



CAPSTONE PROJECT REPORT

Report 4 – Software Design Document

– Ho Chi Minh City, December 2025 –

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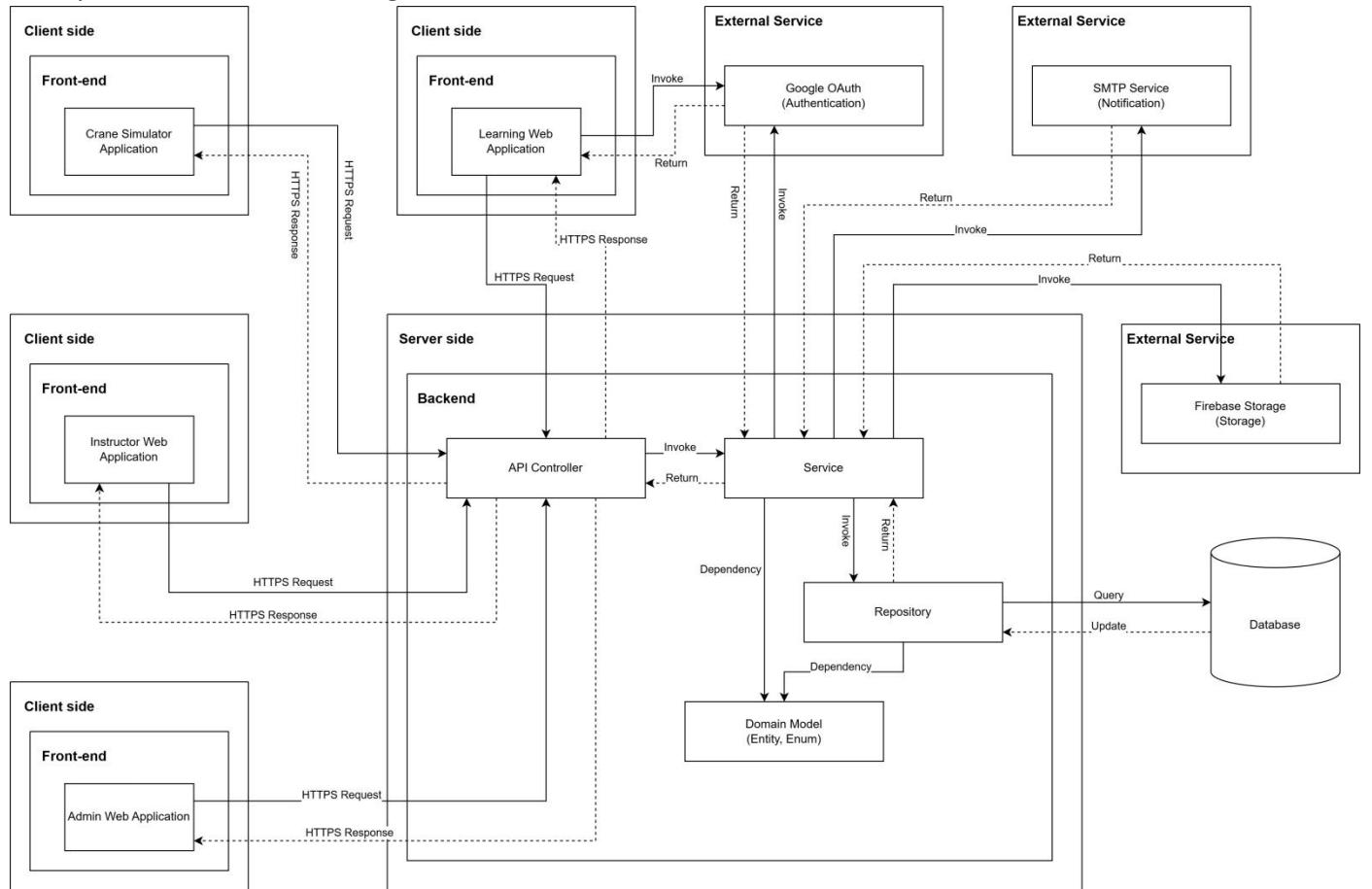
I. Record of Changes

*A - Added M - Modified D - Deleted

II. Software Design Document

1. System Design

1.1 System Architecture Diagram

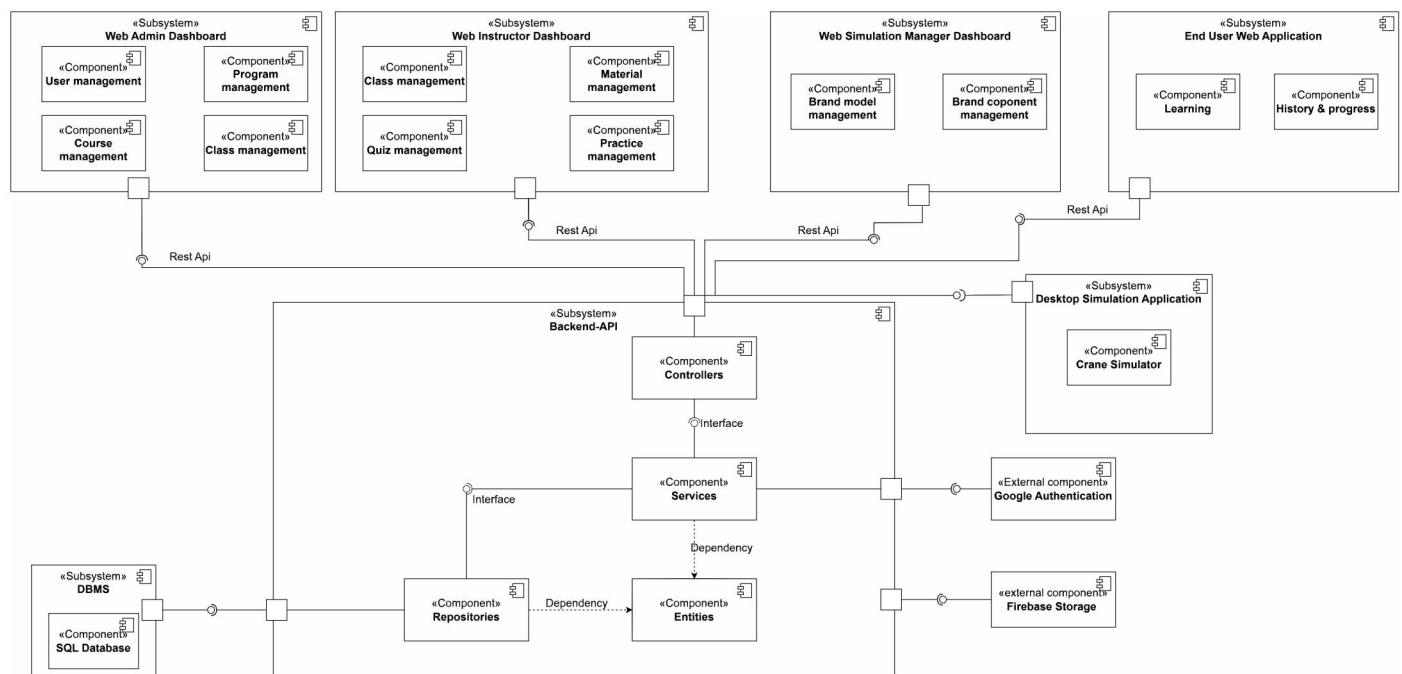


System Architecture Diagram Descriptions

No	Name	Description
1	Crane Simulator Application	Desktop application for practical crane operation training, communicates with backend via HTTPS to access training content and submit practice results
2	Learning Web Application	Web-based application for trainees to access learning materials, complete courses, take quizzes, and track their learning progress
3	Instructor Web Application	Web application for instructors to manage classes, create and grade quizzes, provide feedback, and monitor student progress
4	Admin Web Application	Web application for administrators to manage users, programs, courses, system settings, and overall platform administration
5	API Controller	RESTful API layer that receives HTTPS requests from client applications, routes them to appropriate services, and returns responses
6	Service	Business logic layer containing core application logic, processing business rules, orchestrating workflows, and coordinating between controllers and external services.

