ECE220 Lab2

Brain Teaser – Right Shifting

Left shifting

- 1101 → 1010
- ADD Rx, Rx, Rx

Right shifting

- 1101 → 0110
- ?!?!

Solution

- Use two masks
- 1101 → 0000
- 1101 → 0010
- 1101 → 0110

MP2 – Stack Calculator

Implement a reverse Polish notation/postfix notation calculator

Notations:

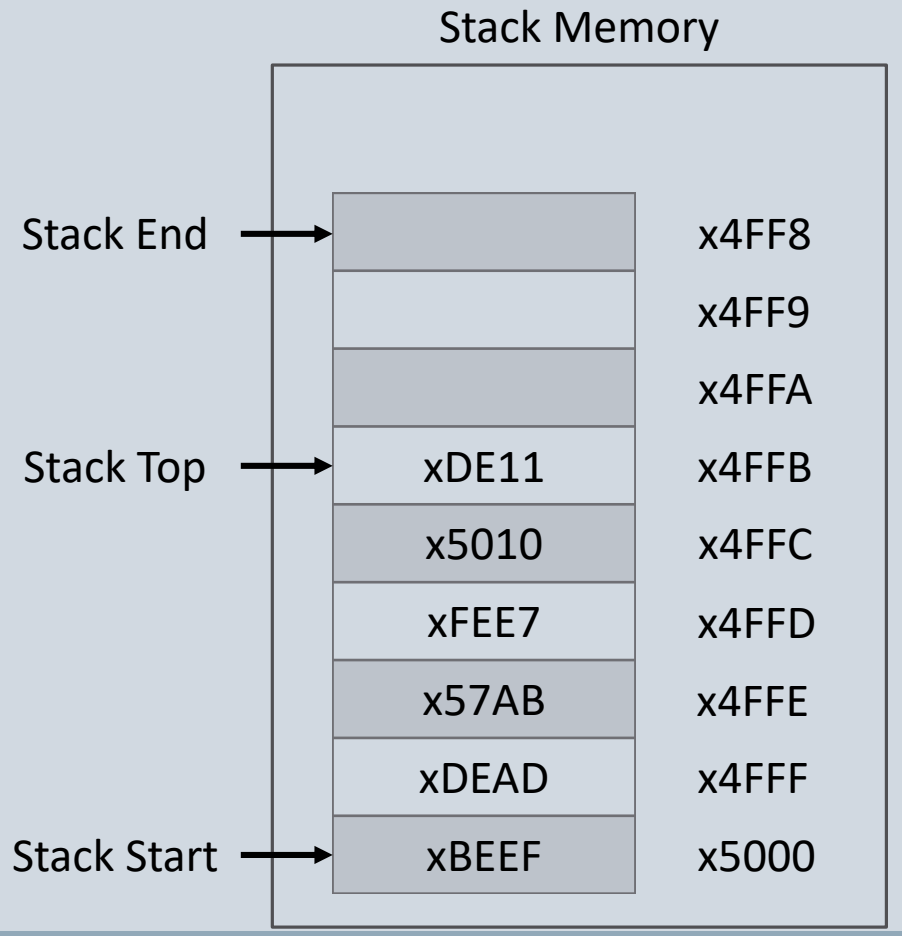
Regular Notation	Postfix Notation
(3 – 4) + 5 = 4	3 4 – 5 + = 4
3 – (4 + 5) = -6	3 4 5 + - = -6

Standard notation requires parenthesis to reduce ambiguity whereas postfix doesn't need any

Stack Data Structure

Data Structure

- Add/remove elements from the top
- Stack of plates or stack of cards
- LIFO (Last In First Out) or FILO (First In Last Out)
- Operations
  - POP – removes an element from the stack
  - PUSH – pushes an element onto the stack
  - SIZE – returns the size of the stack
  - TOP – returns the element at the top of the stack

