

（深圳）

实验报告

开课学期： 2022春季

课程名称：计算机组成原理（实验）

实验名称： 从C语言到机器码

实验性质： 综合设计型

实验学时： 2 地点：

学生班级： 20级计科8班

学生学号： 200210231

学生姓名： 王木一

作业成绩：

实验与创新实践教育中心制

2022年3月

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| 1、实验结果截图 |
| （需贴出执行文件运行的结果截图） |
| 2、汇编代码注释（只需写主程序和子程序即可） |
| 示例：  *将堆栈指针寄存器sp与立即数(-16)相加，再存入堆栈指针寄存器sp，即sp = sp + (-16)*  注：本次实验主程序为main，其中首先打印学号，再调用cube()函数计算立方。以下注释为将.s文件拷贝到rars软件中进行编辑而得。为计算立方，使用两次原码一位乘法，故汇编指令中有两次循环。 |
| 3、机器码注释（只需写主程序和子程序即可） |
| 示例：    1141：二进制为0001 0001 0100 0001  fun3：000，imm：110000，rd/rs1：00010，op：01  c.addi指令：sp = sp + (-16)  注：此机器码来自.o文件（未经链接）  lab1.o: file format elf64-littleriscv  Disassembly of section .text:  0000000000000000 <cube>:  0: 7179 addi sp,sp,-48  7179=011 1 00010 11110 01  op=01 func3=011 rd/rs1=00010 imm=111110 c.addi16sp : sp = sp + (-3)\*16  2: f406 sd ra,40(sp)  f406=111 101000 00001 10  op=10 func3=111 uimm=000101 rs2=00001 c.sdsp: MEM(sp+(10)\*4) = ra  4: f022 sd s0,32(sp)  f022=111 100000 01000 10  op=10 func3=111 uimm=000100 rs2=01000 c.sdsp: MEM(sp+(8)\*4) = ra  6: 1800 addi s0,sp,48  1800=000 11000000 000 00  Op=00 func3=000 uzuimm=00001100 rd’=000 c.addi4spn:s0 = sp + 12\*4  8: 47fd li a5,31  47fd=010 0 01111 11111 01  Op=01 func3=010 imm=011111 rd=01111 c.li: a5 = 31  a: fef42623 sw a5,-20(s0)  fef42623=1111111 01111 01000 010 01100 0100011  Opcode=0100011 func3=010 imm=111111101100 rs2=01111 rs1=01000  sw: MEM(s0-20)=a5  e: 47fd li a5,31  47fd=010 0 01111 11111 01  Op=01 func3=010 imm=011111 rd=01111 c.li: a5 = 31  10: fef42423 sw a5,-24(s0)  fef42423=1111111 01111 01000 010 01000 0100011  Opcode=0100011 func3=010 imm=111111101000 rs2=01111 rs1=01000  sw: MEM(s0-24)=a5  14: 6789 lui a5,0x2  6787=011 0 01111 00010 01  Op=01 func3=011 nzimm=000010 rd=01111 c.lui: a5 = 0x2000  16: f0078793 addi a5,a5,-256 # 1f00 <main+0x1e0e>  f0078793=111100000000 01111 000 01111 0010011  Opcode=0010011 func3=000 func7=0000000 imm=111100000000 rs1=01111 rd=01111  addi: a5 = a5 + (-256)  1a: fcf42e23 sw a5,-36(s0)  fcf42e23=1111110 01111 01000 010 11100 0100011  Opcode=0100011 func3=010 imm=111111011100 rs2=01111 rs1=01000  sw: MEM(s0-36)=a5  1e: 479d li a5,7  479d=010 0 01111 00111 01  Op=01 func3=010 imm=000111 rd=01111 c.li: a5 = 7  20: fef42223 sw a5,-28(s0)  fef42223=1111111 01111 01000 010 00100 0100011  Opcode=0100011 func3=010 imm=111111100100 rs2=01111 rs1=01000  sw: MEM(s0-28)=a5  24: a091 j 68 <.L2>  a091=101 0 0 00 0 1 0 010 0 01  op=01 func3=101 imm=00000100010 c.j: PC=PC+34\*2  0000000000000026 <.L4>:  26: fe842703 lw a4,-24(s0)  fe842703=111111101000 01000 010 01110 0000011  opcode=0000011 func3=010 rs1=01000 rd=01110 imm=111111101000  lw: a4 = MEM(s0-24)  2a: 