		repositories
7	Repository	Data access layer that abstracts database operations, handles CRUD operations, and manages data persistence using Entity Framework or similar ORM
8	Domain Model (Entity, Enum)	Domain entities and enumerations representing the core business objects and data structures (Users, Courses, Classes, Quizzes, etc.)
9	Database	SQL Server database storing all system data including users, courses, enrollments, quiz attempts, practice results, and certificates
10	Google OAuth (Authentication)	External authentication service for user login using Google accounts, providing secure OAuth 2.0 authentication flow
11	SMTP Service (Notification)	External email service for sending notifications, alerts, password resets, and course-related communications to users
12	Firebase Storage (Storage)	Cloud storage service for storing and serving media files including course materials, videos, images, documents, and user-uploaded content

1.2 Component Diagram



Component Diagram Descriptions

No	Name	Description
1	Web Admin Dashboard	Web administrative interface for Admin, including user management, program management, and course management features

2	User management	Component for managing users, handling account information, permissions, and user administration in the system
3	Program management	Component for managing training programs, organizing courses and curriculum
4	Course management	Component for managing courses, learning content, lectures, and materials
5	Web Instructor Dashboard	Web interface for instructors, including class management and quiz management
6	Class management	Component for managing classes, student lists, schedules, and attendance
7	Material management	Component for managing learning materials, lectures, videos, and attached files
8	Quiz management	Component for managing quizzes, questions, answers, and test results
9	Practice management	Component for managing practice exercises, assignments, and homework
10	Web Simulation Manager Dashboard	Simulation management interface, including brand model management and brand component management
11	Brand model management	Component for managing brand models in business simulation
12	Brand component management	Component for managing components and competitors in simulation
13	End User Web Application	Web application for end users (students), including learning features and history & progress tracking
14	Learning	Component handling the learning process, viewing lectures, and completing exercises for students
15	History & progress	Component tracking learning history and course completion progress for students
16	End User Desktop Application	Desktop application for end users, including practical training features
17	Practical Training	Component handling practical exercises on desktop application

18	Firebase Storage	Firebase file storage service for storing images, videos, documents, and attached files
19	Backend API	Backend API system handling business logic, including Controllers, Services, Repositories, and Entities
20	Controllers	Controller layer handling HTTP requests from clients, routing to corresponding services
21	Services	Business logic layer containing business rules and system processing logic
22	Repositories	Data access layer handling CRUD operations with the database
23	Entities	Layer defining data objects (data models) mapped to the database
24	Google Authentication	Component authenticating users through Google OAuth, supporting Google account login
25	DBMS	Database management system containing SQL Database storing all system data
26	SQL Database	SQL database (PostgreSQL/MySQL) storing user data, courses, exercises, and learning results

2. Database Design



Table Descriptions

No	Table	Description
1	users	<p>Stores the core account information for all system users including login credentials and contact info.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: None
2	admins	<p>Stores specific information for users with the Admin role, linked to the main user record.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: id
3	simulation_managers	<p>Stores specific information for Simulation Managers, linked to the main user record.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: id
4	instructors	<p>Stores specific information for Instructors, including employment details.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: id
5	trainees	<p>Stores specific information for Trainees/Learners.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: id
6	instructor_profiles	<p>Contains detailed profile information for instructors such as experience and biography.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: id
7	trainee_profiles	<p>Contains detailed profile information for trainees, including driver license and citizen card details.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: id
8	course_categories	<p>Lookup table for defining different categories of courses.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: None

		Lookup table for defining the difficulty or progression levels of courses. - Primary keys: id - Foreign keys: None
9	course_levels	Lookup table for standardized course codes. - Primary keys: id - Foreign keys: None
10	course_codes	Stores the main course definitions including metadata like price and duration. - Primary keys: id - Foreign keys: category_id, level_id, course_code_id
11	courses	Defines high-level training programs that aggregate multiple courses. - Primary keys: id - Foreign keys: None
12	training_programs	Junction table linking Courses to Training Programs, defining the order of courses within a program. - Primary keys: id - Foreign keys: program_id, course_id
13	program_courses	Defines content sections that organize activities within a course. - Primary keys: Id - Foreign keys: None
14	sections	Junction table mapping sections to courses and defining their sequence. - Primary keys: Id - Foreign keys: course_id, section_id
15	course_sections	Stores individual learning activities (e.g., lessons, quizzes) that belong to sections. - Primary keys: id - Foreign keys: None
16	activities	Stores information about study materials like documents or videos. - Primary keys: id - Foreign keys: None
17	learning_materials	Links learning materials to the instructors who authored them. - Primary keys: id - Foreign keys: instructor_id, material_id
18	material_authors	Junction table mapping activities to specific sections and defining their order. - Primary keys: id - Foreign keys: section_id, activity_id
19	section_activities	

20	activity_materials	Links learning materials to specific activities. - Primary keys: id - Foreign keys: activity_id, learning_material_id
21	quizzes	Defines quiz assessments including time limits and passing criteria. - Primary keys: id - Foreign keys: None
22	quiz_authors	Links quizzes to the instructors who created them. - Primary keys: id - Foreign keys: instructor_id, quiz_id
23	quiz_questions	Stores questions belonging to a specific quiz. - Primary keys: id - Foreign keys: quiz_id
24	quiz_question_options	Stores the possible answer options for a quiz question. - Primary keys: id - Foreign keys: quiz_question_id
25	activity_quizzes	Junction table linking a Quiz to an Activity entity. - Primary keys: id - Foreign keys: quiz_id, activity_id
26	practices	Defines practical training exercises or simulation scenarios. - Primary keys: id - Foreign keys: None
27	sim_tasks	Defines specific tasks or steps required within a simulation. - Primary keys: id - Foreign keys: None
28	practice_tasks	Junction table linking simulation tasks to a practice scenario. - Primary keys: id - Foreign keys: practice_id, task_id
29	activity_practices	Junction table linking a Practice to an Activity entity. - Primary keys: id

		- Foreign keys: activity_id, practice_id
30	brand_models	Specific brand models of equipment (cranes) used in simulations. - Primary keys: id - Foreign keys: None
31	simulation_components	Stores detailed components associated with specific brand models. - Primary keys: id - Foreign keys: brand_model_id
32	class_codes	Lookup table for standardized class codes. - Primary keys: id - Foreign keys: None
33	classes	Represents a scheduled instance of a course (program course) with start/end dates. - Primary keys: id - Foreign keys: program_course_id, class_code_id
34	class_instructors	Assigns instructors to specific classes with a designated position. - Primary keys: id - Foreign keys: class_id, instructor_id
35	enrollments	Records the registration of a trainee in a specific class. - Primary keys: id - Foreign keys: class_id, trainee_id
36	timeslots	Defines specific scheduling slots (date/time/location) for a class. - Primary keys: id - Foreign keys: class_id
37	attendances	Tracks trainee attendance for specific timeslots. - Primary keys: id - Foreign keys: enrollment_id, timeslot_id
38	activity_sessions	Schedules specific activities within a class timeframe. - Primary keys: id - Foreign keys: class_id, activity_id
39	final_exams	Stores the overall record of a final exam for an enrollment.

