Day 5 –Entity Relationships & Advanced LINQ in EF Core **Date:** 20-10-2025

Objective: Learn to model complex relationships like one-to-many and many-to-many using EF Core. Master advanced LINQ queries to efficiently retrieve and manipulate relational data.

1. Introduction

- Define **One-to-Many** and **Many-to-Many** relationships between tables.
- Understand **Navigation Properties** in EF Core.
- Use **LINQ queries** for filtering, joining, and grouping data.
- Perform complex data retrieval using EF Core's query syntax.

Part 1 – Entity Relationships

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2. What Are Relationships in Databases?

A **relationship** defines how two tables are connected to each other.

Entity Framework Core allows you to represent these connections using **navigation properties** in your C# classes.

3. Types of Relationships

Relationship Type	Description	Example
One-to-One	A single record in one table relates to a single record in another.	Each student has one address.
One-to-Many	One record relates to multiple records in another table.	One course has many students.
Many-to-Many	Multiple records relate to multiple records in another table.	Students can enroll in multiple courses.

4. One-to-Many Example

In this example:

- One **Course** can have multiple **Students**.
- Each **Student** belongs to one **Course**.

Course.cs

```
using System.ComponentModel.DataAnnotations;

namespace StudentApi.Models
{
   public class Course
   {
      [Key]
      public int CourseId { get; set; }
      [Required]
      [StringLength(100)]
      public string CourseName { get; set; } = string.Empty;
      public ICollection<Student> Students { get; set; } = new List<Student>();
   }
}
```

Student.cs

```
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;


namespace StudentApi.Models
{
   public class Student
   {
      [Key]
      public int Id { get; set; }
      [Required, StringLength(50)]
      public string Name { get; set; } = string.Empty;
      [Range(1, 100)]
      public int Age { get; set; }
```

```
        [StringLength(10)]
        public string? Grade { get; set; }
        // Foreign Key
        [ForeignKey("Course")]
        public int CourseId { get; set; }
        // Navigation Property
        public Course? Course { get; set; }
    }
}
```

Explanation:

- CourseId in Student acts as a **foreign key**.
- Each Student references a Course.
- The Course class has a collection of Students.

5. Updating DbContext

Update your context to include the new model:

```
public DbSet<Course> Courses { get; set; }
protected override void OnModelCreating(ModelBuilder modelBuilder)
{
    modelBuilder.Entity<Course>()
        .HasMany(c => c.Students)
        .WithOne(s => s.Course)
        .HasForeignKey(s => s.CourseId)
        .OnDelete(DeleteBehavior.Cascade);
}
```

This ensures **referential integrity**:
If a course is deleted, all its students are deleted automatically.

6. SQL Representation

When you run the migration or scaffold, EF Core will create two tables:

```
CREATE TABLE Courses (
   CourseId INT IDENTITY(1,1) PRIMARY KEY,
   CourseName NVARCHAR(100) NOT NULL
);

CREATE TABLE Students (
   Id INT IDENTITY(1,1) PRIMARY KEY,
   Name NVARCHAR(50) NOT NULL,
   Age INT NOT NULL,
   Grade NVARCHAR(10),
   CourseId INT FOREIGN KEY REFERENCES Courses(CourseId)
);
```

Part 2 – LINQ (Language Integrated Query)

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7. Introduction to LINQ

LINQ allows you to query collections (like Lists, Arrays, or DbSets) using C# syntax instead of SQL.
EF Core translates LINQ into SQL automatically.

8. LINQ Query Types

Query Type	Description
Method Syntax	Uses methods like .Where(), .Select(), .OrderBy()
Query Syntax	Uses SQL-like keywords (from, where, select)

Both produce the same result.

