Module 4

Activity: Software Design using MSP432
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Question 1
Write a C function that returns true if an ASCII character is a letter, and false otherwise. The letters exist from 0x41 to 0x5A and from 0x61 to 0x7A inclusive. The prototype for this function is

```c
int bLetter(char data);
```

Question 2
Write a C function to calculate the average of three numbers. Assume the three numbers are passed by value into your function. The prototype for this function is

```c
int32_t Average(int32_t n1, int32_t n2, int32_t n3);
```

Question 3
Write a C function to find the maximum of three numbers. Assume the three numbers are passed by value into your function. The prototype for this function is

```c
int32_t Max(int32_t n1, int32_t n2, int32_t n3);
```

Question 4
Write a C function to calculate the quadratic equation

\[ y = 2x^2 - 3x + 1 \]

assuming \( x \) and \( y \) are 32-bit numbers. Some values of \( x \) will cause the calculation of \( y \) to extend beyond the values allowed by 32-bit signed numbers. Determine the largest possible value for \( x \), such that \( y < 2^{31} \). Use this threshold to return \( y = 0x7FFFFFFF \ (2^{31}-1) \) if the input value would create overflow. Determine the smallest possible value for \( x \), such that \( y > -2^{31} \). Use this threshold to return \( y = 0x80000000 \ (-2^{31}) \) if the input value would create underflow. The prototype for this function is

```c
int32_t Quadratic(int32_t x);
```

Question 5
Write a C function that calculates the square distance between two points \((x_1, y_1)\) and \((x_2, y_2)\)

\[ d = (x_1-x_2)^2 + (y_1-y_2)^2 \]

assuming \( x_1 \), \( x_2 \), \( y_1 \), and \( y_2 \) are signed 32-bit numbers. You may assume the numbers are small enough that overflow does not occur. The prototype for this function is

```c
int32_t SquareDistance(int32_t x1, int32_t y1, int32_t x2, int32_t y2);
```

Question 6
Write a C function that returns true if \( 10 \leq x < 99 \), and false otherwise. The prototype for this function is

```c
int bTwoDigit(uint32_t x);
```

Question 7
Unsigned 32-bit numbers range from 0 to \( 2^{32}-1 \) (4294967295). Write a C function that takes an unsigned 32-bit number and returns a result from 0 to 10 defining the number of decimal digits required to represent the number. For example, the input of 0 returns 0, the input of 1 – 9 returns 1, the input of 10 – 99 returns 2, etc. The prototype for this function is

```c
uint32_t NumDigits(uint32_t x);
```

Question 8
Write a C function that multiplies two unsigned 32-bit numbers. Implement overflow detection such that if the product were to exceed \( 2^{32} - 1 \), the function returns \( 0xFFFFFFFF \ (2^{32}-1) \). The prototype for this function is

```c
uint32_t Product(uint32_t n1, uint32_t n2);
```
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Q1 Conditional
Write a C function to find the minimum of three numbers. Assume the three numbers are passed by value into your function. The prototype is

```c
int16_t Min(int16_t n1, int16_t n2, int16_t n3);
```

Q2 Conditional
Write a C function to returns a true if an ASCII character is a hex digit. Hex digits are 0x30 to 0x39 and 0x41 to 0x46 inclusive. The prototype is

```c
int isHex(char data);
```

Q3 Conditional
Write a C function to returns the absolute value of a number. The input is signed, but the output will be unsigned. The prototype is

```c
uint32_t Abs(int32_t data);
```

Q4 Calculations
Write a C function to calculate the equation

\[ y = \frac{1000}{x} - \frac{3x+1}{4} \]

assuming \( x \) and \( y \) are 32-bit numbers. Return \( y = 0x7FFFFFFF \) (2\(^{31} - 1\)) if the input value is zero, otherwise you can ignore overflow. The prototype for this function is

```c
int32_t Calculate(int32_t x);
```

Q5 Calculations
Assume \( x_1, x_2, x_3, x_4 \) are four measurements collected at 1ms time intervals. Calculate the discrete derivative using this equation

\[ d = x_1 + 3x_2 - 3x_3 - x_4 \]

If the units of \( x_1 \) is mV, then the units of \( d \) will be mV/ms (or V/s). Assume the inputs are 16-bit signed numbers ranging from 0 to 3300. Solve overflow by limiting the output to -1000 to +1000 V/s. Hint, calculate the intermediate result in 32-bit math, check for overflow, and then return a 16-bit result. The prototype for this function is

```c
int16_t Derivative(int16_t x1, int16_t x2, int16_t x3, int16_t x4);
```
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