PHASE LOCK LOOP (1/1 point)

What is a good reason for using the PLL?

- The PLL is a way to run faster, which will execute more instructions per second.
- The PLL is a way to run slower, so that less power is needed and the battery will last longer.
- When using the PLL we usually attach an external crystal, which will make the time more accurate.
- (selected) All of the above ✔

Help

EXPLANATION

Give careful thought about the balance between software execution speed and system power. For systems not requiring accurate time, we can run without a crystal.

Check | Hide Answer

SYSTICK_WAIT (1/1 point)

Assume we are calling SysTick_Wait as defined in Program 10.2. The bus period is 12.5 ns (80 MHz). What is the longest delay in seconds that we can create by calling this function just once?

```
#define NVIC_ST_CTRL_R      (*((volatile unsigned long *)0xE000E010))
#define NVIC_ST_RELOAD_R    (*((volatile unsigned long *)0xE000E014))
#define NVIC_ST_CURRENT_R   (*((volatile unsigned long *)0xE000E018))
void SysTick_Init(void){
  NVIC_ST_CTRL_R = 0;               // disable SysTick during setup
  NVIC_ST_CTRL_R = 0x00000005;      // enable SysTick with core clock
}
// The delay parameter is in units of the 80 MHz core clock. (12.5 ns)
void SysTick_Wait(unsigned long delay){
  NVIC_ST_RELOAD_R = delay-1;  // number of counts to wait
  NVIC_ST_CURRENT_R = 0;       // any value written to CURRENT clears
  while((NVIC_ST_CTRL_R&0x00010000)==0){ // wait for count flag
  }
}
// 800000*12.5ns equals 10ms
void SysTick_Wait10ms(unsigned long delay){
  unsigned long i;
  for(i=0; i<delay; i++){
    SysTick_Wait(800000);  // wait 10ms
  }
}
```

Program 10.2. Use of SysTick to delay for a specified amount of time (SysTick_Wait_xxx.zip).

0.2

0.2

Answer: 0.2

Help

EXPLANATION

Answer 2^24 *12.5ns = 209,715,200ns = 0.2sec +/- 10%

Check

Hide Answer

TYPEDEF (1/1 point)

What does **typedef** do?

- Allows you to group dissimilar elements into one object.
- (selected) Creates a new data type that can be used to define variables. ✔
- Specifies the object should be placed in ROM.
- Specifies the object should be placed in RAM.
- None of the above.

EXPLANATION

A **struct** allows you to group dissimilar elements into one object. The modifier **const** specifies the object should be placed in ROM. Without the modifier **const** specifies the object should be placed in RAM.

Check | Hide Answer

ELEMENTS OF FINITE STATE MACHINES (1/1 point)

Which of the following are properties or elements of a finite state machine?

- Inputs
- States
- State transitions
- Outputs
- All of the above ✔

EXPLANATION

The essence of a finite state machine includes all these elements.

Check | Hide Answer

Help

STATE TRANSITIONS (1/1 point)

If a finite state machine as 4 digital inputs, how many next state transition arrows will each state have?

16

16

Answer: 16

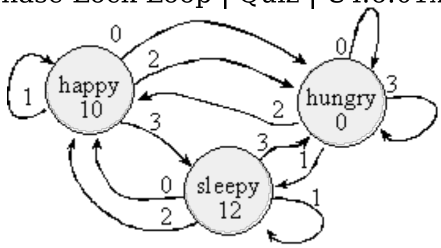
EXPLANATION

Answer 2^4 = 16 next state arrows

Check | Hide Answer

FSM PROBLEM 1 (1/1 point)

In the FSM below, assume we start in the happy state. The input starts and remains 3. What sequence of outputs will occur?



- start and remain at 0
- 10, 12, 0 (and remain at 0) ✔
- 10, 0, 10, 0, 10, 0, 10, 0, 10, over and over
- 10, 12, 10, 12, 10, 12, 10, 12, 10, over and over
- None of the above

EXPLANATION

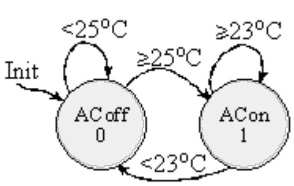
The system starts in happy (output is 10). Since the input is 3, it goes to the sleepy state (output is 12). Once in sleepy, the input is still 3, it goes to the hungry state (output 0). Once in hungry with the input at 3, it will stay in hungry for ever (output remains 0).