9. Basic LINQ Examples

1. Retrieve all students

```
var students = _context.Students.ToList();
```

2. Filter by Grade

```
var topStudents = _context.Students
```

```
    .Where(s => s.Grade == "A")
    .ToList();
```

3. Sort Students by Age

```
var sorted = _context.Students.OrderBy(s => s.Age).ToList();
```

4. Select Specific Columns

```
var names = _context.Students.Select(s => s.Name).ToList();
```

10. LINQ with Relationships (Join Queries)

Join Students and Courses

```
var studentCourses = from s in _context.Students
                     join c in _context.Courses
                     on s.CourseId equals c.CourseId
                     select new
                     {
                        StudentName = s.Name,
                        CourseName = c.CourseName,
                        Grade = s.Grade
                     };
```

Equivalent Method Syntax:

```
var result = _context.Students
   .Include(s => s.Course)
   .Select(s => new
   {
      s.Name,
      s.Course.CourseName,
      s.Grade
   })
   .ToList();
```

11. LINQ Aggregation and Grouping

Group by Course

```
var groupByCourse = _context.Students
   .GroupBy(s => s.Course.CourseName)
   .Select(g => new
   {
      Course = g.Key,
      StudentCount = g.Count()
   })
   .ToList();
```

Aggregate Functions:

```
var stats = new
{
   TotalStudents = _context.Students.Count(),
   MaxAge = _context.Students.Max(s => s.Age),
   AvgAge = _context.Students.Average(s => s.Age)
};
```

12. LINQ Query Translation

EF Core converts LINQ to SQL automatically.
For example:

```
_context.Students.Where(s => s.Grade == "A");
```

Will generate:

```
SELECT * FROM Students WHERE Grade = 'A';
```

This abstraction allows developers to focus on **C# logic** instead of SQL.

13. Eager Loading vs Lazy Loading

Type	Description
Eager Loading	Loads related data immediately using .Include()
Lazy Loading	Loads related data only when accessed (requires setup)

Example:

```
var students = _context.Students.Include(s => s.Course).ToList();
```

This retrieves both Students and their Course data in one query.

14. LINQ with Anonymous Types

You can project specific fields into new anonymous objects:

```
var studentInfo = _context.Students
   .Select(s => new { s.Name, s.Grade })
   .ToList();
```

This reduces data transfer and improves performance.

15. LINQ Performance Tips

- Use .ToList() **only at the end** of a query chain.
- Prefer **async methods** (ToListAsync()).
- Avoid querying in loops.
- Use **projection** to return only needed fields.
- Use **indexes** in SQL Server for large datasets.

