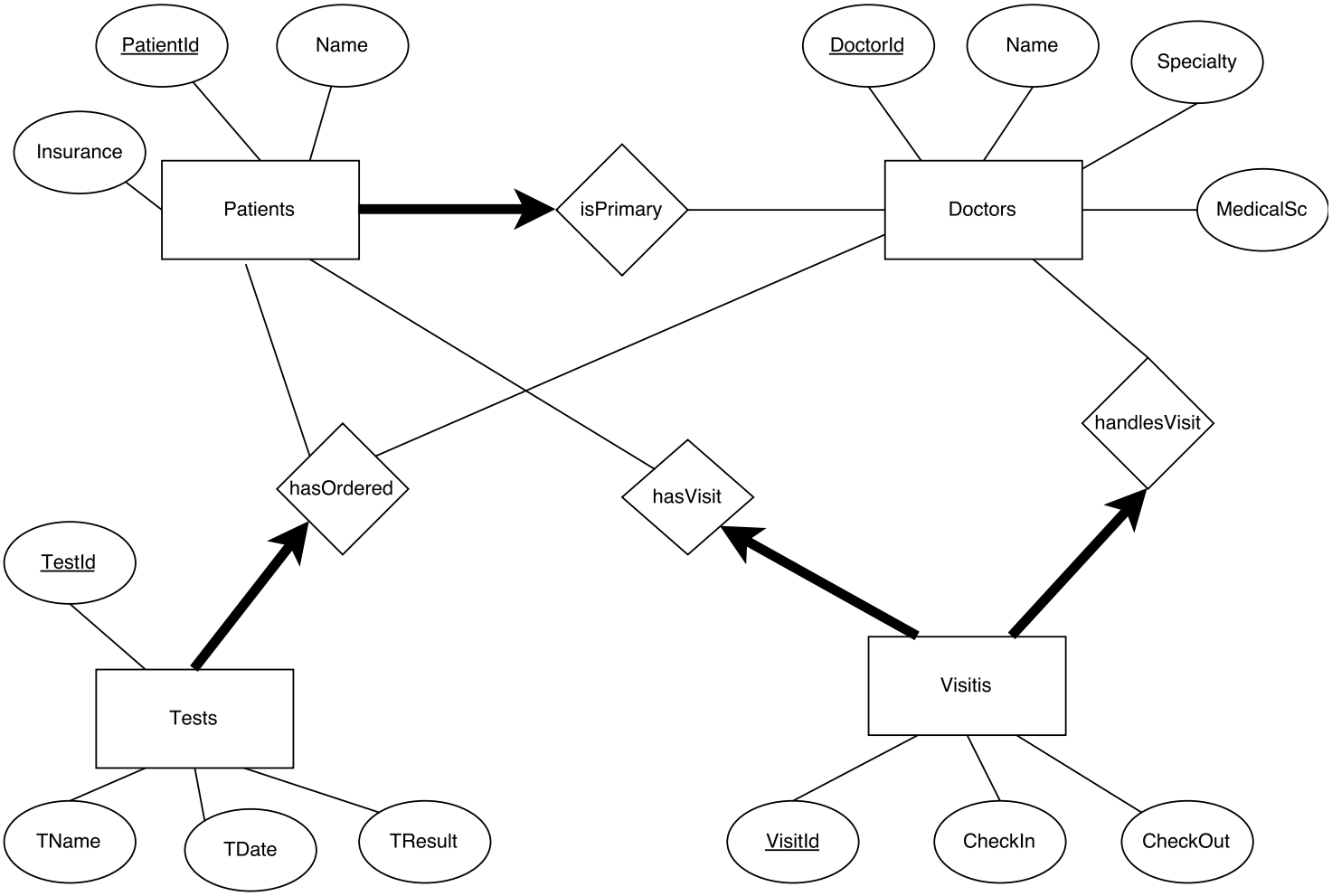
Written Assignment #1
CS 460
Fall 2019
Example Solutions

Problem 1

1) E-R diagram



This is an example of an ER diagram. There are other possible options like having binary relationships between Tests with Patients and Doctors instead than ternary. Another approach is to create a relationship between Visits and Tests and not hasOrdered.

2) Primary keys: PatientId, TestId, VisitId, and DoctorId
Weak Entity: none
Cardinalities:

- Tests to hasOrdered: one-to-many with the Patients and Doctors. We assume that a Test is uniquely associated with a single Patient and single Doctor each time.
- Visits to hasVisit and handlesVisit: one-to-many with Patients and Doctors respectively. We assume that a Visit is associated with a single Patient and Doctor.
- Patients to isPrimary: one-to-many with Doctors. We assume that a Patient has a single primary physician.

