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|  | **MIPS Assembly – Lab Solutions** |

**Exercise 1**

**Step 1**

.text 0x00400000

li $v0,4

la $a0,msg

syscall

li $v0,10

syscall

.data

msg: .asciiz "My first program"

**Exercise 2**

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| **Step 1**.text 0x00400000#Section 1li $v0,4la $a0,msg1syscall#Section 2li $v0,5syscallmove $t0,$v0#Section 3li $v0,4la $a0,msg2syscall#Section 4li $v0,1move $a0,$t0syscall#Section 5li $v0,10syscall.datamsg1: .asciiz "Enter number:"msg2: .asciiz "The number is:"**Step 7**.text 0x00400000#read numbersli $v0,5syscallmove $t1,$v0li $v0,5syscallmove $t2,$v0li $v0,5syscallmove $t3,$v0#display numbersli $v0,4la $a0,msg2syscallli $v0,1move $a0,$t1syscallli $v0,4la $a0,msg2syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,msg2syscallli $v0,1move $a0,$t3syscallli $v0,10syscall.datamsg2: .asciiz "\nNumber=" **Step 9**.text 0x00400000# read numbersli $v0,5syscallmove $t1,$v0li $v0,5syscallmove $t2,$v0add $t0,$t1,$t2#display sumli $v0,4la $a0,msgsyscallli $v0,1move $a0,$t0syscallli $v0,10syscall.datamsg: .asciiz "(X+Y)=" | **Step 4**.text 0x00400000#read numbersli $v0,4la $a0,msg1syscallli $v0,5syscallmove $t1,$v0li $v0,4la $a0,msg1syscallli $v0,5syscallmove $t2,$v0li $v0,4la $a0,msg1syscallli $v0,5syscallmove $t3,$v0#display numbersli $v0,4la $a0,msg2syscallli $v0,1move $a0,$t1syscallli $v0,4la $a0,msg2syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,msg2syscallli $v0,1move $a0,$t3syscallli $v0,10syscall.datamsg1: .asciiz "Enter number:"msg2: .asciiz "\nNumber=" |

**Exercise 3**

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| **Step 1,2**.text 0x00400000# read numbersli $v0,5syscallmove $t1,$v0li $v0,5syscallmove $t2,$v0li $v0,5syscallmove $t3,$v0sub $t0,$t1,$t2sub $t0,$t0,$t3#display resultli $v0,4la $a0,mes1syscallli $v0,1move $a0,$t1syscallli $v0,4la $a0,mes2syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,mes2syscallli $v0,1move $a0,$t3syscallli $v0,4la $a0,mes3syscallli $v0,1move $a0,$t0syscallli $v0,10syscall.datames1: .asciiz "("mes2: .asciiz "-"mes3: .asciiz ")="**Step 9**.text 0x00400000# read numbersli $v0,4la $a0,ar1syscallli $v0,5syscallmove $t1,$v0li $v0,4la $a0,ar2syscallli $v0,5syscallmove $t2,$v0li $v0,4la $a0,ar3syscallli $v0,5syscallmove $t3,$v0#Z1div $t0,$t1,$t2add $t0,$t0,$t3#Z2div $t4,$t3,$t2mul $t4,$t4,2add $t4,$t4,$t1#Z3mul $t5,$t1,$t2mul $t5,$t5,$t3#Z4sub $t6,$t2,$t1div $t6,$t3,$t6li $v0,4la $a0,linesyscall####################Z1 parameterizedli $v0,4la $a0,par1syscallli $v0,1move $a0,$t1syscallli $v0,4la $a0,diasyscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,par2syscallli $v0,4la $a0,synsyscallli $v0,1move $a0,$t3syscallli $v0,4la $a0,isonsyscallli $v0,1move $a0,$t0syscall###################Z2 parameterizedli $v0,4la $a0,linesyscallli $v0,1move $a0,$t1syscallli $v0,4la $a0,synsyscallli $v0,1li $a0,2syscallli $v0,4la $a0,episyscallli $v0,4la $a0,par1syscallli $v0,1move $a0,$t3syscallli $v0,4la $a0,diasyscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,par2syscallli $v0,4la $a0,isonsyscallli $v0,1move $a0,$t4syscall###################Z3 parameterizedli $v0,4la $a0,linesyscallli $v0,1move $a0,$t1syscallli $v0,4la $a0,episyscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,episyscallli $v0,1move $a0,$t3syscallli $v0,4la $a0,isonsyscallli $v0,1move $a0,$t5syscall####################Z4 parameterizedli $v0,4la $a0,linesyscallli $v0,1move $a0,$t3syscallli $v0,4la $a0,diasyscallli $v0,4la $a0,par1syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,plinsyscallli $v0,1move $a0,$t1syscallli $v0,4la $a0,par2syscallli $v0,4la $a0,isonsyscallli $v0,1move $a0,$t6syscallli $v0,10syscall.dataar1: .asciiz "Number1="ar2: .asciiz " Number2 ="ar3: .asciiz " Number3="mes1: .asciiz "\nZ1="mes2: .asciiz "\nZ2="mes3: .asciiz "\nZ3="mes4: .asciiz "\nZ4="par1: .asciiz "("par2: .asciiz ")"dia: .asciiz "/"syn: .asciiz "+"ison: .asciiz "="plin: .asciiz "-"epi: .asciiz "\*"line: .asciiz "\n" | **Step 7**.text 0x00400000# read numbersli $v0,4la $a0,ar1syscallli $v0,5syscallmove $t1,$v0li $v0,4la $a0,ar2syscallli $v0,5syscallmove $t2,$v0li $v0,4la $a0,ar3syscallli $v0,5syscallmove $t3,$v0#Z1div $t0,$t1,$t2add $t0,$t0,$t3#Z2div $t4,$t3,$t2mul $t4,$t4,2add $t4,$t4,$t1#Z3mul $t5,$t1,$t2mul $t5,$t5,$t3#Z4sub $t6,$t2,$t1div $t6,$t3,$t6li $v0,4la $a0,mes1syscallli $v0,1move $a0,$t0syscallli $v0,4la $a0,mes2syscallli $v0,1move $a0,$t4syscallli $v0,4la $a0,mes3syscallli $v0,1move $a0,$t5syscallli $v0,4la $a0,mes4syscallli $v0,1move $a0,$t6syscallli $v0,10syscall.dataar1: .asciiz "Number1="ar2: .asciiz "Number2="ar3: .asciiz "Number3="mes1: .asciiz "\nZ1="mes2: .asciiz "\nZ2="mes3: .asciiz "\nZ3="mes4: .asciiz "\nZ4=" |

