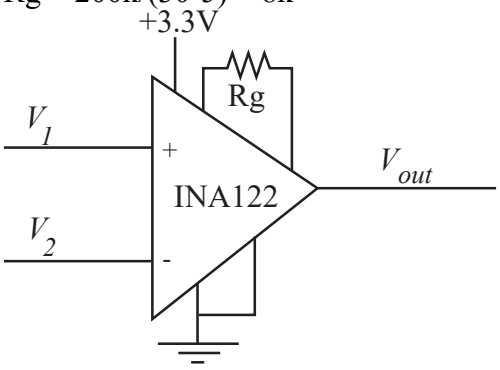
ECE445L Spring 2025 Quiz 2 Solution

April 3, 2025, 12:30 to 1:45 pm. Closed book, one page of crib notes. No electronics devices.

Question 1. Build an interface between the sensor and the ADC.
Gain = 3/0.1 = 30.
Rg = 200k/(30-5) = 8k



Question 2. See the data sheet for the MAX5353 DAC on the last page.
Data required interval = (↑SCLK-T_{DS}, ↑SCLK+T_{DH}) = (↑SCLK-40ns, ↑SCLK)

Question 3. Your microcontroller is the SPI master sending data at 25 kbits/sec.

Part a) Which action occurs once and first?

PB2=0

Part b) List the actions in proper order that transmit one bit. These actions will occur 8 times.

Out **W20** **PB0=1** W20 PB0=0	W20 PB0=0 **Out** **W20** **PB0=1**	PB0=0 **Out** **W20** **PB0=1** W20

Part c)

PB2=4	PB2=4	PB0=0 PB2=4

```
#define PB0  (*((volatile uint32_t *)0x40005004))
#define PB1  (*((volatile uint32_t *)0x40005008))
#define PB2  (*((volatile uint32_t *)0x40005010))
void BitBangOutput(uint8_t data){int i;
  PB2 = 0;             // frame select low
  for(i=0;i<8;i++){
    PB1 = data>>6;     // bit 1 is high or low depending on bit 7
    Delay(20);
    PB0 = 1;           // data valid on rising edge of clock
    Delay(20);
    PB0 = 0;           // clock low
    data = data << 1; // shift next bit into bit 7 position
  }
  PB2 = 0x04;          // frame select high
}
```

Question 4 (quiz 2). You will use **binary fixed-point**.

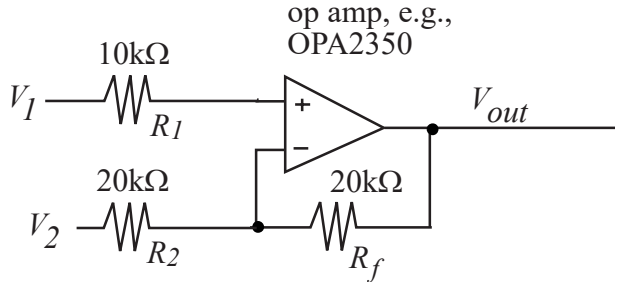
```
// area = width * length
// A/16 = (W/16) *(L/16)
  A = (W*L)>>4;
```

Question 4 (quiz 2b). You will use **binary fixed-point**.

```
// area = width * length
// A/16 = (W/8) *(L/8)
  A = (W*L)>>3;
```

Question 5. Design an analog circuit with the following transfer function:

$V_{out} = 2*V_1 - V_2$.
No reference needed
No ground needed
Rf = common multiple of 2 and 1, choose 20k
R1 = 10k
R2 = 20k
Build

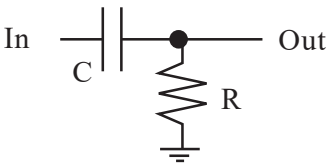


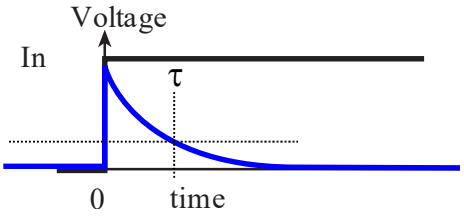
Question 6. A **successive approximation** ADC.

```
uint8_t ADC_In(void){
 uint8_t mask;
 uint8_t data=0;
 for(mask=0x80; mask; mask=mask>>1){
   data |= mask;   // try this bit
   DAC_Out(data);  // guess
   if(PB0==0){ // input is lower than guess
     data &= ~mask; // this bit should have been 0
   }
 }
 return data;
}
```

Question 7. Consider the following *RC* circuit.
Consider four scenarios

Long time before 0, C is open, Out is 0
At time=0+, C is short, Out is positive
Time>0, Out decays exponentially
Long time after 0, C is open, Out is 0

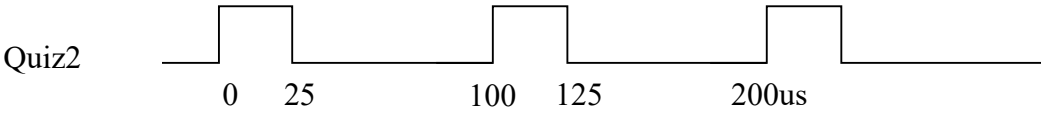




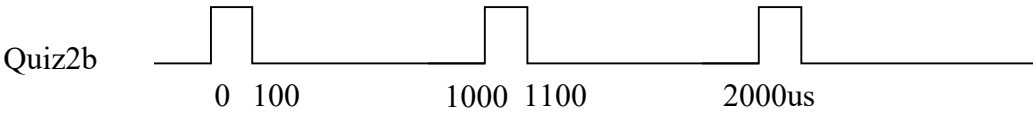
Question 8. PB7 output is connected to a logic analyzer. Quiz2b is PB5.
Part a) Simple pulse

```
#define PB7  (*((volatile uint32_t *)0x40005200))
void SysTick_Handler(void){
  PB7 = 0x80;
  Task();
  PB7 = 0x00;
}
```

