input is 16-bit unsigned in R0
;Output is 16-bit unsigned in R0
Calc   LDR  R1, =Num
       STRH R0, [R1] ;R0 is input

       LDR  R2, =Cnt
       MOV  R3, #0
       STRH R3, [R2]
       B    labelD

labelA LDRH R0, [R1]
       CMP  R0, #0x64
       BHS  labelB
       LDRH R3, [R2]
       ADD  R0, R0, R3
       STRH R0, [R1]
       B    labelC

labelB ADD  R0, R0, #1
       STRH R0, [R1]

labelC LDRH R3, [R2]
       ADD  R3, R3, #1
       STRH R3, [R2]

labelD LDRH R3, [R2]
       CMP  R3, #0x0A
       BLS  labelA

       LDRH R0, [R1]
;R0 is the 16-bit return value
```

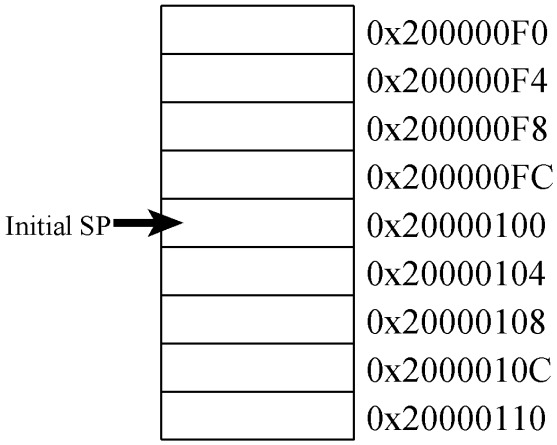
	BX LR

(15) Question 9. Consider the following assembly code. Execution begins at line 127 in **`main`**, and the initial SP equals 0x20000100.

```
111:                ;R0 dividend
112:                ;R1 divisor
113:                ;R0 is returned with remainder
114: 0x000002F8 B500      mod  PUSH {LR}
115: 0x000002FA FBB0F3F1       UDIV R3, R0, R1 ;<-stop execution here
116: 0x000002FE FB03F301       MUL  R3, R3, R1
117: 0x00000302 EBA00003       SUB  R0, R0, R3
118: 0x00000306 BD00           POP  {PC}
119: 0x00000308 B510      fun  PUSH {R4,LR}
120: 0x0000030A F04F040A       MOV  R4, #10
121: 0x0000030E F04F0010  loop MOV  R0, #16
122: 0x00000312 4621           MOV  R1, R4
123: 0x00000314 F7FFFFF0       BL   mod       ;<-what addressing mode??
124: 0x00000318 3C01           SUBS R4, #1
125: 0x0000031A D1F8           BNE  loop
126: 0x0000031C BD10           POP  {R4,PC}
127: 0x0000031E F04F0405  main MOV  R4, #5    ;<- begin execution here
128: 0x00000322 F7FFFFF1       BL   fun
129: 0x00000326 E7FE      done B    done
```

Part a) What is the SP when execution reaches line 115 for the first time?

Part b) What values are stored on the stack as it executes from line 127 to line 115? Show each value as a 32-bit hexadecimal number into the appropriate place on the stack picture. The addresses and machine code are included for each line.



Part c) What is the addressing mode of the instruction at line 123?

Part d) What does **`B500`** at line 114 represent?

Memory access instructions

