Exercise 1: Assume the following relations:

Books(Bid, Title, Publisher, Year)
Students(Sid, Sname, Major, Age)
Authors(AName, Address)
Borrows(Bid, Sid, Date)
Has-written(Bid, Aname)
Describes(Bid, Keyword)

Books

Bid	Title	Publisher	Year
101	Algorithms	Pearson	1990
102	Database Management Systems	McGraw Hill	2003
103	Programming	McGraw Hill	1985

Students

Sid	Sname	Major	Age
1	Dustin	CS	28
2	Andy	ECE	26
3	Brutus	CS	31
4	Zorba	ME	30

Authors

AName	Address
Silberschatz	Palm Springs
Horatio	Davis
Lubber	San Diego

Q. List all books published by McGraw Hill before 1990.

$\sigma_{\text{Publisher = 'McGraw-Hill'} \wedge \text{Year<1990}}(\text{Books})$

Q. List the name of authors who are living in Davis.
$\pi_{AName}(\sigma_{Address\ like\ '\%Davis\%'}(Authors))$

Q. List the name of students who are older than 30 and studying CS.
$\pi_{SName}(\sigma_{Age>30\wedge Major='CS'}(Students))$

Q. List the name of students who are older than 30 and who are not studying CS.
$\pi_{SName}(\sigma_{Age>30}(Students)) - \pi_{SName}(\sigma_{Major='CS'}(Students))$

Q. List all the students with the books they can borrow.
Students x Books

Q. List the names of all the students who have borrowed a book and who are CS majors.
$\pi_{SName}(\sigma_{Students.Sid=Borrows.Sid}(\sigma_{Major='CS'}(Students) \times Borrows))$

Q. Rename ANAME in the relation Authors to Name.
$\rho_{Authors(Name,\ Address)}(Authors)$

Q. Retrieve the name of the students who have borrowed a book written by author "Silberschatz".
$\pi_{Students.Sname}(\sigma_{Students.sid=Borrows.\mathbf{Sid}}(\ Students\ X\ \pi_{Borrows.Sid}(\sigma_{Borrows.Bid=Has\text{-}Written.Bid}(\pi_{Bid,sid}(Borrows)\ X\ \pi_{Bid}(\sigma_{Aname='silberschatz'}(Has\text{-}Written))))))$

Exercise 2: Consider the following relation schema; the schema describes a database containing information about movies. The movie relation includes information about the id, title and year in which it was released. The actor relation includes id, name and gender of the actor. The casting relation provides information about which actor was casted for which movie. The underlined attributes denote the primary keys of the relations. Domain of each field is listed after the field name.

movie(movieid:integer, title:string, year:integer)
actor(actorid:integer, name:string, gender: string)
casting(movieid:integer, actorid:integer)

Express the following queries in relational algebra expression:

a) Find the names of all actors who have been casted for the movie ‘Iron Man’.

$$\pi_{name}(\sigma_{title = 'Iron\ Man'}(movie) \bowtie (actor) \bowtie (casting))$$

b) Find the name of all actors who don’t work in any movie.

$$\pi_{name}(actor) - \pi_{name}(actor \bowtie casting)$$

c) List the titles of movies for which Marilyn Monroe worked.

$$\pi_{title}(\sigma_{name = 'Marilyn\ Monroe'}(actor) \bowtie (movie) \bowtie (casting))$$

d) List the id of the movies done by some female actors.

$$\pi_{movieid}(\sigma_{gender = 'Female'}(actor) \bowtie (casting))$$

e) List the id of the movies done by only male actors.

$$\pi_{movieid}(casting) - \pi_{movieid}(\sigma_{gender = 'Female'}(actor) \bowtie (casting))$$

f) Find the ids of the actors who worked for at least two movies.

$$\pi_{actorid}(\sigma_{movieid \neq m \cap actorid = a}(casting \times \rho_{m,a}(casting)))$$

OR

$\rho(T1, casting)$

$\rho(T2, casting)$

$$\pi_{T1.actorid}(\sigma_{T1.actorid = T2.actorid \cap T1.movieid \neq T2.movieid}(T1 \times T2))$$

g) Find the ids of the actors who worked for only two movies.

$$\rho(T1, casting)$$
$$\rho(T2, casting)$$
$$\rho(T3, casting)$$
$$\pi_{T1.actorid}(\sigma_{T1.actorid = T2.actorid \cap T1.movieid \neq T2.movieid}(T1 \times T2)) -$$
$$\pi_{T1.actorid}(\sigma_{(T1.actorid = T2.actorid \cap T1.movieid \neq T2.movieid) \cap (T2.actorid = T3.actorid \cap T2.movieid \neq T3.movieid) \cap (T1.movieid \neq T3.movieid)}(T1 \times T2 \times T3))$$

h) Find the ids of the actors who worked for at most two movies.

$$\rho(T1, casting)$$
$$\rho(T2, casting)$$
$$\rho(T3, casting)$$

$$\pi_{actorid}(actor) - \pi_{T1.actorid}(\sigma_{(T1.actorid = T2.actorid \cap T1.movieid \neq T2.movieid) \cap (T2.actorid = T3.actorid \cap T2.movieid \neq T3.movieid) \cap (T1.movieid \neq T3.movieid)}(T1 \times T2 \times T3))$$

i) List the titles of the movies that was released after 1990 and casted ‘Bruce Wayne’ for the lead role.

$$\pi_{title}(\sigma_{year >= 1990}(movie) \bowtie \sigma_{name = 'Bruce\ Wayne'}(actor) \bowtie (casting))$$

j) Find the pairs of the actors who were casted in the same movie. [Bonus: If you are returning a, b then it should not return b,a]

$$\rho(T1, casting)$$
$$\rho(T2, casting)$$
$$\pi_{T1.actorid,T2.actorid}(\sigma_{T1.actorid \neq T2.actorid \cap T1.movieid = T2.movieid}(T1 \times T2))$$

For bonus, answer should be:

$\rho(T1, casting)$

$\rho(T2, casting)$

$\pi_{T1.actorid,T2.actorid}(\sigma_{T1.actorid \neq T2.actorid \cap T1.movieid = T2.movieid \cap T1.actorid < T2.actorid}(T1 \times T2))$