Part b) Logic analyzer trace. Quiz2 is 10kHz 25%

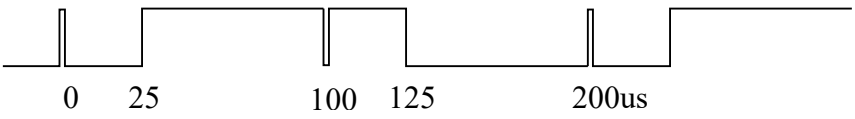


Part b) Logic analyzer trace. Quiz2b is 1 kHz 10%



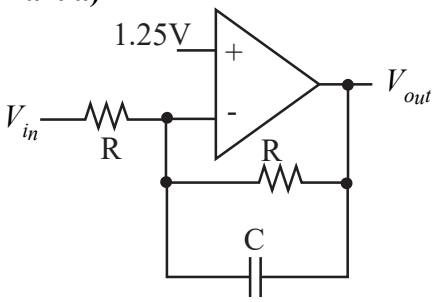
Part a) Triple toggle

```
void SysTick_Handler(void){
  PB7 ^= 0x80;
  PB7 ^= 0x80;
  Task();
  PB7 ^= 0x80;
}
```



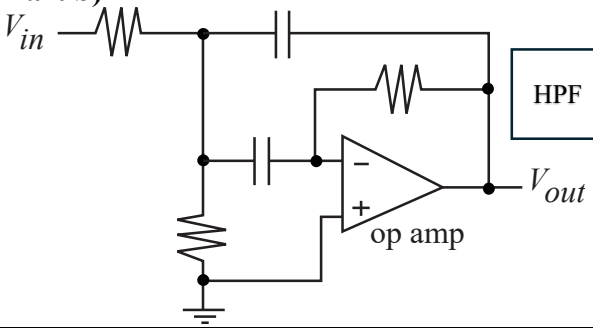
Question 9. Classify these analog circuits. Put LPF HPF or BPF into the boxes

Part a)



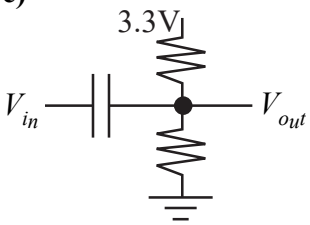
LPF

Part b)



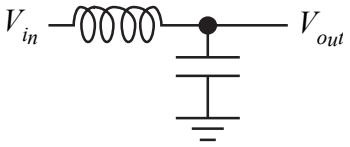
HPF

Part c)



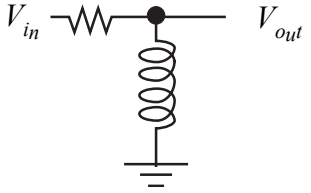
HPF

Part d)



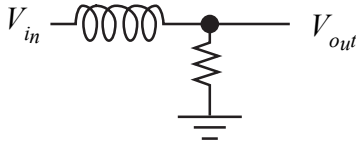
LPF

Part e)



HPF

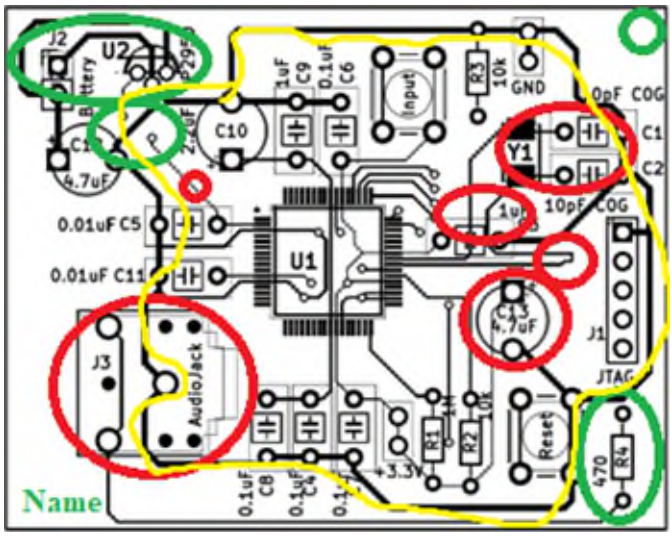
Part f)



LPF

Question 10. There are many PCB layout mistakes.

Critical:
+3.3V trace must be thicker.
Ground loop, GND trace should not form a loop.
AudioJack faces in, towards components, away from edge of board.
C13 must be placed near U2.
Y1 must be placed closer to U1.
Y1 must not have traces routed under it.
Traces from Y1 to U1 should be the same length.



Non-Critical:
No mounting/drill holes.
Rotate U2 and J2 to shorten traces.
Remove 2 vias by going from U2 to C5 on the bottom.
R4 is awkwardly placed far from AudioJack.
There is no name date or board function
90-degree trace
Add testpoiunts

ECE445L Spring 2025 Quiz 2 Solution

Extra questions

Question yy. Capacity = Lifetime*AveCurrent

Part a) Units of battery capacity is mA-Hr

Part b) Units of lifetime is Hr

Part c) Units of average current is mA

Question xx. Classify these regulator types. Put A B or C into the boxes

Part a) Linear …… C) Output current is approximately equal to input current

Part b) Buck …… A) Output power is approximately equal to input power

Part c) Boost …… A) Output power is approximately equal to input power