Problem #1- Design a module which contains both a BCD counter, and a pattern recognizer. Your module should be able to count the number of times the sequences 1010 and 1001 are recognized. Use a ROM as part of your counter, and for your pattern recognizer use a serial-in/parallel-out shift register and gates.

Problem #2- Design an arithmetic module which using a 3 bit 2’s complement adder can either add, subtract, multiply or divide. Show all the necessary control signal, registers, etc. Next show how to augment this module so that it also contains a programmable logic device which can compare the result of the above against a given threshold value.

Problem#3- Two digital systems use unconventional codes to represent integers between 0 and 15 as follows:

System A represents integer n as \( p = 3n \mod 16 \), and \( p \) is represented by the vector \( p \) in binary code. For example, for \( n = 3 \), \( p = 9 \mod 16 = 0 = (1001) \) and for \( n = 13 \), \( p = 39 \mod 16 = 7 = (0111) \)

System B represents integer \( m \) as \( q = 7m \mod 16 \), where the code of \( q \) is binary. For example, for \( m = 6 \), \( q = 42 \mod 16 = 10 = (1010) \).

To link systems A and B, a combinational system is needed to convert an integer between 0 and 15 in the A code to the corresponding B code. Design such a system using

a. one 8-input multiplexer and one 2-input XOR gate
b. one 4-input decoder and one 16-input encoder.

Problem #4- Briefly explained what you have learned in this course, and then show a few applications of some of the materials you have learned.