41f7579b sraiw a5,a4,0x1f  41f7579b=0100000 11111 01110 101 01111 0011011  opcode=0011011 rd=01111 func3=101 rs1=01110 shamt=11111  sraiw:a5 = a4 >> 0x1f  2e: 01f7d79b srliw a5,a5,0x1f  01f7d79b=0000000 11111 01111 101 01111 0011011  opcode=0011011 rd=01111 func3=101 rs1=01111 shamt=11111  srliw:a5 = a5 >> 0x1f  32: 9f3d addw a4,a4,a5  9f3d=100 1 11 110 01 111 01  op=01 rs2’=111 rs1’/rd’=110 func3=100 c.addw: a4 = a4 + a5  34: 8b05 andi a4,a4,1  8b05=100 0 10 110 00001 01  op=01 imm=000001 rs1’/rd’=110 func3=100 c.andi: a4 = a4 & 1  36: 40f707bb subw a5,a4,a5  40f707bb=0100000 01111 01110 000 01111 0111011  opcode=0111011 rd=01111 func3=000 rs1=01110 rs2=01111 func7=0100000  subw: a5 = a4 – a5  3a: 2781 sext.w a5,a5  2781=001 0 01111 00000 01  op=01 func3=001 rd/rs1=01111 c.sext.w: a5 = sext(a5)  3c: 873e mv a4,a5  873e=100 0 01110 01111 10  op=01 rs2=01111 rd=01110 func3=100 c.mv:a4 = a5  3e: 4785 li a5,1  4785=010 0 01111 00001 01  Op=01 func3=010 imm=000001 rd=01111 c.li: a5 = 1  40: 00f71963 bne a4,a5,52 <.L3>  00f71963=0000000 01111 01110 001 10010 1100011  opcode=1100011 imm=0000000010001 fun3=001 rs1=01110 rs2=01111  bne: a4!=a5? PC=PC+imm\*2:PC=PC+4  44: fe842703 lw a4,-24(s0)  fe842703=111111101000 01000 010 01110 0000011  opcode=0000011 func3=010 rs1=01000 rd=01110 imm=111111101000  lw: a4 = MEM(s0-24)  48: fdc42783 lw a5,-36(s0)  fdc42783=111111011100 01000 010 01111 0000011  opcode=0000011 func3=010 rs1=01000 rd=01111 imm=111111011100  lw: a5 = MEM(s0-36)  4c: 9fb9 addw a5,a5,a4  9fb9=100 1 11 111 01 110 01  op=01 rs2’=110 rs1’/rd’=111 func3=100 c.addw: a5 = a5 + a4  4e: fef42423 sw a5,-24(s0)  fef42423=1111111 01111 01000 010 01000 0100011  Opcode=0100011 func3=010 imm=111111101000 rs2=01111 rs1=01000  sw: MEM(s0-24)=a5  0000000000000052 <.L3>:  52: fe842783 lw a5,-24(s0)  fe842783=111111101000 01000 010 01111 0000011  opcode=0000011 func3=010 rs1=01000 rd=01111 imm=111111101000  lw: a5 = MEM(s0-24)  56: 4017d79b sraiw a5,a5,0x1  4017d79b=0100000 00001 01111 101 01111 0011011  opcode=0011011 rd=01111 func3=101 rs1=01111 shamt=00001  sraiw:a5 = a5 >> 0x1  5a: fef42423 sw a5,-24(s0)  fef42423=1111111 01111 01000 010 01000 0100011  Opcode=0100011 func3=010 imm=111111101000 rs2=01111 rs1=01000  sw: MEM(s0-24)=a5  5e: fe442783 lw a5,-28(s0)  fe442783=111111100100 01000 010 01111 0000011  opcode=0000011 rd=01111 func3=010 rs1=01000 imm=111111100100  lw: a5 = MEM(s0-28)  62: 37fd addiw a5,a5,-1  37fd=001 1 01111 11111 01  op=01 func3=001 rs1/rd=01111 imm=111111 c.addiw: a5 = a5 + (-1)  64: fef42223 sw a5,-28(s0)  fef42223=1111111 01111 01000 010 00100 0100011  Opcode=0100011 func3=010 imm=111111100100 rs2=01111 rs1=01000  