**Exercise 4**

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| **Step 5a**.text 0x00400000li $v0,4la $a0,messyscallli $v0,5syscallmove $t1,$v0blt $t1,10,terminationbgt $t1,20,terminationli $v0,4la $a0,msgsyscalltermination:li $v0,10syscall.datamsg: .asciiz "$t1 belongs to [10,20]"mes: .asciiz "give number:"**Step 9**.text 0x00400000li $t1,1start:li $v0,4la $a0,namesyscalladd $t1,$t1,1ble $t1,15,startli $v0,10syscall.dataname: .asciiz "\nPanayotis" | **Step 5b**.text 0x00400000li $v0,4la $a0,messyscallli $v0,5syscallmove $t1,$v0bge $t1,10,synj terminationsyn:ble $t1,20,syn2j terminationsyn2:li $v0,4la $a0,msgsyscalltermination:li $v0,10syscall.datamsg: .asciiz "$t1 belongs to [10,20]"mes: .asciiz "give number:"**Step 10**.text 0x00400000li $t1,1start:ble $t1,15,loopj terminationloop:li $v0,4la $a0,onomasyscalladd $t1,$t1,1j starttermination:li $v0,10syscall.dataonoma: .asciiz "\nPanayotis" |

**Exercise 5**

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| **Step 4**.text 0x00400000li $v0,4la $a0,messyscallli $v0,5syscallmove $t1,$v0li $v0,4la $a0,messyscallli $v0,5syscallmove $t2,$v0li $v0,4la $a0,messyscallli $v0,5syscallmove $t3,$v0add $t0,$t1,$t2bgtz $t0,calculation1beqz $t0,calculation2#calculation3mul $t4,$t3,$t3sub $t4,$t2,$t4add $t4,$t4,$t1j terminationcalculation1:add $t4,$t3,3mul $t4,$t4,$t1j terminationcalculation2:mul $t4,$t1,5mul $t5,$t3,3add $t4,$t4,$t5sub $t4,$t3,$t4termination:li $v0,4la $a0,apotsyscallli $v0,1move $a0,$t4syscallli $v0,10syscall.datames: .asciiz "give number:"apot: .asciiz "result=" | **Step 6** .text 0x00400000li $v0,4la $a0,mes1syscallli $v0,5syscallmove $t1,$v0li $v0,4la $a0,mes1syscallli $v0,5syscallmove $t2,$v0li $v0,4la $a0,mes1syscallli $v0,5syscallmove $t3,$v0# first calculationadd $t0,$t1,$t2sub $t0,$t0,$t3bltz $t0,less\_zerobgt $t0,5,rangebeq $t0,5,eq\_fivej terminationless\_zero:li $t1,1li $t2,0start:mul $t3,$t1,$t1mul $t3,$t3,$t1add $t2,$t2,$t3add $t1,$t1,1ble $t1,10,startli $v0,1move $a0,$t2syscallj terminationrange:blt $t0,6,terminationbgt $t0,10,terminationli $t1,10li $t2,0start2:mul $t3,$t1,$t1add $t2,$t2,$t3add $t1,$t1,-1bgtz $t1,start2li $v0,1move $a0,$t2syscallj terminationeq\_five:li $v0,4la $a0,mes2syscalltermination:li $v0,10syscall.datames1: .asciiz "give number:"mes2: .asciiz "HELLO" |

