# ***CSCI.465 (63.465) Operating Systems: Homework #2***

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**Program 0: Null/Idle Program ASSEMBLY with comments**

| **Label** | **Mnemonic** | **Operands** | **Description** |
| --- | --- | --- | --- |
| main | Function |  | Declare the start of the main function. |
|  | Origin | 0 | State where the start of the program is. |
| Loop | Branch | Loop | Unconditionally jump to the Loop section |
|  | End | Loop | Program execution starts at the start of the Loop section. That is, PC = 0 |

**Program 0: Null/Idle Program (machine code) with comments**

| **Address** | **Content** | **Comment** |
| --- | --- | --- |
| 0 | 60000 | Branch Loop; jump to Loop section |
| 1 | 0 | Address of Loop start to jump to |
| -1 | 0 | End Loop; set the PC to the start of the Loop section;  PC = 0 |

**Program 0: Null/Idle Program Symbol table**

| **Symbol** | **Value (Address)** |
| --- | --- |
| main | 0 |
| Loop | 0 |

**Program 1: Dynamic Memory Allocation & Freeing Program ASSEMBLY with comments**

| **Label** | **Mnemonic** | **Operands** | **Description** |
| --- | --- | --- | --- |
| main | Function |  | Declare the start of the main function. |
|  | Origin | 3 | State where the start of the program is. |
| number | Long | 3 | Declare variable number and initialize it to 3.  number = 3 |
| multiplier | Long | -1 | Declare variable number and initialize it to -1.  multiplier = -1 |
| count | Long | 150 | Declare variable count and initialize it to 150.  count = 150 |
| Start | Move | GPR2,150 | Initialize GPR2 to 150. GPR2 = 150 |
|  | SysCall | 4 | Issue system call ID 4: allocate memory. |
|  | Move | GPR4,GPR1 | Move contents of GPR1 into GPR4; move pointer to new memory block to GPR4.  GPR4 = GPR1 |
| Loop | Move | GPR3,number | Move number to GPR3.  GPR3 = number |
|  | Multiply | GPR3,multiplier | Multiply GPR3 by multiplier.  GPR3 = GPR3 \* -1 |
|  | Move | (GPR4)+,GPR3 | Move GPR3 value into memory location specified by GPR4 then autoincrement GPR4. |
|  | Subtract | count,1 | Subtract 1 from count. That is,  count = count – 1 |
|  | BrOnPlus | count,Loop | If count > 0, then jump to the Loop section. Otherwise, proceed. |
|  | SysCall | 5 | Issue system call ID 5: free memory. |
|  | Halt |  | Issue a CPU halt and stop program execution. |
|  | End | Loop | Program execution starts at the start of the Start section. That is, PC = 6 |

**Program 1: Dynamic Memory Allocation & Freeing Program (machine code) with comments**

| **Address** | **Content** | **Comment** |
| --- | --- | --- |
| 3 | 3 | number Long 3 |
| 4 | -1 | multiplier Long -1 |
| 5 | 150 | count Long 150 |
| 6 | 51260 | Start start; Move GPR2,150; move the constant 150 into GPR2 |
| 7 | 150 | Immediate value of op2 |
| 8 | 126000 | SysCall 4; allocate memory |
| 9 | 4 | Immediate value of op1 |
| 10 | 51411 | Move GPR4,GPR1; move value of GPR1 into GPR4 |
| 11 | 51350 | Move GPR3,number; move value of number into GPR4 |
| 12 | 3 | Address of number |
| 13 | 31350 | Loop start; Multiply GPR3,multiplier; multiply value of GPR3 by -1; GPR3 = GPR3 \* -1 |
| 14 | 4 | Address of multiplier |
| 15 | 53413 | Move (GPR4)+,GPR3; Move value of GPR3 into location in GPR4 in autoincrement mode |
| 16 | 25060 | Subtract count,1; Subtract constant 1 from count;  count = count -1 |
| 17 | 5 | Address of count |
| 18 | 1 | Immediate value of op2 |
| 19 | 85000 | BrOnPlus count,Loop; If the value of count is above 0, jump to the Loop start. |
| 20 | 5 | Address of count |
| 21 | 13 | Address of Loop start to jump to |
| 22 | 126000 | SysCall 5; free memory |
| 23 | 5 | Immediate value of op2 |
| 24 | 0 | Halt |
| -1 | 0 | End Start; set the PC to the start of the Start section;  PC = 6 |

