Railway System Database

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Section I: Project Description

This project is a database system for a railway system. A company shall be able to hire employees and sell tickets. Where these employees are conductors, station managers, and railway police. Conductors will be able to drive trains which contain passengers. Customers are able to create accounts and book tickets for themselves. Once they have a ticket they will become a passenger. Once tickets are booked they are sent to the customer's email or EasyTrips account. Where they can access their tickets on their smartphones instead of having to print paper copies. If the customer wishes to, they may also purchase tickets at kiosks that are within the train stations. Once the passengers have their tickets, they are able to board their respective trains.

Section II: Use Cases

1. Sam is a customer who decides one day that he wants to go on a trip with his family. He decides to order his tickets online through the company's website. Through the website he books 4 coach class seats for his family. The tickets are then sent to his email, where he can choose to print them out.
2. Bobby wanted to go visit his friend who is far away and the only way to travel there is with the railway. He goes online to book a ticket for himself but runs into a problem. The site asks him to enter his birth date and after entering he is alerted with an issue. It turns out that Bobby is under the age of 16 which makes him a minor. This requires him to be accompanied with an adult if he wants to travel using this railway.
3. After Bobby sees the issue that popped up, he still decides that he really wants to visit his friend. So he puts a fake birth date in and is able to purchase the ticket. He gets to the station and boards the train. The conductor goes through the train checking everyone’s tickets. By chance the conductor noticed that Bobby looked young and asked him to show his I.D. to prove his age. Bobby refused and was then asked by the conductor to get off the train. He also refused to do this, which then led to the railway police to get involved and escort him off the train.
4. John wants to go on a trip on his own and he has a bit of extra money to spend. He decides to book a first class train ticket. While booking the ticket he notices that the route he wanted to take had the first class seats filled already. There was still room for coach class seats but he instead chose to book a first class seat with a train that departs later.
5. 10 minutes before the train departs the conductor goes through the train. The conductor checks the tickets of each individual. If someone is caught without a ticket they would be asked to leave. If the individual refuses to leave then the railway police will be called to escort the individual off the train.
6. One day an accident occurs on the railway tracks. This causes a huge delay in departure and arrival times for all trains. The station manager has to alert other station managers of the delay so they can update the arrival and departure times to make up for the delay.

Section III: Business Rules

1. Company
    1.1. A company shall own at least one train.
    1.2. A company hires at least one employee.
    1.3. A company sells at most one ticket.
2. Employee
    2.1. An employee shall work for only one company.
3. Station Manager
    3.1. A station manager shall have one unique employee id.
    3.2. A station manager shall manage at least one station.
4. Conductor
    4.1. A conductor shall drive one train.
5. Railway Police
    5.1. Railway police shall work at, at least one station.
6. Train
    6.1. A train shall have many seats.
    6.2. A train shall have at least one route.
    6.3. A train shall arrive at, at least one station.
    6.4. A train shall depart at, at least one station.
7. Coach Class Seat
    7.1. A coach class seat shall only be seated by a coach class passenger.
8. First Class Seat
    8.1. A first class seat shall only be seated by a first class passenger.
9. Station
    9.1. A station shall hold at least one train.
    9.2. A station will have only one inbound.
    9.3. A station will have only one outbound.
10. Kiosk
    10.1. A kiosk shall belong to only one station.
    10.2. A kiosk shall print only one purchased ticket.
11. Route
    11.1. A route shall have one departure station.
    11.2. A route shall have one arrival station.
    11.3. A route shall have one departure time.
    11.4. A route shall have one arrival time.
    11.5. A route shall have one departure date.
    11.6. A route shall have one arrival date.
    11.7. A route shall be updated by at least one station manager.
12. Customer

12.1. A customer can create only one EasyTrips account.
12.2. A customer shall book at least one ticket.
12.3. A customer shall be able to cancel at least one ticket.
12.4. A customer can purchase one ticket from a kiosk.
12.5. A customer shall create only one EasyTrips account using a unique email.
12.6. A passenger shall have at least one ticket.
12.7. A passenger shall board only one train.
12.8. A passenger with a coach class ticket shall be seated only in the coach class area.
12.9. A passenger with a first class ticket shall be seated only in the first class area.
12.10. A passenger shall be able to upgrade to a first class ticket.
12.11. A passenger shall be able to downgrade to a coach class ticket.