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| **Exercise 6****Step 1**.text 0x00400000li $v0,4la $a0,m\_asyscallli $v0,5syscallmove $t1,$v0li $v0,4la $a0,m\_bsyscallli $v0,5syscallmove $t2,$v0li $v0,4la $a0,m\_csyscallli $v0,5syscallmove $t3,$v0#calculationmul $t4,$t2,$t2mul $t5,$t1,4mul $t5,$t5,$t3sub $t0,$t4,$t5#checkbgtz $t0,two\_rootsbeqz $t0,double\_root#imaginaryli $v0,4la $a0,imgsyscallj terminationtwo\_roots:li $v0,4la $a0,dyosyscallj terminationdouble\_root:li $v0,4la $a0,diplisyscalltermination:li $v0,10syscall.datam\_a: .asciiz "give A:"m\_b: .asciiz "give B:"m\_c: .asciiz "give C:"img: .asciiz "\nMigadikes rizes"dyo: .asciiz "\nDyo pragmatikes rizes"dipli: .asciiz "\nMia dipli riza"**Step 3b**.text 0x00400000li $v0,4la $a0,xsyscallli $v0,5syscallmove $t1,$v0#calculationsub $t2,$t1,2li $t4,2div $t2,$t4mfhi $t2mul $t3,$t1,$t1mul $t3,$t3,$t1sub $t3,$t3,1div $t0,$t2,$t3li $v0,4la $a0,fxsyscallli $v0,1move $a0,$t0syscallli $v0,10syscall.datax: .asciiz "give X:"fx: .asciiz "f(x)="**Step 4a**.text 0x00400000start:li $v0,4la $a0,xsyscallli $v0,5syscallmove $t1,$v0mul $t2,$t1,$t1li $t6,2div $t2,$t6mfhi $t6mul $t6,$t6,2beqz $t6,start#other calculationsmul $t3,$t1,$t1mul $t3,$t3,$t1div $t3,$t1mfhi $t4div $t0,$t4,$t6li $v0,4la $a0,fxsyscallli $v0,1move $a0,$t0syscallli $v0,10syscall.datax: .asciiz "give X:"fx: .asciiz "f(x)=" | **Step 3a**.text 0x00400000li $v0,4la $a0,xsyscallli $v0,5syscallmove $t1,$v0#calculationmul $t2,$t1,$t1 #x^2sub $t3,$t2,$t1add $t4,$t1,2div $t0,$t3,$t4li $v0,4la $a0,fxsyscallli $v0,1move $a0,$t0syscallli $v0,10syscall.datax: .asciiz "give X:"fx: .asciiz "f(x)="**Step 3c**.text 0x00400000li $v0,4la $a0,xsyscallli $v0,5syscallmove $t1,$v0#calculationmul $t3,$t1,$t1mul $t3,$t3,$t1div $t3,$t1mfhi $t4mul $t2,$t1,$t1li $t6,2div $t2,$t6mfhi $t6mul $t6,$t6,2div $t0,$t4,$t6li $v0,4la $a0,fxsyscallli $v0,1move $a0,$t0syscallli $v0,10syscall.datax: .asciiz "giv X:"fx: .asciiz "f(x)="**Step 3d**.text 0x00400000li $v0,4la $a0,xsyscallli $v0,5syscallmove $t1,$v0#calculationmul $t2,$t1,$t1mul $t3,$t2,$t1sub $t4,$t1,3add $t5,$t1,1mul $t5,$t4,$t5li $t6,1div $t5,$t6,$t5add $t0,$t2,$t3sub $t0,$t0,$t5li $v0,4la $a0,fxsyscallli $v0,1move $a0,$t0syscallli $v0,10syscall.datax: .asciiz "give X:"fx: .asciiz "f(x)="**Step 4b**.text 0x00400000start:li $v0,4la $a0,xsyscallli $v0,5syscallmove $t1,$v0sub $t4,$t1,3add $t5,$t1,1mul $t5,$t4,$t5beqz $t5,start#other calculationsmul $t2,$t1,$t1mul $t3,$t2,$t1li $t6,1div $t5,$t6,$t5add $t0,$t2,$t3sub $t0,$t0,$t5li $v0,4la $a0,fxsyscallli $v0,1move $a0,$t0syscallli $v0,10syscall.datax: .asciiz "give X:"fx: .asciiz "f(x)=" |

**Exercise 7**

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| **Step 5**.text 0x00400000li $v0,4la $a0,xsyscallli $v0,5syscallmove $t1,$v0li $t2,2start:div $t1,$t2mflo $t1mfhi $t3li $v0,1move $a0,$t3syscallbgtz $t1,startli $v0,10syscall.datax: .asciiz "give X:" | **Step 7**.text 0x00400000li $v0,4la $a0,xsyscallli $v0,5syscallmove $t1,$v0li $t0,1start:li $t2,1start2:li $v0,4la $a0,asterisksyscalladd $t2,$t2,1ble $t2,$t0,start2li $v0,4la $a0,linesyscalladd $t0,$t0,1ble $t0,$t1,startli $v0,10syscall.datax: .asciiz "give N:"line: .asciiz "\n"asterisk: .asciiz "\*" |

**Exercise 8**

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| **Step 10** .text 0x00400000li $t2,1 li $t1,0 start:li $v0,5syscallmove $t0,$v0sw $t0,arrayA($t1)addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,startli $t2,1 li $t1,0 start2:lw $t0,arrayA($t1)move $a0,$t0li $v0,1syscallli $v0,4la $a0,space\_charsyscalladdi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start2li $v0,10syscall.data.align 2arrayA: .space 40space\_char: .asciiz " " | **Step 13**.text 0x00400000li $t2,1 li $t1,0 start:li $v0,4la $a0,mes1syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,mes2syscallli $v0,5syscallmove $t0,$v0sw $t0,arrayA($t1)addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,startli $t2,1 li $t1,0 start2:lw $t0,arrayA($t1)move $a0,$t0li $v0,1syscallli $v0,4la $a0,space\_charsyscalladdi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start2li $v0,10syscall.data.align 2arrayA: .space 40space\_char: .asciiz " "mes1: .asciiz "A["mes2: .asciiz "]=" |

