

## CMPEN 472, The Pennsylvania State University

**Homework 9: Calculator and Digital Clock Program with HCS12**

Due: Nov. 1, 2023 11:30pm

**Objective**

To learn interrupt based multi-tasking programming.

**Textbook Reading (for next homework):**

1. MC9S12C128 Family Data Sheet: Chapters 5, 9, and 13

**Instruction**

1. Combine the Homework 7 and Homework 8; that is, write Homework 9 program to make a calculator and a digital clock, running at same time. Use the display on the Terminal connected to the HCS12 board and the two 7-segment display connected to the PORTB of the HCS12 board.
2. The calculator and digital clock rules are:
  1. Calculator rules are the same as Homework 7
  2. Digital Clock rules are the same as Homework 8
  3. Show "Tcalc> " prompt for time display and calculator display
  4. Show "CMD> " prompt for clock commands and calculator input
  5. Show "Error> " prompt for error message
  6. Use only one line on the terminal for the "Tcalc", "CMD>", and "Error>" display columns
  7. Echo print user keystrokes until Enter/Return key at CMD> column
  8. Update the time on the terminal and the 7-segment LED displays every second
  9. Calculator output display: on the terminal screen, after the clock time display
  10. Use Real Time Interrupt feature to keep the time
3. The Terminal display should look something like the following (same rules as Homeworks 7 and Homework 8):

Tcalc> 12:34:58	CMD>	Error>
Tcalc> 12:34:59	CMD>	Error>
Tcalc> 12:35:00	CMD> t 11:0	Error>
Tcalc> 12:35:01	CMD> t 11:09:35	Error>
Tcalc> 11:09:35	CMD>	Error>
Tcalc> 11:09:36	CMD>	Error>
Tcalc> 11:09:37	CMD> t 76:5	Error>
Tcalc> 11:09:38	CMD> t 76:54:32	Error>
Tcalc> 11:09:39	CMD> t 76:54:32	Error> Invalid input
Tcalc> 11:09:40	CMD>	Error>
Tcalc> 11:09:41	CMD> m	Error>
Tcalc> 11:09:42	CMD>	Error>
Tcalc> 11:09:43	CMD> s	Error>

Tcalc> 11:09:44		CMD>	Error>
Tcalc> 11:09:45		CMD> a	Error>
Tcalc> 11:09:46		CMD> a	Error> Invalid input
Tcalc> 11:09:47		CMD>	Error>
Tcalc> 11:09:48		CMD> 876	Error>
Tcalc> 11:09:49		CMD> 8765+12	Error>
Tcalc> 11:09:50		CMD> 8765+1234	Error>
Tcalc> 11:09:51	8765+1234=9999	CMD>	Error>
Tcalc> 11:09:52		CMD>	Error>
Tcalc> 11:09:53		CMD> 96*	Error>
Tcalc> 11:09:54		CMD> 96*0015	Error>
Tcalc> 11:09:55	96*15=1440	CMD>	Error>
Tcalc> 11:09:56		CMD>	Error>
Tcalc> 11:09:57		CMD> 456	Error>
Tcalc> 11:09:58		CMD> 456@5	Error>
Tcalc> 11:09:59		CMD> 456@	Error> Invalid input
Tcalc> 11:10:00		CMD>	Error>
Tcalc> 11:10:01		CMD> 3*5	Error>
Tcalc> 11:10:02		CMD> 3*54312	Error>
Tcalc> 11:10:03		CMD> 3*54312	Error> Invalid input ;due to 5th digit
Tcalc> 11:10:04		CMD>	Error>
Tcalc> 11:10:05		CMD> 78*9	Error>
Tcalc> 11:10:06		CMD> 78*9999	Error>
Tcalc> 11:10:07		CMD> 78*9999	Error> Overflow
Tcalc> 11:10:08		CMD>	Error>
Tcalc> 12:34:54			
Tcalc> 12:34:55			
Tcalc> 12:34:56		CMD> t 20:0	
Tcalc> 12:34:57		CMD> t 20:09:35	
Tcalc> 20:09:35			
Tcalc> 20:09:36			
Tcalc> 20:09:37			
Tcalc> 20:09:38		CMD> t 18:0	
Tcalc> 20:09:39		CMD> t 18:094:35	
Tcalc> 20:09:40		CMD> t 18:094:35	Error> Invalid input

Tcalc> 20:09:41

Tcalc> 20:09:42

Tcalc> 12:34:55

Tcalc> 12:34:56

CMD> t 78:0

Tcalc> 12:34:57

CMD> t 78:09:35

Tcalc> 12:34:58

CMD> t 78:09:35      Error> Invalid input

Tcalc> 12:34:59

Tcalc> 12:35:00

CMD> 003

Tcalc> 12:35:01

CMD> 003-678

Tcalc> 12:35:02      3-678=-675

Tcalc> 12:35:03

Tcalc> 12:35:04

CMD> 100

Tcalc> 12:35:05

CMD> 100+99

Tcalc> 12:35:06

CMD> 100+999\*2

Tcalc> 12:35:07

CMD> 100+999\*      Error> Invalid input

Tcalc> 12:35:08

Tcalc> 12:35:09

Tcalc> 12:36:00

CMD> q

Tcalc> 12:36:01

Clock and Calculator stopped and Typewrite program started.  
You may type below.

4. Make your program user friendly by giving simple directions as to how to correctly use your program.
5. Also, make your program 'fool-proof', never crash or stop based on wrong user response.
6. You may add other features or decorations.
7. Use as many re-usable subroutines as possible, and make your overall program to be small. So you may re-visit your Homework 7 and 8, and identify the tasks in your main program that can be made to be subroutines. Once you made those subroutines, your main program becomes much more simpler and your overall program be smaller. In many cases, your program may be run faster too.
8. Design the program to start at \$3100 and data to start at \$3000.
9. Be sure to put much comments so that grader and others can clearly and quickly understand your program. Comments are very important in assembly language programs.
10. You may want to see and check the [Sample Grading Sheet](#) for this homework.
11. Copy your 'main.asm' file to 'cmpen472hw9\_YourLastName.asm'. For example, mine will be 'cmpen472hw9\_choi.asm' Do not ZIP your 'cmpen472hw9\_YourLastName.asm' file.
12. Turn-in your project source code file through [Penn State CANVAS](#). Upload your source code file into the CANVAS Assignment's Homework submission. Be sure to select CMPEN 472 class and correct Homework number, and with correct file name.

Congratulations on your ninth CMPEN 472 homework completion!

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