1. A pressure sensor outputs -2mV when the pressure is 30psi and +13mV when the pressure is 150psi. The input range for the analog-to-digital converter is 0-10V, where 0V corresponds to 30psi and 10V corresponds to 150psi.

   (a) Design the interface circuit.

   Gain = 667

   Bias = 1.33 V

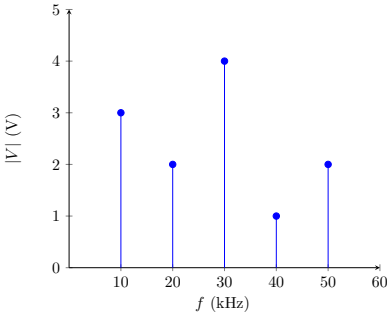
   (b) What does the interface circuit output when the sensor voltage is +6mV?

   $V_{out}$ = 5.33 V

2. An Analog-to-Digital Converter (ADC) has a sampling frequency of 30kHz, what is the maximum input frequency allowed before aliasing occurs?

   $f_{max}$ = 15 kHz

3. Given the following amplitude spectrum for an analog signal being applied to an ADC, what is the minimum sampling frequency required to avoid aliasing? What $V_{min}$ and $V_{max}$ would you recommend to avoid clipping with your ADC?




Sampling: the highest tone in the spectrum is $f_{high} = 50$ kHz, and aliasing is avoided at any rate of at least twice that.

$$f_s \geqslant 2f_{high} = 2(50 \text{ kHz}) = 100 \text{ kHz}$$

Clipping: nothing forces the five tones out of phase, so worst case they peak together and the signal reaches the sum of the amplitudes (3, 2, 4, 1 and 2 V). Nothing sits at $f = 0$, so that swing is symmetric about 0 V.

$$V_{peak} = 3 + 2 + 4 + 1 + 2 = 12 \text{ V} \quad \Rightarrow \quad V_{min} = -12 \text{ V}, \; V_{max} = +12 \text{ V}$$

| | |
|---|---|
| $f_s =$ | 100 kHz |
| $V_{min} =$ | -12 V |
| $V_{max} =$ | 12 V |

4. Perform the following number base conversions

| | |
|---|---|
| (a) $81_{10}$ $\xrightarrow{\text{8-bit binary}}$ | 0101 0001 |
| (b) $65_{10}$ $\xrightarrow{\text{8-bit binary}}$ | 0100 0001 |
| (c) $11110101_2$ $\xrightarrow{\text{Decimal}}$ | 245 |
| (d) $01101110_2$ $\xrightarrow{\text{Decimal}}$ | 110 |

5. Given a 4-bit ADC with $V_{min} = 0V$, what $V_{max}$ is required to get a voltage resolution of $\frac{1}{4}V$?

$V_{max} =$ 4 V

6. Given an ADC with $V_{max} = 10V$ and $V_{min} = 0V$, how many bits would be required to get a voltage resolution less than 2mV? Recall this needs to be an integer value.

b = 13 bits