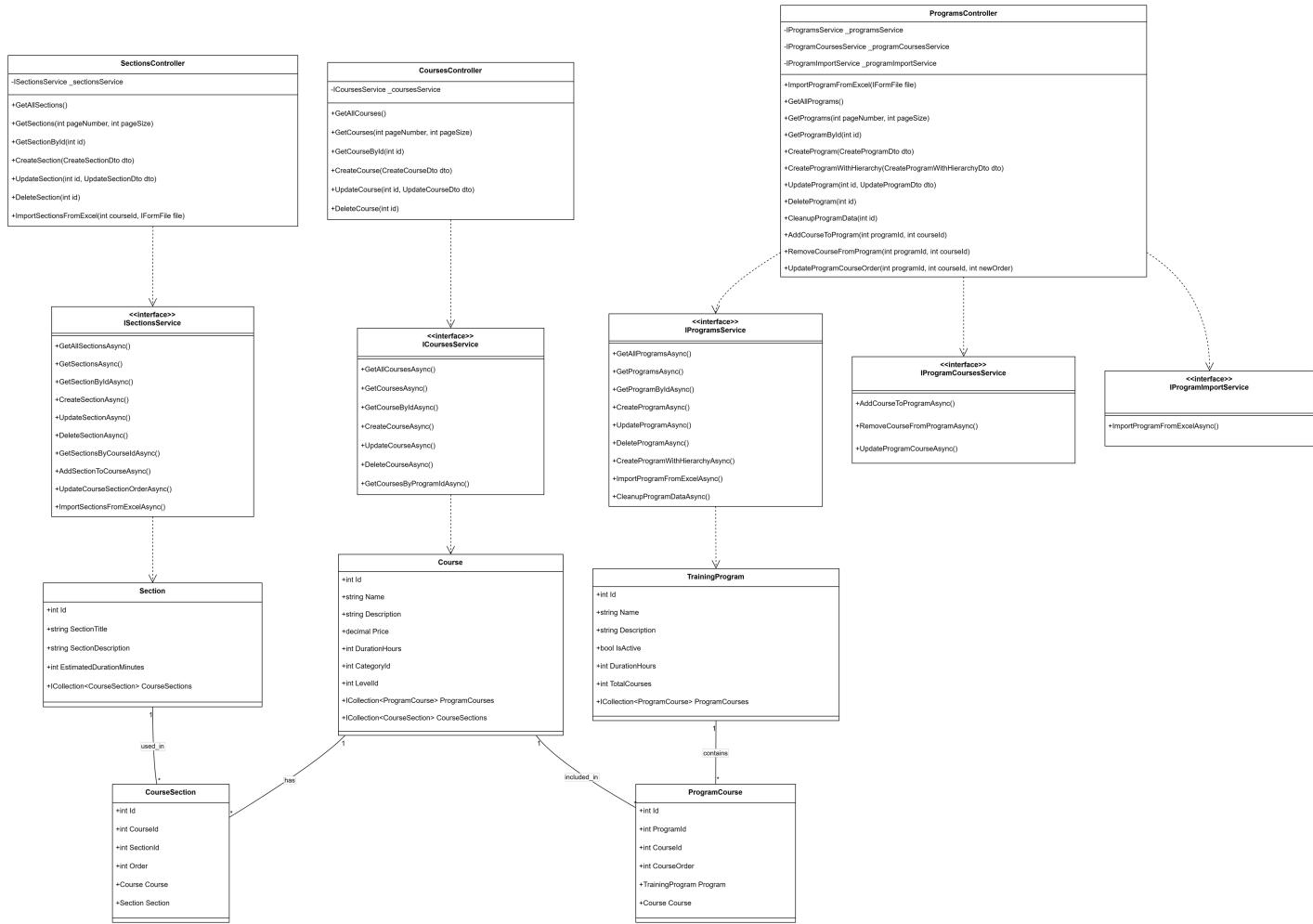
		<ul style="list-style-type: none"> - Primary keys: id - Foreign keys: enrollment_id
40	final_exam_partials	<p>Stores specific parts (theory/practical) of a final exam.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: final_exam_id
41	pe_checklist	<p>Stores checklist items for grading practical final exams.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: final_exam_partial_id
42	fe_theory	<p>Links a final exam partial to a specific theory quiz.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: final_exam_partial_id, quiz_id
43	fe_simulation	<p>Links a final exam partial to a specific simulation practice.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: final_exam_partial_id, practice_id
44	se_tasks	<p>Tracks the result of specific tasks within a simulation final exam.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: fe_simulation_id, sim_task_id
45	certificates	<p>Defines certificate templates available in the system.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: None
46	course_certificates	<p>Links certificates to courses, defining passing requirements.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: course_id, certificate_id
47	trainee_certificates	<p>Records certificates issued to trainees upon course completion.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: enrollment_id, course_certificate_id
48	learning_progresses	<p>Tracks the overall progress of a trainee within an enrollment.</p> <ul style="list-style-type: none"> - Primary keys: id - Foreign keys: enrollment_id

		Tracks a trainee's completion status for specific course sections. - Primary keys: id - Foreign keys: learning_progress_id
49	section_records	Tracks the detailed status and score of a trainee for specific activities. - Primary keys: id - Foreign keys: section_record_id
50	activity_records	Stores feedback provided by instructors on specific activity records. - Primary keys: id - Foreign keys: activity_record_id, instructor_id
51	instructor_feedbacks	Records a specific attempt by a trainee to complete a practice activity. - Primary keys: id - Foreign keys: activity_record_id
52	practice_attempts	Records the result of individual tasks within a practice attempt. - Primary keys: id - Foreign keys: practice_attempt_id
53	practice_attempt_tasks	Records a specific attempt by a trainee to complete a quiz. - Primary keys: id - Foreign keys: activity_record_id
54	quiz_attempts	Records the trainee's answer/score for a specific question in a quiz attempt. - Primary keys: id - Foreign keys: quiz_attempt_id
55	quiz_attempt_questions	Records the specific option selected by a trainee for a question. - Primary keys: id - Foreign keys: quiz_attempt_question_id
56	quiz_attempt_answers	

