1. Project Title

NFCampus: A Digital Student Identification and Access System Using NFC Technology for Android

2. Student Information

Name	Student ID	Programme / Major	Year / Semester	Email
Eu Jin Yang	BSSE2506021	Software Engineering	Y2S5	BSSE2506021@peninsulamalaysia.edu.my
Ng Kean Chun	BSSE2506036	Software Engineering	Y2S5	BSSE2506036@peninsulamalaysia.edu.my
Teoh Yi Shan	BSSE2506022	Software Engineering	Y2S5	BSSE2506022@peninsulamalaysia.edu.my
Yong Ken	BSSE2506025	Software Engineering	Y2S5	BSSE2506025@peninsulamalaysia.edu.my

3. Supervisor Information

Name: Eric Kong Kok Wah

Department: School of Technology and Engineering (SOTE)

Email: eric.kong@peninsulamalaysia.edu.my

4. Background and Problem Statement

Our college uses RFID access cards for entry into campus buildings, libraries, and labs. While effective, this system has a major flaw: "It relies solely on a physical card". Students and staff are frequently locked out due to forgotten, lost, or damaged cards, leading to missed classes, exams, and significant frustration.

The core issue is that the system identifies the card, not the person. While biometrics are an alternative, they are costly and raise privacy concerns. There is a clear need for a secure, convenient backup method.

Our solution is to leverage Near Field Communication (NFC) technology on smartphones. By creating a digital credential, we can integrate access control into a student's device always carry. This provides a user-centric, secure secondary authentication method, ensuring authorized access is always available.

5. Objectives

The primary goal of this project is to develop a secure and reliable smartphone-based authentication system that supplements the existing college access card system. To achieve this, we have established the following the SMART criteria:

- Specific: Develop a functional mobile application prototype that can emulate the college access card's credentials by storing and transmitting access credentials through NFC.

- Measurable: The prototype should successfully interact or communicate with our test reader. Where the test reader will correctly identify a valid digital credential from our app and trigger the "unlock" signal.

- Achievable: We will use the Android Studio app to develop and implement Host Card Emulation (HCE) for Android phones to emulate an access card. Due to the limitations and restrictions imposed on most iOS devices, we will only work on android devices.

- Relevant: This objective directly solves the problem of forgotten access cards by leveraging devices students always carry their smartphone. It provides a practical, modern supplement to the existing card system within a feasible academic project scope.

- Time-Bound: The deadline for the project is expected to be around 28th March 2026.

6. Scope of the Project

- In-Scope
    - I. Development of an Android Mobile Application for Student Users
        - ➔ User Authentication Flows

- ➔ Optical Character Recognition (OCR) Integration
- ➔ Image Capture and Storage
- ➔ NFC Card Binding
- ➔ Multi-Factor Authentication (MFA) Login

II. Backend System and Database

- ➔ User Account Management
- ➔ NFC UID Validation

III. Proof-of-Concept Access Simulation

- Out-of-Scope

I. iOS Application Development

II. Advanced OCR Data Parsing

III. Admin Dashboard or Guard Interface

IV. Automatic Card Deactivation

V. Real-time Communication with University Databases

VI. Fully Functional Reader System for Buildings

7. Literature Review / Related Works

I. Traditional Physical Student Cards

Strengths:

- Simple, low-cost to produce, and universally understood

Weaknesses:

- High Risk of Loss or Theft
- No Inherent Authentication
- Lack of Convenience
- Limited Functionality

II. Proprietary Wallet Passes

Strengths:

Passes are accessible from the lock screen and are seamlessly integrated with the mobile operating system for ultimate convenience while also leveraging built-in security.

Weaknesses:

- Limited Customization & Control
- Closed Ecosystem for Access Control

III. NFC Technology in Access Control

Strengths:

- Security
- Fast and Convenience
- Standardized and Reliable

Weaknesses:

Traditionally, credentials are stored on proprietary, disposable plastic cards.

IV. National Digitalization Initiatives: The MyJPJ Case Study

Strengths:

- Proven Convenience
- Official Recognition
- User-Centric Model

Weaknesses:

- Passive and Visual Verification
- Security Relies on Device Security
- Manual and Slower Process
- No-Machine Readable Data Tap

8. Methodology

- Project Approach / Framework

We will adopt the Agile-Scrum framework to manage the project's development. This iterative approach is well-suited for software projects with evolving requirements.