```
LDR    Rd, [Rn]        ; load 32-bit number at [Rn] to Rd
LDR    Rd, [Rn,#off]   ; load 32-bit number at [Rn+off] to Rd
LDR    Rd, =value      ; set Rd equal to any 32-bit value (PC rel)
LDRH   Rd, [Rn]        ; load unsigned 16-bit at [Rn] to Rd
LDRH   Rd, [Rn,#off]   ; load unsigned 16-bit at [Rn+off] to Rd
LDRSH  Rd, [Rn]        ; load signed 16-bit at [Rn] to Rd
LDRSH  Rd, [Rn,#off]   ; load signed 16-bit at [Rn+off] to Rd
LDRB   Rd, [Rn]        ; load unsigned 8-bit at [Rn] to Rd
LDRB   Rd, [Rn,#off]   ; load unsigned 8-bit at [Rn+off] to Rd
LDRSB  Rd, [Rn]        ; load signed 8-bit at [Rn] to Rd
LDRSB  Rd, [Rn,#off]   ; load signed 8-bit at [Rn+off] to Rd
STR    Rt, [Rn]        ; store 32-bit Rt to [Rn]
STR    Rt, [Rn,#off]   ; store 32-bit Rt to [Rn+off]
STRH   Rt, [Rn]        ; store least sig. 16-bit Rt to [Rn]
STRH   Rt, [Rn,#off]   ; store least sig. 16-bit Rt to [Rn+off]
STRB   Rt, [Rn]        ; store least sig. 8-bit Rt to [Rn]
STRB   Rt, [Rn,#off]   ; store least sig. 8-bit Rt to [Rn+off]
PUSH   {Rt}            ; push 32-bit Rt onto stack
POP    {Rd}            ; pop 32-bit number from stack into Rd
ADR    Rd, label       ; set Rd equal to the address at label
MOV{S} Rd, <op2>       ; set Rd equal to op2
MOV    Rd, #im16       ; set Rd equal to im16, im16 is 0 to 65535
MVN{S} Rd, <op2>       ; set Rd equal to -op2
```

Branch instructions

```
B    label   ; branch to label    Always
BEQ  label   ; branch if Z == 1   Equal
BNE  label   ; branch if Z == 0   Not equal
BCS  label   ; branch if C == 1   Higher or same, unsigned ≥
BHS  label   ; branch if C == 1   Higher or same, unsigned ≥
BCC  label   ; branch if C == 0   Lower, unsigned <
BLO  label   ; branch if C == 0   Lower, unsigned <
BMI  label   ; branch if N == 1   Negative
BPL  label   ; branch if N == 0   Positive or zero
BVS  label   ; branch if V == 1   Overflow
BVC  label   ; branch if V == 0   No overflow
BHI  label   ; branch if C==1 and Z==0  Higher, unsigned >
BLS  label   ; branch if C==0 or  Z==1  Lower or same, unsigned ≤
BGE  label   ; branch if N == V   Greater than or equal, signed ≥
BLT  label   ; branch if N != V   Less than, signed <
BGT  label   ; branch if Z==0 and N==V  Greater than, signed >
BLE  label   ; branch if Z==1 or N!=V  Less than or equal, signed ≤
BX   Rm      ; branch indirect to location specified by Rm
BL   label   ; branch to subroutine at label
BLX  Rm      ; branch to subroutine indirect specified by Rm
```

Interrupt instructions

```
CPSIE  I               ; enable interrupts  (I=0)
CPSID  I               ; disable interrupts (I=1)
```

Logical instructions

```
AND{S} {Rd,} Rn, <op2> ; Rd=Rn&op2    (op2 is 32 bits)
ORR{S} {Rd,} Rn, <op2> ; Rd=Rn|op2    (op2 is 32 bits)
```

```
EOR{S} {Rd,} Rn, <op2> ; Rd=Rn^op2    (op2 is 32 bits)
BIC{S} {Rd,} Rn, <op2> ; Rd=Rn&(~op2) (op2 is 32 bits)
ORN{S} {Rd,} Rn, <op2> ; Rd=Rn|(~op2) (op2 is 32 bits)
LSR{S} Rd, Rm, Rs      ; logical shift right Rd=Rm>>Rs  (unsigned)
LSR{S} Rd, Rm, #n      ; logical shift right Rd=Rm>>n   (unsigned)
ASR{S} Rd, Rm, Rs      ; arithmetic shift right Rd=Rm>>Rs (signed)
ASR{S} Rd, Rm, #n      ; arithmetic shift right Rd=Rm>>n  (signed)
LSL{S} Rd, Rm, Rs      ; shift left Rd=Rm<<Rs (signed, unsigned)
LSL{S} Rd, Rm, #n      ; shift left Rd=Rm<<n  (signed, unsigned)
```

Arithmetic instructions