**Program 1: Dynamic Memory Allocation & Freeing Program Symbol table**

| **Symbol** | **Value (Address)** |
| --- | --- |
| main | 3 |
| number | 3 |
| multiplier | 4 |
| count | 5 |
| Start | 6 |
| Loop | 13 |

**Program 2: Using Stack Program ASSEMBLY with comments**

| **Label** | **Mnemonic** | **Operands** | **Description** |
| --- | --- | --- | --- |
| main | Function |  | Declare the start of the main function. |
|  | Origin | 26 | State where the start of the program is. |
| number | Long | 1738 | Declare variable number and initialize it to 1738.  number = 1738 |
| count | Long | 7 | Declare variable count and initialize it to 7.  count = 7 |
| Loop | Push | number | Push number to process stack. |
|  | Push | number | Push number to process stack. |
|  | Push | number | Push number to process stack. |
|  | Push | number | Push number to process stack. |
|  | Push | number | Push number to process stack. |
|  | Push | number | Push number to process stack. |
|  | Push | number | Push number to process stack. |
|  | Push | number | Push number to process stack. |
|  | Push | number | Push number to process stack. |
|  | Push | number | Push number to process stack. |
|  | Pop |  | Pop top value from process stack. |
|  | Pop |  | Pop top value from process stack. |
|  | Pop |  | Pop top value from process stack. |
|  | Pop |  | Pop top value from process stack. |
|  | Pop |  | Pop top value from process stack. |
|  | Pop |  | Pop top value from process stack. |
|  | Pop |  | Pop top value from process stack. |
|  | Pop |  | Pop top value from process stack. |
|  | Pop |  | Pop top value from process stack. |
|  | Pop |  | Pop top value from process stack. |
|  | Subtract | count,1 | Subtract 1 from count; that is,  count = count -1 |
|  | BrOnPlus | count,Loop | If count > 0, then jump to the Loop section. Otherwise, proceed. |
|  | Halt |  | Issue a CPU halt and stop program execution. |
|  | End | Loop | Program execution starts at the start of the Start section. That is, PC = 28 |

**Program 2: Using Stack Program (machine code) with comments**

| **Address** | **Content** | **Comment** |
| --- | --- | --- |
| 26 | 1738 | number Long 1738 |
| 27 | 7 | count Long 7 |
| 28 | 105000 | Loop start; Push number |
| 29 | 26 | Address of number |
| 30 | 105000 | Push number |
| 31 | 26 | Address of number |
| 32 | 105000 | Push number |
| 33 | 26 | Address of number |
| 34 | 105000 | Push number |
| 35 | 26 | Address of number |
| 36 | 105000 | Push number |
| 37 | 26 | Address of number |
| 38 | 105000 | Push number |
| 39 | 26 | Address of number |
| 40 | 105000 | Push number |
| 41 | 26 | Address of number |
| 42 | 105000 | Push number |
| 43 | 26 | Address of number |
| 44 | 105000 | Push number |
| 45 | 26 | Address of number |
| 46 | 105000 | Push number |
| 47 | 26 | Address of number |
| 48 | 110000 | Pop |
| 49 | 110000 | Pop |
| 50 | 110000 | Pop |
| 51 | 110000 | Pop |
| 52 | 110000 | Pop |
| 53 | 110000 | Pop |
| 54 | 110000 | Pop |
| 55 | 110000 | Pop |
| 56 | 110000 | Pop |
| 57 | 110000 | Pop |
| 58 | 25060 | Subtract count,1; Subtract constant 1 from count;  count = count -1 |
| 59 | 27 | Address of count |
| 60 | 1 | Immediate value of op2 |
| 61 | 85000 | BrOnPlus count,Loop; If the value of count is above 0, jump to the Loop start. |
| 62 | 27 | Address of count |
| 63 | 28 | Address of Loop start to jump to |
| 24 | 0 | Halt |
| -1 | 28 | End Loop; set the PC to the start of the Start section;  PC = 28 |

**Program 2: Using Stack Program Symbol table**

| **Symbol** | **Value (Address)** |
| --- | --- |
| main | 26 |
| number | 26 |
| count | 27 |
| Loop | 28 |