**Exercise 9**

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| **Step 2**.text 0x00400000li $t2,1 li $t1,0 start:li $v0,4la $a0,mes1syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,mes2syscallli $v0,5syscallmove $t0,$v0sw $t0,arrayA($t1)addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,startli $t2,1 li $t1,0 start2:lw $t0,arrayA($t1)blez $t0,synmul $t0,$t0,$t0sw $t0,arrayA($t1)lw $t0,arrayA($t1)syn:move $a0,$t0li $v0,1syscallli $v0,4la $a0,space\_charsyscalladdi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start2li $v0,10syscall.data.align 2arrayA: .space 40space\_char: .asciiz " "mes1: .asciiz "A["mes2: .asciiz "]="**Step 5** .text 0x00400000li $t2,1 li $t1,0 start:li $v0,4la $a0,mes1syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,mes2syscallli $v0,5syscallmove $t0,$v0sw $t0,arrayA($t1)addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,startli $t2,1 #loopli $t1,0 #deviationli $t3,0 #sumli $t4,2 #modli $t7,0 #odd numbersstart2:lw $t0,arrayA($t1)div $t0,$t4mfhi $t5beqz $t5,evenadd $t7,$t7,1j syneven:add $t3,$t3,$t0syn:addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start2li $v0,4la $a0,mes3syscallmove $a0,$t3li $v0,1syscallli $v0,4la $a0,mes4syscallmove $a0,$t7li $v0,1syscallli $v0,10syscall.data.align 2arrayA: .space 40space\_char: .asciiz " "mes1: .asciiz "A["mes2: .asciiz "]="mes3: .asciiz "SUM (even num)="mes4: .asciiz "\nodd numbers="**Step 8** .text 0x00400000li $v0,4la $a0,xsyscallli $v0,5syscallmove $t1,$v0li $t2,2li $t0,0start:div $t1,$t2mflo $t1mfhi $t3sw $t3,array($t0)add $t0,$t0,4bgtz $t1,start#displayli $t0,36start2:lw $t3,array($t0)li $v0,1move $a0,$t3syscalladd $t0,$t0,-4bgez $t0,start2li $v0,10syscall.datax: .asciiz "give X:".align 2array: .space 40**Step 9** .text 0x00400000li $v0,4la $a0,xsyscallli $v0,5syscallmove $t1,$v0li $t2,2li $t0,0start:div $t1,$t2mflo $t1mfhi $t3sw $t3,array($t0)add $t0,$t0,4bgtz $t1,start#displayadd $t0,$t0,-4start2:lw $t3,array($t0)li $v0,1move $a0,$t3syscalladd $t0,$t0,-4bgez $t0,start2li $v0,10syscall.datax: .asciiz "give X:".align 2array: .space 40 | **Step 3**.text 0x00400000li $t2,1 li $t1,0 start:li $v0,4la $a0,mes1syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,mes2syscallli $v0,5syscallmove $t0,$v0sw $t0,arrayA($t1)addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,startli $t2,1 li $t1,0 li $t3,0start2:lw $t0,arrayA($t1)add $t3,$t3,$t0addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start2li $v0,4la $a0,mes3syscallmove $a0,$t3li $v0,1syscallli $v0,10syscall.data.align 2arrayA: .space 40space\_char: .asciiz " "mes1: .asciiz "A["mes2: .asciiz "]="mes3: .asciiz "SUM="**Step 6** .text 0x00400000li $t2,1 li $t1,0 start:li $v0,4la $a0,mes1syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,mes2syscallli $v0,5syscallmove $t0,$v0sw $t0,arrayA($t1)addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,startli $t2,1 #loopli $t1,0 #deviationli $t3,0 #sumli $t4,2 #modli $t7,0 #odd numbersstart2:lw $t0,arrayA($t1)div $t0,$t4mfhi $t5beqz $t5,evenadd $t3,$t3,$t0j syneven:add $t7,$t7,1syn:addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start2li $v0,4la $a0,mes3syscallmove $a0,$t3li $v0,1syscallli $v0,4la $a0,mes4syscallmove $a0,$t7li $v0,1syscallbgt $t7,$t3,zerosj terminationzeros:li $t2,1 #loopli $t1,0 #deviationli $t3,0 #zero numbersstart3:lw $t0,arrayA($t1)bnez $t0,syn2add $t3,$t3,1syn2:addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start3li $v0,4la $a0,mes5syscallmove $a0,$t3li $v0,1syscalltermination:li $v0,10syscall.data.align 2arrayA: .space 40space\_char: .asciiz " "mes1: .asciiz "A["mes2: .asciiz "]="mes3: .asciiz "SUM (odd numbers)="mes4: .asciiz "\neven numbers="mes5: .asciiz "\nzero numbers=" |