```
ADD{S} {Rd,} Rn, <op2> ; Rd = Rn + op2
ADD{S} {Rd,} Rn, #im12 ; Rd = Rn + im12, im12 is 0 to 4095
SUB{S} {Rd,} Rn, <op2> ; Rd = Rn - op2
SUB{S} {Rd,} Rn, #im12 ; Rd = Rn - im12, im12 is 0 to 4095
RSB{S} {Rd,} Rn, <op2> ; Rd = op2 - Rn
RSB{S} {Rd,} Rn, #im12 ; Rd = im12 - Rn
CMP    Rn, <op2>       ; Rn - op2      sets the NZVC bits
CMN    Rn, <op2>       ; Rn - (-op2)   sets the NZVC bits
MUL{S} {Rd,} Rn, Rm    ; Rd = Rn * Rm       signed or unsigned
MLA    Rd, Rn, Rm, Ra  ; Rd = Ra + Rn*Rm    signed or unsigned
MLS    Rd, Rn, Rm, Ra  ; Rd = Ra - Rn*Rm    signed or unsigned
UDIV   {Rd,} Rn, Rm    ; Rd = Rn/Rm         unsigned
SDIV   {Rd,} Rn, Rm    ; Rd = Rn/Rm         signed
```

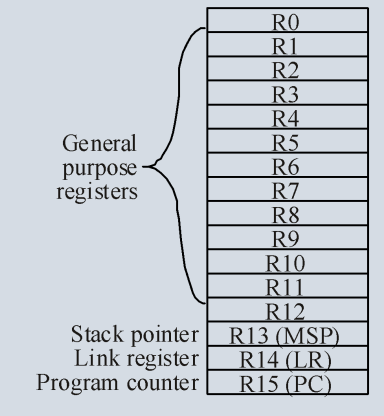
Notes `Ra Rd Rm Rn Rt` represent 32-bit registers

```
value   any 32-bit value: signed, unsigned, or address
{S}     if S is present, instruction will set condition codes
#im12   any value from 0 to 4095
#im16   any value from 0 to 65535
{Rd,}   if Rd is present Rd is destination, otherwise Rn
#n      any value from 0 to 31
#off    any value from -255 to 4095
label   any address within the ROM of the microcontroller
op2     the value generated by <op2>
```

Examples of flexible operand `<op2>` creating the 32-bit number. E.g., `Rd = Rn+op2`

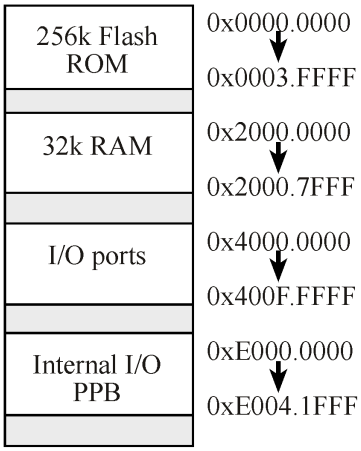
```
ADD Rd, Rn, Rm         ; op2 = Rm
ADD Rd, Rn, Rm, LSL #n ; op2 = Rm<<n  Rm is signed, unsigned
ADD Rd, Rn, Rm, LSR #n ; op2 = Rm>>n  Rm is unsigned
ADD Rd, Rn, Rm, ASR #n ; op2 = Rm>>n  Rm is signed
ADD Rd, Rn, #constant  ; op2 = constant, where X and Y are hexadecimal digits:
```

- produced by shifting an 8-bit unsigned value left by any number of bits
- in the form `0x00XY00XY`
- in the form `0xXY00XY00`
- in the form `0xXYXYXYXY`



Condition code bits

N	negative
Z	zero
V	signed overflow
C	carry or unsigned overflow



Homework 6. Loops and Arrays in C

Due: Friday 3/10 midnight on Canvas

The purpose of this homework is to practice loops and arrays in C programming.

1) Read EdX Chapters 7 and 9: all sections; watch the videos
http://users.ece.utexas.edu/~valvano/Volume1/E-Book/

Problem6.1: Solve Lab4 in C and submit screenshot showing your logic analyzer window with all 5 duty-cycles and your C source code showing your DebugCapture function. Find the starter file here:http://users.ece.utexas.edu/~valvano/Volume1/Homework6.zip

Problem6.2: Write a function (`most_freq`), that takes an array of numbers and finds out the most frequently occurring value in the array.