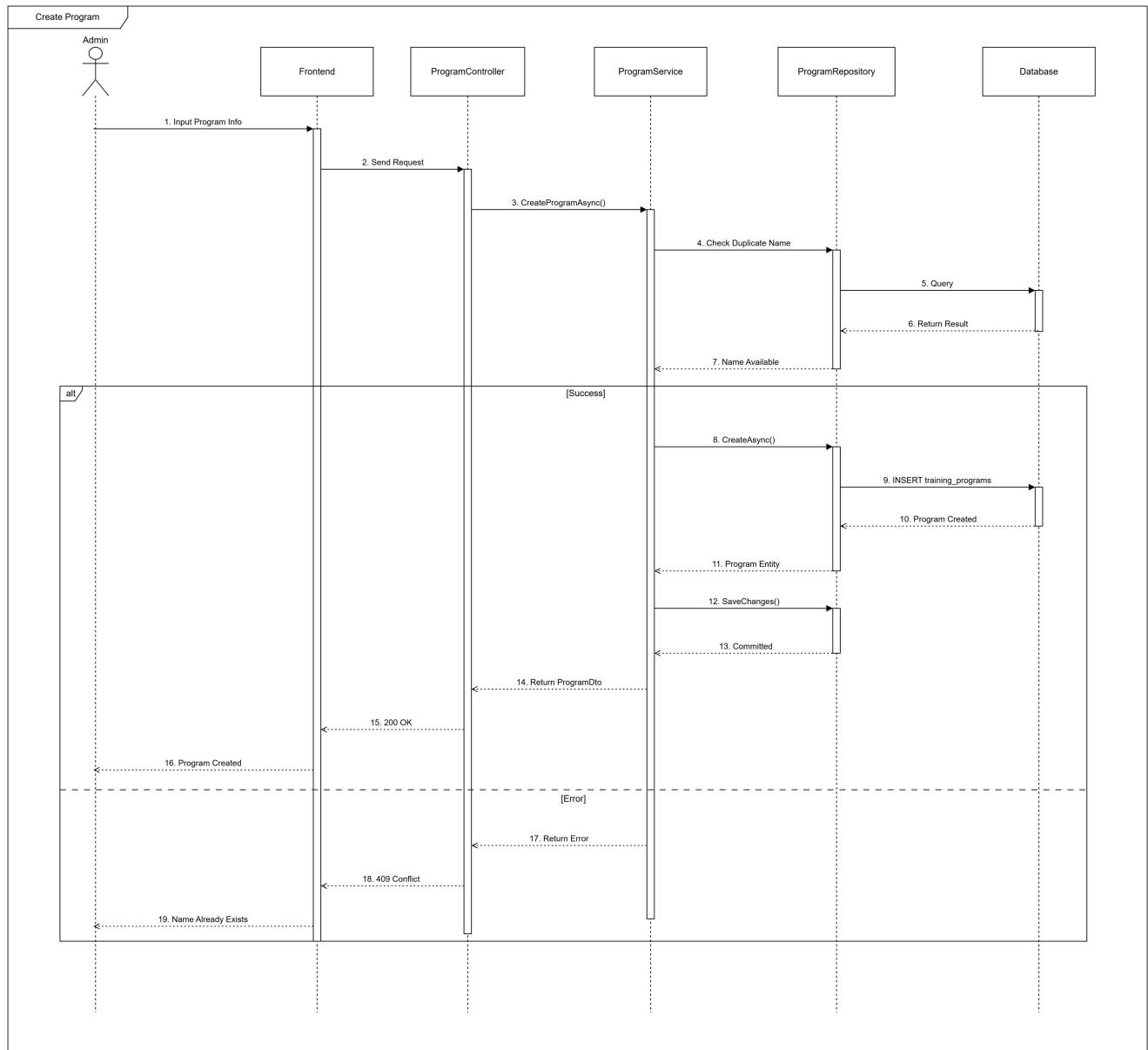
3. Detailed Design

3.1 Program & Course Management

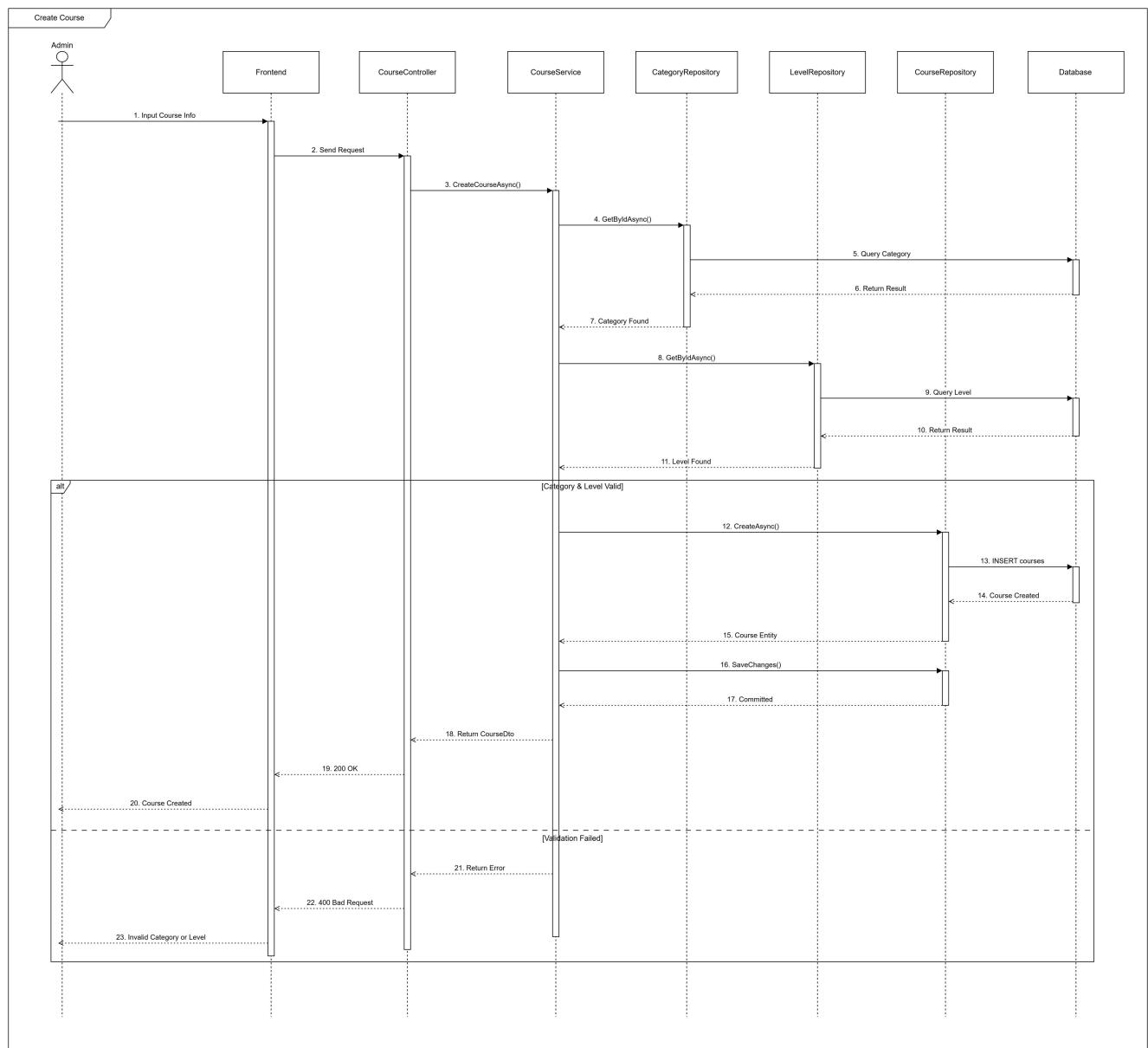
3.1.1 Class Diagram



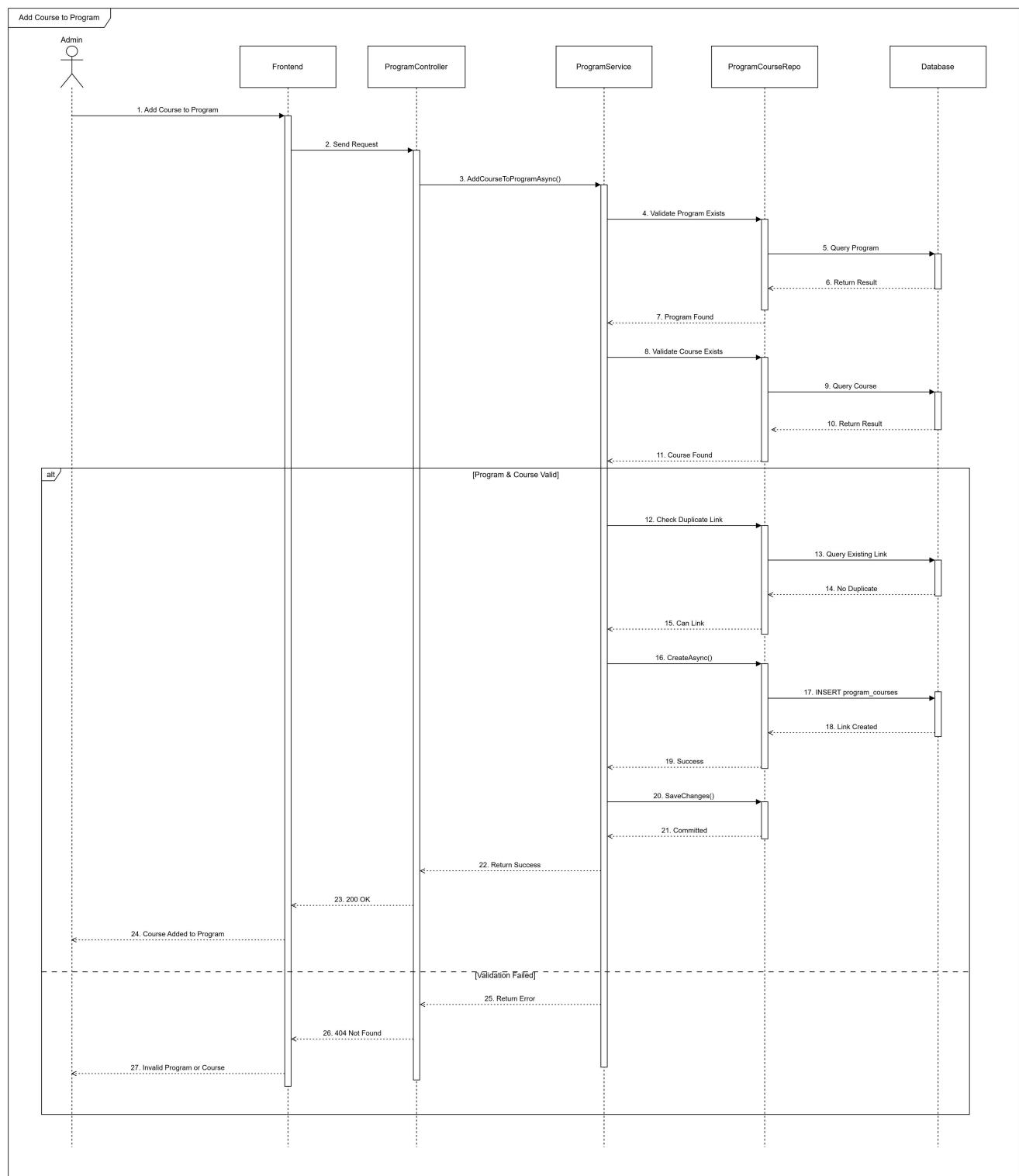
3.1.2 Sequence Diagram - Admin Creates Program



