1. **Query Planning I.** *Sign up!* [Exercise]

Schema:

Student(id, name, major)
Enrol(id, course#, section, term, grade)
FK (id) refs **Student**
FK (course#, section, term) refs **Class**
Class(course#, section, term, instructor, room, time)

Statistics:

- **Student**: 100,000 records on 2,000 pages
  - major: 100 distinct values
- **Enrol**: 4,000,000 records on 40,000 pages
  - course#: 1000, ..., 4999 (so 4000 values)
- **Class**: 200,000 records on 6,000 pages
  - instructor: 8,000 distinct values

Indexes:

- **Student**:
  - hash index on id (linear hash, 200 data entries per page)
- **Enrol**:
  - clustered tree index on id, course#, section, term (50 data entries per page)
  - unclustered tree index on course#, section, term, id (50 data entries per page)
- **Class**:
  - clustered tree index on course#, section, term (60 data entries per page)
  - unclustered tree index on instructor# (200 data entries per page)

All indexes are of alternative #2. For each tree index, the index pages are 3 deep.

Query:

```
select name, instructor, C.term
    from Student S, Enrol E, Class C
    where S.id = E.id
      and E.course# = C.course# and E.section = C.section
      and E.term = C.term
      and instructor = 'Dogfurry';
```

a. How many records should the query produce?

b. Devise a good query plan for the query. Show the query tree, *fully* annotated with the chosen algorithms and access paths.

You have an allocation of 20 buffer-pool frames.

Estimate the cost of your plan. Can you find a plan that costs less than 2,000 I/O's?

2. **Query Planning II.** *Of course a course is par for the course.* [EXERCISE]

Schema:

Student(sid, sname, startdate, major, advisor)
FK (advisor) refs **Prof** (pid)
Class(cid, dept, number, section, term, year, room, time, pid, ta)
FK (pid) refs **Prof**
FK (ta) refs **Student** (sid)
Enrol(sid, cid, date, grade)
FK (sid) refs **Student**
FK (cid) refs **Class**
Prof(pid, pname, pdept, office)

Assume no attribute is nullable. The attribute pid in **Class** refers to the the professor / instructor for the class. The attribute ta in **Class** refers to the teaching assistant for the class. The attribute advisor in **Student** refers to the student's academic advisor.

Statistics:

- **Student**: 50,000 records on 1,000 pages
  - advisor: 2,500 distinct values
- **Enrol**: 2,000,000 records on 20,000 pages
  - sid: 50,000 distinct values
  - cid: 80,000 distinct values
- **Class**: 80,000 records on 1,600 pages
  - pid: 4,000 distinct values
  - ta: 5,000 distinct values
- **Prof**: 4,000 records on 40 pages

Indexes:

- **Student**:
  - clustered tree index on sid (200 data entries per page)
- **Enrol**:
  - clustered tree index on cid, sid (167 data entries per page)
  - unclustered tree index on sid, cid (167 data entries per page)
- **Class**:
  - clustered tree index on cid (200 data entries per page)
- **Prof**:
  - clustered tree index on pid (200 data entries per page)

All indexes are of alternative #2. For each tree index, the index pages are 3 deep, except for the index on **Prof**.pid which is 2 deep.

```
select sid, sname, dept, number, section, term, year, pid
    from Student S, Enrol E, Class C
    where S.sid = E.sid and E.cid = C.cid
      and S.advisor = C.pid;
```

a. Estimate the number of rows the query returns.

b. Devise the best query plan for the query. Show the query tree, *fully* annotated with the chosen algorithms and access paths.

Assume you have an allocation of 50 buffer-pool frames.

Estimate the cost of your plan.

c. Name an additional index that would allow a less expensive query plan than in 2b, and sketch briefly that query plan using the index.