**Exercise 10**

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| **Step 2**.text 0x00400000li $t2,1 li $t1,0 start:li $v0,4la $a0,mes1syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,mes2syscallli $v0,5syscallmove $t0,$v0#fill array Asw $t0,arrayA($t1)li $v0,4la $a0,mes3syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,mes2syscallli $v0,5syscallmove $t0,$v0#fill array Bsw $t0,arrayB($t1)addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start#display arrays before li $t2,1 li $t1,0 start3:lw $t4,arrayA($t1)lw $t5,arrayB($t1)li $v0,4la $a0,mes1syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,mes2syscallli $v0,1move $a0,$t4syscallli $v0,4la $a0,space\_charsyscallli $v0,4la $a0,mes3syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,mes2syscallli $v0,1move $a0,$t5syscallli $v0,4la $a0,space\_charsyscalladdi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start3#swap (arrayA <=> arrayB)li $t2,1 li $t1,0 start2:lw $t4,arrayA($t1)lw $t5,arrayB($t1)move $t6,$t4sw $t5,arrayA($t1)sw $t6,arrayB($t1)addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start2li $v0,4la $a0,linesyscall#display arrays after li $t2,1 li $t1,0 start4:lw $t4,arrayA($t1)lw $t5,arrayB($t1)li $v0,4la $a0,mes1syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,mes2syscallli $v0,1move $a0,$t4syscallli $v0,4la $a0,space\_charsyscallli $v0,4la $a0,mes3syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,mes2syscallli $v0,1move $a0,$t5syscallli $v0,4la $a0,space\_charsyscalladdi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start4li $v0,10syscall.data.align 2arrayA: .space 40arrayB: .space 40space\_char: .asciiz " "mes1: .asciiz "A["mes2: .asciiz "]="mes3: .asciiz "B["line: .asciiz "\n"**Step 6** .text 0x00400000li $t1,-10again:mul $t0,$t1,$t1addi $t0,$t0,-1again2:li $v0,4la $a0,space\_charsyscalladdi $t0,$t0,-1bgtz $t0,again2li $v0,4la $a0,asterisksyscalladdi $t1,$t1,1ble $t1,10,againli $v0,10syscall.dataasterisk: .asciiz "\*\n"space\_char: .asciiz " "**Step 9** .text 0x00400000#fillli $t1,1li $t3,0start:li $t2,1start2:li $v0,4la $a0,mes1syscallli $v0,1move $a0,$t1syscallli $v0,4la $a0,mes2syscallli $v0,1move $a0,$t2syscallli $v0,4la $a0,mes3syscallli $v0,5syscallmove $t0,$v0sw $t0,array($t3)add $t3,$t3,4add $t2,$t2,1ble $t2,5,start2add $t1,$t1,1ble $t1,5,start#display arrayli $t1,1li $t3,0start3:li $t2,1start4:lw $t0,array($t3)li $v0,1move $a0,$t0syscallli $v0,4la $a0,space\_charsyscalladd $t3,$t3,4add $t2,$t2,1ble $t2,5,start4li $v0,4la $a0,linesyscalladd $t1,$t1,1ble $t1,5,start3#display diagonal (scan all the array)li $v0,4la $a0,diagsyscallli $t1,1li $t3,0start5:li $t2,1start6:lw $t0,array($t3)bne $t2,$t1,contli $v0,1move $a0,$t0syscallli $v0,4la $a0,space\_charsyscallcont:add $t3,$t3,4add $t2,$t2,1ble $t2,5,start6#li $v0,4#la $a0,line#syscalladd $t1,$t1,1ble $t1,5,start5li $v0,10syscall.datames1: .asciiz "A["mes2: .asciiz ","mes3: .asciiz "]="space\_char: .asciiz " "line: .asciiz "\n"diag: .asciiz "\n\n\n \*\*\* diagonal".align 2array: .space 40 | **Step 3**.text 0x00400000li $t2,1 li $t1,0 start:li $v0,5syscallmove $t0,$v0sw $t0,arrayA($t1)addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start#swapli $t2,1 li $t1,0 li $t3,20start2:lw $t0,arrayA($t1)lw $t4,arrayA($t3)move $t5,$t0sw $t4,arrayA($t1)sw $t5,arrayA($t3)addi $t1,$t1,4addi $t3,$t3,4addi $t2,$t2,1ble $t2,5,start2#afterli $t2,1 li $t1,0 start3:lw $t0,arrayA($t1)li $v0,1move $a0,$t0syscallli $v0,4la $a0,space\_charsyscalladdi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start3li $v0,10syscall.data.align 2arrayA: .space 40space\_char: .asciiz " "**Step 4** .text 0x00400000li $t2,1 #li $t1,0 again:li $v0,4la $a0,mes1syscallmove $a0,$t2li $v0,1syscallli $v0,4la $a0,mes2syscallli $v0,5syscallmove $t0,$v0sw $t0,pinax($t1)addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,againli $t2,1li $t1,0 again2:lw $t3,pinax($t1)li $v0,4la $a0,mes3syscallmove $a0,$t2li $v0,1syscallli $v0,4la $a0,mes4syscallbgtz $t3,displayreturn:la $a0,new\_lineli $v0,4syscalladdi $t1,$t1,4addi $t2,$t2,1ble $t2,10,again2li $v0,10syscalldisplay:move $t4,$t3again3: la $a0,asteriskli $v0,4syscallsub $t4,$t4,1bgtz $t4,again3j return.datames1: .asciiz "A["mes2: .asciiz "]="mes3: .asciiz "["mes4: .asciiz "]"new\_line: .asciiz "\n"asterisk: .asciiz "\*"space\_char: .asciiz " ".align 2pinax: .space 40**Step 5**.text 0x00400000main:li $t1,-10again:mul $t0,$t1,$t1again2:li $v0,4la $a0,asterisksyscalladdi $t0,$t0,-1bgtz $t0,again2li $v0,4la $a0,linesyscalladdi $t1,$t1,1ble $t1,10,againli $v0,10syscall.dataasterisk: .asciiz "\*"line: .asciiz "\n" |

