1. **ER-to-Relational Mapping (50 pts):** Apply ER-to-relational mapping to the ER diagram to the below ER-diagram. Show application of each step of the mapping algorithm and the final database schema.

![Figure 1: ER Diagram](image)

**Solution:** The relations are given Figure 2.

2. **SQL Queries: (50 pts)** Consider the following database schema that keeps track of Sailors, Boats and the boats reserved by sailors.

   - `Sailors(*sid, sname, rating, age)`
   - `Boats(*bid, bname, color)`
   - `Reserves(*sid, *bid, *date)`

Sample tuple for each relation is given below

   - `Sailors(22, Dustin, 7, 45)`
   - `Boats(101, Interlake, blue)`
   - `Reserves(22, 101, 1998-10-10)`
Keys are denoted by *. Specify the following queries in SQL using above database schema.

(a) find sailors who have reserved at least one boat

```
select s.sid
from sailors s, reserves r
where s.sid = r.rid;
```

(b) find sid’s of sailors who have reserved a red and a green boat

```
select s.sid
from sailors s, boats b, reserves r
where r.sid = s.sid and r.bid = b.bid and b.color = 'red';
intersect
select s.sid
from sailors s, boats b, reserves r
where r.sid = s.sid and r.bid = b.bid and b.color = 'green';
```

(c) find names of sailors who have reserved boat #103

```
select s.sname
from sailors s
where s.sid in (select r.sid
from reserves r
where r.bid = 103);
```

(d) find sid’s of sailors who have not reserved boats
select s.sname
from sailors s
where not exists (select r.bid
                   from reserves r
                   where r.sid = s.sid);

(c) find names of sailors who made at least 3 reservations

select s.sname
from sailors s
where 3 <= (select count(*)
            from reserves r
            where s.sid = r.sid);

(f) find the name of sailors with the highest rating

select s.sname
from sailors s
where s.rating = (select max(s2.rating)
                   from sailors s2);

(g) find the name and age of oldest sailors

select s.sname, s.age
from sailors s
where s.age = (select max(s2.age)
               from sailors s2);

(h) find the age of youngest sailor for each rating level

select rating, min(age)
from sailors
group by rating;

(i) find the names of sailors who reserved more red boats than green

select s.sname
from sailors s
where (select count(*)
       from reserves r, boats b
       where s.sid = r.sid and r.bid = b.bid and b.color = 'red') >
     (select count(*)
      from reserves r, boats b
      where s.sid = r.sid and r.bid = b.bid and b.color = 'green');

(j) find sailors who have reserved all the boats

select s.sname
from sailors s
where not exists (select b.bid
    from boats b
    where not exists (select r.bid
        from reserves r
        where r.bid = b.bid and r.sid = s.sid));