**Program 3: Performing Input & Output Operations Program ASSEMBLY with comments**

| **Label** | **Mnemonic** | **Operands** | **Description** |
| --- | --- | --- | --- |
| main | Function |  | Declare the start of the main function. |
|  | Origin | 66 | State where the start of the program is. |
| count | Long | 5 | Declare variable count and initialize it to 5.  count = 5 |
| print | Long | 5 | Declare variable print and initialize it to 5.  print = 5 |
| Start | Move | GPR2,9 | Initialize GPR2 to 9. GPR1 = 9 |
|  | SysCall | 4 | Issue system call ID 4: allocate memory. |
|  | Move | GPR7,GPR1 | Move contents of GPR1 into GPR7;  GPR7 = GPR1 |
|  | Move | GPR6,GPR1 | Move contents of GPR1 into GPR6;  GPR6 = GPR1 |
|  | Move | GPR5,GPR1 | Move contents of GPR1 into GPR5;  GPR5 = GPR1 |
| Loop | SysCall | 4 | Issue system call ID 8: get character input |
|  | Move | (GPR6)+, GPR1 | Move GPR1 value into memory location specified by GPR6 then autoincrement GPR6. |
|  | Subtract | count,1 | Subtract 1 from count; that is,  count = count -1 |
|  | BrOnPlus | count,Loop | If count > 0, then jump to the Loop section. Otherwise, proceed. |
| Loop2 | Move | GPR1,(GPR7)+ | Move value in memory location specified by GPR7 into GPR1 then autoincrement GPR7. |
|  | SysCall | 9 | Issue system call ID 9: print character |
|  | Subtract | print,1 | Subtract 1 from print; that is,  print = print -1 |
|  | BrOnPlus | print,Loop2 | If print > 0, then jump to the Loop2 section. Otherwise, proceed. |
|  | Move | GPR1,GPR5 | Move contents of GPR5 into GPR1;  GPR1 = GPR5 |
|  | SysCall | 5 | Issue system call ID 5: free memory |
|  | Halt |  | Issue a CPU halt and stop program execution. |
|  | End | Start | Program execution starts at the start of the Loop section. That is, PC = 68 |

**Program 3: Performing Input & Output Operations Program (machine code) with comments**

| **Address** | **Content** | **Comment** |
| --- | --- | --- |
| 66 | 5 | count Long 5 |
| 67 | 5 | print Long 5 |
| 68 | 51260 | Start start; Move GPR2,9; move the constant 9 into GPR2 |
| 69 | 9 | Immediate value of op2 |
| 70 | 126000 | SysCall 4; allocate memory |
| 71 | 4 | Immediate value of op1 |
| 72 | 51711 | Move GPR7,GPR1; move value of GPR1 into GPR7; move new block address to GPR7 |
| 73 | 51611 | Move GPR6,GPR1; move value of GPR1 into GPR6; move new block address to GPR6 |
| 74 | 51511 | Move GPR5,GPR1; move value of GPR1 into GPR5; move new block address to GPR5 |
| 75 | 126000 | Loop start; SysCall 8; io\_getc |
| 76 | 8 | Immediate value of op1 |
| 77 | 53611 | Move (GPR6)+,GPR1; Move value of GPR1 into location in GPR6 in autoincrement mode |
| 78 | 25060 | Subtract count,1; Subtract constant 1 from count;  count = count -1 |
| 79 | 66 | Address of count |
| 80 | 1 | Immediate value of op2 |
| 81 | 85000 | BrOnPlus count,Loop; If the value of count is above 0, jump to the Loop start. |
| 82 | 66 | Address of count |
| 83 | 75 | Address of Loop start to jump to |
| 84 | 51137 | Loop2 start; Move GPR1,(GPR7)+; move value in memory location specified by GPR7 into GPR1 in autoincrement mode |
| 85 | 126000 | SysCall 9; io\_putc |
| 86 | 9 | Immediate value of op1 |
| 87 | 25060 | Subtract print,1; Subtract constant 1 from print;  print = print -1 |
| 88 | 67 | Address of print |
| 89 | 1 | Immediate value of op2 |
| 90 | 85000 | BrOnPlus print,Loop2; If the value of print is above 0, jump to the Loop2 start. |
| 91 | 67 | Address of print |
| 92 | 84 | Address of Loop2 start to jump to |
| 93 | 51115 | Move GPR1,GPR5; move value of GPR5 into GPR1; move block address to GPR1 |
| 94 | 126000 | SysCall 9; free memory |
| 95 | 5 | Immediate value of op1 |
| 96 | 0 | Halt |
| -1 | 0 | End Start; set the PC to the start of the Start section;  PC = 68 |

**Program 3: Performing Input & Output Operations Program Symbol table**

| **Symbol** | **Value (Address)** |
| --- | --- |
| main | 66 |
| count | 66 |
| print | 67 |
| Start | 68 |
| Loop | 75 |
| Loop2 | 84 |