1. (2 pts) Name the architecture that is characterized by a shared program and data memory ________________________________.

2. (3 pts) Name three different 8-bit microcontroller families.
   (a) ________________________________
   (b) ________________________________
   (c) ________________________________

3. (5 pts) Name 10 criteria that you might use to select a microcontroller (we discussed about 13 in class).
   (a) ________________________________
   (b) ________________________________
   (c) ________________________________
   (d) ________________________________
   (e) ________________________________
   (f) ________________________________
   (g) ________________________________
   (h) ________________________________
   (i) ________________________________
   (j) ________________________________

4. (3 pts) On the 8051, how wide (in bits) are the following:
   (a) The accumulator __________________
   (b) The program status word ________________
   (c) The program counter ________________

5. (2 pt) How much (internal) RAM is available on the original 8051? ____________

6. (6 pts) Other than RAM and ROM, the original 8051 has three types of peripheral devices. Name them, and tell how many there are of each.
   (a) ________________________________ number of them:____
   (b) ________________________________ number of them:____
   (c) ________________________________ number of them:____

7. (2 pts) What is the address of the first instruction executed immediately after reset? __________________

8. (3 pts) What is the difference between MOV A, #42H and MOV A, 42H?
   ________________________________
   ________________________________
   ________________________________

9. (2 pts) What assembly statement would you use if you want the symbol count to be synonymous with 3?
   ________________________________

10. (2 pts) The instruction MUL AB multiplies registers A and B.
    (a) Is the multiplication signed, unsigned or both? __________________
    (b) In which register is the least significant byte of the result stored? ________.
11. (2 pts) What does the following sequence of assembly statements do?

```assembly
cseg
...
frogs:  db  2
```
(a) Allocates 2 bytes from code memory and names them frogs
(b) Allocates 1 byte from the code memory, names it frogs and initializes it to 2.
(c) Allocates 2 bytes from internal RAM and names them frogs.
(d) Allocates 1 byte from internal RAM, names it frogs and initializes it to 2.
(e) None of the above

12. (4 pts) Assume the following instructions are executed right after a reset:

```
MOV  PSW, #98H
MOV  R2, sp
```
What value will be stored? __________ To what address? ______________

13. (2 pts) After the instructions in problem 12 are executed, what is the value of:
(a) the carry flag (C)? ______________
(b) the auxiliary carry flag (AC)? ______________

14. (4 pts) Consider the following instructions:

```
MOV  A, #87H
ADD  A, #79H
```
After these instructions have executed,
(a) What is the value of A? ______________________
(b) What is the value of C? ______________
(c) What is the value of AC? ______________________
(d) What is the value of OV? ______________________

15. (2 pts) Assume the accumulator is 0916, C=0, AC = 1. What will the accumulator hold after the instruction DA A is executed? __________

16. (4 pts) Consider the following assembly code.

```
CLR  A
MOV  R7, #3
LOOP1: MOV  B, #4
LOOP2: INC  A
DJNZ  B, LOOP2
INC  R7
CJNE  R7, #6, LOOP1
```
What will the values of A, B, R7 and C be when this code has finished executing?
A = __________
B = __________
R7 = __________
C = __________

17. (2 pts) What is the fundamental difference between a call and a jump instruction?
(a) the destination address of the jump is pushed onto the stack
(b) the destination address of the jump is popped from the stack
(c) the address of the CALL instruction is pushed onto the stack
(d) the address of the instruction that follows the CALL is pushed onto the stack
18. (3 pts) Match the jump instructions to their descriptions:
(a) LJMP  ____ Jump to a location in the range (PC-128..PC+127)
(b) SJMP  ____ Jump anywhere in program memory
(c) AJMP  ____ Jump to a location in a 2K block of program memory

19. (3 pts) Consider the following 2 assembly code fragments:

<table>
<thead>
<tr>
<th>Fragment 1</th>
<th>Fragment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANL A, P3</td>
<td>ANL P3, A</td>
</tr>
<tr>
<td>MOV P3, A</td>
<td>MOV A, P3</td>
</tr>
</tbody>
</table>

In what way do these fragments behave differently? (Hint: Don’t forget about the port latch.)

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

20. (6 pts) Write a single instruction to:
(a) toggle pins P1.0 – P1.1
(b) select register bank 3
(c) complement (toggle) the overflow flag

_____________________________________________________________________
_____________________________________________________________________

21. (4 pts) An original 8051 has a 6 MHz crystal.
(a) What is the period of a machine cycle?
(b) How long will it take to execute the delay loop, below?

MOV R2, #2
MOV R3, #141
LOOP: DJNZ R3, LOOP
DJNZ R2, LOOP

22. (5 pts) Analyze the following subroutine (Hint: assume the input is a signed number):

; Subroutine foo
; description: left as an exercise for the student
; input: A
; output: A
foo:   JNB ACC.7, done
       CPL A
       INC A
done:  RET

Describe what this function does and suggest a better name for it.

_____________________________________________________________________
_____________________________________________________________________

23. (3 pts) Which bit address is used for the following instructions?
(a) SETB P1.1  Bit address = ______________
(a) CLR ACC.7  Bit address = ______________
(a) CPL PSW.3  Bit address = ______________
24. (6 pts) A listing file contains the line shown below.

<table>
<thead>
<tr>
<th>address</th>
<th>code</th>
</tr>
</thead>
<tbody>
<tr>
<td>167E</td>
<td>B414F6</td>
</tr>
<tr>
<td></td>
<td>CJNE</td>
</tr>
<tr>
<td>A, #20,</td>
<td>foo</td>
</tr>
</tbody>
</table>

Assume the accumulator contains 10H when this instruction is executed.
(a) Will the branch be taken or not?
___________________
(b) What will the carry flag be after the instruction is executed?
___________________
(c) What is the address (in code memory space) of foo?
___________________

25. (6 pts) Write a code fragment to subtract the 16-bit value \{R5,R4\} from \{R7,R6\}, leaving the result in \{R3,R2\} and setting the carry flag if a borrow occurs.
(7 instructions)

26. (4 pts) The code below purports to convert a 3-bit number (in the accumulator) into a bit mask (e.g. 0 → 00000001, 1 → 00000010, 7 → 10000000), but there is a problem. Find it and show the correction(s) below. Do not use D PTR.

```assembly
get_mask:
    MOVC A, @A+PC
    RET

db 01H, 02H, 04H, 08H, 10H, 20H, 40H, 80H
```

27. (6 pts) Write a code fragment to divide a 16-bit unsigned value in \{R3,R2\} by 2. (Hint: shift the value right except for its sign bit, which should be loaded with 0).
(7 instructions)

Extra Credit. (3 pts)
Write code to jump to the address in registers \{B,A\} without using D PTR.