

Name: _____

1. (1 pt.)

- **Read all material carefully.**
- *If in doubt whether something is allowed, ask, don't assume.*
- You may refer to your books, papers, and notes during this test.
- E-books may be used *subject to the restrictions* noted in class.
- Computers are not permitted, except when used strictly as ebooks.
- Network access of any kind (cell, voice, text, data, ...) is not permitted.
- Write, and draw, carefully. Ambiguous or cryptic answers receive zero credit.
- Use class and textbook conventions for notation, algorithmic options, etc.
- There is an question marked with \star . It is much harder than the rest. It is required for COS 580 but optional (extra credit) for COS 480.

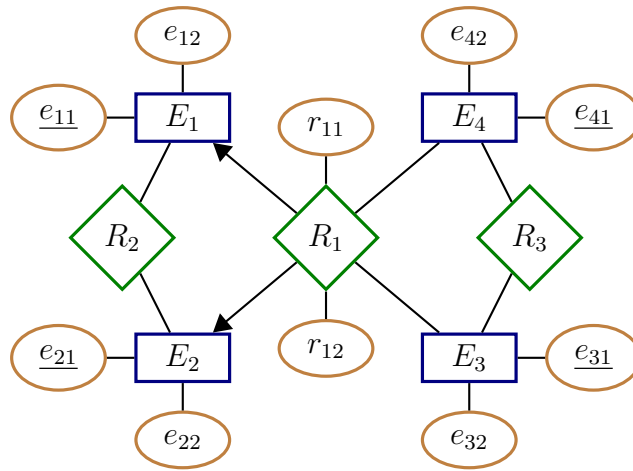
Write your name in the space provided above.

WAIT UNTIL INSTRUCTED TO CONTINUE TO REMAINING QUESTIONS.

Do not write in the following table.

Q	Full Score
1	1
2	10
3	14
4	5
5	5
6	5
total	40

2. (10 pts.) Convert the following ER diagram into an equivalent one that contains neither multiway relationships nor relationships with attributes. *Explain your answer briefly.*



3. (15 pts.) Map both (1) the original and (2) the transformed ER diagram of Question 2 to relational schemas. *Explain your answer briefly.*

4. (5 pts.) Indicate the result of evaluating the following expression in the *extended bag algebra* as discussed in class on the database instance depicted below. *Explain your answer briefly.*

$$\pi_K \sigma_{H > 0.5} P$$

PTides

location varchar(20)	ptime timestamp	kind char(1)	height float
Blue Hill	2022-10-13 01:27	L	0.29
Blue Hill	2022-10-13 07:42	H	9.80
Blue Hill	2022-10-13 13:47	L	1.00
Blue Hill	2022-10-13 19:59	H	10.98
Eastport	2022-10-13 01:25	L	0.77
Eastport	2022-10-13 07:31	H	17.60

DockSched

harbor varchar(20)	boat varchar(20)	pilot varchar(20)	dtime timestamp	blength integer
Blue Hill	Why Knot	Knotting	2022-10-13 08:00	14
Blue Hill	Why Knot	Knotting	2022-10-14 08:00	14
Blue Hill	Phair Game	Phair	2022-10-13 08:10	10
Castine	Phair Game	Phair	2022-10-13 08:30	10

For notational convenience in algebraic queries, we use the following abbreviations

$$\begin{aligned} \text{PTides}(\text{location}, \text{ptime}, \text{kind}, \text{height}) & \quad P(L, P, K, H) \\ \text{DockSched}(\text{harbor}, \text{boat}, \text{pilot}, \text{dtime}, \text{blength}) & \quad D(H, B, P, D, L) \end{aligned}$$

5. (5 pts.) Repeat Question 4, where we use (henceforth) the notation X' to denote descending order of X .

$$\mathcal{T}_{LK'} \gamma_{LK} P$$

6. (5 pts.) Repeat Question 4 for the expression:

$$\mathcal{T}_B \gamma_{B, \text{sum}(L') \rightarrow X} (\pi_B D \times \rho_{D'(B'L')} \pi_{BL} D)$$

[additional space for answering the earlier question]