sw: MEM(s0-28)=a5  0000000000000068 <.L2>:  68: fe442783 lw a5,-28(s0)  fe442783=111111100100 01000 010 01111 0000011  opcode=0000011 rd=01111 func3=010 rs1=01000 imm=111111100100  lw: a5 = MEM(s0-28)  6c: 2781 sext.w a5,a5  2781=001 0 01111 00000 01  op=01 func3=001 rd/rs1=01111 c.sext.w: a5 = sext(a5)  6e: fa07dce3 bgez a5,26 <.L4>  fa07dce3=1111101 00000 01111 101 11001 1100011  opcode=1100011 imm=1111111011100 func3=101 rs1=01111 rs2=00000  bne: a5>=0? PC=PC+imm\*2:PC=PC+4  72: fe842783 lw a5,-24(s0)  fe842783=111111101000 01000 010 01111 0000011  opcode=0000011 func3=010 rs1=01000 rd=01111 imm=111111101000  lw: a5 = MEM(s0-24)  76: 0087979b slliw a5,a5,0x8  0087979b=0000000 01000 01111 001 01111 0011011  opcode=0011011 rd=01111 func3=001 rs1=01111 shamt=01000  slliw:a5 = a5 << 0x8  7a: fef42423 sw a5,-24(s0)  fef42423=1111111 01111 01000 010 01000 0100011  Opcode=0100011 func3=010 imm=111111101000 rs2=01111 rs1=01000  sw: MEM(s0-24)=a5  7e: 479d li a5,7  479d=010 0 01111 00111 01  Op=01 func3=010 imm=000111 rd=01111 c.li: a5 = 7  80: fef42023 sw a5,-32(s0)  fef42023=1111111 01111 01000 010 00000 0100011  Opcode=0100011 func3=010 imm=111111100000 rs2=01111 rs1=01000  sw: MEM(s0-32)=a5  84: a091 j c8 <.L5>  a091=101 0 0 00 0 1 0 010 0 01  op=01 func3=101 imm=00000100010 c.j: PC=PC+34\*2  0000000000000086 <.L7>:  86: fec42703 lw a4,-20(s0)  fec42703=111111101100 01000 010 01110 0000011  opcode=0000011 rd=01110 func3=010 rs1=01000 imm=111111101100  lw: a4 = MEM(s0-20)  8a: 41f7579b sraiw a5,a4,0x1f  41f7579b=0100000 11111 01110 101 01111 0011011  opcode=0011011 rd=01111 func3=101 rs1=01110 shamt=11111  sraiw:a5 = a4 >> 0x1f  8e: 01f7d79b srliw a5,a5,0x1f  01f7d79b=0000000 11111 01111 101 01111 0011011  opcode=0011011 rd=01111 func3=101 rs1=01111 shamt=11111  srliw:a5 = a5 >> 0x1f  92: 9f3d addw a4,a4,a5  9f3d=100 1 11 110 01 111 01  op=01 rs2’=111 rs1’/rd’=110 func3=100 c.addw: a4 = a4 + a5  94: 8b05 andi a4,a4,1  8b05=100 0 10 110 00001 01  op=01 imm=000001 rs1’/rd’=110 func3=100 c.andi: a4 = a4 & 1  96: 40f707bb subw a5,a4,a5  40f707bb=0100000 01111 01110 000 01111 0111011  opcode=0111011 rd=01111 func3=000 rs1=01110 rs2=01111 func7=0100000  subw: a5 = a4 – a5  9a: 2781 sext.w a5,a5  2781=001 0 01111 00000 01  op=01 func3=001 rd/rs1=01111 c.sext.w: a5 = sext(a5)  9c: 873e mv a4,a5  873e=100 0 01110 01111 10  op=01 rs2=01111 rd=01110 func3=100 c.mv:a4 = a5  9e: 4785 li a5,1  4785=010 0 01111 00001 01  Op=01 func3=010 imm=000001 rd=01111 c.li: a5 = 1  a0: 00f71963 bne a4,a5,b2 <.L6>  00f71963=0000000 01111 01110 001 10010 1100011  opcode=1100011 imm=0000000010001 fun3=001 rs1=01110 rs2=01111  bne: a4!