# IMTR School Management System (Kenya)

You are a senior full-stack architect. Build a **School Management System (SMS)** for the **Institute for Meteorological Training and Research (IMTR), Kenya,** from scratch to production. Generate code, configs, and docs. Prefer clarity, modularity, and security. Use **Node.js + Express + MySQL** on the backend; **Next.js + Tailwind CSS** on the frontend (SPA feel using App Router or Pages—pick one and be consistent). Enforce **JWT in httpOnly cookies**, **bcrypt**, **validation middleware**, **RBAC**, and **audit logging**.

## **Global Context & Non-Functional Requirements**

- Institution: IMTR (Kenya). Stakeholders: Students, Lecturers/Trainers, Admin, Finance/Accounts, Librarians, IT Support, External (KMD/WMO, Donors, Parents/Guardians).
- **Locale**: Africa/Nairobi (UTC+3), currency KES, date format YYYY-MM-DD, phone numbers align with KE standards.
- **Compliance**: Kenya Data Protection Act (2019)—data minimization, consent for PII, role-based access, audit trails, encryption in transit, proper retention and deletion.
- Availability & Performance: Aim for p95 API < 300ms on core endpoints at 1k RPS (scalable via horizontal scaling).
- **Security**: OWASP Top 10, CSRF defense, strict cookie flags, rate limiting, input validation, safe file uploads, secrets in env.
- Observability: Structured JSON logs, request IDs, health checks, metrics endpoints, error tracking.
- **DevEx**: Dockerized, reproducible dev env, seed data, make scripts, CI/CD pipeline.

# 1) Core Features / Modules (DDD)

Implement as **domain modules** (each with controller, service, repo/ORM, routes, validation, tests):

- 1. **Auth & Users**: Login/logout, refresh, password reset, email verification (optional), MFA (optional). Roles: ADMIN, LECTURER, STUDENT, FINANCE, LIBRARIAN, IT.
- 2. **SIS (Student Information)**: Admissions, enrollment, profiles, transcripts, progression, ID generation, clearance, exam card application, fees status(balance), fee payments(M-Pesa, card payments).
- 3. **Courses & Timetables**: Course catalog (meteorology specializations), class sections, rooms, schedules, lecturer assignment.
- 4. **Academic Admin**: Attendance, gradebook, exam scheduling, results publishing, GPA calculation rules.
- 5. **Finance**: Invoicing, receipts, fee structures, scholarships/bursaries, M-Pesa STK push integration (sandbox + prod), exports.
- 6. **Library**: Catalog, lending, returns, fines, integration-ready hooks for external research databases.
- 7. **Research & Projects**: Project registry, teams, deliverables, document repository (with safe storage).
- 8. **Notifications**: Email/SMS (Safaricom SMS gateway or provider-agnostic interface), in-app alerts.
- Reporting & Compliance: Student performance, attendance, finance summaries, KMD/WMO compliance reports, downloadable CSV/PDF.
- 10. **System Admin**: User management, role/permission editor, audit logs, configuration, backups.

## 2) Tech Stack & Libraries

- Backend: Node.js 20+, Express, MySQL 8, Sequelize, Joi for validation, bcrypt, jsonwebtoken, cookie-parser, helmet, cors, express-rate-limit, multer (uploads), winston/pino for logs, uuid, dayjs, nodemailer, bull/agenda (optional jobs), swagger-ui-express / OpenAPI 3.
- Frontend: Next.js (App Router recommended), React Query (TanStack) for data fetching + caching, Axios, Tailwind CSS, Headless UI/Radix, React Hook Form + Zod, Context for lightweight state, recharts for charts.
- Infra: Docker + docker-compose, Nginx reverse proxy, PM2 (or node:18-alpine-based), GitHub Actions CI, S3-compatible object storage (e.g., MinIO) for files, Redis (jobs/cache), Mailhog in dev.

