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November 16, 2012, 10:00-10:50am. Open book, open notes, calculator (no laptops, phones, devices with screens larger than a TI-89 calculator, devices with wireless communication). You have 50 minutes, so please allocate your time accordingly. ***Please read the entire quiz before starting***.

(5) Question 1. What is dropout voltage of a linear regulator? All choices are more or less true statements; pick the one that best defines dropout voltage of a linear regulator.

A) The regulator needs capacitance at its output in order to stabilize the +3.3V supply. The manufacturer of each regulator will suggest appropriate capacitance values and capacitor types at its input and output. If the system tries to sink more current than the regulator can supply the voltage at the regulator output will drop off.

B) A linear regulator produces a constant output voltage under conditions of variable current. In order to operate properly, a linear regulator needs an input voltage greater than or equal to the output voltage plus a fixed constant.

C) CMOS logic needs charge whenever a digital line rises or falls. Current through the resistance of the wire will cause a voltage drop. The closer the capacitor is to the chip, the less voltage drop there will be on the V_{dd} pin.

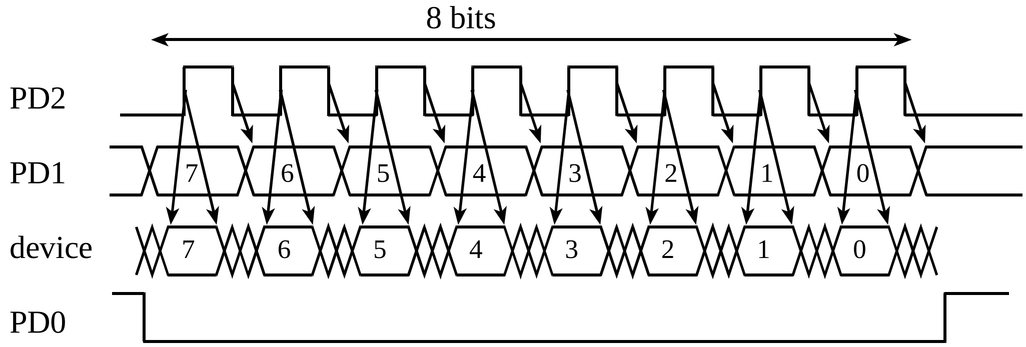
D) Dropout is a software error (loss of information) occurring on a division or right shift.

E) When transmitting data from one digital module to another, capacitance in the line connecting the two modules will limit the dV/dt. As the communication goes faster and faster there will be a point at which the signal will drop out and information is no longer being transferred.

F) When current is removed from a motor coil, the dI/dt in the coil will cause a large voltage drop across the coil.

Put your answer in the box.

(25) Question 2. The goal is to transmit synchronous serial data as fast as possible using regular output pins (not the built-in SSI module). The PD2-PD0 pins do not constitute an SSI port; you will solve this interface with three regular output ports. The 8-bit data follows this protocol. The bus frequency is 50 MHz.



You may use any of the standard definitions in the LM3S1968.h file. In addition, you may use these bit-specific definitions

```
#define PD0   (*((volatile unsigned long *)0x40007004))
#define PD1   (*((volatile unsigned long *)0x40007008))
```

```
#define PD2   (*((volatile unsigned long *)0x40007010))
```

(10) Part a) Show the initialization code that configures PD2, PD1, and PD0. Be friendly.

(15) Part c) Show the function that outputs one byte to the PD2-PD0 pins. Be friendly. The goal is to make it run as fast as possible.

```
void SS_Output(unsigned char data){
```

(10) Question 3. You are building a quantitative data acquisition system that measures voltage. The input voltage range is 0 to 10 mV, and the desired resolution is 10 μV. The frequencies of interest are 0 to 1000 Hz. The ADC sampling rate is 5000 samples/sec. An analog amplifier and an analog filter are used to convert the input to the ADC, which has 10 bits and a range of 0 to 3V.

Part a) What gain is required?

Part b) What two considerations determine the appropriate cutoff frequency for the analog low-pass filter?

Part c) What is the maximum voltage noise allowable at the input of the analog amp?

(5) Question 4. As applied to EE445L labs 5 and 9, how are resolution and accuracy related?

A) Accuracy does not depend on resolution. Accuracy only depends on calibration drift.

B) These are synonyms. They mean the same thing.

C) Resolution is important for DACs and accuracy is important for ADCs.

D) Resolution is often dominated by noise. Accuracy does not depend on noise.

E) Accuracy depends on resolution in addition to calibration drift.

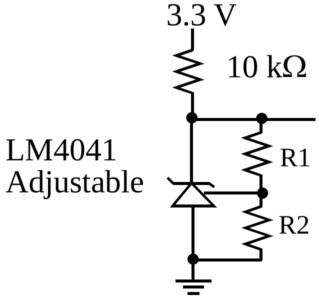
Put your answer in the box.

(10) Question 5. Illustrate the use of **binary fixed point** by defining π and using it to implement

$C = \pi D$ (circumference is π times diameter)

Assume C and D are both unsigned 32-bit integers. Write C code that calculates C given D.

(20) Question 6. Design an analog circuit with the following transfer function $V_{out} = 25*(V_{in}+0.05)$. The input is a single voltage (not differential). The input range is -0.05 to 0.05 V and the output range is 0 to 2.5V. Use an analog reference and one rail to rail op amp (not an instrumentation amp). Show your work and label all chip numbers and resistor values, including R1 and R2. You do not have to show pin numbers.



(25) Question 7. The goal is to toggle the output PD1 every time there is a rising edge of input PD0. You may use any constants from the LM3S1968.h file plus these bit-specific definitions

```
#define PD0   (*((volatile unsigned long *)0x40007004))
#define PD1   (*((volatile unsigned long *)0x40007008))
```

(10) Part a) Show the initialization code that configures PD1 and PD0. In particular fill in C code for the 9 boxes. It should arm and enable the appropriate edge-triggered interrupt. Make this ISR the highest possible interrupt priority. You may add private global variables. Be friendly. No backward jumps are allowed in the ISR.

```
void PortD_Init(void){
```

`SYSCTL_RCGC2_R`	
`GPIO_PORTD_DIR_R`	
`GPIO_PORTD_DEN_R`	
`GPIO_PORTD_IS_R`	
`GPIO_PORTD_IBE_R`	
`GPIO_PORTD_IEV_R`	
`GPIO_PORTD_IM_R`	
`NVIC_PRI0_R`	
`NVIC_EN0_R`	

```
  EnableInterrupts(); }
```

(15) Part b) Show the edge-triggered interrupt service routine. This is the highest priority ISR in the system. No backward jumps are allowed in the ISR. You do not need to show the main program.

```
void GPIOPortD_Handler(void){
```