A. Sprints: The project schedule will be divided into two-week sprints.

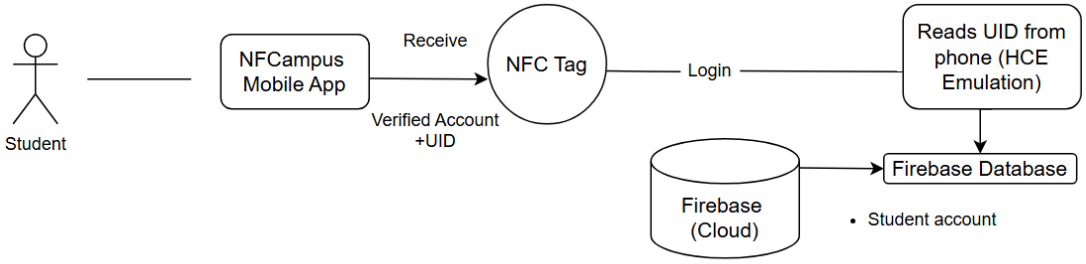
B. Sprint Planning: At the beginning of each sprint, our team will select a set of tasks from the product backlog to complete.

C. Daily Stand-ups: Brief daily meetings will be held to synchronize activities and identify blockers.

D. Sprint Review & Retrospective: At the end of each sprint, we will demonstrate completed functionality and reflect on the process to improve the next sprint. This allows for regular feedback and continuous refinement of the product.

- Tools and Technologies
  A. Android Studio
  B. Firebase / Firestore
  C. Figma
  D. Kotlin
  E. GitHub

- System Design / Architecture



- Implementation Plan

  A. Module 1: Implement Basic Foundations for the Project
     - Develop a backend server, database, and basic API endpoints.
     - Build an Android app with a login system, user interface and navigation.

  B. Module 2: Develop and Implement the Core Features for the App such as OCR Registration System and Basic Security Features
     - Implement the OCR registration flow and the NFC UID capture during registration.
     - Develop the password and NFC MFA login flow. After entering a password, the user must verify identity by entering a code sent to their email.
     - Develop a one-card-per-account system to prevent one account from having multiple accesses.

  C. Module 3: Implement and Integrate HCE Service into the Application
     - Implement the HCE service to successfully emulate the card's UID. Integrate the “Simulate Access” feature.
     - Test the tap-to-login and tap-to-simulate-access functionalities.

  D. Module 4: Testing, Reviews and Polishing
     - Perform end-to-end testing, security auditing, and user testing. Use gathered data and experience to further improve the application.
     - Document any findings and changes.

- Testing and Evaluation

  To ensure the NFCampus system works correctly, securely, and efficiently, several testing stages will be carried out:

  I. Unit Testing
     - Test each part of the system (e.g., Login, NFC Scan, Database).

- Make sure every module works properly before integration.

II. Integration Testing
- Combine all modules and test how they work together.
- Check communication between the app, server, and NFC reader.

III. System Testing
- Test the full system in real-world scenarios.
- Try cases like valid/invalid users, lost devices, and no internet.

IV. Security Testing
- Check how well the system protects user data and access.
- Test for unauthorized access, NFC cloning, and encryption.

V. Usability Testing
- Let students and staff use the app and give feedback.
- Measure ease of use, speed, and satisfaction.

VI. Performance Evaluation
- Evaluate the system's speed and reliability under heavy use.
- Simulate multiple users and long usage periods.