# 3) Target Folder Structures (Generate these)

#### **Backend**

```
backend/
 - src/
    -- config/
        -- env.js
        ├-- db.js
                                  # Sequelize client
        └─ logger.js
      - middleware/
                                  # JWT + RBAC
        - auth.js
        --- validate.js
        --- rateLimiter.js
        - errorHandler.js
        └─ cors.js
      - utils/
                                 # bcrypt helpers
        -- crypto.js
        -- jwt.js
        --- responses.js
                                 # UUID, student IDs
        - id.js
        └── files.js
                                  # uploads, MIME checks
      - modules/
         — auth/
            — auth.controller.js
```

```
--- auth.service.js
           --- auth.routes.js
         — auth.validation.js
          L— auth.types.js
         — users/ ... (same pattern)
        --- students/ ...
         — courses/ ...
        --- academics/ ...
        — finance/ ...
       —— library/ ...
       --- research/ ...
       — notifications/ ...
       L— reports/ ...
     -- jobs/
       — index.js
       --- email.scheduler.js
                                 # mount all module routes
    -- routes.js
                                 # create app, middleware
    - app.js
                                 # listen, graceful shutdown
   L— server.js
  - sequelize
   --- schema.prisma(sequlised)
   L— migrations/
 - tests/ (vitest/jest + supertest)
 - .env.example
 — dockerfile
  - package.json
L-- README.md
```

### **Frontend**

```
- courses/page.jsx
       — finance/page.jsx
       library/page.jsx
       research/page.jsx
       - reports/page.jsx
       └── admin/page.jsx
      - components/
       —— ui/ (Navbar, Sidebar, Tabs, Modal, Toast, Loader)
       — tables/ (DataTable w/ pagination, filters)
       └── forms/ (RHForm wrappers, inputs)
    — hooks/ (useAuth, useToast, useModal)
   —— lib/ (axios instance, auth helpers)
   - styles/ (globals.css, tailwind.css)
   -- constants/ (roles, endpoints, tabs)
   - types/ (user.d.ts, student.d.ts)
   store/ (Zustand or context)
 — public/
 — tailwind.config.js
 - next.config.js
 — dockerfile
 - .env.example
___ package.json
```

## 4) Database Design (Generate SQL/Models + ERD)

Create a normalized schema with FKs and indexes. Minimum tables:

- users (id, email, password\_hash, role, status, last\_login\_at, created\_at)
- profiles (user\_id FK, first\_name, last\_name, phone, gender, dob, address, national\_id)
- students (id, user\_id FK, student\_no, admission\_date, program\_id, status)
- lecturers (id, user\_id FK, staff\_no, department\_id)
- programs (id, name, code, level, duration\_months)
- courses (id, program id FK, code, title, credits, semester)
- class\_sections (id, course id, lecturer id, room, schedule json)
- enrollments (id, student\_id, class\_section\_id, status)
- attendance (id, class\_section\_id, student\_id, date, status)
- assessments (id, class\_section\_id, title, max\_score, weight)
- grades (id, assessment id, student id, score, graded at)
- fee\_structures (id, program\_id, item, amount\_kes)
- invoices (id, student id, total kes, due date, status)
- invoice\_items (id, invoice\_id, item, amount\_kes)
- payments (id, invoice\_id, amount\_kes, method, mpesa\_ref, paid\_at)
- library\_items (id, isbn, title, authors, type, copies\_total, copies\_available)
- loans (id, library\_item\_id, borrower\_user\_id, borrowed\_at, due\_at, returned\_at, fine\_kes)

- research\_projects (id, title, lead\_lecturer\_id, sponsor, start\_date, end\_date, status)
- project\_members (project\_id, user\_id, role)
- notifications (id, user id, channel, title, body, sent at, meta json)
- audit\_logs (id, actor\_user\_id, action, entity, entity\_id, ip, user\_agent, created\_at)

**Deliver**: Sequelize models + migrations and an ER diagram (mermaid). Add **indexes** for lookups (email, student\_no, mpesa\_ref, etc.).

