Introduction and Administrativa

Lecture 1

Discrete Structures (DS) - Monsoon-2025

Diptapriyo Majumdar

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Outline

General Information

- **Lectures:** Monday and Wednesday
  Time Slot: 9:30 a.m. to 11:00 a.m.
- **Tutorials:** Monday (all groups) 1:30 pm - 3 pm.
- **No Tutorial today**.

Instructors

- **Lectures:** Diptapriyo Majumdar
- **Office Hours:** To be announced. B-501 R&D Block.
- **Email:** diptapriyo@...

Instructor Team

- **PhD-TAs:** Sourav Das, Esha Jain, Mahesh Dutt.
- **Other TAs:** To be announced.
- Each of you will be assigned to one TA who will be clearing your doubts.

How to address query?

Your Friend/Senior -> Your TA -> PhD TAs -> me.

Platforms

- **Google Classroom:** *zszxlcsv* (*ZSZXLCSV* - all lower case)
- All announcements will be posted in Google Classroom (GC).
- All evaluated components will be graded in this Google Classroom.
- Do not make your solutions public.

General policies - Lectures and Tutorials (*zszxlcsv*)

- Solutions to the Tutorial problems will not be uploaded in the GC.
- Tutorial problems will only be discussed during the tutorial slots by the respective TAs. (or PhD TA)

Tut

- Instructor reserves the right to take a class fully over the board. In such a case, no lecture slides/scribbles will be uploaded.
- Even if a class is taught using projector and scribbles, then also instructor reserves the right not to upload the scribbles when the attendance falls below a certain threshold.

Evaluation (*zszxlcsv*)

- **Quiz/Class-Test:** 25%. There will be 5-6 quizzes. Best $(n-1)$-policy in Quiz.

Re-quiz requests will not be accepted.

- **Homework Assignments:** 10% → Late submission policies.
- Theory assignments only. [Only PDF submission is allowed. Latex template will be shared soon.. Submission of Multiple PDF files, submission of zip files will not be accepted and will be given 0 marks. Submission of image-files (.jpg, .png etc) will not be accepted and will be given 0 marks.]
- All homework assignments will be considered. No best (n-1) policy in homework.
- **Mid-Sem:** 30%
- **End-Sem:** 35%

11 Lectures → before mid-Sem

15 Lectures → after mid-Sem

Evaluation (*zszxlcsv*)

- **Quizzes:** Proctored offline. In-class or during Tutorials.
- Surprise Quiz will happen.
- Instructor reserves the right to take each of 5-6 quiz as surprise quiz.
- **Mid-Sem and End-Sem:**
  - Proctored Exam in offline mode.

} - institute policy.

- **Re-Quiz requests, irrespective of surprise quiz or prior announced quiz, even from medical ground will not be accepted.**
- Only make-up exam will be accepted for Mid-sem and End-Sem subject to the approval policy of IIITD.

Decorums during the class ($zszx\ell csv$)

- Your mobile phones are strictly not allowed to ring. **Keep your mobile phone in silent mode.**
- You are not allowed to talk over the phone during the class.
- Gossiping is strictly not allowed during the class.
- You are not allowed to watch any video in laptop/mobile-phone during the class.

Anti-Plagiarism Policy ($zszx\ell csv$)

- Every instance of plagiarism will be sent to DAC following the **institute plagiarism policy** and **process to handle plagiarism**.
- **Theory Homeworks:** You can discuss with your friends and/or seniors. If you do, then mention their names. If you find the solutions from the internet or any LLM model platform, please mention the link or acknowledge the specific LLM model platform where you have found it or taken help from. Finally write your own solution for Theory homework.
- **Theory Homework Policy:** It is desirable to submit through a group of 2 students.
- For every group, one of the members submitting is sufficient. If some student wants to do single, then that is also okay. But declare it from the beginning. No modification requests in homework groups will be permitted.
- Theory homework groups have to be formed in the next one week. Head-TAs will initiate a GC announcement for the same.

Late submission policy ($zszx\ell csv$)

- **Homework Assignment:** No extension of deadline will be accepted.
  - 1**-Day Late submission:** 30% deduction of the obtained in that particular assignment.
  - 2**-days late submission:** 60% deduction of obtained marks in that assignment.
  - **More than** 2**-days late submission:** 0 in that assignment.
- **General advise:** Do not try to submit at the 11th hour. You are advised to try submitting at least 3 hours before the deadline set in the Google-Classroom.

Homework submission/evaluation rules ($zszx\ell csv$)

- ONLY a single PDF file (converted from Word-doc/LATEX) will be accepted for Theory assignments.
- If you want to submit handwritten assignment, then your handwriting and its must be **readable**, then scan it. **Scanned version must be readable as well.** Submission has to be in a **single PDF**.
- Zipped files, or multiple PDF files are strictly disallowed in homework. Such submissions will result in 0 marks irrespective of the merit. Handwriting that is unreadable (not properly scanned) will result in 0 marks.
- Handwaving argumentations in homework assignment will result in 0 marks.
- Please mention your assumptions at the beginning of your homework solutions.
- Every homework will have a page-limit policy. Please strictly follow that. Write answers that are brief and to the point. Exceeding the page-limit policy will cause penalty of marks.