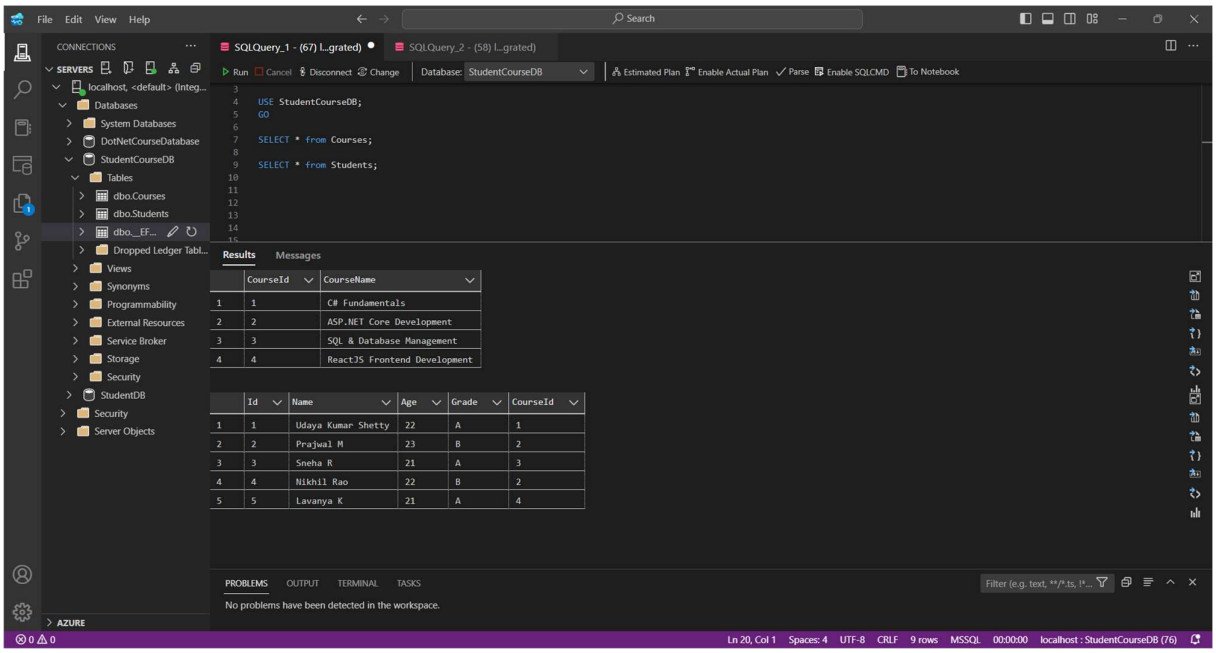
Mini Task for Day 5

Objective:
Create a Course table and link it to Student (One-to-Many relationship).

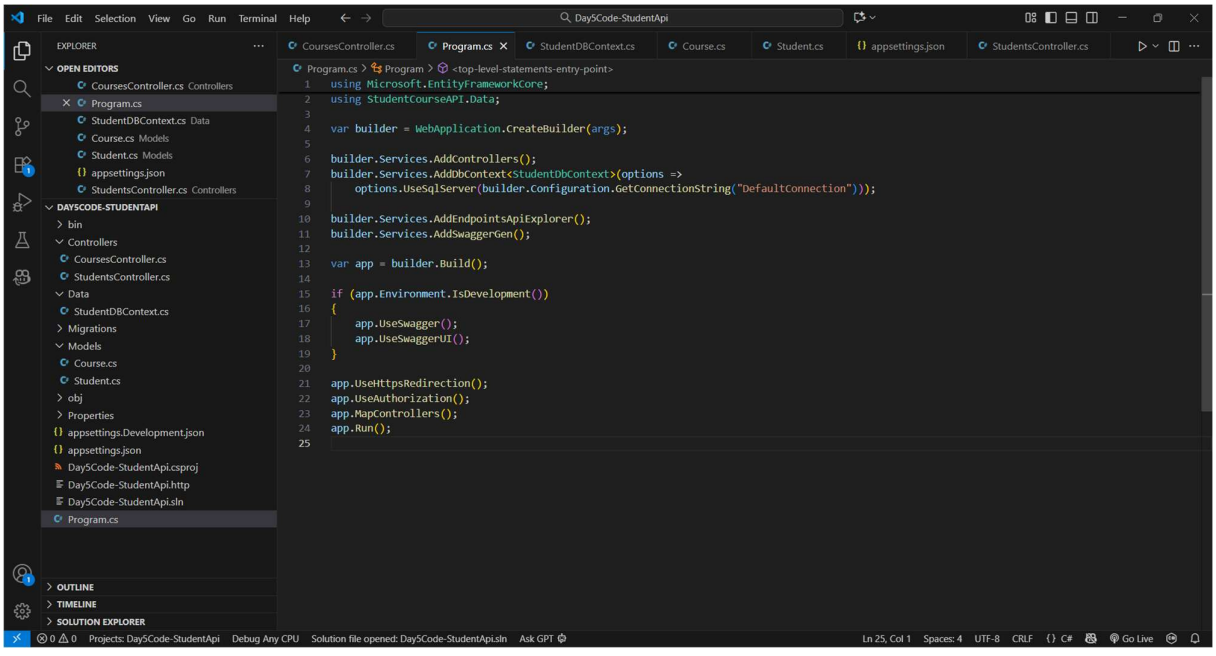
Tasks:

1. Update your model and StudentDBContext.
2. Create new endpoints in CoursesController:
    - GET /api/courses → List all courses
    - GET /api/courses/{id} → List students in that course
3. Write LINQ queries to:
    - List all students per course
    - Count students per course