Help

Check   Hide Answer

FSM PROBLEM 2 (1/1 point)

The basic idea of this air conditioner is to control the room temperature between 23 and 25 °C using this FSM. Think about why there are two temperature thresholds. In particular, assuming the temperature is 24 °C, is the AC on or off?



- The AC is definitely on.
- The AC is definitely off.
- The AC toggles on and off over and over again.
- The AC could be on or it could be off, depending on previous values of temperature and state. ✔
- None of the above

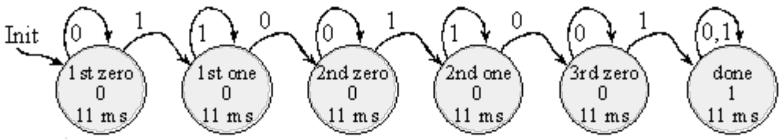
EXPLANATION

If we were to be in the ACon state (air conditioner is cooling the room), then we would remain in the ACon state until the temperature drops below 23 °C. If we were to be in the ACoff state (air conditioner is not cooling the room), then we would remain in the ACoff state until the temperature rises above 25 °C. These two thresholds are called **hysteresis** and prevents the AC from toggling on/off/on/off/on... too quickly.

Check Hide Answer

FSM PROBLEM 3 (1/1 point)

The input is connected to a positive logic switch and the output to a positive logic LED. Determine what this FSM does:



- The LED toggles on and off each time the switch is pressed.
- The FSM counts the number of switch pushes and displays the results on the LED display.
- The LED comes on and stays on after three touches of the switch. ✔
- The FSM waits 55 ms and turns on the LED.
- None of the above

EXPLANATION

Notice the only state with the LED on is the **done** state. Also notice, the FSM only goes right and never goes left. We start in **1stzero** state. When we touch the switch for the first time, we go to the **1stone** state. We stay in this state as long as the switch is touched. When we release the switch for the first time, we go to the **2ndzero** state. We stay in this state as long as the switch is released. When we touch the switch for the second time, we go to the **2ndone** state. We stay in this state as long as the switch is touched. When we release the switch for the second time, we go to the **3rdzero** state. We stay in this state as long as the switch is released. Finally, when we touch the switch for the third time, we go to the **done** state with output 1. We stay in the **done** state forever.

With an FSM it is important to assign a "what do we know" definition to being in each state.
1stzero means the switch has been never been touched
1stone means the switch was touched once
2ndzero means the switch was touched once and released
2ndone means touch, released, touched again
3rdzero means the switch was touched and released twice
done means the switch has been touched for the third time

Check Hide Answer

STEPPER MOTOR ROBOT (1/1 point)

A stepper motor robot has two steppers (like Example 10.3). The motors have 50 steps per revolution, the wheel radius is 10 cm, and the FSM wait times are 100 ms/step. Both wheels are stepping forward. How fast is the robot moving in cm/sec?

12.57

12.57

Answer: 12.56

EXPLANATION

Answer (2π10cm/rev)* (1/50 rev/step)*(10 steps/sec) = 12.56 cm/sec

Check Hide Answer

STEPPER ROBOT FSM (1/1 point)

Assume the FSM in program 10.7 is replaced with the following. What would the robot do if the input were 0?

```
StateType Fsm[4] = {
   {0x55, 2, {1, 1, 1, 1} },
   {0x59, 2, {2, 2, 2, 2} },
   {0x5A, 2, {3, 3, 3, 1} },
   {0x56, 2, {0, 0, 0, 2} }
};
```

- Rotate about a point between the two wheels.
- Pivot (rotate) about the right wheel. ✔
- Pivot (rotate) about the left wheel.
- Go backwards.
- None of the above.

EXPLANATION

With the input 0, the output sequence will be 55, 59, 5A and 56. This sequence will repeat over and over, with a delay of 2. Since the right wheel does not move, it will pivot on the right wheel. Since the left wheel steps backwards, the robot will turn such that the left wheel moves back.

Check Hide Answer

Help

Help