# 5) API Design (OpenAPI 3 + Controllers)

Produce an **OpenAPI spec** with these routes (indicative):

- Auth: POST /auth/login, POST /auth/logout, POST /auth/refresh, POST /auth/forgot, POST /auth/reset
- Users/Admin: CRUD users, assign roles, list by role
- **Students**: POST /students (admit), GET /students/:id, GET /students?search=&page=, PATCH /students/:id
- **Courses**: CRUD programs/courses/sections, timetable endpoints
- Academics: attendance, assessments, grading, publish results, compute GPA
- **Finance**: fee structures, invoices (GET /students/:id/invoices), payments (POST /finance/mpesa/stk, POST /finance/mpesa/callback)
- **Library**: catalog search, borrow/return, fines
- Research: CRUD projects, members, uploads
- **Notifications**: POST /notify (role-guarded), templates
- Reports: downloadable CSV/PDF endpoints
- Admin: audit logs, backups trigger (if applicable), config

Include **RBAC** matrix (e.g., only FINANCE can create invoices/payments; LECTURER can grade only their own sections).

# 6) Security Model

- **JWT**: access token (short TTL) + refresh token (longer TTL) in **httpOnly**, **secure**, **sameSite=strict** cookies. Rotate refresh tokens.
- **Password**: bcrypt with a strong cost factor, reject common passwords.
- Validation: Zod/Joi schemas for all inputs. Central error formatting.
- CSRF: Double-submit cookie or SameSite + CSRF token for state-changing endpoints from the browser.
- CORS: strict origins from env.
- Rate Limiting: per IP + per user on sensitive routes.
- Uploads: MIME/type/size checks, virus scan hook placeholder, store in S3/MinIO.
- Audit: Log sensitive actions (grades changed, payments posted, role changes).

# 7) Frontend (SPA UX with Next.js + Tailwind)

#### Deliver a production-ready UI shell:

- **Layouts**: AuthLayout (public), MainLayout (private) with responsive Sidebar + Navbar + Breadcrumbs + Tabs component.
- **Auth Screens**: Login (email/password), remember me, errors; optional register (admin use).

#### Dashboards:

- Student: timetable, enrolled courses, grades, invoices/payments, notifications.
- Lecturer: sections, attendance taker, gradebook, submissions, messaging.
- Admin: user management, programs, courses, reports, audit logs.

- Finance: invoices, payments, reconciliation, exports.
- Library: catalog, loans, fines.
- **UX**: Tables with pagination, column filters; modals for CRUD; toasts; skeleton loaders; empty states; accessible forms with RHF + Zod.
- Theming: Light/dark, Tailwind config.

**Data layer**: Axios instance with cookie credentials, React Query for caching & mutations, global auth guard (redirect to /login when unauthenticated), 401/403 handling.

# 8) Payments (M-Pesa)

Implement an abstraction around M-Pesa STK Push:

- Endpoints: POST /finance/mpesa/stk to initiate; POST /finance/mpesa/callback to confirm.
- States: pending → success/failed; idempotency key; store M-Pesa receipt number.
- Testing: sandbox credentials in .env.example.
- Security: verify callback signature/origin if available; reconcile jobs, retry on pending.

## 9) Notifications

- Email: Nodemailer (Mailhog dev), templating (MJML/Handlebars).
- **SMS**: Provider-agnostic interface; plug Safaricom or Africa's Talking.
- In-App: Notification center + unread badge.

## 10) Docs to Generate

- README.md (root, backend, frontend) with:
  - Set up, env variables (document all)

- o Running dev (docker-compose), migrations, seeding
- Testing, linting, formatting, and commit conventions
- Deployment steps
- OpenAPI docs served at /docs.
- Architecture diagram (mermaid) and ERD (mermaid).
- RBAC policy table.
- Backup/Restore guide.

## 11) Dev & Prod Tooling

- Docker Compose: services api, web, db (MySQL), redis, minio, mailhog, nginx.
- Nginx: TLS termination, gzip, caching for static assets.
- CI (GitHub Actions):
  - Lint (ESLint), type check, test (backend+frontend)
  - Build containers
  - Run migrations
  - Deploy to staging/prod (push to registry + compose up)
- **PM2**: process manager in prod, graceful shutdown, health checks.
- Logs: JSON logs to stdout, sample filebeat/ELK notes.
- Metrics: /health, /metrics (Prometheus format if possible).