13. Ticket
    13.1. Tickets shall be sent to the customer's unique email.
    13.2. Tickets shall be sent to the customer's EasyTrips account.
    13.3. A ticket shall have only one route.
14. Payment Type
    14.1. A payment type can be Credit Card or Debit Card.
    14.2. A payment type shall have one billing address.
    14.3. A payment type shall have one city.
    14.4. A payment type shall have one state.
    14.5. A payment type shall have one zip code.
    14.6. A payment type shall have one country.
15. EasyTrips Account
    15.1. An EasyTrips Account can only be created by one Customer.
    15.2. An EasyTrips Account shall have only one user logged in.
16. Phone App
    16.1. A phone app shall have zero or more tickets.

Section IV: Detailed List of Main Entities, Attributes, Keys

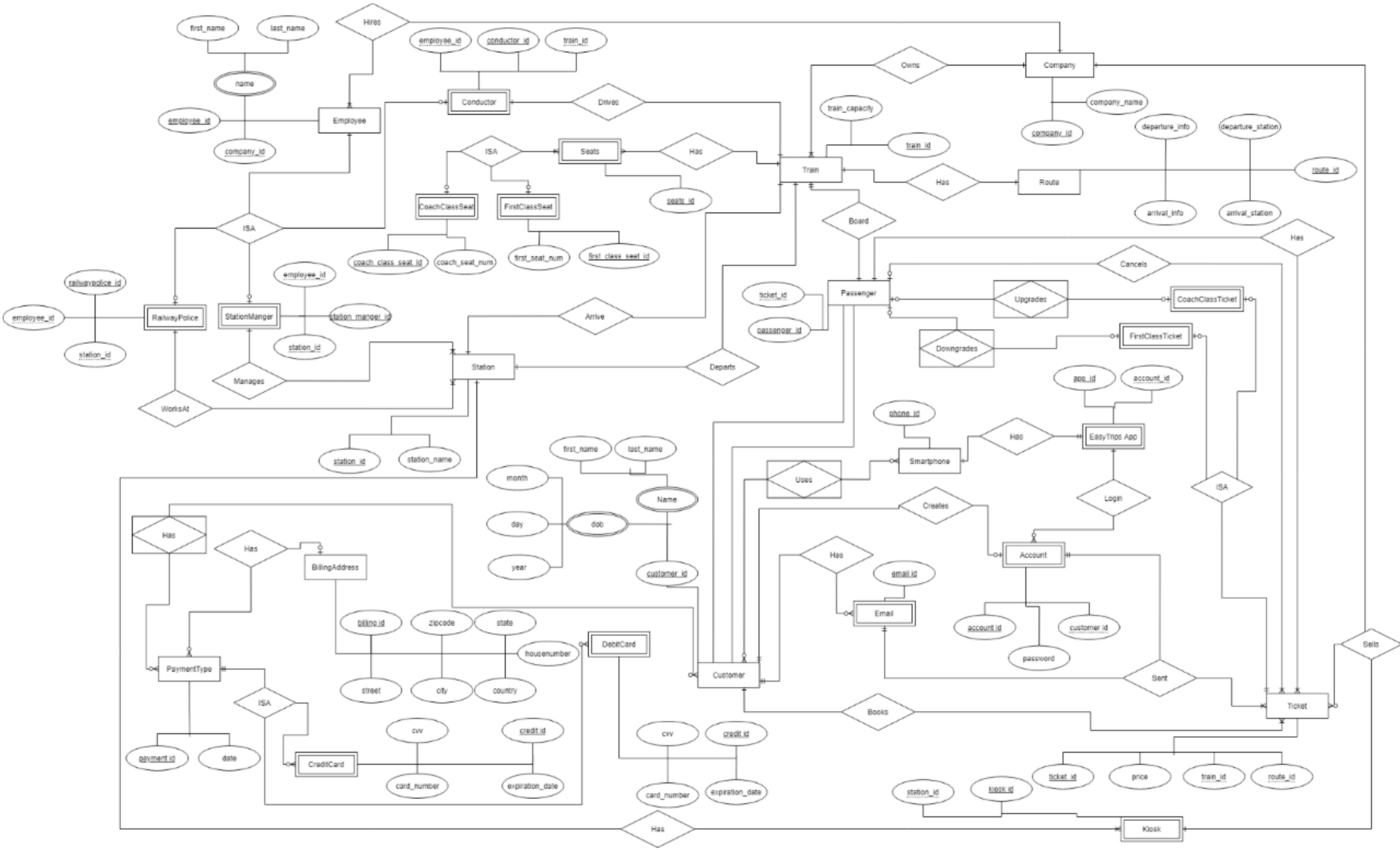
1. Company (Strong)
    * company_id: key, numeric
    * company_name: alphanumeric
2. Employee (Strong)
    * employee_id: key, numeric
    * name: composite
        i. first_name: alphanumeric
        ii. last_name: alphanumeric
    * company_id: weak key, numeric
3. Station Manager (Weak)
    * station_manger_id: key, numeric
    * employee_id: weak key, numeric
    * station_id: weak key, numeric
4. Conductor(Weak)
    * conductor_id: key, numeric
    * employee_id: weak key, numeric
    * train_id: weak keym numeric
5. Railway Police(Weak)
    * railwaypolice_id: key, numeric
    * employee_id: weak key, numeric
    * station_id: weak key, numeric
6. Train(Strong)
    * train_id: key, numeric
    * train_capacity: numeric
7. Seats(Weak)
    * seats_id: key, numeric
8. First Class Seat(Weak)
    * first_class_seat_id: key, numeric
    * first_seat_num: numeric
9. Coach Class Seat(Weak)
    * coach_class_seat_id: key, numeric
    * coach_seat_num: numeric
10. Station(Strong)
    * station_id: key, numeric
    * station_name: multivalue alphanumeric
    *
11. Kiosk(Weak)
    * kiosk_id: key, numeric