9. Expected Deliverables

I. Mobile Application (Android)

- Fully functional NFCampus Mobile App built for Android devices

- Features include:
  - Student/Lecturer registration and login
  - OCR integration for scanning front/back of student card
  - NFC UID reading and binding to user account

    - Multi-Factor Authentication (MFA) using password + email code or physical card
    - Host Card Emulation (HCE) to emulate the access card for building entry

II. Backend System & Database

- Cloud-based backend (Firebase) consisting of:
    - User accounts (Student & Lecturer)
    - UID binding and validation
    - Secure storage of card images and OCR data
    - API endpoints for login, registration, and access validation

- Database security rules and structure documentation

III. System Architecture & Design Documents

- System Design Diagram
- Use Case Diagram, Class Diagram, and relevant UML diagrams
- Data flow diagrams and API documentation
- Architecture explanation and module descriptions

IV. Prototype Demonstration

- Working proof-of-concept access simulation showing that a phone (via HCE) can be read by a standard NFC reader as if it were the original physical card

- Demonstration of UID validation and successful user authentication

V. Testing & Evaluation Documents

- Test plan covering:
    - Functional testing
    - NFC reading and HCE tests
    - Usability testing
    - Security and validation tests

- Test reports, results, and identified improvements

VI. Project Report & Documentation

- Complete final written report including:
  - Problem statement
  - Literature review
  - Methodology
  - System design
  - Development process
  - Evaluation
  - Conclusion and future work

- Properly formatted references (Harvard style)

VII. Presentation Materials

- Final presentation slides
- Demonstration video
- System overview for evaluation panel

VIII. Project Management Deliverables

- Gantt chart showing project timeline
- Meeting logs, planning notes, and task assignments

10. Project Timeline

2025		Sept			Oct			Nov			Dec		
Task	Description	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
Early Development (POC)	Set up Android Studio, repo, read NFC UID on test phone / reader.	🟨	🟨										
Requirement Analysis	Identify problems, gather requirements, stakeholder interviews.	🟨	🟨	🟨									
Literature Review & Background Study	Survey related works, summarize strengths / weaknesses.			🟨	🟨								
Define Scope, Objectives & Methodology	Finalize scope, SMART objectives, select framework (e.g., Agile-Scrum).					🟨							
System Design & Planning	High-level architecture, database schema, and interface planning.						🟨	🟨	🟨				
Frontend (Android) - UI/OCR	Login / Registration UI; Integrate OCR for card text.							🟦	🟦	🟦	🟦	🟦	🟦
Multi-Factor Authentication	Password and email link											🟦	🟦
Proposal Writing & Interim Submission	Draft, review with supervisor, finalize and submit proposal.		🟧		🟧		🟧		🟧		🟧		🟧

2026		Jan			Feb			Mar			Apr		
Task	Description	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23	W24
NFC HCE Integration	Implement HCE and reader interaction.	🟦	🟦	🟦									
Backend - API & DB	User accounts, NFC UID validation, one-card-per-account rules.	🟦	🟦	🟦	🟦								
Testing & Debugging	Unit, integration, and usability testing; Bug fixing.				🟩	🟩	🟩						
Documentation & Final Report	Update docs, figures, screenshots; Finalize report.						🟪	🟪	🟪				
Final Presentation & Submission	Rehearsal, slide deck, demo prep; Final Submission								🟥	🟥	🟥		

11. Resources Required

I. Hardware Resources

- Development Hardware:
  - Developer Computers
  - Android Smartphones for Testing

- Testing & Deployment Hardware:
  - NFC/RFID Readers

II. Software Resources

- Development Software & Tools:
  - Android Studio
  - Kotlin Compiler & Libraries
  - Firebase/Firestore
  - Figma
  - GitHub

12. Expected Outcome and Significance

- Anticipated Results
  1. A Fully Functional Android Application
  2. Seamless NFC-Based Access Control
  3. Enhanced Security Model

- Contributions and Significance
  1. Academic Contributions:
     - Advancement in Mobile Computing and Security

  2. Industrial and Practical Contributions:
     - Modernization of Campus Infrastructure

3. Societal Contributions and Benefits:
    - Enhanced User Convenience and Inclusivity

- Beneficiaries

  The following groups will directly benefit from the NFCampus project:

  1. Students
  2. The Developer Team and Academic Institution

13. References

Android Developers. “NFC Basics | Connectivity.” Android Developers, October 29, 2025. https://developer.android.com/develop/connectivity/nfc/nfc.

Google Developers. “Recognize Text in Images with ML Kit on Android.” Google for Developers, November 21, 2025. https://developers.google.com/ml-kit/vision/text-recognition/v2/android.

MyJPJ. *MyJPJ - Portal Rasmi JPJ*. April 11, 2025. https://www.jpj.gov.my/myjpj/.