Syllabus For Beginner Level In CCS(CUET Computer Society)

General programming issues in contests

a. Arithmetic Precision - [Beginner].

■ Suggested Reading -

1.http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=integersReals

b.Representing sets with bitmasks and manipulating bitmasks - [Beginner].

■ Suggested Reading -

1.http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=bitManipulation

Geometry

Basic Geometry/ Euclidian Geometry/ Co-ordinate Geometry [up to 12th Grade]

Data Structures

a. Arrays / Stacks / Queues :

■Problems

1.https://www.spoj.pl/problems/STPAR/

2.https://www.spoj.pl/problems/SHOP/

3.https://www.spoj.pl/problems/WATER/

■Reading:

1. Corman

2.http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=dataStructures

b. Singly/Doubly Linked List :

■ Problems

1. https://www.spoj.pl/problems/POSTERS/

■ Reading: CLRS: section 10.2, Mark Allen Weies Chapter 3

c. Circular linked list / queue

■Problems

1.https://www.spoj.pl/problems/CTRICK/

d. Binary/nary Trees

■Reading

1.CLRS: section 10.4

2.CLRS: Chapter 12

3.Mark Allen Weies Chapter 4

4.http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=binarySearchRedBlack

e. Tree

■Problems

1.https://www.spoj.pl/problems/MORSE/

2.https://www.spoj.pl/problems/EMOTICON/

f. Heaps

■Problems

1.https://www.spoj.pl/problems/PRO/

2.https://www.spoj.pl/problems/EXPEDI/

■Reading : Mark Allen Weies Chapter 6

STL

- vector
- stack
- queue
- priority queue
- String Library
- Iterator
- Pair
- list
- STL algorithms
- set
- map

Suggested reading from topcoder tutorial for STL.

String Algorithm

- Knuth Morris pratt (KMP) algorithm
  - Problems - NHAY, PERIOD on SPOJ
  - suggested reading

  1. Corman chapter on strings
  2.http://community.topcoder.com/tc?module=Static&d1=tutorials&d2=stringSearching

- Aho Corasick Algorithm
  - Problems - WPUZZLES on SPOJ

Graph

- Representation of graphs as adjacency list, adjacency matrix, incidence matrix & edge list and uses of different representations in different scenarios.
- Breadth First Search
  - Problems - PPATH, ONEQERO, WATER on SPOJ
- Depth First Search
- Strongly Connected Components
  - Problems - TOUR and BOTTOM on SPOJ
- Biconnected Components, Finding articulation points and bridges

- problems - RELINETS ,PT07A on SPOJ
- Dijkstra algorithm
  - problems - SHPATH on SPOJ
- Floyd Warshall algorithm
  - problems - COURIER on SPOJ
- Flood-fill algorithm
- Topological sort
- Bellman-Ford algorithm
- Minimum Spanning Tree (Prims, Kruskal)
  - Problems - BLINNET on SPOJ
- Graph Coloring
- Union Finding

Dynamic Programming

- Longest Common Subsequence (LCS)
- Matrix Chain Multiplication (MCM)
- Longest Increasing/Decreasing Subsequence (LIS/ LDS)
- Coin Change
- Edit Distance

DP with data structures

- http://www.spoj.pl/problems/INCSEQ/
- http://www.spoj.pl/problems/INCDSEQ/
- http://www.spoj.pl/problems/LIS2/
- http://www.topcoder.com/stat?c=problem_statement&pm=1986

Greedy:

- Task Scheduling
- Maximum Sum 1D in O(n).
- Suggested Reading –
  - Chapter on Greedy algorithms in Cormen.
  - http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=greedyAlg

problems - refer to the topcoder tutorial.

Number Theory:

a. Modulus arithmetic – (+ , - , * , /)
   - Suggested Reading –
     1. Chapter 1 from Number Theory for Computing by SY Yan [Recommended]
     2. Related Chapter from Cormen
     3. www.topcoder.com/tc?module=Static&d1=tutorials&d2=primeNumbers

- Problems
  1. http://projecteuler.net/index.php?section=problems&id=64
  2. http://projecteuler.net/index.php?section=problems&id=65
  3. http://projecteuler.net/index.php?section=problems&id=66
  4. http://www.topcoder.com/stat?c=problem_statement&pm=6408&rd=9826
  5. http://www.topcoder.com/stat?c=problem_statement&pm=2342

b. Fermat's theorem, Euler Totient theorem (totient function, order , primitive roots)
   - Suggested Reading
     1. 1.6, 2.2 from Number Theory by SY Yan
     2. From Cormen
   - Problems
     1. http://projecteuler.net/index.php?section=problems&id=70
     2. http://www.spoj.pl/problems/NDIVPHI/

c. Primality tests –
   - Deterministic O(sqrt(n)) approach
   - Probabilistic primality tests - Fermat primality test, Miller-Rabin Primality test

