**Project Design Phase**

**Solution Architecture**

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| Date | 9 February 2026 |
| Team ID | LTVIP2026TMIDS24988 |
| Project Name | Civil Engineering Insight Studio |
| Maximum Marks | 4 Marks |

**Solution Architecture:**

Solution architecture bridges the gap between the business problem (manual structural documentation) and the technological implementation (AI-powered structural analysis). It defines how the system components interact to deliver automated engineering insights.

### Architecture Goals

* Provide an automated AI-based solution for analyzing civil engineering structures from images.
* Define modular components (UI, Application Logic, API Integration, Infrastructure).
* Ensure scalability, reliability, and maintainability.
* Deliver structured engineering documentation efficiently.
* Enable seamless deployment in local or cloud environments.

### Layered Architecture Overview

The Civil Engineering Insight Studio follows a four-layer architecture:  
  
1️⃣ Client Layer – Civil Engineer or Site Supervisor interacting with the web application.  
2️⃣ Presentation Layer – Streamlit Web Interface handling user interaction and display.  
3️⃣ Application Layer – Python application logic managing input validation, prompt construction, Gemini API integration, report formatting, and error handling.  
4️⃣ Infrastructure Layer – Deployment environment (Local Machine / Streamlit Cloud / Cloud Hosting) and external integration with Google Gemini API.

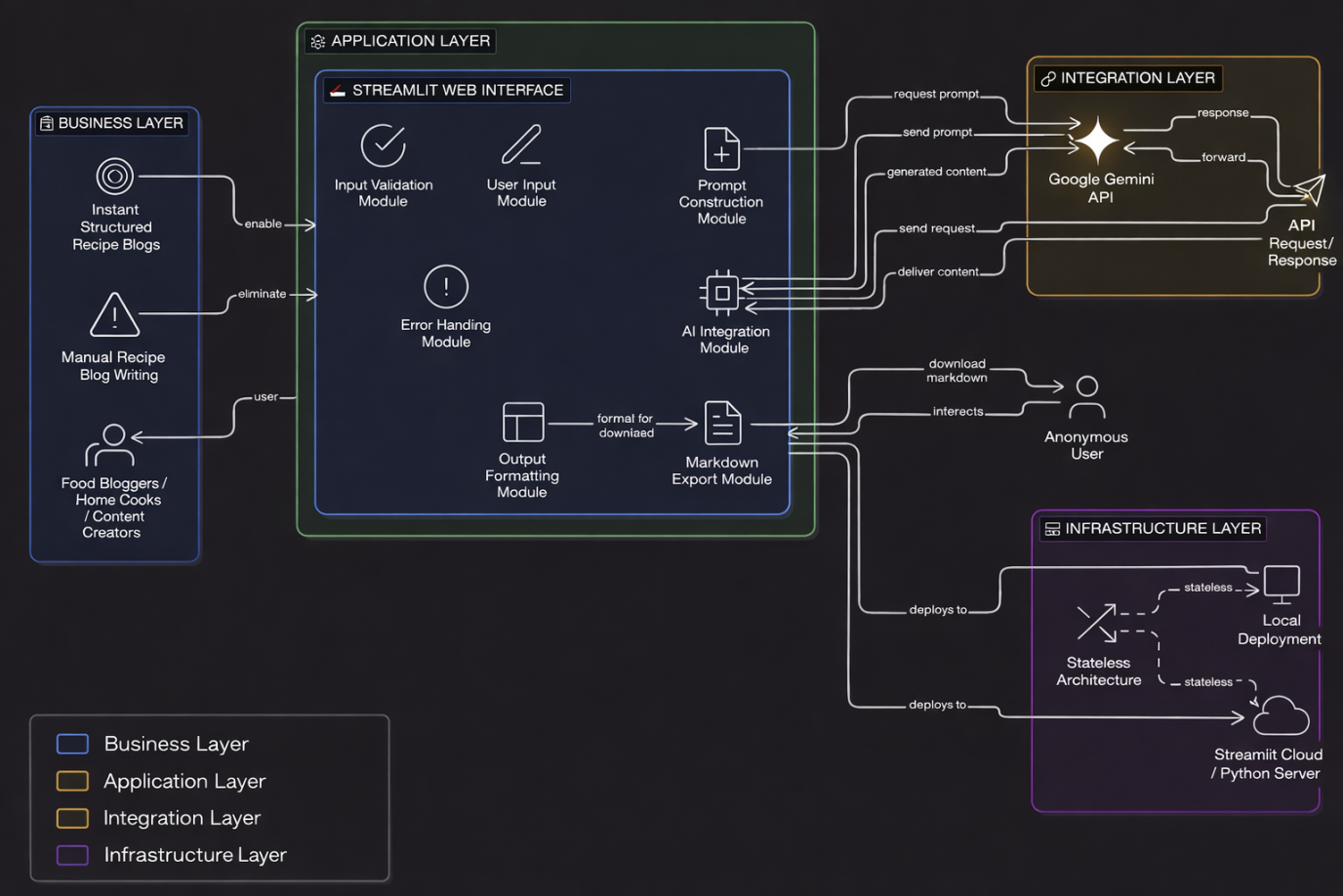
### Application Layer Components

* Input Validation Module – Ensures image and text input are valid before processing.
* Prompt Construction Module – Constructs structured engineering prompts for Gemini API.
* Gemini API Integration Module – Sends image + structured prompt to Gemini Vision model and retrieves analysis.
* Report Formatting Module – Formats AI response into structured engineering documentation.
* Error Handling Module – Handles API failures and invalid inputs gracefully.

### Data Flow Description

* Step 1: User uploads construction image and enters analysis request.  
  Step 2: Streamlit interface forwards input to application logic.  
  Step 3: Input validation and prompt construction occur.  
  Step 4: Structured prompt and image are sent to Google Gemini Vision API.  
  Step 5: AI-generated structural analysis is received.  
  Step 6: Report is formatted and displayed to the user.  
  Step 7: Optional report download or session storage.

**Solution Architecture Diagram:**

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