- Surprise quizzes will happen.
- In every class, be ready with two/three A4 papers.
- In the case of surprise quiz during the class, you will be given the question paper (either through the scribble slide or printed question paper). You will have to write your solution with name, roll number, branch and submit.

- **Policy of Copy-showing:** Slots will be decided by the instructor team to show quiz, mid-sem, end-sem copies.
- Requests for alternative slots for showing copies will not be accepted under any circumstances.

Quiz

Mobile phones not allowed during quiz.

Passing Criteria ($zszx\ell csv$)

In order to pass the course, **both the following conditions** have to be satisfied.

(i) You have to score 30% aggregate, and

(ii) You have to score at least 25% marks in mid-sem exam or at least 25% marks in end-sem exam.

- Final grading will be a mixture of absolute and relative.
- Grade-buckets will not be disclosed at this point of time.

Other decorums ($zszxlcsv$)

- Be polite in your emails and words. We are all working in stressful conditions, and we understand your concerns. Rude wordings/sentences in emails **will cause deduction of marks**, and **will be reported as misbehavior**.
- Keep checking Google-Classroom for details.
- No fooling around or spamming in online platforms.
- **Regrading requests:** If a marks increase request is found to be **frivolous**, then there will be a penalty of marks in the corresponding evaluation component.
- Think carefully before putting a request to increase marks. **Example:** Suppose you get 7/8 marks in a question and request for marks increase. If it is found that that you actually do not deserve that extra marks, then it will be considered as frivolous.
- Persistent demands for extra marks will not be entertained and will incur penalty of marks.

Other decorums ($zszx\ell csv$)

- Keep checking Google-Classroom for latest updates/announcements.
- No fooling around or spamming in online platforms.
- Grade Buckets will not be disclosed at any point of time. Emails requesting for extra marks for one grade point loss will not be responded.
- Do not overstep your boundary.
- Query regarding grade bucket will not be responded, and doing it persistently will be considered as overstepping boundary and will cause marks reduction from your overall score.

Outline

Discrete Structures (*zszxlcsv*)

Designing Computer

Solving problems.

Sequence of instructions

↓

Algorithms

↙ ↘

Correct — Efficient

↓

Needs a proof.

↓

(i) Formally prove that algorithm is correct

Input size = n

should take as few steps as possible. (time complexity)

↓

Analysis

Design

(i) Methods of proof and the logic behind this

Count the number of steps

↓

methods of counting techniques

↙

mathematical methods

(ii) Graph Theory

↓

Combinatorics.

(i) Logic and Methods of proof. → Sets, Relations, Functions,

(ii) Combinatorics (iii) Graph Theory

Problem definition:

Input: Two sets of integers A and B, each having n numbers.

Objective: Find out if $A \leq_L B$

A	12	7	14	18	10
B	6	8	24	5	16

Answer: Yes.

$A \leq_L B$ if for every $x \in A$, there exists $y \in B$ such that $x < y$.

A	12	7	14	18	10
B	6	8	4	5	16

Answer: No

Better Algorithm:

$n+1$

(i) Find $w = \max(A)$;

(ii) Find $z = \max(B)$ $n+1$

(iii) If $(w < z)$ then output Yes

Else. Output No

↓ Why correct

$2n + 4$

Naive Algorithm:

For every $x \in A$ search whether there exists some number in B that is greater than x.

For every $x \in A$, there is a search operation from B.

$|A| = n \quad |B| = n$

$\approx n^2$ steps $2n^2$

Lemma: $A \leq_L B$ if and only if $\max(A) < \max(B)$

Proof: (i) If $A \leq_L B$, then $\max(A) < \max(B)$

(ii) If $\max(A) < \max(B)$, then $A \leq_L B$.

Proof: (i) Assume $A \leq_L B$.

Then, for every $x \in A$, there exists $y \in B$ such that $x \prec y$.

Let $w = \max(A)$ ✗

Then for every $x \in A$, $x \preceq w$.

As $A \leq_L B$ (by assumption), there exists $r \in B$ such that $w \prec r$. ✗ ✓

Consider $z = \max(B)$. ✗

Then, $z \succeq r$ Hence, $z \succeq r \succ w$.

Therefore $\max(B) > \max(A)$

(ii) Assume $\max(A) < \max(B)$

$w_A = \max(A) \prec z_A = \max(B)$

Consider any arbitrary $x \in A$.

$w_A = \max(A) \succeq x$ for every $x \in A$.

Then $z_A \succ x$ for every $x \in A$.

Hence, for every $x \in A$ there is $y = z_A$ such that $x \prec y$.

Therefore, $A \leq_L B$

$A \leq_L B$ if and only if

for every $x \in A$, there exists $y \in B$ such that $x \prec y$.

↓

Logical expression

there exists $y \in B$ such that for all $x \in A$, $x \prec y$

Direct Proof

$\forall x \in A \; \exists y \in B \; (x \prec y)$

$\forall$ → for all

$\exists$ → there exists

Propositions are

Propositional and Predicate Logic

First Order Logic

Books to Follow:

- Discrete Mathematics and its Applications – Kenneth. E. Rosen. 8th Edition / 8th Edition
- Discrete and Combinatorial Mathematics – Ralph P. Grimaldi.

Text Book

- Invitation to Discrete Mathematics – Jiri Matousek, and Jeroslav Nesetril.

Reference Books