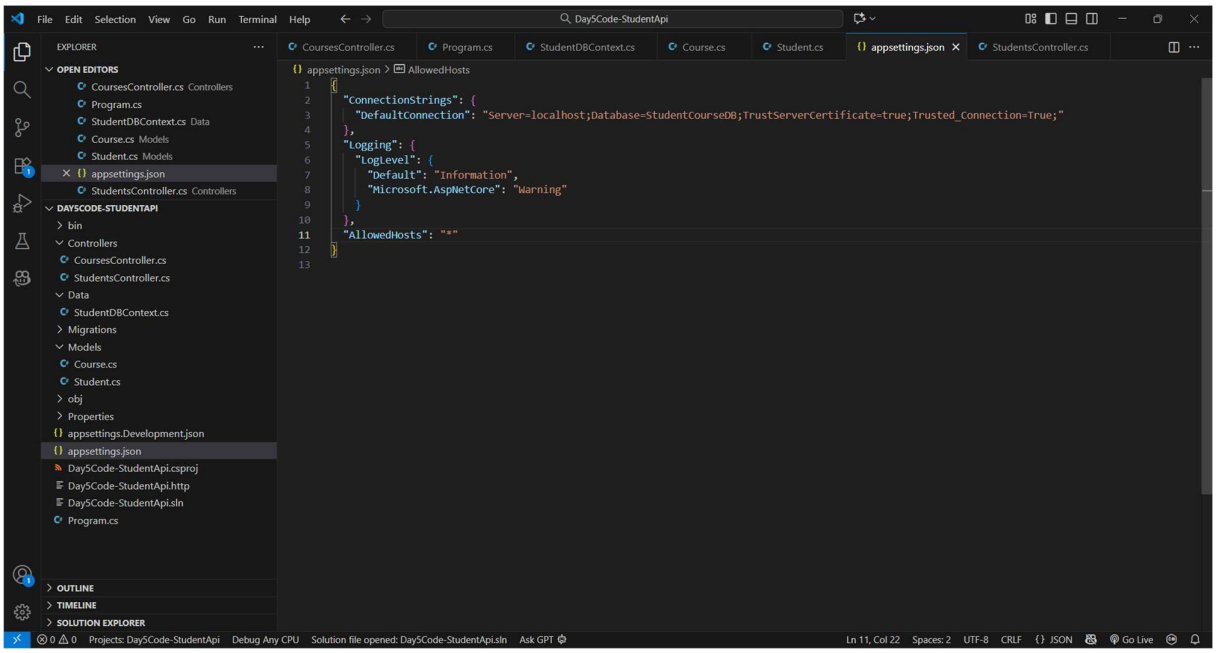
Snapshots :



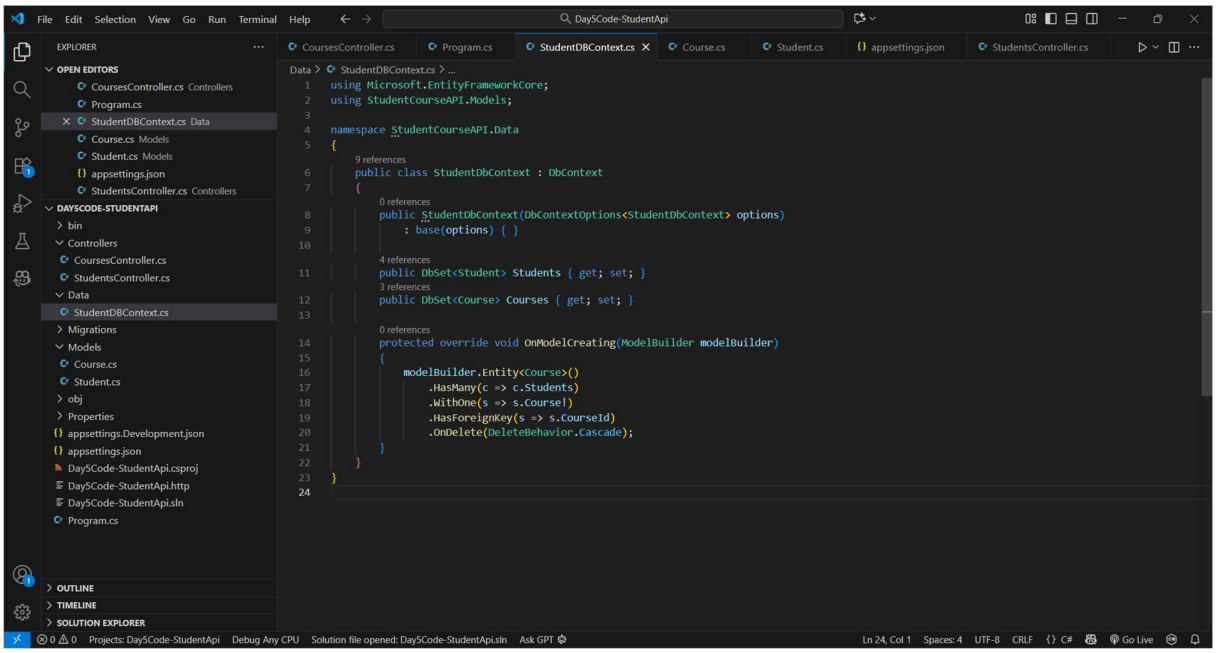
StudentCourseDB created and tables verified in SSMS