    - station_id: weak key, numeric
12. Route(Strong)
    - route_id: key, numeric
    - departure_info: alphanumeric, timestamp
    - arrival_info: alphanumeric, timestamp
    - departurel_station: alphanumeric
    - arrival_station: alphanumeric
13. Customer(Strong)
    - customer_id: key, numeric
    - name
        i. first_name: alphanumeric
        ii. last_name: alphanumeric
    - dob: composite, alphanumeric
        i. month: numeric
        ii. day: numeric
        iii. year: numeric
14. Passenger(Strong)
    - passenger_id: key, numeric
    - ticket_id: weak key, numeric
15. Ticket(Ticket)
    - ticket_id: key, numeric
    - train_id: weak key, numeric
    - route_id: weak key, numeric
    - price: numeric
16. Payment Type(Strong)
    - payment_id: key, numeric
    - date: timestamp
17. Credit Card(Weak)
    - credit_id: key, numeric
    - card_number: numeric
    - cvv: numeric
    - expiration_date: composite, alphanumeric
        i. month: numeric
        ii. year: numeric
18. Debit Card(Weak)
    - debit_id: key, numeric
    - card_number: numeric
    - cvv: numeric
    - expiration_date: composite, alphanumeric
        i. month: numeric

    ii. year: numeric

19. Billing Address(Strong)
    - billing_id: key, numeric
    - street: alphanumeric
    - zipcode: numeric
    - city: alphanumeric
    - state: alphanumeric
    - country: alphanumeric
    - house_number: numeric
20. Account(Weak)
    - account_id: key, numeric
    - customer_id: weak key, numeric
    - password: alphanumeric
21. Smartphone(Strong)
    - phone_id: key, numeric
22. EasyTrips App(Weak)
    - app_id: key, numeric
    - account_id: weak key, numeric

Section V: Entity Relationship Diagram (ERD)



Section VI: Testing Table

Rule	Entity A	Relation	Entity B	Cardinality	P/F	Error Description
1	Company	Own	Train	1-to-M	P	
2	Company	Hires	Employee	1-to-M	P	
3	Company	Sells	Ticket	1-to-M	F	It is possible for a company to make 0 to many ticket sales
4	Employee	Work	Company	1-to-1	P	
5	Station Manager	Manage	Station	1-to-Only 1	F	A station manager should be able to work at, at least one station. It cannot work only at a single station.
6	Conductor	Drives	Train	1-to-1	P	
7	Railway Police	WorksAt	Station	M-to-Only 1	F	One Railway Police shall work at, at least one station. They should not be locked to working at only one station.
8	Trains	Has	Seats	1-to-M	P	
9	Train	Has	Route	1-to-1	P	
10	Train	Arrives	Station	1-to-M	F	A train should arrive at one station.
11	Train	Departs	Station	1-to-M	F	A train should