3.1.3 Sequence Diagram - Admin Creates Course

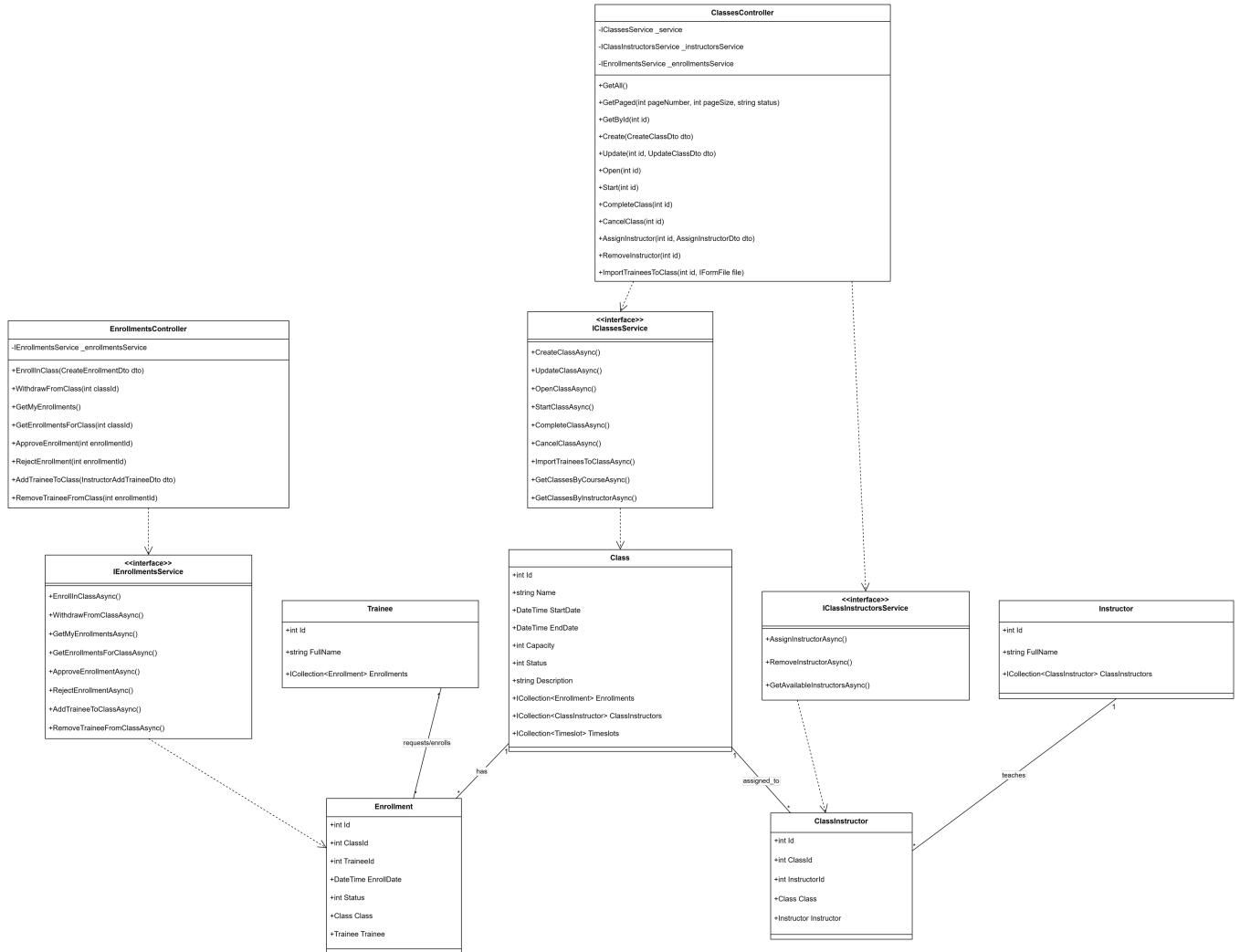


3.1.4 Sequence Diagram - Admin Adds Course To Program

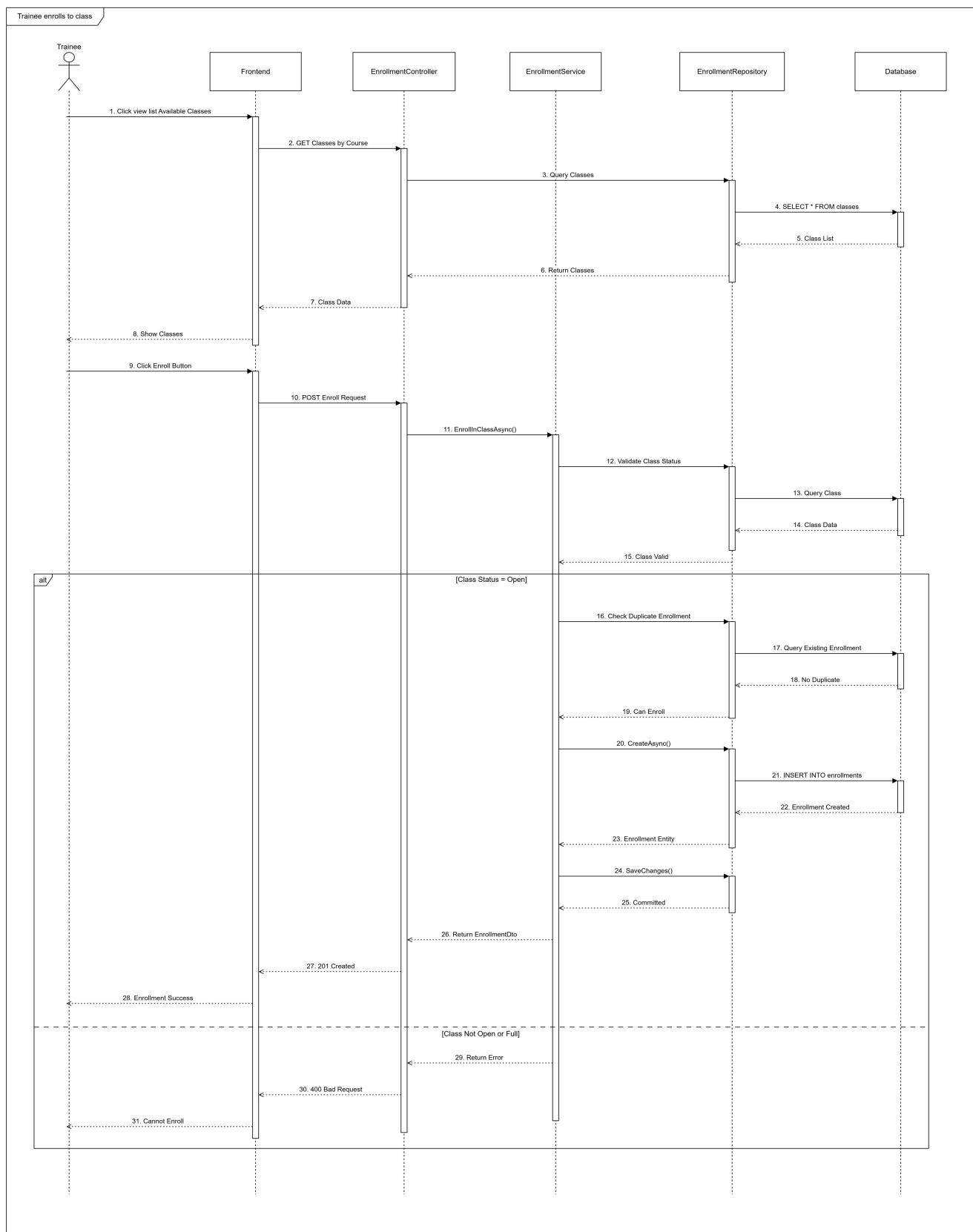


3.2 Class Management & Enrollment

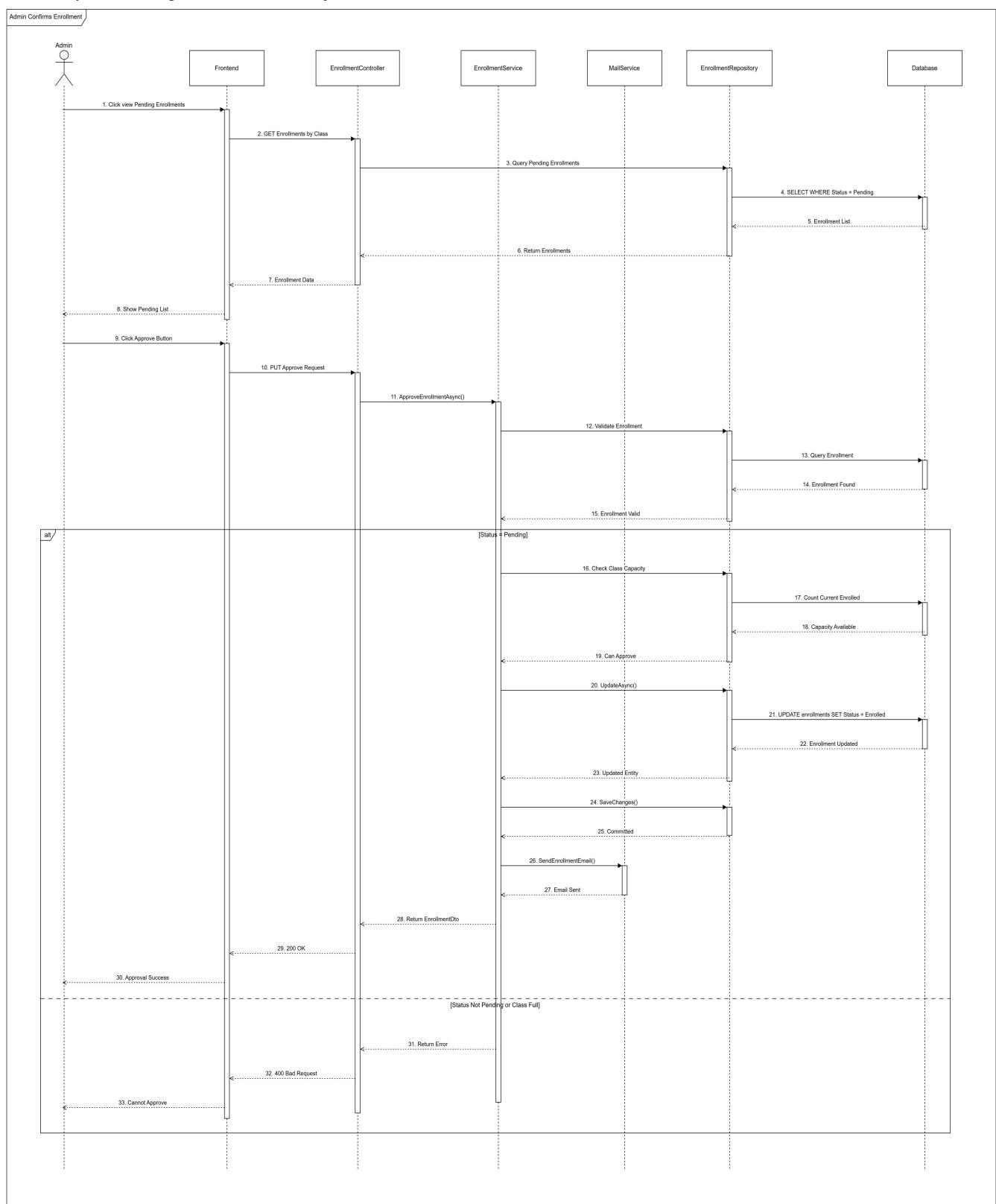
