

# Answers

- (1) A PhD student must work in the same laboratory as his/her supervisor.

The events that may violate this constraint are:

- (a) Insertion of PhDStudent
- (b) Update of Laboratory or Supervisor in PhDStudent
- (c) Update of Laboratory in Professor
- (d) Delete in Professor

Trigger of events a) and b).

```
create trigger PhDLab_PhDStud_InsUpd on PhDStudent
after insert, update as
if exists (
    select * from Inserted, Professor
    where Professor.ProfNo=Inserted.Supervisor
    and Professor.Laboratory <> Inserted.Laboratory )
begin
    raiserror 13000 'Constraint Violation:
    A PhD student must work in the same laboratory as his/her supervisor'
    rollback
end
```

Trigger of event c). For this event we suppose that if a professor changes its laboratory, his associated PhD students follow him.

```
create trigger PhDLab_Prof_Upd on Professor
after update as
begin
    update PhDStudent
    set PhDStudent.Laboratory = (
        select Laboratory from Inserted
        where Supervisor = Inserted.ProfNo )
    where Supervisor in ( select ProfNo from Inserted )
end
```

Trigger of event d). In this case, there are several possibilities.

- The professor is deleted and the attributes Laboratory and Supervisor of the PhD students who worked for the deleted professor are set to null.
- A `rollback` is made avoiding the deletion of the professor is not allowed if there are PhD students associated with him. This is taken care by the referential integrity.
- The professor is deleted and all PhD students associated with him are also deleted. This is taken care by the referential integrity with the option `on update cascade`.

The following trigger implements the first case. As SQL Server does not implement the option `on delete set null` for the referential integrity, it is necessary to drop the foreign key constraint in the table PhDStudent.

```

alter table PhDStudent
  drop constraint FK_PhDStudent_Professor
create trigger PhDLab_Prof_Del on Professor
after delete as
begin
  update PhDStudent
  set Laboratory = null, Supervisor = null
  where Supervisor in ( select ProfNo from deleted )
end

```

(2) A PhD student must take at least one course.

The events that may violate this constraint are:

- (a) Insertion of PhDStudent.
- (b) Deletion in CoursesTaken.
- (c) Update of PhDStName in CoursesTaken

Trigger of event a). If one of the new PhD students does not take any course, the transaction is aborted.

```

create trigger PhDStudOneCourse_PhDStud_Ins on PhDStudent
after insert as
if exists (
  select * from Inserted
  where not exists (
    select * from CourseTaken where StudentNo=Inserted.StudentNo ) )
begin
  raiserror 13000 'Constraint Violation:
  A PhD student must take at least one course'
  rollback
end
begin transaction
INSERT PhDStudent (StudentNo, Name, Laboratory, Supervisor) values
('999999999', 'Michel Dupont', 'Databases', '12345')
INSERT CourseTaken (StudentNo, CourseNo) values
('999999999', 'INF0364')
commit transaction

```

However, this does not work in SQL Server since a trigger is executed immediately after the triggering instruction.

Trigger of events b) and c). For each tuple of the table Deleted, verify if the corresponding PhD student takes no course. If there is at least one, then abort.

```

create trigger PhDStudOneCourse_CourseTaken_UpdDel on CourseTaken
after update, delete as
if exists (
  select * from Deleted
  where StudentNo not in (
    select StudentNo from CourseTaken ) )
begin

```

```

    raiserror 13000 'Constraint Violation:
      A PhD student must take at least one course'
    rollback
end

```

- (3) A PhD student must take all courses taught by his/her supervisor.

Many operations may violate this constraint. In the following a possible repair action is specified for each operation.

- (a) Insertion or update of Supervisor in PhDStudent. Action: register the student in all courses given by his/her (new) supervisor.

```

create trigger PhDStudAllCourses_PhDStudent_InsUpd on PhDStudent
after insert, update as
insert into CourseTaken (StudentNo, CourseNo)
select Inserted.StudentNo, Course.CourseNo
FROM Inserted, Course
WHERE Inserted.Supervisor = Course.ProfNo

```

- (b) Insertion or update of ProfessorName in Course. Action: if the (new) professor is a supervisor, add the course to all his/her supervisees.

```

create trigger PhDStudAllCourses_Course_InsUpd on Course
after insert, update as
insert into CourseTaken (StudentNo, CourseNo)
select PhDStudent.StudentNo, Inserted.CourseNo
FROM PhDStudent, Inserted
WHERE PhDStudent.Supervisor = Inserted.ProfNo

```

- (c) Deletion or update in CoursesTaken. Action: abort the transaction if the constraint is violated.

```

create trigger PhDStudAllCourses_CourseTaken_UpdDel on CourseTaken
after update, delete as
if exists (
select * from Deleted, Course, PhDStudent
where Deleted.CourseNo = Course.CourseNo
and Course.ProfNo = PhDStudent.Supervisor
and Deleted.StudentNo = PhDStudent.StudentNo )
begin
raiserror 13000 'Constraint Violation:
  A PhD student must take all courses given by his/her supervisor'
rollback
end

```