1.

Switch value in binary	PWM Duty Cycle	Numerator	Denominator
000	11%	Y1=1	X=9
001	22%	Y1=2	X=9
010	33%	Y1=3	X=9
011	44%	Y1=4	X=9
100	55%	Y1=5	X=9
101	66%	Y1=6	X=9
110	77%	Y1=7	X=9
111	88%	Y1=8	X=9

2. To get the required delay time, let us consider the snippet of code below for yet to be determined positive integers x and y.

```
DELAY:
          MOV R0, #x
LOOP0:    MOV R1, #y
LOOP1:    DJNZ R1, LOOP1
          DJNZ R0, LOOP0
```

The number of machine cycles for this code is

$$2 + [2 + 4 \cdot y + 4] \cdot x = 4xy + 6x + 2.$$

Since we our machine is a DS89C450 and since we want to generate a $\frac{1}{5400}s$ delay time, we must have that

$$(4xy + 6x + 2) \cdot 90.42ns = \frac{1}{5400}.$$

So choose $x = 11$ and solve to get $y \approx 45$.

3.

```
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;PULSE-MODULATION CODE;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

         MOV      P0, #0        ;Set Port 0 as output
         MOV      P1, #07H      ;Use low 3-bit of P1 for modulation

MAIN_LOOP:
         MOV      R2, P1        ;Read data from switch into R2
         INC      R2            ;Add 1 to get index of switch
         MOV      P0, #0FFH     ;Turn on LEDs

DELAY_ON:
```

```
        ACALL   DELAY           ;Keep LEDs on for R2 * Delay time
        DJNZ    R2, DELAY_ON

        MOV     R2, P1          ;Read data from switch into R2

        MOV     A, #8
        SUBB    A, R2           ;Off Time = (8 - R2) * Delay time
        MOV     R2, A

        MOV     P0, #0          ;Turn off LEDs

DELAY_OFF:
        ACALL   DELAY           ;Keep LEDs on for R2 * Delay time
        DJNZ    R2, DELAY_OFF

        SJMP MAIN_LOOP

DELAY:
                MOV R0, #11     ;Delay time for DS89C450 at 600 Hz
        LOOP0:
                MOV R1, #45
        LOOP1:
                DJNZ R1, LOOP1
                DJNZ R0, LOOP0
        RET
END
```

4. **Flow Chart**

JOSEPH OKONOBOH, 013755064
Computer Science
Cal State Long Beach