



### Question 1 (5 points)

For each of the following statements, state "T" for true or "F" for false. No explanation necessary. Correct answers are worth +1 point, while incorrect answers yield -1 point. No points for unanswered questions. Your minimum total score on this problem is zero points.

1. The roll-off slope of two cascaded single stage active low-pass filters is -40 dB/decade.
2. For an N-bit successive approximation ADC, the worst case conversion time is 2N clock cycles.
3. In order for the digital output of an ADC to be converted again to analog later on, the minimum rate at which the original analog signal (of bandwidth B) is sampled is B/2.
4. Hall effect sensors detect the change of magnetic field.
5. The precision of a sensor is the error between the result of a measurement and the true value being measured.

### Question 2 (10 points)

1. [8 points] Design a PID controller using the minimum number of required Opamps that generates an output signal

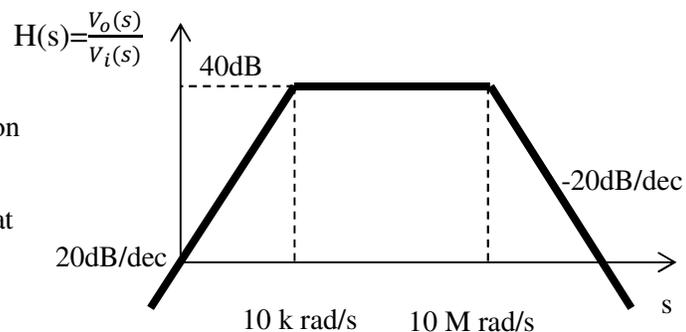
$$v_o = 30v_i + 5 \frac{dv_i}{dt} + 25 \int v_i dt$$

2. [2 points] What is the Transfer Function  $H(s) = \frac{V_o(s)}{V_i(s)}$  of the PID controller designed above?

### Question 3 (10 points)

A filter has the frequency response shown asid

1. [5 points] What is the Transfer function  $H(s) = \frac{V_o(s)}{V_i(s)}$  of the filter?
2. [5 points] Design an opamp circuit that realizes this filter.



### Question 4 (10 points)

1. [6 points] An 8 bit bipolar DAC has an output range of -2V to 2V.
  - a) Find the step size and the percent resolution of the DAC.
  - b) What is the output for an input of (10100101)
  - c) What input produces the closest output to 0V
  - d) What input produces the closest output to -1.5V
2. [2 points] An 8-bit digital ramp type ADC uses a 500 kHz clock. Find the minimum and maximum conversion times
3. [2 points] Assume you wish to design a 6-bit flash ADC. How many comparators are required?