**Exercise 11**

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| **Step 2**.text 0x00400000start:jal read\_choicemove $t0,$s0bltz $t0,startbgt $t0,3,startbeq $t0,1,choice\_1 beq $t0,2,choice\_2 beq $t0,3,choice\_3 beqz $t0,terminationreturn:j startread\_choice:li $v0,4la $a0,mes1syscallli $v0,5syscallmove $s0,$v0jr $31choice\_1:li $v0,4la $a0,e1syscallj returnchoice\_2:li $v0,4la $a0,e2syscallj returnchoice\_3:li $v0,4la $a0,e3syscallj returntermination:li $v0,10syscall.datae1: .asciiz "\nchoice activated1"e2: .asciiz "\nchoice activated2"e3: .asciiz "\nchoice activated3"mes1: .asciiz "\nepilogh [1-3 or 0]:"**Step 4**.text 0x00400000start:jal print\_menujal read\_choicemove $t0,$s0bltz $t0,startbgt $t0,4,startbeqz $t0,terminationjal read\_numbersbeq $t0,1,choice\_1 beq $t0,2,choice\_2 beq $t0,3,choice\_3beq $t0,4,choice\_4 return:jal print\_resultj startread\_choice:li $v0,4la $a0,mes1syscallli $v0,5syscallmove $s0,$v0jr $31read\_numbers:li $v0,4la $a0,give\_asyscallli $v0,5syscallmove $t1,$v0li $v0,4la $a0,give\_bsyscallli $v0,5syscallmove $t2,$v0jr $31print\_menu:li $v0,4la $a0,menu1syscalljr $31choice\_1:add $t3,$t1,$t2j returnchoice\_2:sub $t3,$t1,$t2j returnchoice\_3:mul $t3,$t1,$t2j returnchoice\_4:div $t3,$t1,$t2j returnprint\_result:li $v0,1move $a0,$t3syscalljr $31termination:li $v0,10syscall.datae1: .asciiz "\n \*\*\*[+]"e2: .asciiz "\n \*\*\*[-]"e3: .asciiz "\n \*\*\*[\*]"e4: .asciiz "\n \*\*\*[/]"mes1: .asciiz "\nepilogh [1-3 or 0]:"menu1: .ascii "\n==========="menu2: .ascii "\n1. Addition"menu3: .ascii "\n2. Subtraction"menu4: .ascii "\n3. Multiplication"menu5: .ascii "\n4. Division"menu6: .ascii "\n0. Exits"menu7: .asciiz "\n==========="give\_a: .asciiz "A="give\_b: .asciiz "B=" | **Step 3**.text 0x00400000start:jal print\_menujal read\_choicemove $t0,$s0bltz $t0,startbgt $t0,3,startbeq $t0,1,choice\_1 beq $t0,2,choice\_2 beq $t0,3,choice\_3 beqz $t0,terminationreturn:j startread\_choice:li $v0,4la $a0,mes1syscallli $v0,5syscallmove $s0,$v0jr $31print\_menu:li $v0,4la $a0,menu1syscalljr $31choice\_1:li $v0,4la $a0,e1syscallj returnchoice\_2:li $v0,4la $a0,e2syscallj returnchoice\_3:li $v0,4la $a0,e3syscallj returntermination:li $v0,10syscall.datae1: .asciiz "\n \*\*\*choice activated1"e2: .asciiz "\n \*\*\*choice activated2"e3: .asciiz "\n \*\*\*choice activated3"mes1: .asciiz "\nepilogh [1-3 or 0]:"menu1: .ascii "\n==========="menu2: .ascii "\n1. item 1"menu3: .ascii "\n2. item 2"menu4: .ascii "\n3. item 3"menu5: .ascii "\n0. Exodos"menu6: .asciiz "\n==========="**Step 5**.text 0x00400000li $t6,0 #stack pointerstart:jal print\_menujal read\_choicemove $t0,$s0bltz $t0,startbgt $t0,3,startbeq $t0,1,choice\_1 beq $t0,2,choice\_2 beq $t0,3,choice\_3 beqz $t0,terminationreturn:jal print\_stackj startread\_choice:li $v0,4la $a0,mes1syscallli $v0,5syscallmove $s0,$v0jr $31print\_menu:li $v0,4la $a0,menu1syscalljr $31choice\_1:li $t3,1li $t4,0li $t5,0again:sw $t5,stack($t4)add $t4,$t4,4add $t3,$t3,1ble $t3,10,againli $t6,0j returnchoice\_2:beq $t6,10,return1li $v0,4la $a0,timhsyscallli $v0,5syscallmove $t7,$v0add $t6,$t6,1mul $t3,$t6,4sub $t3,$t3,4#add $t6,$t6,1sw $t7,stack($t3)#j return4return1:#li $t6,10#return4:j returnchoice\_3:li $t7,0mul $t3,$t6,4sub $t3,$t3,4sw $t7,stack($t3)beq $t6,0,return2add $t6,$t6,-1return2:j returnprint\_stack:li $t3,1li $t4,0loop:lw $t5,stack($t4)bnez $t5,synli $v0,4la $a0,starsyscallj syn2syn:li $v0,1move $a0,$t5syscallsyn2:beq $t6,$t3,print\_pointerreturn:li $v0,4la $a0,linesyscalladd $t3,$t3,1add $t4,$t4,4ble $t3,10,loopjr $31print\_pointer:li $v0,4la $a0,pointersyscallj returntermination:li $v0,10syscall.datames1: .asciiz "\nSelect [1-3 or 0]:"menu1: .ascii "\n==========="menu2: .ascii "\n1. Initialization"menu3: .ascii "\n2. Push"menu4: .ascii "\n3. Pop"menu5: .ascii "\n0. Exit"menu6: .asciiz "\n==========="line: .asciiz "\n"star: .asciiz "\*"pointer: .asciiz "<=="timh: .asciiz "New value=".align 2stack: .space 40 |