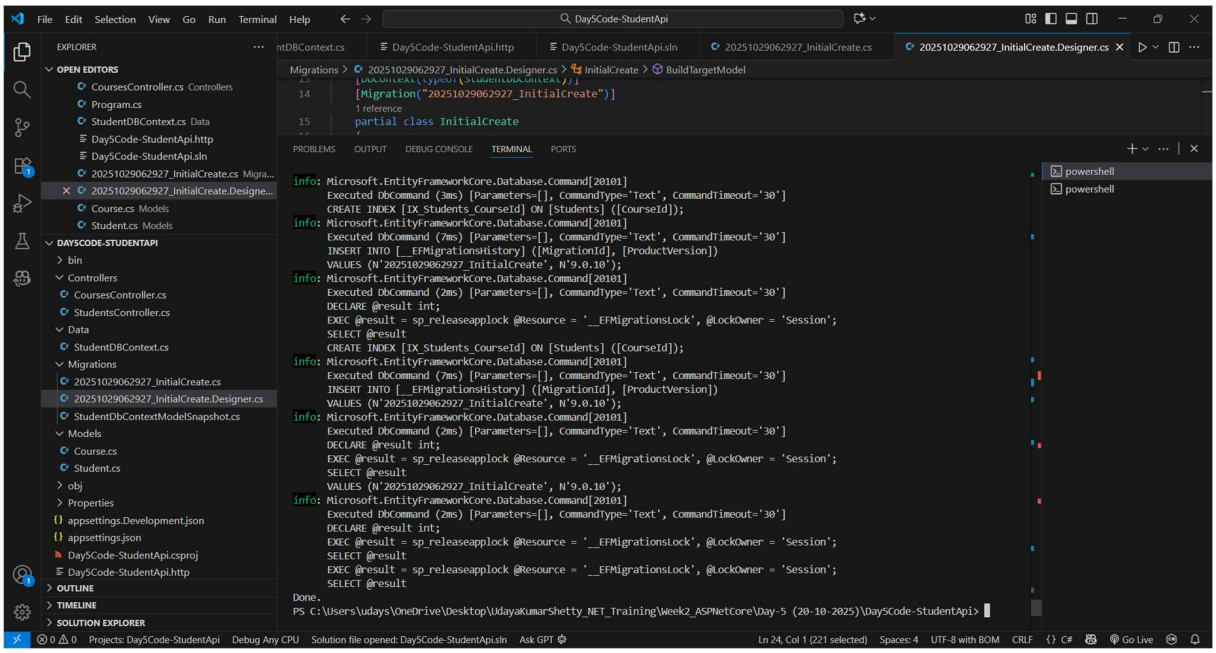
Project structure in VS Code with required folders



