FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGIES
FALL 2025
FINAL EXAMINATION

COURSE TITLE:	Advanced Software Engineering Methodology
COURSE CODE:	6114
INSTRUCTOR:	Dr Fosso
DATE:	
DURATION:	Three weeks

PROJECT: *Design, engineering, and securing of a full software and cloud infrastructure for a nationwide smart tourism platform*

Instructions

The final report must include:

- Professional architecture diagrams (microservices, APIs, CI/CD pipeline, deployment architecture)

- UML models (Use Case, Class, Component, Sequence)

- Domain-Driven Design (DDD) bounded contexts

- API specifications (OpenAPI)

- CI/CD pipeline configuration

- Testing plans and automated test scripts

- Containers and Dockerfiles

- Cloud orchestration design (Kubernetes)

- Documentation of system quality, performance, and scalability decisions

- A complete risk and ethics analysis

This project focuses on the design, engineering, deployment, and governance of a large-scale tourism information system for Cameroon using modern software engineering methodologies.

The fictitious national entity NaTourCam aims to digitize, modernize, and promote the country's cultural and natural heritage.

PROJECT CONTEXT

NaTourCam provides the following digital services:

i) Interactive tour guides for national parks and cultural sites

ii) Multilingual cultural content for 250+ Cameroonian languages

iii) Smart recommendation systems for visitors

iv) E-ticketing with mobile payments

v) Geolocated itineraries and travel safety alerts

vi) VR/AR immersive experiences

vii) APIs for tourism agencies, hotels, and transport operators

viii) Analytics dashboards for the Ministry of Tourism

NaTourCam operates with:

- 7 million expected users
- 10 regional data centers
- Hundreds of tourism partners (agences, hôtels, chefferies, parcs)
- A distributed development team (Yaoundé, Buea, Douala, Maroua)
- Strict requirements in security, availability, cultural ethics, and multilingual support

Your mission is to design, justify, model, and secure the full NaTourCam platform based on advanced software engineering methodologies.

PART I : DOMAIN-DRIVEN DESIGN and AGILE ARCHITECTURE (20 marks)

The system must adopt a Domain-Driven Design (DDD) methodology.

Tasks

1. Identify and define at least six (06) bounded contexts, including:

    - Cultural Heritage
    - Tourism Sites
    - User Profiles
    - Ticketing & Payments
    - Recommendation Engine
    - Geo-Services

2. Provide a Ubiquitous Language dictionary for three contexts.

3. Choose between Scrum, Kanban, or XP as the primary Agile method.
   Justify your choice using four criteria:
   scalability, uncertainty, stakeholder diversity, and incremental delivery.

4. Produce a Use Case Diagram covering the major interactions of NaTourCam.

5. Explain how Agile improves collaboration between developers, linguists, cultural custodians, local tourism operators, and government agencies.

PART II : SOFTWARE ARCHITECTURE and MICROservices (20 marks)

NaTourCam must adopt a cloud-native microservices architecture.

A. Microservices Architecture (5 marks)

1. Design a full microservices decomposition for NaTourCam (minimum 10 services).

2. Provide a Component Diagram showing interactions.

3. Explain how the architecture supports multilingual content and cultural diversity.

4. Describe the role of the API Gateway and Service Mesh.

B. Data Management and APIs (10 marks)

5. Design a distributed database architecture (SQL + NoSQL).

6. Produce OpenAPI specifications for two critical APIs:

   a) Tourism Site Search API

   b) Cultural Content API

C. Performance and Scalability (5 marks)

7. Explain:

   a) horizontal vs vertical scaling

   b) caching strategies (Redis, CDN)

   c) handling 500,000 concurrent visitors during holidays/festivals

PART III : CI/CD, DEVOPS and SOFTWARE QUALITY (10 marks)

NaTourCam must support continuous delivery and high quality.

Tasks

1. Design a complete CI/CD pipeline including:

   a) linting

   b) automated tests

       c) security scanning

       d) container build

       e) deployment to Kubernetes

2. Provide an example of a build script or pipeline file (GitHub Actions, GitLab CI, Jenkins).

3. Propose a Test Strategy including:

       a) unit tests

       b) integration tests

       c) load tests

       d) UI/UX tests

       e) Model-Based Testing (MBT)

4. Define KPIs for software quality such as availability, MTTR, test coverage, response times.

5. Explain how DevOps practices improve coordination across NaTourCam's distributed regions.

PART IV : CLOUD ARCHITECTURE, CONTAINERS and ORCHESTRATION (10 marks)

Cloud and Virtualization (5 marks)

1. Select the appropriate cloud model for NaTourCam:

       a) Private Cloud

       b) Hybrid Cloud

       c) Public Cloud

2. Justify your selection using:

       a) cost

       b) performance

       c) sovereignty

       d) cultural data protection

3. Design the deployment architecture for these services across 10 regions.

Containerization and Kubernetes (5 marks)

4. Containerize the Recommendation Engine or Ticketing System. Include a complete Dockerfile.

5. Provide a Kubernetes deployment and service specification.

6. Explain:

      a) auto-scaling

      b) rolling updates

      c) self-healing

7. Describe the impact of latency on recommendation results for tourists.

PART V : SECURITY, ETHICS and DATA GOVERNANCE (10 marks)

NaTourCam handles sensitive cultural and personal data.

Tasks

1. Provide a Zero-Trust security model adapted to tourism and cultural data.

2. Describe:

      a) authentication (OIDC, OAuth2)

      b) access control (RBAC, ABAC)

      c) data encryption

3. Identify four ethical risks related to digitizing Cameroonian cultural heritage.

4. Propose mitigation strategies for:

      a) data misuse

      b) misrepresentation of cultural artifacts

      c) unauthorized access

      d) geolocation tracking risks

5. Provide a security incident response plan for a cultural data breach.