```
int  most_freq (int* input, int size);

void main()
{
      int array[10] = {1,2,2,3,3,3,7,8,9,3};
      int freq = most_freq(array, 10);
      print(freq); // assume this prints to an LED screen or an output port

}
```

Homework 7. Subroutines in C, Parameter-passing and Pointers

Due: Friday 3/24 on Canvas

The purpose of this homework is to practice subroutines in C and to pass parameters to and results from a subroutine. You will also learn the use of pointers.

Problem7.1: Solve Lab5 in assembly and submit a screenshot showing your score of 100. You will find the starter code, at
http://users.ece.utexas.edu/~valvano/Volume1/Lab5_EE319Kassembly.zip
You will use the auto-grader to check your solution and print a screenshot including your name from the source code comments and the full score of 100 points.
If you are missing the dll, you can download it from here:
http://users.ece.utexas.edu/~valvano/Volume1/EE319KLab5.dll
Download and copy into your Keil\ARM\BIN folder.

Problem7.2: Write a function (called `freq_count`) to count the number of times a string occurs in another. Assume both strings are terminated by a null character ('\0') and assume that the each occurrence of `str_find` in `str` is disjoint (i.e. two `str_find` instances do not overlap). Return zero if there are no occurrences.

```
int freq_count (char* str, char* str_find);

void main()
{
      char str = "abcdefghijklabcdef";
      char str_find = "def";
      int freq = freq_count(str, str_find);
}
```

Homework 8. Practice Exam 2

Due: Friday 3/31 on Canvas

Download the following old exam:
http://users.ece.utexas.edu/~valvano/Volume1/CExam2_StringCompare.zip

Assignment 8.1: Do the exam:
1) Unzip the file
2) Print out **pdf** (read just the first page)
3) Launch **the uvproj** that starts Keil uVision
4) Build the object code **Target->Rebuild all target files**
Start a stopwatch and measure how many points you achieve in 35 minutes. Measure how many minutes it takes you to get to 100 points. Print one page of your solution and write the two measurements (points in 35 minutes, and time to 100 points for the exam)

Assignment 8.2: Do the exam:
1) Unzip **http://users.ece.utexas.edu/~valvano/Volume1/CExam2_DataBase.zip**
2) Print out **pdf** (read just the first page)
3) Launch **the uvproj** that starts Keil uVision
4) Build the object code **Target->Rebuild all target files**
Start a stopwatch and measure how many points you achieve in 60 minutes. Measure how many minutes it takes you to get to 100 points. Print one page of your solution and write the two measurements (points in 60 minutes, and time to 100 points for the exam)
See http://users.ece.utexas.edu/~valvano/Volume1/Exam2thoughts.pdf for more information on the exam.

There are four other practice exams in C at http://users.ece.utexas.edu/~valvano/Volume1/

Homework 9. Practice Exam 2 (2/2)

Due: Wednesday 3/29 / Thursday 3/30 in Class

Homework 10. Final exam study

Due: Wednesday 4/17 / Thursday 4/18 in Class
http://users.ece.utexas.edu/~valvano/Volume1/FinalS15.pdf

Exercise 10: Do Final Exam Spring 2015
Questions 1,4,5,6

Assignment 10.1: Do Final Exam Spring 2015
Do Questions 8,9 in one color, look at the answers and correct your mistakes in another color.

Homework 11. Final exam study

Due: Wednesday 4/19 / Thursday 4/20 in Class
http://users.ece.utexas.edu/~valvano/Volume1/FinalS15.pdf

Exercise 11: Do Final Exam Spring 2015
Questions 2,3

Assignment 11.1: Do Final Exam Spring 2015
Do Question 7 in one color, look at the answers and correct your mistakes in another color.

Homework 12. Final exam study

Due: Wednesday 4/26 / Thursday 4/27 in Class
http://users.ece.utexas.edu/~valvano/Volume1/FinalF14.pdf

Exercise 12: Do Final Exam Fall 2014
Questions 1,3,4,6,7,8

Assignment 12.1: Do Final Exam Fall 2014
Do Questions 2,5 in one color, look at the answers and correct your mistakes in another color.

Homework 13. Final exam study

Due: Wednesday 5/4 / Thursday 5/5 in Class
http://users.ece.utexas.edu/~valvano/Volume1/FinalF15.pdf

Exercise 13: Do Final Exam Fall 2015
Questions 1,2 (skip 2a) 3,4,5

Assignment 13.1: Do Final Exam Fall 2015
Do Questions 7,8,9