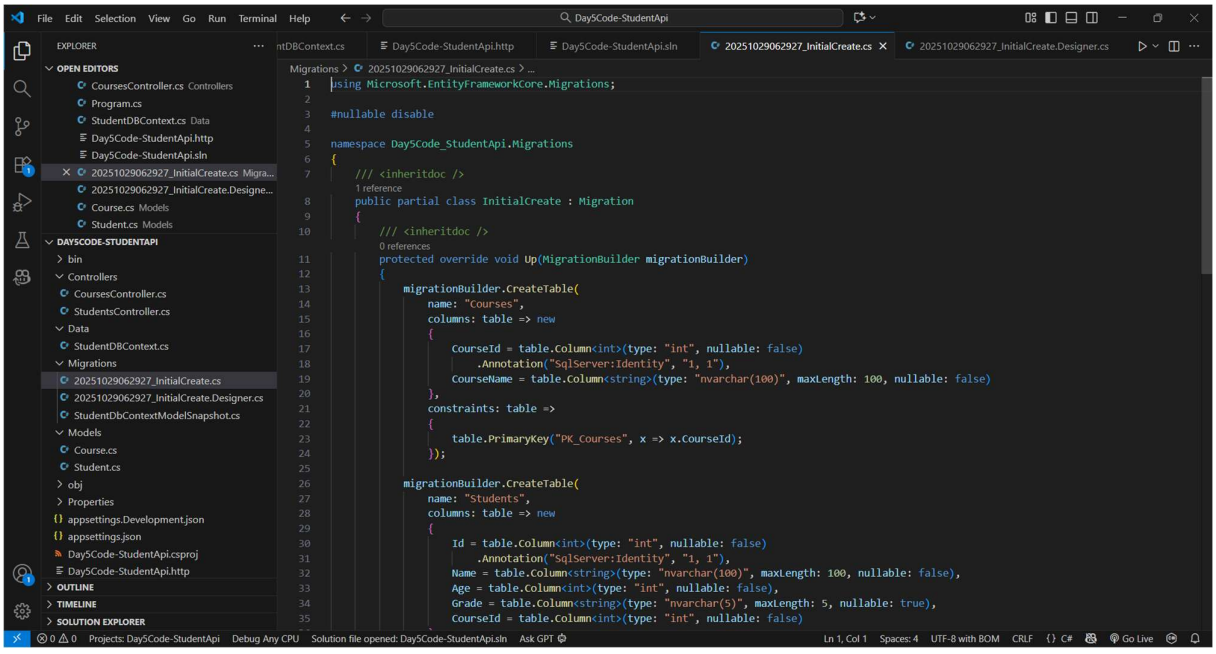
Connection string setup in appsettings.json



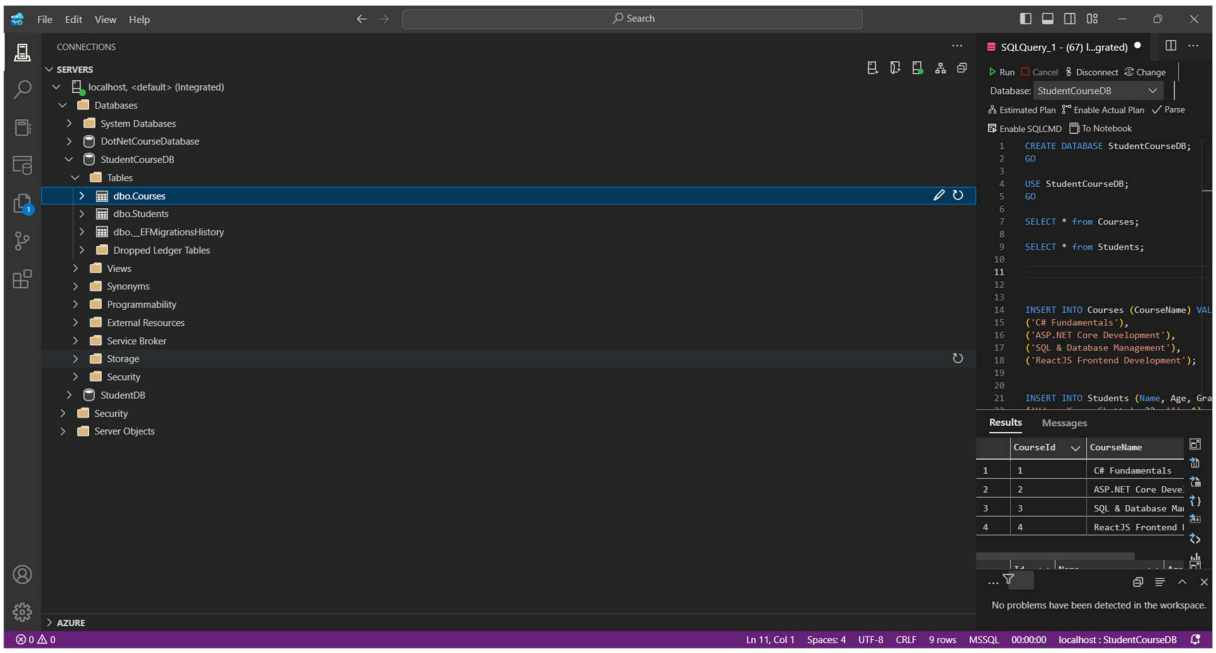
DbContext class with DbSet<Student> and DbSet<Course>



