1. Assume that the A/D converter has been set up to output an analog signal on PA4. The following two lines will do one conversion:

```
DAC_DHR12R1 = out & 0xFFF;
DAC_SWTRIGR |= 0x1;        //Start the D/A conversion
```

Where the variable `out` is an int. If `out` is zero the converter puts out a zero volts. If out = 0xFFF the converter puts out 3.0 volts. You are also given a delay function called

```
Delay1();
```

which produces a 1 msec delay.

    A) Write a program to output a ramp function to PA4 with 1 msec between output samples.

        B) Write a program to output a square wave to PA4 with a frequency of 100 Hz.

2. An equation in C produces values which range from 4 to 8. We want to scale these values such that if they are sent to the 12-bit D/A converter the output will be 0 to 3.0 volts. Write the scaling equation (in C) to output this range to the DAC_DHR12R1 register for the D/A.

3. Suppose PA0 to PA3 have been set up as input bits and all other bits on GPIOA have been set up as output bits. Show how to input four bits from PA0-PA3 and output those same four bits to PA9-PA12 without changing any of the other output bits on GPIOA.

4. Answer the following with one line that shows how to shift a variable.
    A) Show how to shift a variable left four times using C code. Assume the variable name is *x*.

    B) Show how to shift register R2 left four times using assembly code.

5. The program below is meant to be an embedded assembly routine titled *Mystery*. Answer the following questions.
    A) Write a few sentences explaining what the program does.

```
__asm int Mystery(int x)
{   MOVS R3, #0;
    LSL R3, R3, #4;
    MOVS R0, R3;
    BX LR;
};
```

    B) How is the parameter *x* used, if it is used at all?

    C) Give an example of a C-Statement that could call this subprogram.

6. The STM32F446 processor is running with the internal 16 MHz clock. What is the value to be loaded into the *baud rate divisor* register if we want to use UART 6 on PC6 at 28,800 baud. Show your work. Use 16 bit oversampling so that the *over8* bit is 0.

7. Answer the questions below about the following program

A. Which pin is used for output?_____

B. How often is the output pin changed?

C. what is the frequency of the output waveform.

D. What is the purpose of line 22?
_____
_____

E. Is Timer 3 polled or does it use an interrupt?
_____
_____

F. What change can be made to double the
frequency of the output?
_____
_____
_____

```
1    #include "stm32f407vg.h"
2    int main()
3      {int i, tmp;
4       RCC_AHB1ENR |= 1;
5       RCC_APB1ENR |= (1 << 29);
6       RCC_APB1ENR |= 2;
7       GPIOA_MODER |= 0xF00;
8       GPIOA_PUPDR &= 0xFFFFF0FF;
9       DAC_CR |= 0x3E;
10      DAC_CR |= 1;
11      TIM3_CR1 |= (1 << 7);
12      TIM3_CR1 |= (1 << 3);
13      TIM3_PSC = 9;
14      TIM3_ARR = 12000;
15      TIM3_CR1 |= 1;
16      while(1)
17        {tmp = 0;
18         for(i=0;i<20;i++)
19           {DAC_DHR12R1 = tmp;
20            DAC_SWTRIGR |= 0x1;
21            tmp += 4000/20;
22            while((TIM3_CR1 & 1) !=0);
23            TIM3_CR1 |= 1;
24           }
25        }
26     }
27
28
```

8. In many assembly language programs for the ARM processor we see instructions that look like this:

`ldr r0, =0x00789012;`

But in checking the ARM assembly language manual we find that this is not a legitimate assembly language instruction. Instead it is referred to as a pseudo-instruction. This pseudo-instruction is converted by the assembler to something that might look like this:

`ldr r0, [pc+45];`

Explain why this conversion is better than the original.

9. For the STM32F446 processor write the C-code sequence to input from bit PA.6 and send its complement to PB.5 without changing any other bits on PB. Assume PA.6 is in the input mode and PB.5 is in the output mode.