   1. Suggested Reading –
   a. http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=primalityTesting
   b. Cormen
   c. 2.2 from Number Theory by SY Yan

   2.Problems –
   a. PON, PRIC, SOLSTRAS on SPOJ
   b. http://www.topcoder.com/stat?c=problem_statement&pm=4515

d. Prime generation techniques - Sieve of Erastothenes
   - Suggested Problems - PRIME1 on SPOJ

e. GCD using euclidean method
   - Suggested Reading
     1. Cormen
   - Problems –
     1. GCD on SPOJ
     2. http://uva.onlinejudge.org/external/114/11424.html

f. Number of Divisor

g. Factorizing n!

Math (Probability, Counting, Generating functions, Permutation Cycles, Linear Algebra)

a. Probability:
   - Basic probability and Conditional probability

   1. Suggested problems
      a. http://www.spoj.pl/problems/CT16E/

b. http://www.spoj.pl/problems/CHICAGO/

■Random variables, probability generating functions

■Mathematical expectation + Linearity of expectation

1. Suggested problems
   a. http://www.spoj.pl/problems/FAVDICE/
   b. http://www.topcoder.com/stat?c=problem_statement&pm=10744

b. Counting

■Basic principles - Pigeon hole principle, addition, multiplication rules

1.Suggested problems
   a. http://acm.timus.ru/problem.aspx?space=1&num=1690
   b. http://www.topcoder.com/stat?c=problem_statement&pm=10805

3.Suggested readings
   a. http://en.wikipedia.org/wiki/Combinatorial_principles
   b. http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=combinatorics
   c. http://www.maa.org/editorial/knot/pigeonhole.html

■Inclusion-exclusion

1.Suggested readings
   a. http://en.wikipedia.org/wiki/Inclusion–exclusion_principle

2.Suggested problems
   a. http://www.topcoder.com/stat?c=problem_statement&pm=4463&rd=6536
   b. http://www.topcoder.com/stat?c=problem_statement&pm=10238

c. Linear Algebra

■Matrix Operations

1.Addition and subtraction of matrices
   a. Suggested Reading : Corman

2. Multiplication (Strassen's algorithm), logarithmic exponentiation
   a.Suggested reading
      i. Cormen
      ii. Linear Algebra by Kenneth Hoffman Section 1.6

   b.Problems
      i. http://uva.onlinejudge.org/external/111/11149.html

■ Polynomials

1. Roots of a polynomial [Prime factorization of a polynomial, Integer roots of a polynomial, All real roots of apolynomial]
   a. Problems
   i. http://www.topcoder.com/stat?c=problem_statement&pm=8273&rd=10798
   ii. POLYEQ , ROOTCIPH on Spoj

2. Lagrange Interpolation
    a. Problems
    i. http://www.topcoder.com/stat?c=problem_statement&pm=10239
    ii. http://www.topcoder.com/stat?c=problem_statement&pm=8725

3.Simultaneous Linear Algebraic Equation
    a. Gauss Elimination method
    b. Gauss Jordan method
    c. Gauss Seidel method

Search Techniques / Brute force writing techniques / Randomized algorithms:

a. Backtracking -
    ■problems-
        1.N queens problems
        2.Knights Tour
        3. Tower of Hanoi
b. Binary Search -
    ■ problems - AGGRCOW on SPOJ. Refer the tutorial for more problems.
    ■ finding all real roots of a polynomial using binary search. [intermediate].
    ■ Suggested Reading -
    1.http://www.topcoder.com/tc?module=Static&d1=tutorials&d2=binarySearchd.

d. Ternary Search - [Intermediate].
    ■ problems –
    1.http://www.spoj.pl/problems/KPPOLY/
    2.http://www.codechef.com/DEC09/problems/K1/
    3.http://www.topcoder.com/stat?c=problem_statement&pm=4705&rd=7993
    4.http://www.topcoder.com/stat?c=problem_statement&pm=7741&rd=10671
    5.http://www.topcoder.com/stat?c=problem_statement&pm=6464&rd=9994
    6.http://www.topcoder.com/stat?c=problem_statement&pm=3501&rd=6529
    7.http://www.topcoder.com/stat?c=problem_statement&pm=4567&rd=6539

e. Meet in the middle [Intermediate].
    ■ problems -
    1.http://www.spoj.pl/problems/MAXISET/
    2.http://acm.zju.edu.cn/onlinejudge/showProblem.do?problemCode=2868

f. Randomized Algorithms [Intermediate]-
    ■ Quick-Sort.