

## Assignment for Week 4 (August 26, 2019)

Total Marks: 40

Submission Deadline: 17:45

### INSTRUCTIONS

1. Submit a separate C file for each of the problems. The solution for problem  $i$  should be named **[rollno]-probi.c** where '[rollno]' is your roll number.
2. You are not allowed to use arrays for any of the problems.
3. You may consult your notes, books or manual pages.

### PROBLEMS

1. A Harshad number (or Niven number) in a given number base, is an integer that is divisible by the sum of its digits when written in that base. Harshad numbers in base  $b$  are known as  $b$ -Harshad numbers.
  - (a) Write a function `isHarshad(int n)` which returns 1 if  $x$  is a 10-Harshad number and 0 otherwise.
  - (b) Write a function `isbHarshad(int n, int b)` which returns 1 if  $n$  is a  $b$ -Harshad number and 0 otherwise.
  - (c) Print all 10-Harshad numbers between 101 and 201.
  - (d) Given a base  $b$  as input by the user, print the first 50  $b$ -Harshad numbers.

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#### Expected output

```
10-Harshad numbers between 101 and 201:
102 108 110 111 112 114 117 120 126 132 133 135 140 144 150 152 153 156 162
171 180 190 192 195 198 200 201

Enter a base: 12
First 50 12-Harshad numbers written in base 10:
1 2 3 4 5 6 7 8 9 10 11 12 22 24 33 36 44 48 55 60 66 72 77 84 88 96 99 108
110 120 121 132 144 154 156 161 165 168 170 176 180 184 187 198 204 207 209
220 230 231
```

2. (a) Write a recursive function `euclid` that takes as input two non-negative integers and returns their *greatest common divisor* (gcd). Use Euclid's theorem:  $\text{gcd}(a, b) = \text{gcd}(b, a \bmod b)$ . Maintain a global variable `count_gcd` that counts the number of calls to the function `euclid`.

- (b) The Fibonacci sequence is given by  $F_0 = 1, F_1 = 1, F_2 = 2, F_3 = 3, F_4 = 5, F_5 = 8, \dots$  and its recursive definition is  $F_n = F_{n-1} + F_{n-2}, n \geq 2$  with  $F_0 = 1, F_1 = 1$ . Write a recursive function `fibonacci` that inputs a non-negative integer  $n$  and outputs  $F_n$ .
- (c) Describe a recursive function `logbase2` that inputs an integer  $a$  and outputs  $\lfloor \log_2 a \rfloor$ , that is the greatest integer smaller than  $\log_2 a$ .
- (d) Define  $ub(i) = \lfloor \log_2 F_i \rfloor + \lfloor \log_2 F_{i-1} \rfloor$ . In the `main()` function, for integers  $i$  ranging from 10 to 24, print the following:  $F_i; F_{i-1}; \text{gcd}(F_i, F_{i-1});$  number of calls to `euclid` on input  $F_i, F_{i-1}; i - 1; ub(i)$

Make sure the functions you define are correct by calling the functions on different inputs and verifying the output. For instance, the following `main()` function using your functions

```
int main(){
    printf("%d %d %d\n", euclid(1248,318), fib(26), logbase2(4095));
}
```

when executed, must output

6 19648 11

[20]

### Expected Output

```
i=10:      89,      55,    gcd(89,55) = 1,    #calls to euclid = 9, i-1 = 9,    ub(10) = 11
i=11:     144,      89,    gcd(144,89) = 1,    #calls to euclid = 10, i-1 = 10,    ub(11) = 13
i=12:     233,     144,    gcd(233,144) = 1,    #calls to euclid = 11, i-1 = 11,    ub(12) = 14
i=13:     377,     233,    gcd(377,233) = 1,    #calls to euclid = 12, i-1 = 12,    ub(13) = 15
i=14:     610,     377,    gcd(610,377) = 1,    #calls to euclid = 13, i-1 = 13,    ub(14) = 17
i=15:     987,     610,    gcd(987,610) = 1,    #calls to euclid = 14, i-1 = 14,    ub(15) = 18
i=16:    1597,     987,    gcd(1597,987) = 1,    #calls to euclid = 15, i-1 = 15,    ub(16) = 19
i=17:    2584,    1597,    gcd(2584,1597) = 1,    #calls to euclid = 16, i-1 = 16,    ub(17) = 21
i=18:    4181,    2584,    gcd(4181,2584) = 1,    #calls to euclid = 17, i-1 = 17,    ub(18) = 23
i=19:    6765,    4181,    gcd(6765,4181) = 1,    #calls to euclid = 18, i-1 = 18,    ub(19) = 24
i=20:   10946,    6765,    gcd(10946,6765) = 1,    #calls to euclid = 19, i-1 = 19,    ub(20) = 25
i=21:   17711,   10946,    gcd(17711,10946) = 1,    #calls to euclid = 20, i-1 = 20,    ub(21) = 27
i=22:   28657,   17711,    gcd(28657,17711) = 1,    #calls to euclid = 21, i-1 = 21,    ub(22) = 28
i=23:   46368,   28657,    gcd(46368,28657) = 1,    #calls to euclid = 22, i-1 = 22,    ub(23) = 29
i=24:   75025,   46368,    gcd(75025,46368) = 1,    #calls to euclid = 23, i-1 = 23,    ub(24) = 31
```