=a5? PC=PC+imm\*2:PC=PC+4  a4: fec42703 lw a4,-20(s0)  fec42703=111111101100 01000 010 01110 0000011  opcode=0000011 rd=01110 func3=010 rs1=01000 imm=111111101100  lw: a4 = MEM(s0-20)  a8: fe842783 lw a5,-24(s0)  fe842783=111111101000 01000 010 01111 0000011  opcode=0000011 func3=010 rs1=01000 rd=01111 imm=111111101000  lw: a5 = MEM(s0-24)  ac: 9fb9 addw a5,a5,a4  9fb9=100 1 11 111 01 110 01  op=01 rs2’=110 rs1’/rd’=111 func3=100 c.addw: a5 = a5 + a4  ae: fef42623 sw a5,-20(s0)  fef42623=1111111 01111 01000 010 01100 0100011  Opcode=0100011 func3=010 imm=111111101100 rs2=01111 rs1=01000  sw: MEM(s0-20)=a5  00000000000000b2 <.L6>:  b2: fec42783 lw a5,-20(s0)  fec42783=111111101100 01000 010 01111 0000011  opcode=0000011 rd=01111 func3=010 rs1=01000 imm=111111101100  lw: a5 = MEM(s0-20)  b6: 4017d79b sraiw a5,a5,0x1  4017d79b=0100000 00001 01111 101 01111 0011011  opcode=0011011 rd=01111 func3=101 rs1=01111 shamt=00001  sraiw:a5 = a5 >> 0x1  ba: fef42623 sw a5,-20(s0)  fef42623=1111111 01111 01000 010 01100 0100011  Opcode=0100011 func3=010 imm=111111101100 rs2=01111 rs1=01000  sw: MEM(s0-20)=a5  be: fe042783 lw a5,-32(s0)  fe042783=111111100000 01000 010 01111 0000011  opcode=0000011 rd=01111 func3=010 rs1=01000 imm=111111100000  lw: a5 = MEM(s0-32)  c2: 37fd addiw a5,a5,-1  37fd=001 1 01111 11111 01  op=01 func3=001 rs1/rd=01111 imm=111111 c.addiw: a5 = a5 + (-1)  c4: fef42023 sw a5,-32(s0)  fef42023=1111111 01111 01000 010 00000 0100011  Opcode=0100011 func3=010 imm=111111100000 rs2=01111 rs1=01000  sw: MEM(s0-32)=a5  00000000000000c8 <.L5>:  c8: fe042783 lw a5,-32(s0)  fe042783=111111100000 01000 010 01111 0000011  opcode=0000011 rd=01111 func3=010 rs1=01000 imm=111111100000  lw: a5 = MEM(s0-32)  cc: 2781 sext.w a5,a5  2781=001 0 01111 00000 01  op=01 func3=001 rd/rs1=01111 c.sext.w: a5 = sext(a5)  ce: fa07dce3 bgez a5,86 <.L7>  fa07dce3=1111101 00000 01111 101 11001 1100011  opcode=1100011 imm=1111111011100 func3=101 rs1=01111 rs2=00000  bne: a5>=0? PC=PC+imm\*2:PC=PC+4  d2: fec42783 lw a5,-20(s0)  fec42783=111111101100 01000 010 01111 0000011  opcode=0000011 rd=01111 func3=010 rs1=01000 imm=111111101100  lw: a5 = MEM(s0-20)  d6: 85be mv a1,a5  85be=100 0 01011 01111 10  op=01 rs2=01111 rd=01011 func3=100 c.mv: a1 = a5  d8: 000007b7 lui a5,0x0  000007b7=0000000000000000000 01111 0110111  opcode=0110111 rd=01111 imm=00000000000000000000  lui:a5 = 0x0  dc: 00078513 mv a0,a5  00078513=0000000 00000 01111 000 01010 0010011  opcode=0010011 rd=01010 func3=000 rs1=01111 rs2=00000 func7=0000000  mv: add a0 = a5 + 0  e0: 00000097 auipc ra,0x0  00000097=00000000000000000000 00001 0010111  opcode=0010111 rd=00001 imm=00000  auipc:ra = PC+0  e4: 000080e7 