## 12) Testing Strategy

Unit: services, utils (vitest/jest).

- Integration: API with supertest and a test DB.
- **E2E**: Playwright/Cypress for critical flows (login, enroll, pay).
- **Security**: auth/permission tests; input validation tests; rate limit tests.

# 13) Seeding

Provide seed scripts for:

- Roles and an admin user.
- Sample programs, courses, and sections.
- Demo students/lecturers.
- Fee structures, invoices.
- Library items.

## 14) Make It Run

Provide all files needed to run:

- 1. docker-compose.yml (db, redis, minio, mailhog, nginx, api, web).
- 2. Dockerfile for api and web with multistage builds.
- Makefile (targets: make up, down, logs, migrate, seed, test).
- 4. .env.example for both frontend and backend with documented variables (DB creds, JWT secrets, cookie settings, M-Pesa keys, SMTP, S3/MinIO, CORS origins).

# 15) Coding Standards

- JavaScript is preferred across both frontend and backend.
- ESLint + Prettier configs.

- Commit style: Conventional Commits.
- PR templates & CODEOWNERS examples.

# 16) Deliverables (Generate Now)

#### 1. Backend:

- Sequelize models + migration
- o Example controllers/services/routes for auth, students, finance
- o Middleware: auth, rbac, validate, errorHandler, rateLimiter
- OpenAPI.yaml or runtime OpenAPI generator
- Seed + migration scripts

#### 2. Frontend:

- Layouts, pages, routes
- UI kit components (Sidebar, Navbar, Tabs, Modal, Toast, Loader)
- Forms with RHF + Zod
- Axios instance with cookie creds, React Query setup
- ProtectedRoute/AuthGuard pattern

#### 3. Infra:

- docker-compose.yml
- Nginx config
- o GitHub Actions CI workflow
- o PM2 ecosystem file

#### 4. **Docs**:

- Root README.md with step-by-step quickstart
- ERD + architecture diagrams (mermaid)
- RBAC matrix
- Security checklist (OWASP) + Kenya DPA notes

# 17) Acceptance Criteria

- docker compose up starts full stack.
- Access **frontend** at https://localhost (nginx TLS self-signed ok) → login page.
- Default admin can login, create a program, course, class section.
- Student can be admitted, enrolled, marked present, graded.
- Finance can issue invoice and complete an **M-Pesa sandbox** payment flow.
- Library loan/return works; fines compute.
- Reports export CSV; notifications send to Mailhog.
- Logs are structured; /health returns OK; errors are standardized.
- Tests run green; migrations + seeds idempotent.

# 18) Theme & UI Design Guide

## 1. Brand Colors

We'll use Tailwind CSS color tokens for simplicity and maintainability.

Purpose	Color Family	Tailwind Range
Background	Slate (cool neutral)	slate-500 → slate-950 (dark mode primary backgrounds)
Primary (CTA, Buttons, Links)	Blue	blue-500 → blue-800
Text (on dark bg)	White	text-white
Danger / Delete	Red	red-500 → red-700
Warning	Yellow / Orange	yellow-400 → orange-500
Light Mode Background	Gray / Off-White	gray-100 → gray-200
Light Mode Text	Slate / Dark Gray	slate-800/gray-900

## 2. Typography

- Font Family: Roboto (import via Google Fonts or include in Tailwind config).
- Weights:
  - 400 → Regular (body text)
  - 500 → Medium (labels, minor headers)
  - 700 → Bold (section headers, emphasis)

#### 3. Icons

- Primary sets:
  - react-icons/fa → FontAwesome
  - o react-icons/fi → Feather Icons
- Guidelines:
  - Keep icons stroke-based (outlined) for a clean, modern look.
  - Use **filled icons only** for status indicators (success, error).

#### 4. Animations & Transitions

- Framer Motion (preferred) for page transitions, modals, and dashboards.
- Tailwind transitions for micro-interactions:
  - o transition-all ease-in-out duration-200 for hover states.