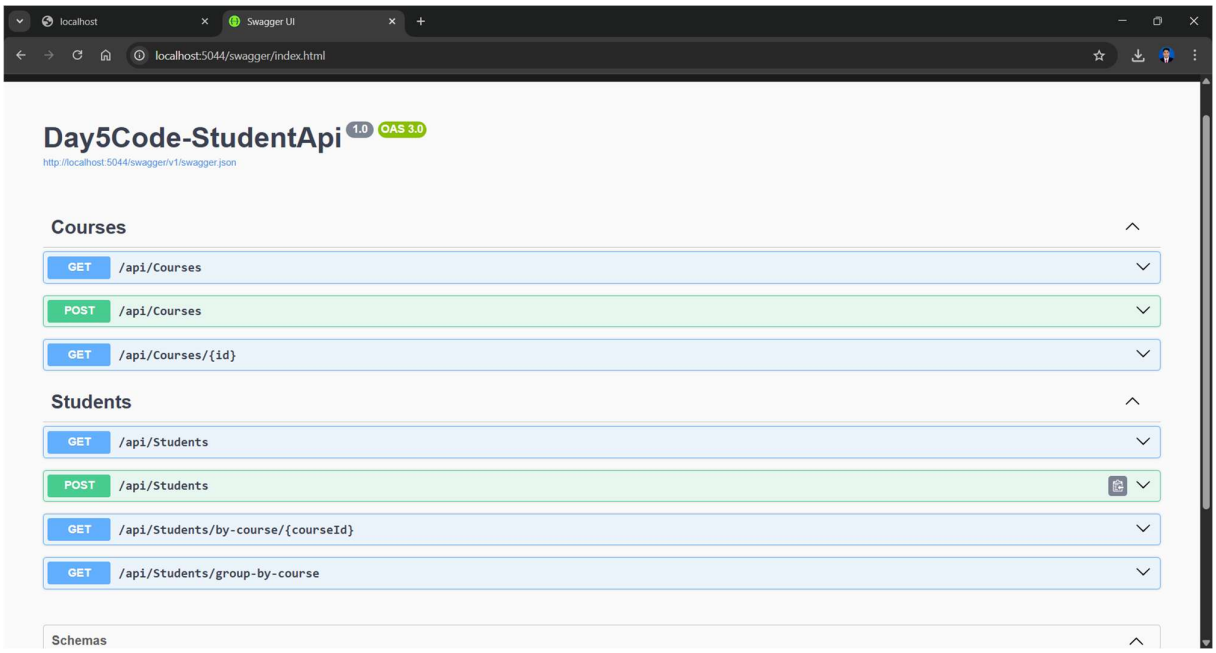
EF Core migration command executed successfully



