Homework Number: hw09

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Due Date: Thursday 4/02/2020 at 4:29PM

1. Theory Problems
   1. Show whether or not the set of remainders forms a group with either one of the modulo addition or modulo multiplication operations.
      1. forms a group with modulo addition
         1. Closure: a = x mod 12, b = y mod 12, a+b = (x mod 12) + (y mod 12) = (x+y) mod 12. x+y is an integer and any integer divided by 12 must has a remainder . is closed.
         2. Associativity:

w = 12a + , x = 12b + , y = 12c +

w+x = 12a + + 12b +

(w+x)+y = 12a + + 12b + + 12c +

x+y = 12b + + 12c +

w+(x+y) = 12a + + 12b + + 12c +

(w+x)+y = w+(x+y)

[(w+x)+y] mod 12 = [w+(x+y)] mod 12

* + - 1. existence of a unique identity element:

For each w, 0+w = w+0 = w

(0+w) mod n = (w+0) mod n = w mod n

* + - 1. existence of an inverse element for each element:

For each w, there exists a z such that (w+z)mod12 = 0. 0+0=0, [1+(12-1)] mod 12 =0, [2+(12-2)] mod 12 =0…

[5+(12-5)] mod 12 =0, [6+(12-6)] mod 12 = 0

* + 1. does not form a group with modulo multiplication

Existence of an inverse element is not for each element. Zero doesn’t have multiplicative inverse.

* 1. Compute gcd(29495, 16983) using Euclid's algorithm. Show all the steps.

gcd(29495, 16983) = gcd(16983, 29495%16983)= gcd(16983, 12512)

= gcd(12512, 16983%12512) = gcd(12512, 4471)

= gcd(4471, 12512%4471)= gcd(4471, 3570)

= gcd(3570, 4471%3570)= gcd(3570, 901)

= gcd(901,3570%901)= gcd(901,867)

= gcd(867,901%867)= gcd(867,34)

= gcd(34,867%34)= gcd(34,17)

= gcd(17,34%17)= gcd(17,0)=17

* 1. With the help of Bezout's identity, show that if c is a common divisor of two integers a, b > 0, then c | gcd(a,b) (i.e. c is a divisor of gcd(a,b)).

A>b, a=mb+r, common divisor of a and b is the common divisor of a, b, r

* 1. Use the Extended Euclid's Algorithm to compute by hand the multiplicative inverse of 25 in. List all of the steps.

gcd(28,25)= gcd(25,3) residue 3=11

= gcd(3,1) residue 1=1

=1

=9

So the multiplicative inverse of 25 in is 9.

* 1. In the following, find the smallest possible integer x. Briefly explain (i.e. you don't need to list out all of the steps) how you found the answer to each. You should solve them without using brute-force methods:

(a) 8x 11 (mod 13)

8x 11 (mod 13)

gcd(13,8) = gcd(8,5) residue 5 = 1

= gcd(5,3) residue 3 = 1

= gcd(3,2) residue 2 = 1

= gcd(2,1) residue 1 = 1

X = 11 mod 13=

(b) 5x 3 (mod 21)

21+1-5=17

X = mod 21=

(c) 8x 9 (mod 7)

Gcd(8,7) = gcd(7,1) residue 1 = 1

X = mod 7=

1. Programming Problem