- Button hover → background darkens (blue-600 → blue-700), text stays white.
- Dropdowns, tooltips  $\rightarrow$  scale-95  $\rightarrow$  scale-100 pop-in.

## 5. Light & Dark Mode

- Default Mode: Dark (slate background, white text).
- Light Mode:
  - Background → gray-100 / gray-200
  - $\circ$  Text → slate-800 / gray-900
  - Accent colors (blue, red, yellow/orange) remain the same.
- Switch using Tailwind's dark: modifier or next-themes.

## 6. Component Guidelines

#### Buttons:

- o Primary → bg-blue-600 hover:bg-blue-700 text-white
- o Danger → bg-red-600 hover:bg-red-700 text-white
- Warning → bg-orange-500 hover:bg-orange-600 text-white
- o Rounded (rounded-x1), subtle shadow (shadow-md).

#### • Cards / Containers:

 $\circ$  Dark  $\rightarrow$  bg-slate-800 text-white

- $\circ$  Light  $\rightarrow$  bg-white text-slate-800 shadow-sm
- Rounded corners (rounded-2x1), padding (p-6).

#### • Inputs / Forms:

- o Border → border-slate-600 focus:border-blue-500
- $\circ$  Background  $\rightarrow$  bg-slate-900 text-white placeholder-gray-400 (dark)
- Animated focus glow: focus:ring-2 focus:ring-blue-500.

#### Tables / DataGrid:

- Zebra stripes using odd:bg-slate-800 even:bg-slate-700.
- $\circ$  Hover highlight  $\rightarrow$  hover:bg-slate-600.
- o In light mode → subtle gray-100 / gray-50 background stripes.

## 7. Example Tailwind Config Snippet

```
// tailwind.config.js

module.exports = {
    darkMode: "class",
    theme: {
        extend: {
            fontFamily: {
                sans: ["Roboto", "sans-serif"],
            },
            colors: {
```

```
brand: {
          bg: {
            dark: "#0f172a", // slate-950
            light: "#f8fafc", // gray-50
          },
          primary: {
            DEFAULT: "#2563eb", // blue-600
            dark: "#1e40af", // blue-800
          },
          danger: "#dc2626", // red-600
          warning: "#f59e0b", // amber-500
        },
      },
   },
 },
};
```

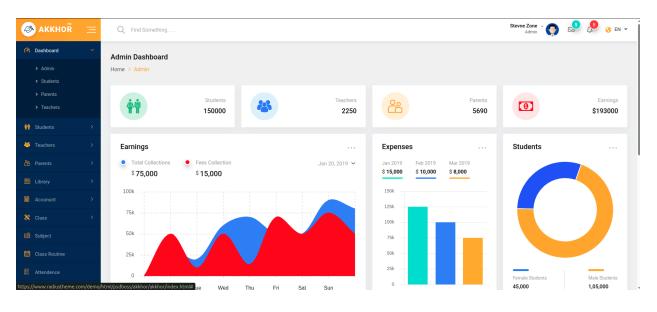
## 8. Deliverables

- Figma/Storybook Design System with:
  - o Buttons, Forms, Tables, Modals, Alerts (danger/warning/success).
- Reusable Components in React:

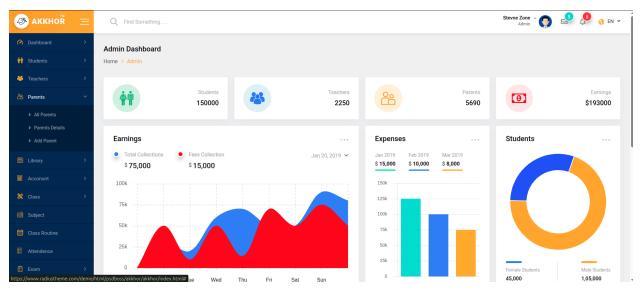
```
o <Button variant="primary" />
o <Card />
o <Alert type="danger" />
```

• **Animations**: Page fade/slide, modal pop-in/out, toast notifications.

