EE234

Microprocessor Systems

Midterm Exam 2

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Name:

WSU ID:

Problem	Points	
1	20	
2	40	
3	40	
Total	100	

Problem #1 (Stack and Subroutines, 20 points)

Correct: +2.5 points. Wrong: -2.5 points. Min: 0.

Assume

- The system we are talking about is single-threaded, single-application.
- Function arguments and return values are processed in the stack.

Answer the following questions.

- The maximum size of the stack in a main memory is dependent on the capacity of the main memory. (True / False)

- The maximum size of the stack in a main memory is dependent on the size of the application code being executed. (True / False)

- If a code contains a recursive function call, it might cause a stack overflow error while the recursive function call is being executed. (True / False)

- If a function has many many many arguments, calling the function might cause a stack overflow error. (True / False)

- If a function has one argument, calling the function will never cause a stack overflow error. (True / False)

- If a function has no argument, calling the function will never cause a stack overflow error. (True / False)

- If a function has no argument and no return value, calling the function will never cause a stack overflow error. (True / False)

- If a function has no argument, no return value, and no function call in it, calling the function will never cause a stack overflow error. (True / False)

Problem #2 (Subroutines and Stack, 40 points)

Answer the following questions for the assembly code shown below.

```
main:
  PUSH {R0}
  SUB SP, SP, #8
  MOV R0, #5
  STR R0, [SP]
  BL com
  LDR R0, [SP, #4]
  ADD SP, SP, #8
  STR R0, [SP, #4]
  POP {R0}
end:
```

```
com:
  PUSH {LR}
  LDR R0, [SP, #4]
  CMP R0, #1
  BGT com_1
  MOV R0, #1
  STR R0, [SP, #8]
  POP {LR}
  BX LR
com_1:
  PUSH {R1,R2,R3,R4}
  MOV R1, #0
  MOV R2, #1
  SUB R3, R0, #1
com_1_loop:
  CMP R2, R3
  BGT com_1_loop_end
  SUB SP, SP, #8
  STR R2, [SP]
  BL com
  LDR R4, [SP, #4]
  ADD SP, SP, #8
  ADD R1, R1, R4
  ADD R2, R2, #1
  B com_1_loop
com_1_loop_end:
  STR R1, [SP, #24]
  POP {R1,R2,R3,R4}
  POP {LR}
  BX LR
```

The main function looks like this in C/C++:

```
int main () {
  int s;
  ..
  s = com(5);
  …
}
```

(1) (30 points) Translate the assembly code of the com() function into a C code. It has one argument and one return value.

```
int main () {
  int s;
  ..
  s = com(5);
  …
}

int com (int x) {
  if ( x <= 1 )
    return 1;

  int s = 0;
  for ( int i = 1 ; i <= x-1 ; i++ ) {
    s += com(i);
  }

  return s;
}
```

(2) (10 points) What is the value stored at [SP+4] when the program ends? (You get 10 points only when you solve the first part above and answer this question correctly.)

com(1): 1

com(2): 1

com(3): com(1)+com(2) = 2

com(4): com(1)+com(2)+com(3) = 4

com(5): com(1)+com(2)+com(3)+com(4) = 8

Problem #3 (Subroutines and Stack, 40 points)

You should use the following instructions only.

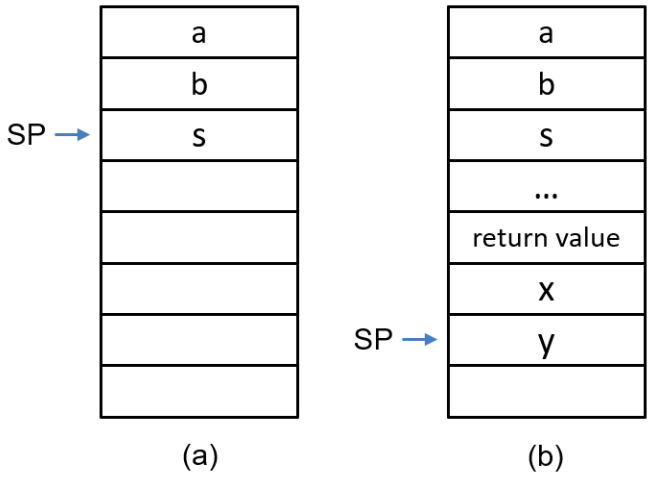
- Instructions
  - ADD, SUB
  - AND, ORR, EOR
  - CMP, BGE/BLT/BGT/BLE/BEQ/BNE
  - B, BL, BX
  - MOV
  - LDR, STR

Write an assembly code for the following C code (the line s=com(a,b) in the main function and the com() function).

```
int main () {
  int s, a, b;
  …
  s = com (a, b);
  …
}
```

```
int com (int x, int y) {
  if ( x < y )
    return x;
  else {
    return com(com(x-y, x+y), com(x-2*y, x+y));
  }
}
```

The following shows the memory map for the function call. (a) in the main function. (b) for the function call.



- In the main function, assume that R0-R12 are being used by other variables (right before the function call s=com(a,b)). This means that you should preserve their values if you want to use any of them.
- Use the stack memory for the function arguments and the return value (shown in (b)).

```
main:
  PUSH {R0}
  SUB SP, SP, #12
  LDR R0, [SP, #24]
  STR R0, [SP, #4]
  LDR R0, [SP, #20]
  STR R0, [SP]
  BL com
  LDR R0, [SP, #8]
  STR R0, [SP, #16]
  ADD SP, SP, #12
  POP {R0}
end:
```

```
com:
  PUSH {R0, R1, R2, R3}
  LDR R0, [SP, #20]
  LDR R1, [SP, #16]
  CMP R0, R1
  BGE com_1
  STR R0, [SP, #24]
  POP {R0, R1, R2, R3}
  BX LR
com_1:
  PUSH {LR}
  SUB SP, SP, #12
  SUB R2, R0, R1
  STR R2, [SP, #4]
  ADD R2, R0, R1
  STR R2, [SP]
  BL com
  LDR R3, [SP, #8]
  MOV R2, R1, LSL #1
  SUB R2, R0, R2
  STR R2, [SP, #4]
  ADD R2, R0, R1
  STR R2, [SP]
  BL com
  LDR R2, [SP, #8]
  STR R3, [SP, #4]
  STR R2, [SP]
  BL com
  LDR R2, [SP, #8]
  STR R2, [SP, #40]
  ADD SP, SP, #12
  POP {LR}
  POP {R0, R1, R2, R3}
  BX LR
```