1. Describe and compare “branch”, “macro” and “procedure” in assembly programming.
   1. Branch is setting PC to a value
   2. Macros simplify long or complicated assembly code
   3. Procedure is a set of instructions to accomplish a task
2. Illustrate (give examples) all MSP 430 addressing modes.
   1. Register Mode
      1. MOV.W R5,R6 ; move (copy) word from R5 to R6
   2. Indexed Mode
      1. MOV.B 3(R5),R6 ; load byte from address 3+(R5)=7 into R6
   3. Symbolic Mode (PC Relative)
      1. MOV.W LoopCtr ,R6 ; load word LoopCtr into R6, symbolic mode
      2. The assembler replaces this by the indexed form
      3. MOV.W X(PC),R6 ; load word LoopCtr into R6, symbolic mode
   4. Absolute Mode
      1. MOV.B &P1IN ,R6 ; load byte P1IN into R6 , absolute mode
      2. The assembler replaces this by the indexed form
      3. MOV.B P1IN(SR),R6 ; load byte P1IN into R6 , absolute mode
   5. SP-Relative Mode
      1. MOV.W 2(SP),R6 ; copy most recent word but one from stack
   6. Indirect Register Mode
      1. MOV.W @R5 ,R6 ; load word from address (R5)=4 into R6
      2. MOV.W R6 ,0(R5) ; store word from R6 into address 0+(R5)=4
   7. Indirect Autoincrement Register Mode
      1. MOV.W @R5+,R6
   8. Immediate Mode
      1. MOV.W @PC+,R6 ; load immediate word into R6
3. What is interrupt? List all MSP 430 interrupts along with their interrupt vectors.
   1. Interrupts are a mechanism to notify CPU when some urgent events accur.
   2. External interrupts
      1. From I/O pins of microcontroller
   3. Internal interrupts
      1. Timers
         1. Output compare
         2. Input capture
         3. Overflow
   4. Communication units
      1. Receiving something
      2. Done sending
   5. ADC
      1. Completed conversion
   6. Interrupt Vectors

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| INTERRUPT SOURCE | INTERRUPT FLAG | SYSTEM INTERRUPT | ADDRESS | SECTION | PRIORITY |
| Power-up  External reset  Watchdog | PORIFG  RSTIFG  WDTIFG | Reset | 0xFFFE | .reset | 15, highest |
| NMI  Oscillator fault  Flash memory violation | NMIIFG  OFIFG  ACCDVIFG | Non-maskable | 0xFFFC | .int14 | 14 |
| Timer\_B3 | TBCCR0 CCIFG | Maskable | 0xFFFA | .int13 | 13 |
| Timer\_B3 | TBCCR1 CCIFG  TBCCR2 CCIFG, TBIFG | Maskable | 0xFFF8 | .int12 | 12 |
|  |  |  | 0xFFF6 | .int11 | 11 |
| Watchdog Timer | WDTIFG | Maskable | 0xFFF4 | .int10 | 10 |
| Timer\_A3 | TACCR0 CCIFG | Maskable | 0xFFF2 | .int09 | 9 |
| Timer\_A3 | TACCR1 CCIFG,  TACCR2 CCIFG, TAIFG | Maskable | 0xFFF0 | .int08 | 8 |
| USCI\_A0/USCI\_B0 Rx | UCA0RXIFG, USB0RXIFG | Maskable | 0xFFEE | .int07 | 7 |
| USCI\_Z0/USCI\_B0 Tx | UCA0TXIFG, UCB0TXIFG | Maskable | 0xFFEC | .int06 | 6 |
| ADC10 | ADC10IFG | Maskable | 0xFFEA | .int05 | 5 |
|  |  |  | 0xFFE8 | .int04 | 4 |
| I/O Port P2 | P2IFG.0 – P2IFG.7 | Maskable | 0xFFE6 | .int03 | 3 |
| I/O Port P1 | P1IFG.0 – P1IFG.7 | Maskable | 0xFFE4 | .int02 | 2 |
|  |  |  | 0xFFE2 | .int01 | 1 |
|  |  |  | 0xFFE0 | .int00 | 0 |

1. What low power modes are supported by MSP 430?
   1. Low-power mode 0 (LPM0)
      1. CPU is disabled, ACLK and SMCLK remain active, MCLK is disabled
   2. Low-power mode 1 (LPM1)
      1. CPU is disabled, ACLK and SMCLK remain active, MCLK is disabled, DCO’s dc-generator is disabled if DCO not used in active mode
   3. Low-power mode 2 (LPM2)
      1. CPU is disabled, ACLK and SMCLK remain disabled, DCO’s dc-generator remains enabled, ACLK remains active
   4. Low-power mode 3 (LPM3)
      1. CPU is disabled, ACLK and SMCLK remain disabled, DCO’s dc-generator is disabled, ACLK remains active
   5. Low-power mode 4 (LPM4)
      1. CPU is disabled, ACLK and SMCLK remain disabled, DCO’s dc-generator is disabled, Crystal oscillator is stopped