Total participation:

- Tests to hasOrdered
- Visits to hasVisit and handlesVisit
- Patients to isPrimary

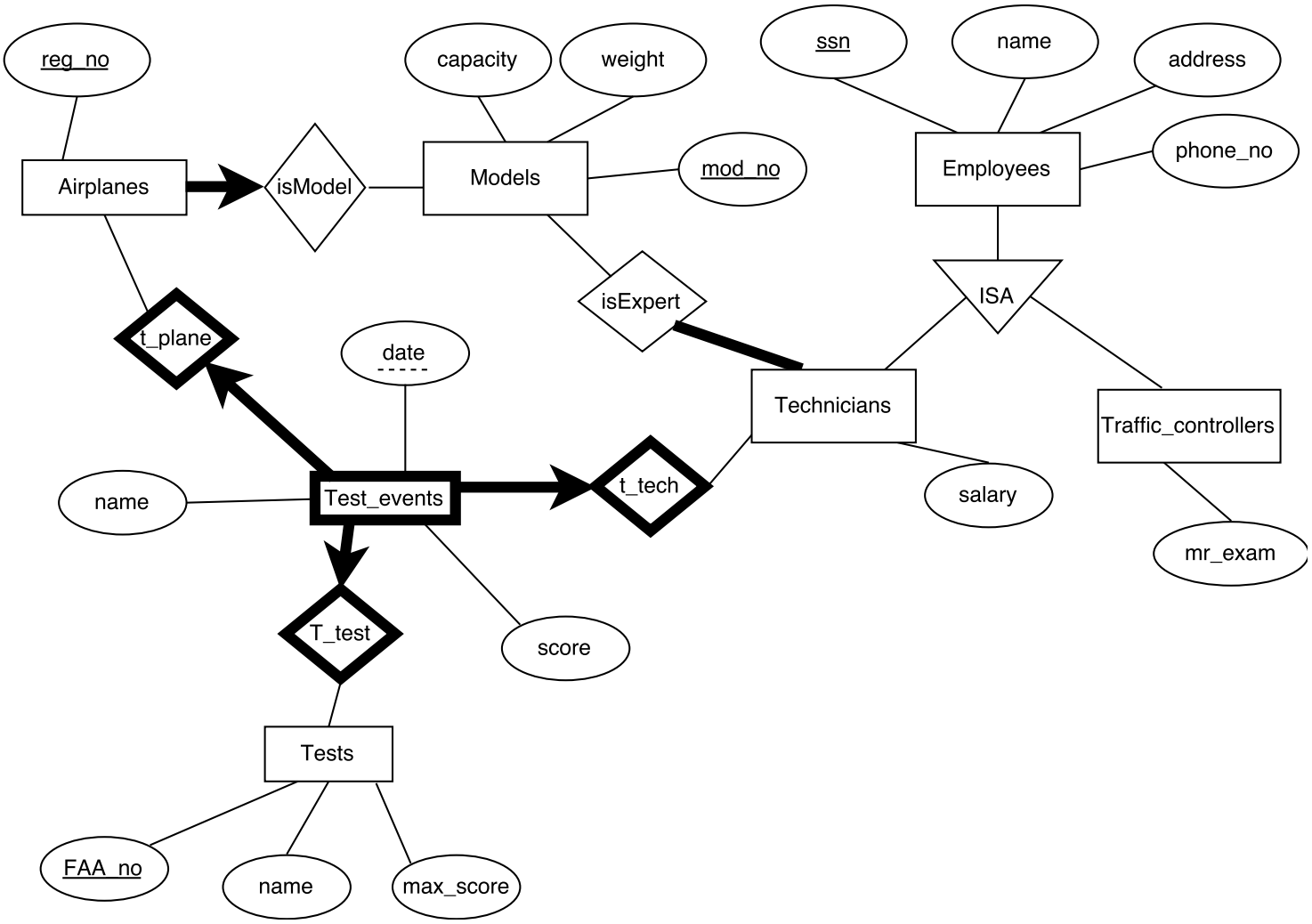
3) Relational Model:

```
CREATE TABLE Doctors( DoctorId  INT, Name VARCHAR(100), Specialty
VARCHAR(60), MedicalSc VARCHAR(100), PRIMARY KEY (DoctorId));

CREATE TABLE Patients( PatientId  INT, Name VARCHAR(100), Insurance
VARCHAR(100), DoctorId  INT, PRIMARY KEY (PatientId),
FOREIGN KEY (DoctorId) REFERENCES Doctors(DoctorId));

CREATE TABLE Tests( TestId  INT, TName VARCHAR(100), TDate DATE, TResult
VARCHAR(60), PatientId  INT, DoctorId  INT, PRIMARY KEY(TestId),
FOREIGN KEY (PatientId) REFERENCES Patients(PatientId),
FOREIGN KEY (DoctorId) REFERENCES Doctors(DoctorId));

CREATE TABLE Visits( VisitId INT, CheckIN DATE, CheckOut DATE, PatientId  INT,
DoctorId  INT, PRIMARY KEY(VisitId),
FOREIGN KEY (PatientId) REFERENCES Patients(PatientId),
FOREIGN KEY (DoctorId) REFERENCES Doctors(DoctorId));
```