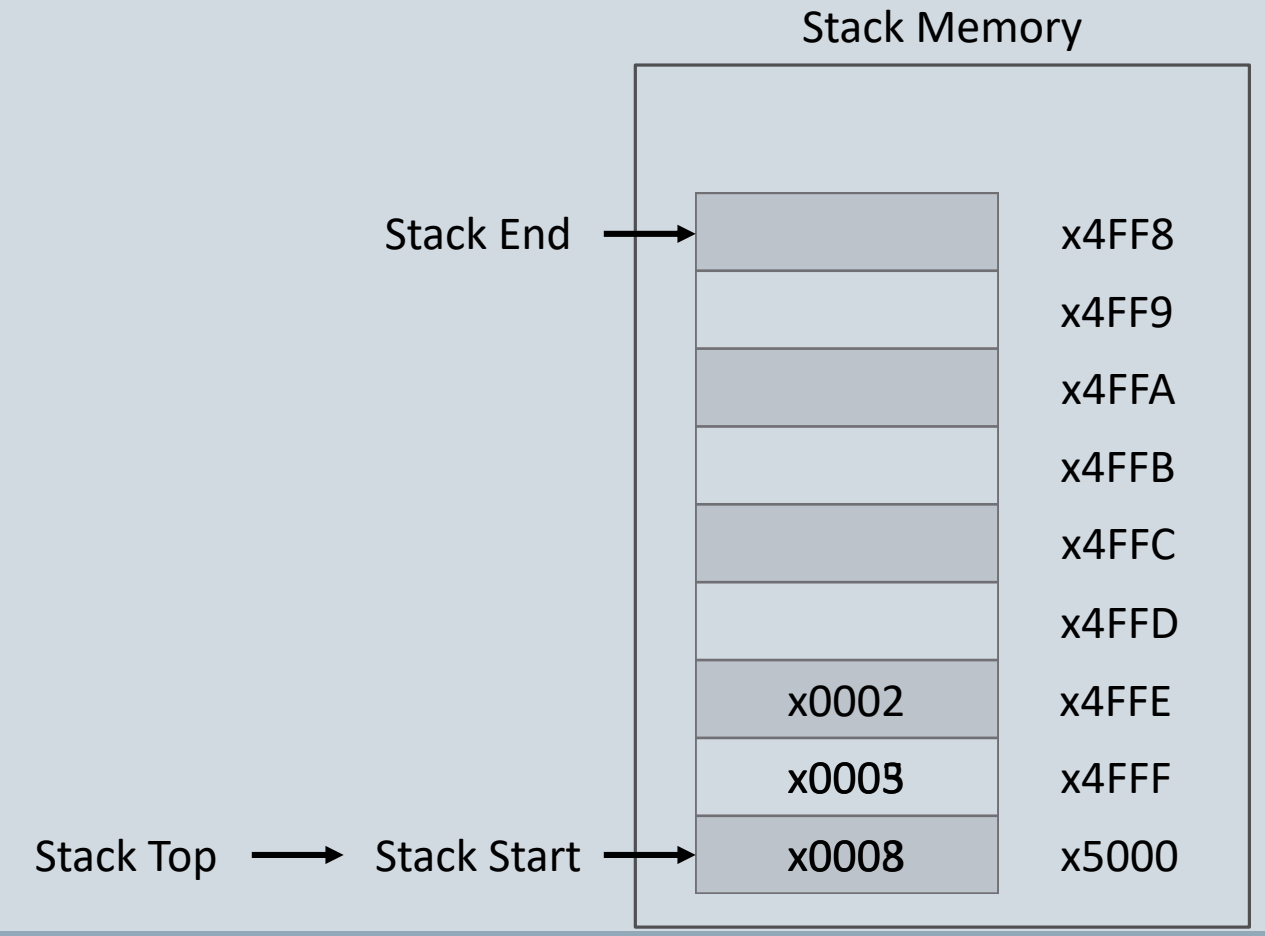


Postfix Calculator on a Stack

Example input
- 8 – (3 + 2) = ↔ 8 3 2 + - =

Algorithm
- PUSH when digit
- POP when operator, evaluate, PUSH result
- HALT on ‘=‘

Input
- 8
- 3
- 2
- +
- -
- =



Implementation

Read user input:

- GETC – Read a character from console into register R0 but don’t echo
- KBSR / KBDR – Status/display registers for keyboard

Echo user input:

- OUT – Write the character in register R0[7:0] to console
- DSR / DDR – Status/display registers for display

Subroutines

- JSR – saves contents of PC in register R7 and sets PC to new location
- RET – returns from a subroutine and replaces contents of PC with return address in register R7
- Save register values
  - Caller vs callee saved registers
  - SAVE_REGISTER .BLKW #1
  - ST/LD instructions to save/load register values in subroutines

Lab2 – Balancing Parentheses

Check if string of parentheses is balanced:

- Balanced
  - ()()
  - (())()
- Unbalanced
  -)(
  - ())
  - (()

Output:

- Register R6 = x0001 (1) if balanced
- Register R6 = xFFFF (-1) if unbalanced

Algorithm

- Parse input from keyboard
  - If input == '(', push to stack
  - If input == ')', pop from stack
  - If input == ' ' (space), ignore it
  - If input == '\n' (xA) or '\r' (xD)
    - Check if stacks empty
    - Halt

Balancing Parentheses on a Stack

Input

- (
- (
-)
-)