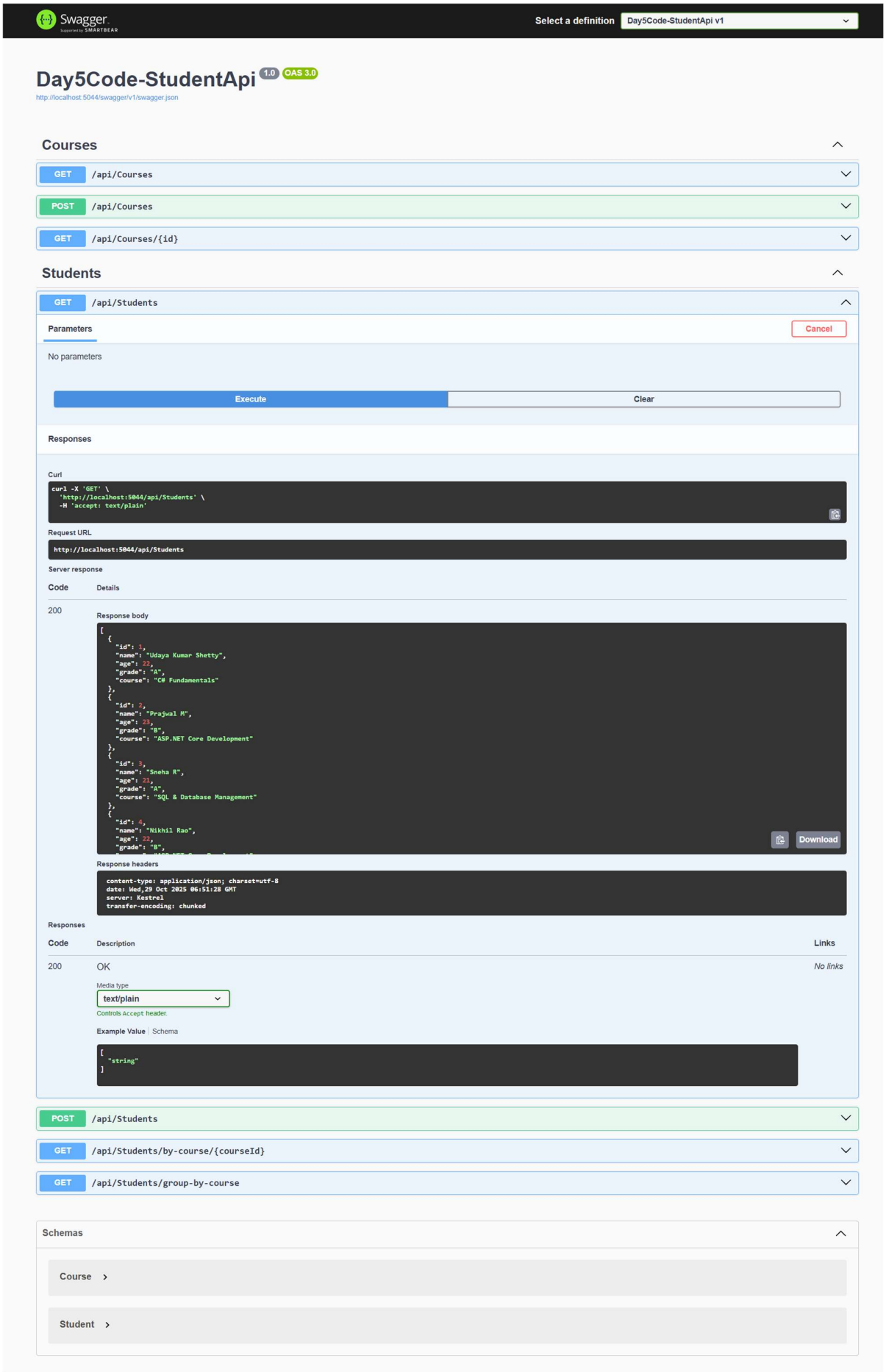
EF Core migration Files Created



Tables created in SQL Server after migration



Swagger UI to test API



GET /api/students tested successfully in Swagger