CENG 355 Midterm Solutions

1. There are many possible solutions. One of them is shown below.

```
#define PBIN (volatile char *) 0xFFFFFFF3
#define PBOUT (volatile char *) 0xFFFFFFF4
#define PBDIR (volatile char *) 0xFFFFFFF5
#define PCONT (volatile char *) 0xFFFFFFF7
#define CNTM (volatile int *) 0xFFFFFFD0
#define CTCON (volatile char *) 0xFFFFFFD8
#define CTSTAT (volatile char *) 0xFFFFFFD9
#define IVECT (volatile int *) (0x20)

interrupt void intserv();

int main() {
  unsigned char digit = 0;                 /* Digit to be displayed */
  *PBDIR = 0xF0;                           /* Set Port B direction */
  *IVECT = (volatile int *) &intserv;      /* Set interrupt vector */
  asm("MoveControl PSR,#0x40");            /* CPU responds to IRQ */
  *PCONT = 0x40;                           /* Enable PBIN interrupts */
  *CTCON = 0x02;                           /* Stop Timer */
  *CSTAT = 0x0;                            /* Clear "reached 0" flag */
  *CNTM = 100000000;                       /* Initialize Timer */
  *PBOUT = 0x0;                            /* Display 0 */

  while (1) {
    while ((*CTSTAT & 0x1) == 0);          /* Wait until 0 is reached */
    *CSTAT = 0x0;                          /* Clear "reached 0" flag */
    digit = (digit + 1)%10;                /* Increment digit */
    *PBOUT = digit << 4;                   /* Update display */
  }

  exit(0);
}

interrupt void intserv() {
  unsigned char sample;          /* Port B input sample */
  sample = *PBIN & 0x3;          /* Sample PBIN, isolate E and D */
  if (sample == 0x1) *CTCON = 0x01; /* Timer will run */
  if (sample == 0x2) *CTCON = 0x02; /* Timer will not run */
}
```
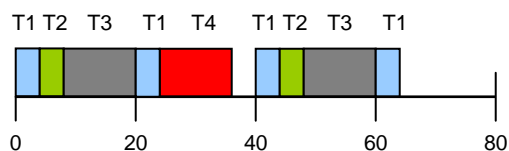
2. The LCM (least common multiple) of all four periods is 80; hence, we only need to figure out our EDF schedule in the time interval **[0, 80)**, after which it is repeated:

3.

(a) Direct-mapped: 3-bit **Block = A_{6-4}**, 2-bit **Word = A_{3-2}**; miss rate = 6/10.

Tag	Word 3	Word 2	Word 1	Word 0	
1	[8C]	[88]	[84]	[80]	Block 0
					Block 1
0	[2C]	[28]	[24]	[20]	Block 2
					Block 3
1	[CC]	[C8]	[C4]	[C0]	Block 4
					Block 5
					Block 6
					Block 7

(b) 4-way set-associative: 1-bit **Set = A_4**, 2-bit **Word = A_{3-2}**; miss rate = 6/10.

Tag	Word 3	Word 2	Word 1	Word 0	
110	[CC]	[C8]	[C4]	[C0]	Set 0
010	[4C]	[48]	[44]	[40]	Set 0
001	[2C]	[28]	[24]	[20]	Set 0
100	[8C]	[88]	[84]	[80]	Set 0
					Set 1
					Set 1
					Set 1
					Set 1

(c) Fully associative: 2-bit **Word = A_{3-2}**; miss rate = 5/10.

Tag	Word 3	Word 2	Word 1	Word 0
1000	[8C]	[88]	[84]	[80]
0100	[4C]	[48]	[44]	[40]
0010	[2C]	[28]	[24]	[20]
0000	[0C]	[08]	[04]	[00]
1100	[CC]	[C8]	[C4]	[C0]