

## Solutions to Assignment 8 A/D and D/A Converters

### Question 1

At 40C the sensor generates a voltage of  $1200 + 30 \times 40 = 2400$  mV. At -30C the voltage is  $1200 + 30 \times -30 = 300$  mV. The voltage range  $\Delta V = 2400 - 300 = 2100$  mV. The resolution,  $r$ , required is 2 degrees which corresponds to 60 mV (the sensor voltage increases by 30 mV per degree). The number of bits must be chosen so that:

$$\frac{\Delta V}{2^N - 1} < 60$$

or

$$N > \log_2 \left( \frac{2100}{60} + 1 \right)$$

The smallest number of bits that meets this condition is 6 bits.

You could also solve this problem by realizing that the A/D converter must resolve the temperature to two parts in 70. This requires a minimum of 35 steps and so a 6-bit (64 step) A/D is required.

### Question 2

The D/A output range is  $\Delta V = 10$  V. The speed increases by 1000 rpm per volt or 1 rpm per mV. Since the speed needs to be controlled to within 10 rpm, the voltage must be controlled to  $r = 10$  mV. Thus

$$\frac{\Delta V}{2^N - 1} < 0.010$$

or

$$N > \log_2 \left( \frac{10}{0.01} + 1 \right)$$

The smallest value of  $N$  that meets this condition is 10 bits ( $2^N = 1024$ ).

### Question 3

```
/*
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*/
main()
{
    int i, fact[8] ;

    /* compute n! for n=0 to 7 */

    for ( i = 0 ; i <= 7 ; i++ ) {
        if ( i == 0 ) {
            fact[i] = 1 ;
        } else {
            fact[i] = fact[i-1] * i ;
        }
    }

    /* print saved values of n! in
reverse order */

    for ( i = 7 ; i >= 0 ; i-- ) {
        printf ( "%d\n", fact[i] ) ;
    }
}
```