						depart from one station.
12	Seats	IS-A	Coach Class Seat	M-to-1	P	
13	Seats	IS-A	First Class Seat	M-to-1	P	
14	Station	Has	Kiosk	1-to-M	P	
15	Customer	Books	Ticket	1-to-M	P	
16	Customer	Creates	Account	1-to-M	F	Customers should only be able to create zero or one account
17	Customer	Has	Email	1-to-M	P	
18	Customer	Has	Payment Type	M-to-N	P	
19	Customer	Uses	Smartphone	M-to-N	P	
20	Payment Type	IS-A	Credit Card	1-to-M	P	
21	Payment Type	IS-A	Debit Card	1-to-M	P	
22	Payment Type	Has	Billing Address	M-to-1	P	
23	Passenger	Has	Ticket	1-to-M	P	
24	Passenger	Cancels	Ticket	M-to-N	P	
25	Passenger	Upgrades	Ticket	M-to-N	F	Passenger should only be allowed to upgrade one ticket at a time
26	Passenger	Downgrades	Ticket	M-to-N	F	Passenger should only be

						allowed to downgrade one ticket at a time
27	Passenger	Boards	Train	1-to-Only 1	P	
28	Ticket	Sent	Account	M-to-Only 1	P	
29	Ticket	Sent	Email	M-to-Only 1	P	

Section VII: Database Model/EER

Table	FK	ON DELETE	ON UPDATE	COMMENT
Account	customer	ON CASCADE	ON CASCADE	If a customer is deleted, then the Account from that customer is deleted as well.
Account	email	ON CASCADE	ON CASCADE	If an email is deleted, then the Account with that email is deleted as well
Seats	train	ON CASCADE	ON CASCADE	If a train is deleted, then the Seats that belong to that train are deleted as well
FirstClassSeat	seat	ON CASCADE	ON CASCADE	If a seat is deleted, then the FirstClassSeat from that seat is deleted as well.
CoachClassSeat	seat	ON CASCADE	ON CASCADE	If a seat is deleted, then a CoachClassSeat from that seat is deleted as well.
Employee	company	ON CASCADE	ON CASCADE	If a company is deleted, then the Employee from that company is deleted as well.
StationManger	station	SET NULL	ON CASCADE	If a station is deleted from the StationManager table, the StationManager with that station will have no station until a new one is assigned.
StationManager	employee_id	ON CASCADE	ON CASCADE	If an employee is deleted, then the StationManger that is an employee is deleted.
RailwayPolice	employee_id	ON CASCADE	ON CASCADE	If an employee is deleted, then the RailwayPolice that is an employee is deleted as well.
RailwayPolice	station	SET NULL	ON CASCADE	If a station is deleted from the RailwayPolice table, the RailwayPolice with that station will

				have no station until a new one is assigned.
Conductor	employee_id	ON CASCADE	ON CASCADE	If an employee is deleted, then the Conductor that is an employee is deleted as well.
Conductor	train	SET NULL	ON CASCADE	If a train is deleted from the Conductor table, then the Conductor will have no train until a new one is assigned.
Customer	email	SET NULL	ON CASCADE	If an email is deleted from the customer table, then the Customer will have no email until a new one is assigned.
PaymentType	billing_address	SET NULL	ON CASCADE	If a billing_address is deleted from the PaymentType table, then it will have no billing address until a new one is assigned.
CreditCard	payment_type	ON CASCADE	ON CASCADE	If a payment_type is deleted, then the CreditCard that is a payment_type is deleted a s well.
DebitCard	payment_type	ON CASCADE	ON CASCADE	If a payment_type is deleted, then the DebitCard that is a payment_type is deleted as well.
CustomerPayment	payment_id	SET NULL	ON CASCADE	If the payment_id is deleted, then the CustomerPayment table will have no payment_id until a new one is assigned.
CustomerPayment	customer_id	SET NULL	ON CASCADE	If the customer_id is deleted, then the CustomerPayment table will have no customer_id until a new one is assigned.
CustomerSmartphone	smartphone	ON CASCADE	ON CASCADE	If a smartphone is deleted, then the CustomerSmartphone from that smartphone is deleted as well.
CustomerSmartphone	customer	ON CASCADE	ON CASCADE	If a customer is deleted, then the CustomerSmartphone of that customer is deleted as well.
Smartphone	app	SET NULL	ON CASCADE	If the app is deleted, then the Smartphone with the app will have no app until a new one is assigned.
EasyTrips App	account	SET NULl	ON CASCADE	If the account is deleted in the EasyTrips App table, the EasyTrips App will ha