We created one table for Patients and isPrimary. We created one table for Tests and hasOrdered. We created one table for Visits, hasVisit, and handlesVisit. For all of them we used the fact we have one-to-many and total participation constraints to create single tables.

Problem 2

1) E-R diagram



This is also one possible ER diagram. We created Test_events as weak entity with date as the partial key and owner entities to be Airplanes, Tests, and Technicians. Another approach is to create a relationship instead of the weak entity. This is also correct.

2) Relational Model:

CREATE TABLE Models(mod_no INT, capacity INT, weight INT,
PRIMARY KEY(mod_no));

CREATE TABLE Airplanes(reg_no INT, mod_no INT, PRIMARY KEY (reg_no),
FOREIGN KEY (mod_no) REFERENCES Models(mod_no));

CREATE TABLE Tests(FAA_no INT, name VARCHR(100), max_score INT,
PRIMARY KEY(FAA_no));

```
CREATE TABLE Employees( SSN CHAR(9), name VARCHR(100), address
VARCHAR(150), phone_no CHAR(12), PRIMARY KEY(SSN));

CREATE TABLE Traffic_controllers( SSN CHAR(9), mr_exam DATE, PRIMARY
KEY(SSN), FOREIGN KEY (SSN) REFERENCES Employees(SSN));

CREATE TABLE Technicians( SSN CHAR(9), salary INT, PRIMARY KEY(SSN),
FOREIGN KEY (SSN) REFERENCES Employees(SSN));

CREATE TABLE isExpert( SSN CHAR(9), mod_no  INT,
PRIMARY KEY(SSN, mod_no),
FOREIGN KEY (mod_no) REFERENCES Models(mod_no),
FOREIGN KEY (SSN) REFERENCES Technicians(SSN));

CREATE TABLE Test_events( SSN CHAR(9), reg_no  INT, FAA_no INT, date DATE,
name VARCHR(100), score INT, PRIMARY KEY( SSN, reg_no, FAA_no, date),
FOREIGN KEY (SSN) REFERENCES Technicians(SSN),
FOREIGN KEY (reg_no) REFERENCES Airplanes(reg_no),
FOREIGN KEY (FAA_no) REFERENCES Tests(FAA_no));
```

Problem 3.

1. $\pi_{model}(\sigma_{speed > 3}(PC))$

2. $\pi_{maker}(\sigma_{hd> 100}(Laptop) \bowtie Product))$

3. $\pi_{maker}(Laptop \bowtie Product) - \pi_{maker}(PC \bowtie Product)$

4. $\rho(T(1\text{->}model2, 2\text{->}speed2, 3\text{->}ram2, 4\text{->}hd2, 5\text{->}price2), PC)$
   $\pi_{hd}(\sigma_{hd=hd2 \text{ AND } model<> model2}(PC \times T)$

5. $\rho(T, \pi_{model, speed}(PC))$
   $\rho(Y(1\text{->}model1, 2\text{->}speed1), T \times T)$

$\pi_{maker}(\pi_{model}(PC) - \pi_{model}(\sigma_{speed1> speed}(Y))) \bowtie Product)$

Problem 4.

Empl is short for Employees

1. $\pi_{SSN,name}((\sigma_{Location='Boston'}\ Project) \bowtie (\sigma_{hours>100}\ HourLog) \bowtie Empl))$

2. $\pi_{SSN,name}((\sigma_{PNo = 2}\ HourLog) \bowtie (\sigma_{DNo=1}\ Empl))$

3. $\rho(T(1\text{->}\ SSN1,\ 2\text{->}PNo1),\ HourLog\ X\ HourLog))$
   $\pi_{SSN,name}(Empl \bowtie (\sigma_{SSN1 = SSN\ AND\ PNo1 <> PNo}(T))$

4. $\pi_{SSN,name}((\pi_{SSN,PNo}(HourLog) / \pi_{PNo}(Project)) \bowtie Empl)$