3.2.1 Class Diagram



3.2.2 Sequence Diagram - Trainee Enrolls to Class

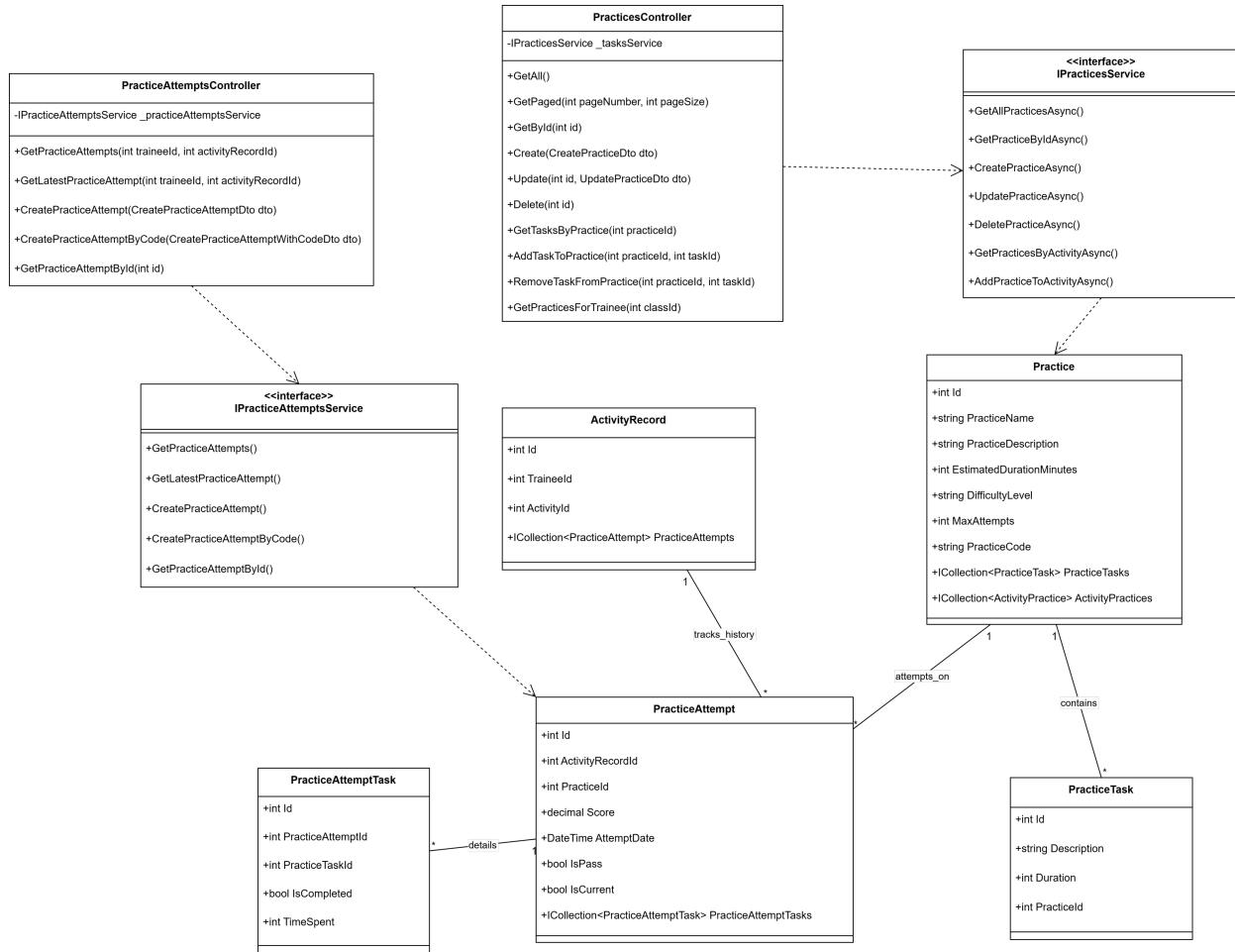


3.2.3 Sequence Diagram - Admin Confirms Enrollment

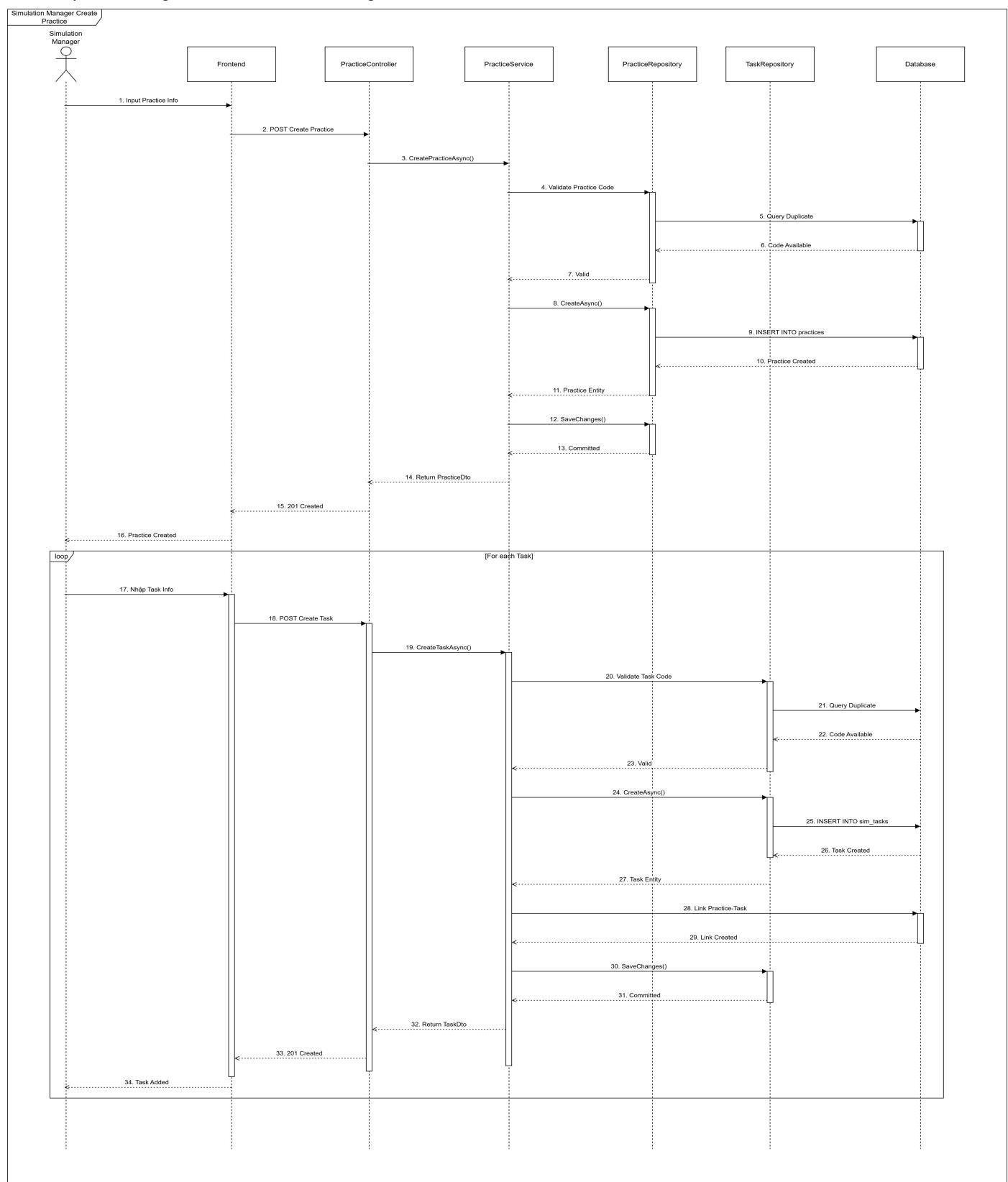


3.3 Simulation Practice Management

