

TUTORIAL-1

1. The following problems deal with translating from C to ARM. Assume that the variables g, h, i and j are given and considered 32-bit integers as declared in a C program.
 - a) $f = g + h + i + j$;
 - b) $f = g + (h + 5)$;
 - (a) For the C statements above, what is the corresponding ARM assembly code? Use a minimal number of ARM assembly instructions.
 - (b) For the C statements above, how many ARM assembly instructions are needed to perform the C statement?
 - (c) If the variables f, g, h, i, j have values 1, 2, 3, 4, 5 respectively, what is the end value of f?
 - (d) The following problems deal with translating from ARM to C. Assume that the variables g, h, i and are given and considered 32-bit integers as declared in a C program.
 - a) ADD f, g, h
 - b) ADD f, f, #1
ADD f, g, h
 - i. For the ARM statements above, what is the corresponding C statement?
 - ii. If the variables f, g, h, i, j have values 1, 2, 3, 4, 5 respectively, what is the end value of f?
2. The following problems deal with translating from C to ARM. Assume that the variables g, h, i and j are given and considered 32-bit integers as declared in a C program.
 - a) $f = f + g + h + i + j + 2$;
 - b) $f = g - (f + 5)$;

- (a) For the C statements above, what is the corresponding ARM assembly code? Use a minimal number of ARM assembly instructions.
 - (b) For the C statements above, how many ARM assembly instructions are needed to perform the C statement?
 - (c) If the variables f, g, h, i, j have values 1, 2, 3, 4, 5 respectively, what is the end value of f?
 - (d) The following problems deal with translating from ARM to C. Assume that the variables g, h, i and are given and considered 32-bit integers as declared in a C program.
 - a) ADD f, -g, h
 - b) ADD h, f, #1
SUB f, g, h
 - i. For the ARM statements above, what is the corresponding C statement?
 - ii. If the variables f, g, h, i, j have values 1, 2, 3, 4, 5 respectively, what is the end value of f?
3. The following problems deal with translating from C to ARM. Assume that the variables f, g, h, i and j are assigned to registers r0, r1, r2, r3 and r4, respectively. Assume that the base address of the arrays A and B are in registers r6 and r7, respectively.
- a) $f = g + h + B[4];$
 - b) $f = g - A[B[4]];$
- (a) For the C statements above, what is the corresponding ARM assembly code? Use a minimal number of ARM assembly instructions.
 - (b) For the C statements above, how many ARM assembly instructions are needed to perform the C statement?
 - (c) For the C statements above, how many different registers are needed to carry out the C statement?
 - (d) The following problems deal with translating from ARM to C. Assume that the variables f, g, h, i, j are assigned to registers r0, r1, r2, r3, r4, respectively. Also assume that $r1 = r2$ and the base address of the arrays A and B are in registers r6 and r7, respectively.
 - a) ADD r0, r0, r1
ADD r0, r0, r2
ADD r0, r0, r3
ADD r0, r0, r4
 - b) LDR r0, [r6, #0x4]

- i. For the ARM statements above, what is the corresponding C statement?
 - ii. For the ARM assembly instructions above, rewrite the assembly code to minimize the number of ARM instructions (if possible) needed to carry out the same function.
 - iii. How many registers are needed to carry out the ARM assembly as written above? If you could rewrite the code above, what is the minimal number of registers needed?
4. The following problems deal with translating from C to ARM. Assume that the variables f, g, h, i and j are assigned to registers r0, r1, r2, r3 and r4, respectively. Assume that the base address of the arrays A and B are in registers r6 and r7, respectively.
 - a) $f = -g + h + B[1];$
 - b) $f = A[B[g]+1];$
 - (a) For the C statements above, what is the corresponding ARM assembly code? Use a minimal number of ARM assembly instructions.
 - (b) For the C statements above, how many ARM assembly instructions are needed to perform the C statement?
 - (c) For the C statements above, how many different registers are needed to carry out the C statement?
 - (d) The following problems deal with translating from ARM to C. Assume that the variables f, g, h, i, j are assigned to registers r0, r1, r2, r3, r4, respectively. Assume that the base address of the arrays A and B are in registers r6 and r7, respectively.
 - a) ADD r0, r0, r1
ADD r0, r3, r2
ADD r0, r0, r3
 - b) ADD r6, r6, #-20 ;(SUB r6, r6, #20)
ADD r6, r6, r1
LDR r0, [r6, #8]
 - i. For the ARM statements above, what is the corresponding C statement?
 - ii. For the ARM assembly above, assume that the registers r0, r1, r2, r3 contain the values 10, 20, 30, 40 respectively. Also, assume that register r6 contains the value 256, and that memory contains the following values.

| Address | Value |
|---------|-------|
| 256 | 100 |
| 260 | 200 |
| 264 | 300 |

- iii. For each ARM instruction, show the value of the opcode, Rd, Rn, operand2 and I fields. Remember to distinguish between Dp-type and DT-type instructions.

- 5. In the following problems, the data table contains the values for registers r3 and r4. You will be asked to perform several ARM logical operations on these registers.
 - a) r3 = 0x55555555, r4 = 0x12345678
 - b) r3 = 0xBEADFEED, r4 = 0xDEADFADE

 - (a) For the lines above, what is the value of r5 for the following sequence of instructions :
 OR r5, r4, r3, LSL #4
 - (b) For the values in the table above, what is the value of r2 for the following sequence of instructions:
 MVN r3, #1
 ADD r5, r3, r4, LSL #4
 - (c) For the lines above, what is the value of r5 for the following sequence of instructions:
 MOV r5, 0xFFEF
 AND r5, r5, r3, LSR #3

 - (d) In the following problems, the data table contains various ARM logical operations. You will be asked to find the result of these operations given values of registers r0 and r1.
 - ORR r2, r1, r0, LSL #1
 - AND r2, r1, r0, LSR #1

 - i. Assume that r0 = 0x0000A5A5 and r1 = 00005A5A. What is the value of r2 after the two instructions mentioned above.
 - ii. Assume that r0 = 0xA5A50000 and r1 = A5A50000. What is the value of r2 after the two instructions mentioned above.
 - iii. Assume that r0 = 0xA5A5FFFF and r1 = A5A5FFFF. What is the value of r2 after the two instructions mentioned above.