System Blueprint: Generic Student Management System

1. 🎯 Goals

- **Generic & reusable**: Core features work for any school.
- **Customizable**: Easy to adapt branding, modules, and workflows.
- **Scalable**: Can grow from small schools to large institutions.
- **Secure**: Role-based access for admins, teachers, students.
- **Modern stack**: Reliable backend, optional frontend, portable deployment.

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2. ⚙️ Technologies

Layer	Technology	Purpose
Backend	**Spring Boot**	Core framework for REST APIs, modular services
Database	**PostgreSQL/MySQL**	Relational DB for student/course data
ORM	**Spring Data JPA (Hibernate)**	Simplifies DB access
Security	**Spring Security + JWT**	Authentication & role-based authorization
Frontend (optional)	**React.js** or **Thymeleaf**	UI for schools (React for modern SPAs, Thymeleaf for server-side rendering)
API Docs	**Swagger/OpenAPI**	Auto-generated API documentation
Deployment	**Docker + Kubernetes (optional)**	Portability and scalability
CI/CD	**GitHub Actions**	Automated testing and deployment
Reporting	**JasperReports / PDFBox**	Generate certificates, transcripts, reports

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3. 🗂️ Core Modules

A. Student Module

- CRUD: Add, update, delete, view students.
- Fields: ID, name, DOB, guardian info, contact.
- Customizable: Add school-specific fields.

B. Teacher Module

- CRUD for teachers.
- Assign teachers to courses.
- Role-based access.

C. Course Module

- Manage subjects, grades, timetables.
- Link students ↔ courses ↔ teachers.

D. Authentication & Roles

- Roles: Admin, Teacher, Student.
- JWT-based login.
- Role-based endpoints.

E. Reports & Certificates

- Export student lists, grades, attendance.
- Configurable certificate templates (school logo, signature, CEO title).

F. Branding Layer

- Configurable school name, logo, colors.
- Stored in DB or config files for easy customization.

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4. 🛠️ Advanced/Optional Modules

- **Attendance Tracking** → Daily/weekly logs.
- **Fee Management** → Payments, invoices.
- **Library Management** → Books, borrowing.
- **Notifications** → Email/SMS integration.

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5. 🗄️ Database Schema (Simplified)

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Student (id, name, dob, email, guardian_name, guardian_contact, school_id)
Teacher (id, name, email, subject_specialization, school_id)
Course (id, name, description, teacher_id, school_id)
Enrollment (id, student_id, course_id, grade)
User (id, username, password, role, school_id)
School (id, name, logo_url, address, contact)
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- **School table** → makes system multi-tenant (one DB, multiple schools).
- **Enrollment table** → many-to-many relationship between students and courses.

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6. 🔄 Workflow

1. **Admin logs in** → manages school branding, adds teachers/students.
2. **Teachers log in** → manage courses, upload grades, track attendance.
3. **Students log in** → view courses, grades, certificates.
4. **Reports generated** → branded certificates, transcripts.

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7. 🚀 Development Roadmap

1. **Phase 1**: Core CRUD (Students, Teachers, Courses).
2. **Phase 2**: Authentication & roles.
3. **Phase 3**: Reports & branding layer.
4. **Phase 4**: Optional modules (attendance, fees).
5. **Phase 5**: Frontend integration (React/Thymeleaf).
6. **Phase 6**: Deployment (Docker, CI/CD).

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8. 📓 Notebook Exercises

- Document each module with:
  - **Concept learned** (e.g., JPA relationships).
  - **Code snippet** (controller/service).
  - **Customization idea** (how to adapt for a school).
  - **Reflection** (what worked, what was tricky).