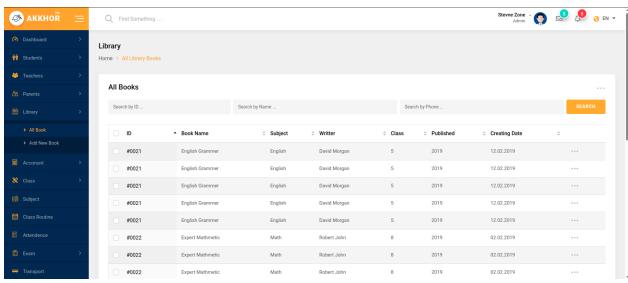
# Below are images for possible screens but not actual on the final product we are developing

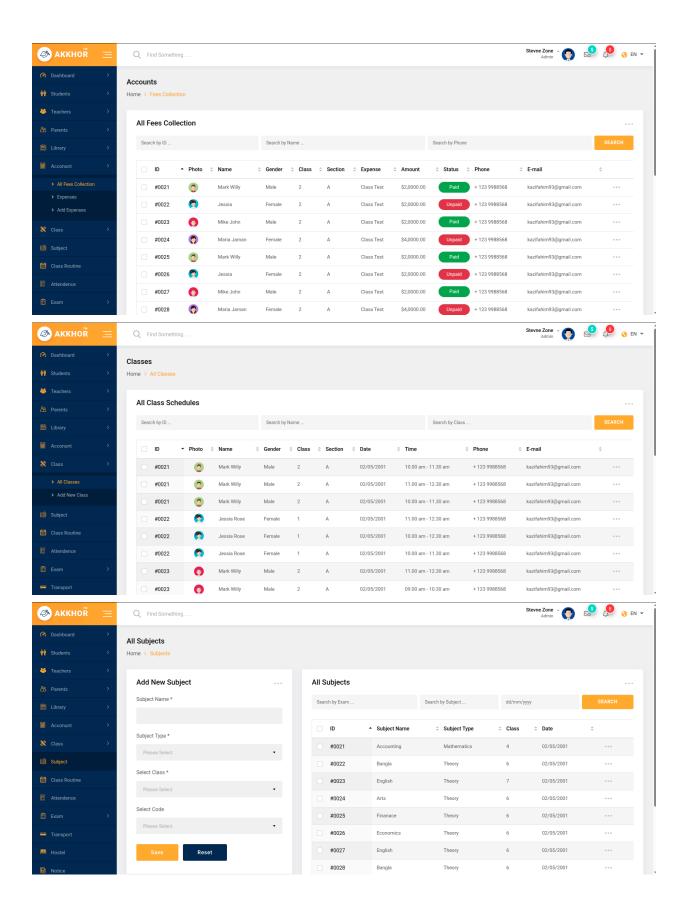


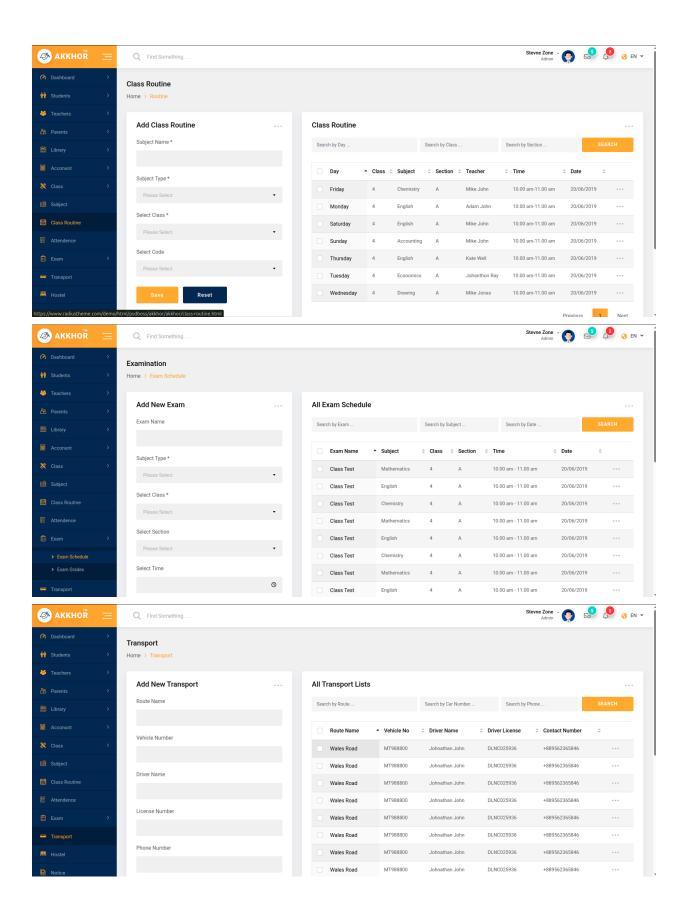


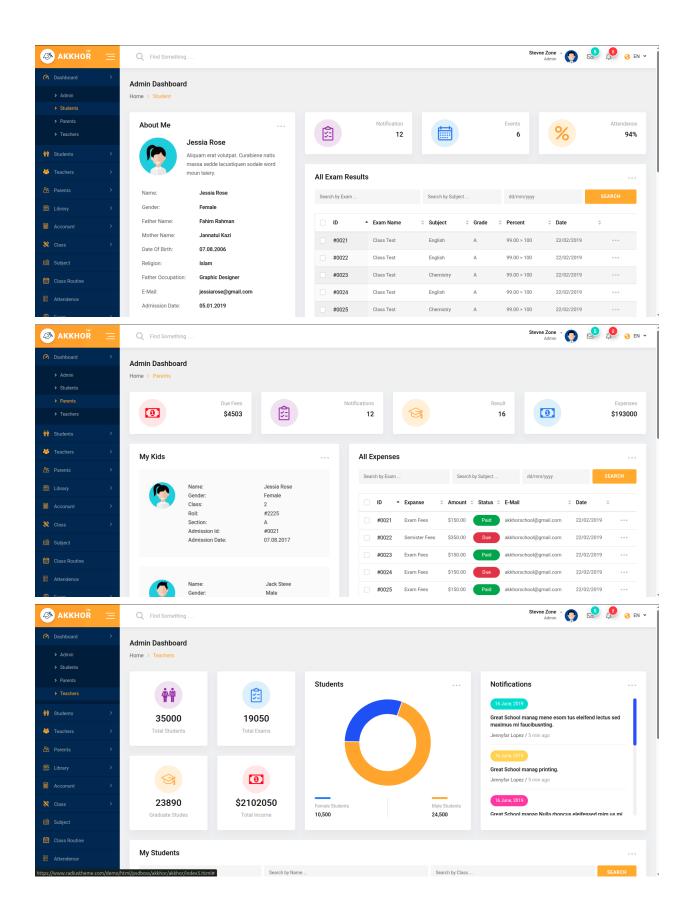


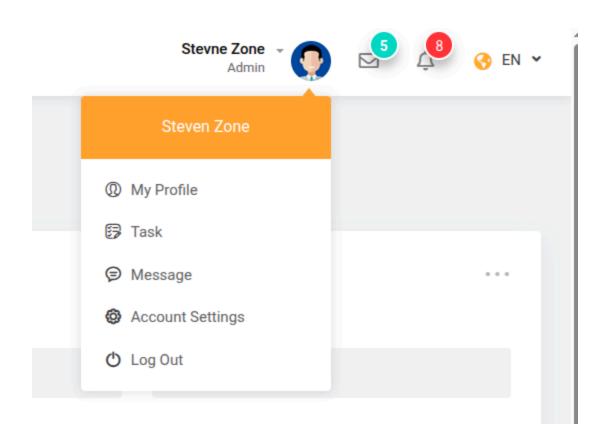
























## 05 Message



#### Maria Zaman

18:30

What is the reason of buy this item. Is it usefull for me.....



## Benny Roy

10:35

What is the reason of buy this item. Is it usefull for me.....



#### Steven

02:35

What is the reason of buy this item. Is it usefull for me.....



## Joshep Joe

12:35

What is the reason of buy this item. Is it usefull for me.....