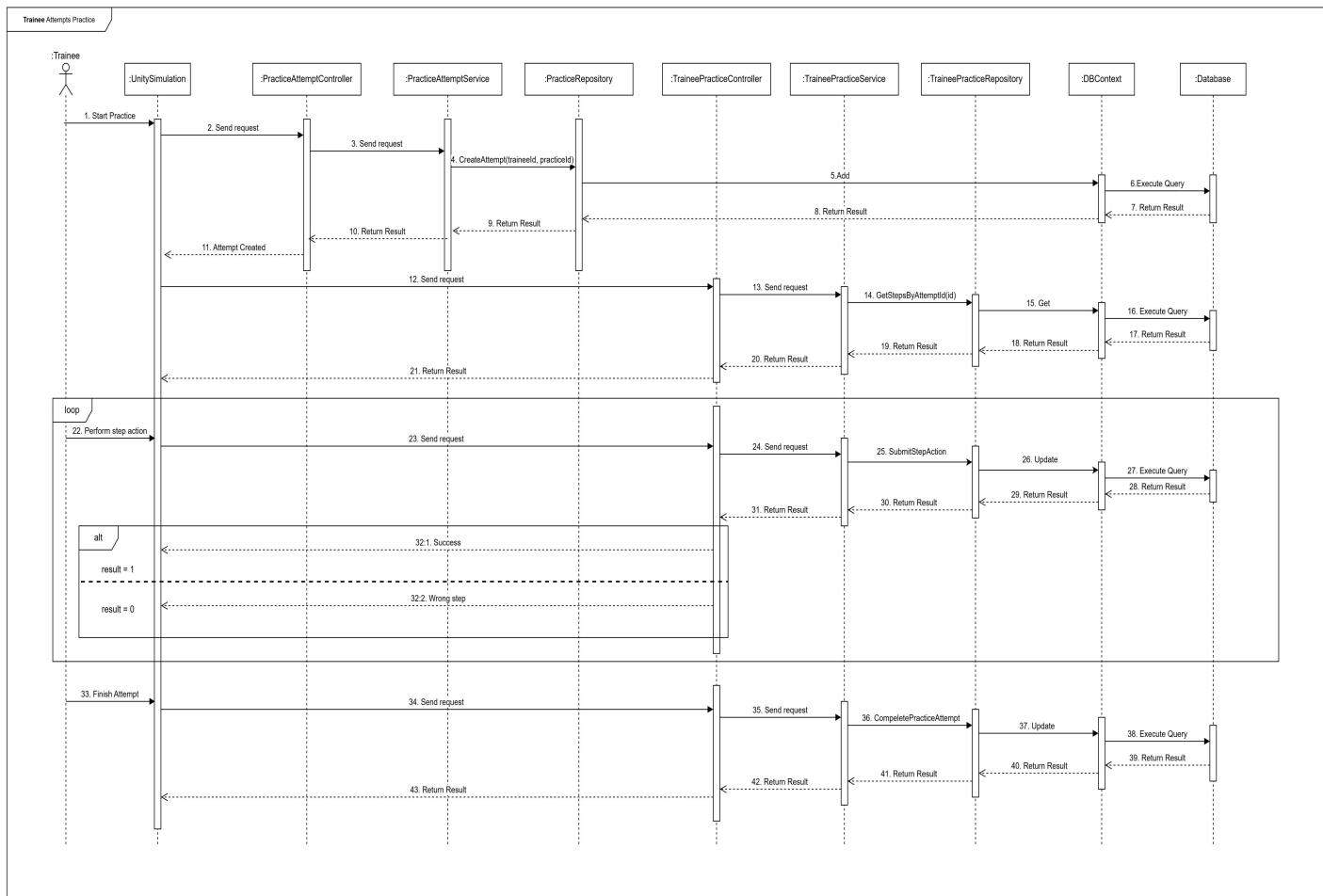
3.3.1 Class Diagram



3.3.2 Sequence Diagram - Simulation Manager Creates Practice

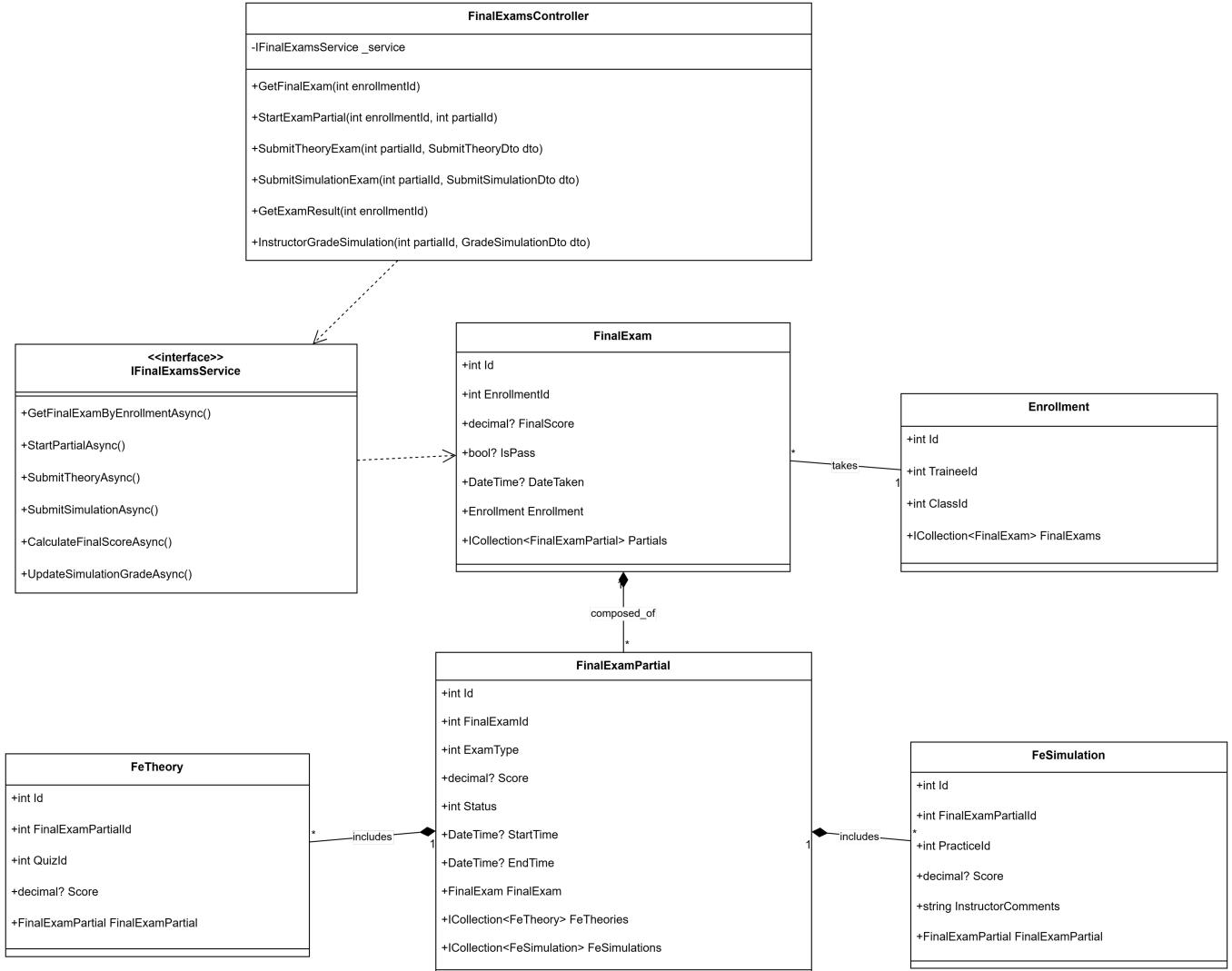


3.3.3 Sequence Diagram - Trainees Attempt Practice

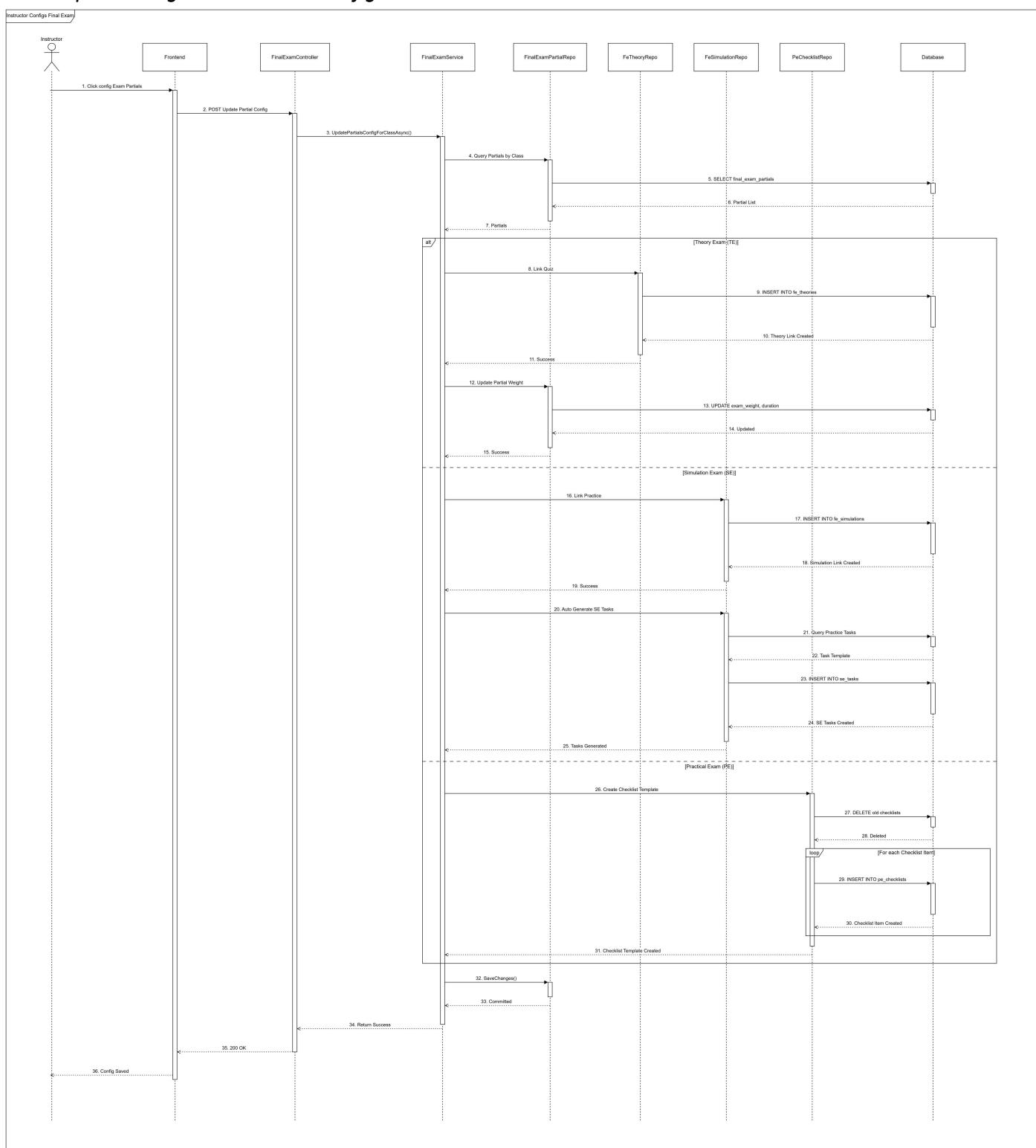