**Exercise 12**

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| **Step 1**.text 0x00400000start:jal print\_menujal read\_choicemove $t0,$s0bltz $t0,startbgt $t0,2,startbeq $t0,1,choice\_1 beq $t0,2,choice\_2 beqz $t0,terminationreturn:j startread\_choice:li $v0,4la $a0,mes1syscallli $v0,5syscallmove $s0,$v0jr $31print\_menu:li $v0,4la $a0,menu1syscalljr $31choice\_1:li $v0,4la $a0,e1syscallli $t2,1 li $t1,0 start1:li $v0,4la $a0,e3syscallli $v0,5syscallmove $t0,$v0sw $t0,arrayA($t1)addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start1j returnchoice\_2:li $v0,4la $a0,e2syscallli $t2,1 li $t1,0 start2:lw $t0,arrayA($t1)move $a0,$t0li $v0,1syscallli $v0,4la $a0,space\_charsyscalladdi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start2j returntermination:li $v0,10syscall.datae1: .asciiz "\n \*\*\* Fill array (after each number press <enter>)\n"e2: .asciiz "\n \*\*\* Display array\n"e3: .asciiz ">"mes1: .asciiz "\nSelect [1-2 or 0]:"menu1: .ascii "\n==========="menu2: .ascii "\n1. Fill"menu3: .ascii "\n2. Display"menu5: .ascii "\n0. Exit"menu6: .asciiz "\n===========".align 2arrayA: .space 40space\_char: .asciiz " "**Step 4**.text 0x00400000start:jal print\_menujal read\_choicemove $t0,$s0bltz $t0,startbgt $t0,7,startbeq $t0,1,choice\_1 beq $t0,2,choice\_2 beq $t0,3,choice\_3 beq $t0,4,choice\_4beq $t0,5,choice\_5 beq $t0,6,choice\_6 beq $t0,7,choice\_7 beqz $t0,terminationreturn:j startread\_choice:li $v0,4la $a0,mes1syscallli $v0,5syscallmove $s0,$v0jr $31print\_menu:li $v0,4la $a0,menu1syscalljr $31choice\_1:li $v0,4la $a0,e1syscallli $t2,1 li $t1,0 start1:li $v0,4la $a0,e3syscallli $v0,5syscallmove $t0,$v0sw $t0,arrayA($t1)addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start1j returnchoice\_2:li $v0,4la $a0,e2syscallli $t2,1 li $t1,0 start2:lw $t0,arrayA($t1)move $a0,$t0li $v0,1syscallli $v0,4la $a0,space\_charsyscalladdi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start2j returnchoice\_3:li $v0,4la $a0,e2syscallli $t2,1 li $t1,0 lw $t3,arrayA($t1)start3:lw $t0,arrayA($t1)bge $t0,$t3,syn2move $t3,$t0syn2:addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start3li $v0,4la $a0,e4syscallli $v0,1move $a0,$t3syscallj returnchoice\_4:li $v0,4la $a0,e2syscallli $t2,1 li $t1,0 lw $t3,arrayA($t1)start4:lw $t0,arrayA($t1)ble $t0,$t3,syn3move $t3,$t0syn3:addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start4li $v0,4la $a0,e5syscallli $v0,1move $a0,$t3syscallj return#Sumchoice\_5:li $t2,1 li $t1,0 li $t3,0start5:lw $t0,arrayA($t1)add $t3,$t3,$t0addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start5li $v0,4la $a0,e6syscallli $v0,1move $a0,$t3syscallj return#Zero, positive, negativechoice\_6:li $t2,1 li $t1,0 li $t4,0 #positiveli $t5,0 #negativeli $t6,0 #zerosstart6:lw $t0,arrayA($t1)beqz $t0,zerobgtz $t0,megadd $t5,$t5,1syn4:addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start6li $v0,4la $a0,e7syscallli $v0,1move $a0,$t6syscallli $v0,4la $a0,e8syscallli $v0,1move $a0,$t4syscallli $v0,4la $a0,e9syscallli $v0,1move $a0,$t5syscallj returnzero:add $t6,$t6,1j syn4meg:add $t4,$t4,1j syn4#Sortingchoice\_7:#Homework!!!j returntermination:li $v0,10syscall.datae1: .asciiz "\n \*\*\* Fill array (after each number press <enter>)\n"e2: .asciiz "\n \*\*\* Display array\n"e3: .asciiz ">"e4: .asciiz "\nMin="e5: .asciiz "\nMax="e6: .asciiz "\nSum="e7: .asciiz "\n Zeros="e8: .asciiz "\n Positive="e9: .asciiz "\n Negative="mes1: .asciiz "\nSelect [1-4 or 0]:"menu1: .ascii "\n==========="menu2: .ascii "\n1. Fill"menu3: .ascii "\n2. Display"menu4: .ascii "\n3. Find min"menu5: .ascii "\n4. Find max"menu6: .ascii "\n5. Sum"menu7: .ascii "\n6. Zeros, positive, negative"manu8: .ascii "\n7. Sorting"menu9: .ascii "\n0. Exit"menu10: .asciiz "\n===========".align 2arrayA: .space 40space\_char: .asciiz " " | **Step 3**.text 0x00400000start:jal print\_menujal read\_choicemove $t0,$s0bltz $t0,startbgt $t0,4,startbeq $t0,1,choice\_1 beq $t0,2,choice\_2 beq $t0,3,choice\_3 beq $t0,4,choice\_4beqz $t0,terminationreturn:j startread\_choice:li $v0,4la $a0,mes1syscallli $v0,5syscallmove $s0,$v0jr $31print\_menu:li $v0,4la $a0,menu1syscalljr $31choice\_1:li $v0,4la $a0,e1syscallli $t2,1 li $t1,0 start1:li $v0,4la $a0,e3syscallli $v0,5syscallmove $t0,$v0sw $t0,arrayA($t1)addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start1j returnchoice\_2:li $v0,4la $a0,e2syscallli $t2,1 li $t1,0 start2:lw $t0,arrayA($t1)move $a0,$t0li $v0,1syscallli $v0,4la $a0,space\_charsyscalladdi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start2j returnchoice\_3:li $v0,4la $a0,e2syscallli $t2,1 li $t1,0 lw $t3,arrayA($t1)start3:lw $t0,arrayA($t1)bge $t0,$t3,syn2move $t3,$t0syn2:addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start3li $v0,4la $a0,e4syscallli $v0,1move $a0,$t3syscallj returnchoice\_4:li $v0,4la $a0,e2syscallli $t2,1 li $t1,0 lw $t3,arrayA($t1)start4:lw $t0,arrayA($t1)ble $t0,$t3,syn3move $t3,$t0syn3:addi $t1,$t1,4addi $t2,$t2,1ble $t2,10,start4li $v0,4la $a0,e5syscallli $v0,1move $a0,$t3syscallj returntermination:li $v0,10syscall.datae1: .asciiz "\n \*\*\* Fill array (after each number press <enter>)\n"e2: .asciiz "\n \*\*\* Display array\n"e3: .asciiz ">"e4: .asciiz "\nMin="e5: .asciiz "\nMax="mes1: .asciiz "\nSelect [1-4 or 0]:"menu1: .ascii "\n==========="menu2: .ascii "\n1. Fill"menu3: .ascii "\n2. Display"menu4: .ascii "\n3. Find min"menu5: .ascii "\n4. Find max"menu6: .ascii "\n0. Exit"menu7: .asciiz "\n===========".align 2arrayA: .space 40space\_char: .asciiz " " |