Train	company	SET NULL	ON CASCADE	If a company is deleted from the train table, then the train will have no company until a new one is assigned.
Train	route	SET NULL	ON CASCADE	If a route is deleted from the train table, then the train will have no route until a new one is assigned.
Train	station	SET NULL	ON CASCADE	If a station is deleted from the train table, then the train will have no station until a new one is assigned.
Seats	train	ON CASCADE	ON CASCADE	If a train is deleted, then the Seats with the train are deleted as well.
FirstClassSeat	seat	ON CASCADE	ON CASCADE	If a seat is deleted, then the FirstClassSeat is deleted as well.
CoachClassSeat	seat	ON CASCADE	ON CASCADE	If a seat is deleted, then the CoachClassSeat is deleted as well.
Ticket	train	SET NULL	ON CASCADE	If a train is deleted from the Ticket table, the Ticket will have no train until a new one is assigned.
Ticket	route	SET NULL	ON CASCADE	If a route is deleted from the Ticket table, the Ticket will have no route until a new one is assigned.
Ticket	customer	SET NULL	ON CASCADE	If a customer is deleted from the Ticket table, the Ticket will have no customer until a new one is assigned.
Ticket	company	ON CASCADE	ON CASCADE	If the company is deleted, the Ticket that belongs to the company is deleted as well.
CoachClassTicket	ticket	ON CASCADE	ON CASCADE	If the ticket is deleted, then the CoachClassTicket that is a ticket is deleted as well.
FirstClassTicket	ticket	ON CASCADE	ON CASCADE	If the ticket is deleted, then the FirstClassTicket that is a ticket is deleted as well.
Passenger	customer	ON CASCADE	ON CASCADE	If the customer is deleted, then the passenger will be deleted as well.
Passenger	train	SET NULL	ON	If the train is deleted from the passenger

			CASCADE	table, then the passenger will have no train until a new one is assigned.
Passenger	ticket	ON CASCADE	ON CASCADE	If the ticket is deleted, then the passenger will also be deleted.

Section VIII: Forward Engineering

Section IX: Inserting Data

Section X: Testing

Section XI: Testing Table

Entity	SQLQUERY	Pass/Fail	Error Description	Possible Solution
Company	DELETE	PASS	None	None
Company	UPDATE	PASS	None	None
Station	DELETE	PASS	None	None
Station	UPDATE	PASS	None	None
Train	DELETE	PASS	None	None
Train	UPDATE	PASS	None	None
Seats	DELETE	PASS	None	None
Seats	UPDATE	PASS	None	None
FirstClassSeat	DELETE	PASS	None	None
FirstClassSeat	UPDATE	PASS	None	None
CoachClassSeat	DELETE	PASS	None	None
CoachClassSeat	UPDATE	PASS	None	None
Employee	DELETE	PASS	None	None
Employee	UPDATE	PASS	None	None
RailwayPolice	DELETE	PASS	None	None
RailwayPolice	UPDATE	PASS	None	None
StationManager	DELETE	PASS	None	None
StationManager	UPDATE	PASS	None	None
Conductor	DELETE	PASS	None	None
Conductor	UPDATE	PASS	None	None

Email	DELETE	PASS	None	None
Email	UPDATE	PASS	None	None
Customer	DELETE	PASS	None	None
Customer	UPDATE	PASS	None	None
Route	DELETE	PASS	None	None
Route	UPDATE	PASS	None	None
Ticket	DELETE	PASS	None	None
Ticket	UPDATE	PASS	None	None
CoachClassTicket	DELETE	PASS	None	None
CoachClassTicket	UPDATE	PASS	None	None
FirstClassTicket	DELETE	PASS	None	None
FirstClassTicket	UPDATE	PASS	None	None
Passenger	DELETE	PASS	None	None
Passenger	UPDATE	PASS	None	None
Account	DELETE	PASS	None	None
Account	UPDATE	PASS	None	None
EasyTripsApp	DELETE	PASS	None	None
EasyTripsApp	UPDATE	FAIL	Cannot update or add a child row	account may not exist so have to insert into it first before updating
Smartphone	DELETE	PASS	None	None
Smartphone	UPDATE	FAIL	Cannot update or add a child row	May need to insert row into app, inserting into nonexistent app
BillingAddress	DELETE	PASS	None	None
BillingAddress	UPDATE	PASS	None	None
PaymentType	DELETE	PASS	None	None

PaymentType	UPDATE	PASS	None	None
CreditCard	DELETE	PASS	None	None
CreditCard	UPDATE	PASS	None	None
DebitCard	DELETE	PASS	None	None
DebitCard	UPDATE	PASS	None	None
CustomerPayment	DELETE	PASS	None	None
CustomerPayment	UPDATE	PASS	None	None