3.4 Final Exam Management

3.4.1 Class Diagram

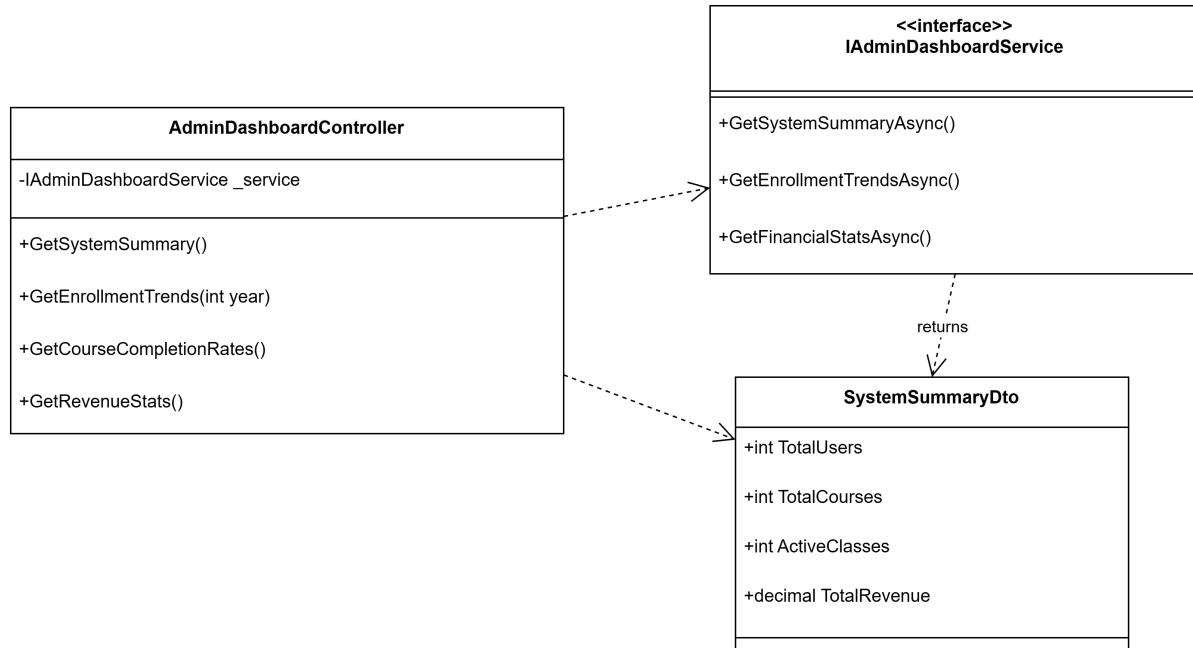


3.4.2 Sequence Diagram - Instructor Configs Final Exam



3.5 Dashboard & Reports

3.5.1 Class Diagram



3.5.2 Sequence Diagram - Admin Views Dashboard