**Exercise 13**

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| **Step 1**.text 0x00400000li $v0,4la $a0,messyscallli $v0,8la $a0,alphali $a1,11syscallli $v0,10syscall.dataalpha: .space 11mes: .asciiz "String:"**Step 5**.text 0x00400000la $a0,mes\_wordli $v0,4syscallla $a0,wordli $a1,31li $v0,8syscallla $t0,wordagain:lb $t1,($t0)beqz $t1,again\_exitblt $t1,'a',no\_changebgt $t1,'z',no\_changeaddi $t1,$t1,-32no\_change:sb $t1,($t0)addi $t0,$t0,1j againagain\_exit:la $a0,mes\_capitalsli $v0,4syscallla $a0,wordli $v0,4syscallli $v0,10syscall.datames\_word: .asciiz "Word (small letters):"mes\_capitals: .asciiz "\nword with capitals:"word: .space 41**Step 7**.text 0x00400000la $a0,mes\_wordli $v0,4syscallla $a0,wordli $a1,31li $v0,8syscallla $t0,wordagain:lb $t1,($t0)beqz $t1,again\_exitblt $t1,'a',no\_changebgt $t1,'z',no\_changeaddi $t1,$t1,-1no\_change:sb $t1,($t0)addi $t0,$t0,1j againagain\_exit:la $a0,mes\_capitalsli $v0,4syscallla $a0,wordli $v0,4syscallli $v0,10syscall.datames\_word: .asciiz "Word (encrypted):"mes\_capitals: .asciiz "\nInitial word:"word: .space 21**Step 9**.text 0x00400000la $a0,mes\_wordli $v0,4syscallla $a0,wordli $a1,31li $v0,8syscallla $t0,wordli $t3,0li $t5,0again:lb $t1,($t0)beqz $t1,again\_exitblt $t1,'a',no\_changebgt $t1,'z',no\_changebeq $t1,'a',char\_abeq $t1,'b',char\_bno\_change:sb $t1,($t0)addi $t0,$t0,1j againagain\_exit:beqz $t3,syn2 la $a0,fali $v0,4syscallmove $t4,$t3jal printsyn2:beqz $t5,syn3la $a0,fbli $v0,4syscallmove $t4,$t5jal printsyn3:li $v0,10syscallchar\_a:add $t3,$t3,1j no\_changechar\_b:add $t5,$t5,1j no\_changeprint:li $t6,1start:li $v0,4la $a0,starsyscalladd $t6,$t6,1ble $t6,$t4,startjr $31 .datames\_word: .asciiz "Word:"fa: .asciiz "\n[a]"fb: .asciiz "\n[b]"star: .asciiz "\*"word: .space 31 | **Step 2**.text 0x00400000li $v0,4la $a0,mes1syscallli $v0,8la $a0,alphali $a1,11syscallli $v0,4la $a0,mes2syscallli $v0,4la $a0,alphasyscallli $v0,10syscall.dataalpha: .space 11mes1: .asciiz "String:"mes2: .asciiz "\n\nThe string is:"**Step 6**.text 0x00400000la $a0,mes\_wordli $v0,4syscallla $a0,wordli $a1,31li $v0,8syscallla $t0,wordagain:lb $t1,($t0)beqz $t1,again\_exitblt $t1,'a',no\_changebgt $t1,'z',no\_changeaddi $t1,$t1,1no\_change:sb $t1,($t0)addi $t0,$t0,1j againagain\_exit:la $a0,mes\_capitalsli $v0,4syscallla $a0,wordli $v0,4syscallli $v0,10syscall.datames\_word: .asciiz " Word (small letters):"mes\_capitals: .asciiz "\nEncrypted word"word: .space 21**Step 8**.text 0x00400000la $a0,mes\_wordli $v0,4syscallla $a0,wordli $a1,31li $v0,8syscallla $t0,wordli $t3,0again:lb $t1,($t0)beqz $t1,again\_exitblt $t1,'a',no\_changebgt $t1,'z',no\_changebne $t1,'a', no\_changeadd $t3,$t3,1no\_change:sb $t1,($t0)addi $t0,$t0,1j againagain\_exit:la $a0,frequencyli $v0,4syscallli $v0,1move $a0,$t3syscallli $v0,10syscall.datames\_word: .asciiz "Word:"frequency: .asciiz "\nNumber of symbols 'a'="word: .space 21 |