jalr ra # e0 <.L5+0x18>  000080e7=000000000000 00001 000 00001 1100111  Opcode=1100111 rd=00001 func3=000 rs1=00001 imm=000000000000  jalr: ra = PC+4;PC=ra+0  e8: 0001 nop  0001=000 0 00000 00000 01 c.nop:无操作  ea: 70a2 ld ra,40(sp)  70a2=011 1 00001 01000 10  op=10 func3=011 rd=00001 uimm=000101 c.ldsp: ra = MEM(sp+10\*4)  ec: 7402 ld s0,32(sp)  7402=011 1 01000 00000 10  op=10 func3=011 rd=01000 uimm=000100 c.ldsp: s0 = MEM(sp+8\*4)  ee: 6145 addi sp,sp,48  6145=011 0 00010 10001 01  op=01 func3=011 rd=00010 nzimm=000011 c.addi16sp : sp = sp + (+3)\*16  f0: 8082 ret  8082=100 0 00001 00000 10  op=10 func3=100 rs1=00001 imm=000000 c.jr: PC=ra+0  00000000000000f2 <main>:  f2: 1141 addi sp,sp,-16  1141=000 1 00010 10000 01  op=01 func3=000 rs1/rd=00010 nzimm=110000 c.addi: sp = sp + (-16)  f4: e406 sd ra,8(sp)  e406=111 001000 00001 10  op=10 func3=111 rs2=00001 uimm=000001 c.sdsp: MEM(sp+(2)\*4) = ra  f6: e022 sd s0,0(sp)  e022=111 000000 01000 10  op=10 fun3=111 rs2=01000 uimm=000000 c.sdsp: MEM(sp+(0)\*4) = s0  f8: 0800 addi s0,sp,16  0800=000 01000000 000 00  op=00 func3=000 rd’=000 nzuimm=00000100 c.addi4spn: s0 = sp + 16  fa: 000007b7 lui a5,0x0  000007b7=0000000000000000000 01111 0110111  opcode=0110111 rd=01111 imm=00000000000000000000  lui:a5 = 0x0  fe: 00078513 mv a0,a5  00078513=0000000 00000 01111 000 01010 0010011  opcode=0010011 rd=01010 func3=000 rs1=01111 rs2=00000 func7=0000000  mv: add a0 = a5 + 0  102: 00000097 auipc ra,0x0  00000097=00000000000000000000 00001 0010111  opcode=0010111 rd=00001 imm=00000  auipc:ra = PC+0  106: 000080e7 jalr ra # 102 <main+0x10>  000080e7=000000000000 00001 000 00001 1100111  Opcode=1100111 rd=00001 func3=000 rs1=00001 imm=000000000000  jalr: ra = PC+4;PC=ra+0  10a: 00000097 auipc ra,0x0  00000097=00000000000000000000 00001 0010111  opcode=0010111 rd=00001 imm=00000  auipc:ra = PC+0  10e: 000080e7 jalr ra # 10a <main+0x18>  000080e7=000000000000 00001 000 00001 1100111  Opcode=1100111 rd=00001 func3=000 rs1=00001 imm=000000000000  jalr: ra = PC+4;PC=ra+0  112: 4781 li a5,0  4781=010 0 01111 00000 01  Op=01 func3=010 imm=00000 rd=01111 c.li: a5 = 0  114: 853e mv a0,a5  853e=100 0 01010 01111 10  op=01 rs2=01111 rd=01010 func3=100 c.mv:a0 = a5  116: 60a2 ld ra,8(sp)  60a2=011 0 00001 01000 10  op=10 func3=011 rd=00001 uimm=000001 c.ldsp: ra = MEM(sp+2\*4)  118: 6402 ld s0,0(sp)  6402=011 0 01000 00000 10  op=10 func3=011 rd=01000 uimm=000000 c.ldsp: s0 = MEM(sp+0\*4)  11a: 0141 addi sp,sp,16  0141=000 0 00010 10000 01  op=01 func3=000 rs1/rd=00010 nzimm=010000 c.addi: sp = sp + (+6)  11c: 8082 ret  8082=100 0 00001 00000 10  op=10 func3=100 rs1=00001 imm=000000 c.jr: PC=ra+0 |