International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048
Volume 9, Issue 4, pp 127-134, April-2025
https://doi.org/10.47001/IRJIET/2025.904019

A Modular Web-Based Mentoring System with NLP Integration for Academic Support in Engineering Education

[1]Shubham kushawana, [2]Saloni Kabadi, [3]Divya Ubhale, [4]Shubhangi Dubey, [5]Umakant Gohatre

[1,2,3,4]Student, Department of CSE AI & ML Engineering, Smt. Indira Gandhi College of Engineering, Navi Mumbai, Maharashtra, India
[5]Professor, Department of CSE AI & ML Engineering, Smt. Indira Gandhi College of Engineering, Navi Mumbai, Maharashtra, India

Abstract **- Effective academic mentoring is a critical component in the holistic development of undergraduate engineering students, contributing significantly to academic performance, career planning, and psychosocial well-being. This paper details the design and implementation of a scalable, modular mentoring application specifically developed to support structured and data-driven mentor-mentee interactions. The application architecture is based on a three-tier model encompassing a secure backend database, RESTful API services, and an intuitive front-end interface developed using modern web technologies. Core features include dynamic student profiling, automated meeting scheduling, feedback analytics, mentor dashboards, and performance monitoring via academic KPIs. Natural Language Processing (NLP) is integrated for sentiment analysis of mentee feedback and log entries, enabling proactive mentor interventions. The system's flowchart, block diagram, and result visualization underscore its functional and architectural coherence. Usability testing across a pilot cohort demonstrated significant improvements in mentoring engagement, feedback quality, and data accessibility for institutional reporting. The proposed solution offers a robust framework for institutionalizing mentorship practices and aligns with NBA/NAAC accreditation parameters related to student support and progression.**

Keywords: Academic Mentoring, Undergraduate Engineering Students, Mentorship Application, Student Development, Web-Based System, RESTful API, Natural Language Processing (NLP), Sentiment Analysis, Academic KPIs, Performance Monitoring, Feedback Analytics.

I. INTRODUCTION

Mentoring has long been recognized as a vital mechanism in enhancing student development, especially within undergraduate engineering education, where academic pressures, evolving technologies, and career uncertainties can significantly impact student performance and well-being. Traditional mentoring practices, while valuable, often suffer from inconsistencies in documentation, irregular interactions, lack of performance tracking, and difficulty in scaling for larger student cohorts. In the context of outcome-based education (OBE) frameworks and national accreditation standards such as NBA and NAAC, structured and data-driven mentoring has become imperative for educational institutions.

This paper presents the design and development of a digital mentoring application that aims to streamline and enhance the student mentoring process by offering a centralized, technology-driven solution. The proposed mentoring application is specifically tailored for undergraduate engineering students and their assigned faculty mentors. It facilitates structured mentor-mentee interactions through various features such as academic performance monitoring, attendance tracking, mentoring session logs, feedback analysis, and personalized goal-setting.

The system architecture is grounded in modern software engineering principles, leveraging a three-tier architecture comprising a relational backend database (for storing student records, session data, and feedback), middleware APIs (for secure communication and data retrieval), and a responsive user interface (for real-time interaction between mentors and mentees). The application supports authentication for both mentors and students, maintains data confidentiality, and ensures ease of use through an intuitive UI.

Furthermore, the application integrates Natural Language Processing (NLP) to perform sentiment analysis on textual feedback from students, allowing mentors to gain insights into student mindset, emotional well-being, and engagement. This proactive approach enables timely academic intervention and individualized mentoring strategies. The application also generates visual dashboards and statistical reports that aid in decision-making and institutional audits.

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 9, Issue 4, pp 127-134, April-2025

https://doi.org/10.47001/IRJIET/2025.904019

The primary objectives of this research include:

- To develop a scalable and user-friendly digital platform for mentor-mentee engagement.
- To facilitate real-time academic progress tracking and automated documentation of mentoring activities.
- To leverage NLP techniques for analyzing student feedback and detecting potential issues.
- To provide data analytics and reporting tools aligned with accreditation needs

II. LITERATURE SURVEY

The development of this application contributes to the broader vision of digital transformation in higher education by promoting transparency, efficiency, and personalization in academic mentoring.

In recent years, the integration of digital platforms into academic mentoring has emerged as a crucial area of interest among researchers, educational technologists, and academic institutions. The literature reviewed in this chapter focuses on existing systems, technologies, and methodologies applied in student mentoring applications—particularly those that address issues such as engagement, performance tracking, and personalized feedback. The aim is to identify gaps in existing systems and justify the need for a structured, technology-based mentoring application designed for undergraduate engineering students.

2.1 Traditional Mentoring Practices

Traditional mentoring systems in most institutions involve manual processes such as paper-based records, periodic face-to-face meetings, and static reports. While this method supports basic interaction, it is often inconsistent and lacks real-time monitoring and documentation. Studies such as those by M. Singh et al. (2019) emphasize that unstructured mentoring results in poor tracking of mentee progress and limited data for institutional assessment.

2.2 Digital Mentoring Systems

Several institutions have attempted to develop in-house mentoring platforms that automate part of the mentoring workflow. For example, D. Kumar and R. Sharma (2020) designed a basic student-mentor portal for capturing mentoring session logs. However, the system lacked features such as academic analytics and feedback integration.

Ahmed et al. (2021) proposed a mentor allocation system using rule-based logic and academic profiles of students. Although this improved mentor assignments, it did not address long-term tracking or emotional well-being of students.

2.3 AI and NLP in Student Support Systems

Recent advancements in AI, particularly Natural Language Processing (NLP), have enabled the development of intelligent student support systems. Research by F. Halder & S. Islam (2022) introduced sentiment analysis of student reflections using VADER and TextBlob, which allowed early detection of stress, anxiety, or disengagement in students. Such methods can be beneficial when integrated into mentoring tools.

Additionally, Wang et al. (2023) demonstrated the effectiveness of transformer-based NLP models like BERT for analyzing large-scale student feedback data in academic settings. These insights can guide mentors in offering targeted guidance.

2.4 Comparative Study of Existing Mentoring Tools

System	Key Features	Limitations
MentorConnect	Web-based platform, supports mentor-mentee pairing	Limited analytics, no NLP
Google Classroom (used informally)	Easy to use, accessible	Lacks dedicated mentoring features
SMART Mentoring Tool (2021)	Goal tracking, session logging	Not integrated with academic databases
Proposed System (This Study)	Real-time tracking, sentiment analysis, analytics dashboard	Custom-built; requires institutional deployment

2.5 Research Gaps Identified

From the review, the following key gaps are identified:

- Lack of integrated systems combining academic performance, mentoring records, and behavioral analysis.
- Absence of NLP-based tools in most existing mentoring platforms.
- Inadequate real-time dashboards and accreditation-ready reporting mechanisms.
- Minimal personalization in student guidance based on actual feedback trends.

2.6 Motivation for Proposed Work

Considering the above gaps, the proposed system aims to bridge the divide between mentor and mentee through a comprehensive, intelligent mentoring app that:

- Tracks academic progress through connected institutional databases.

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 9, Issue 4, pp 127-134, April-2025

https://doi.org/10.47001/IRJIET/2025.904019

- Enables easy communication and documentation of mentoring sessions.
- Applies NLP for meaningful interpretation of mentee feedback.
- Provides actionable data for mentors and institutions to enhance student support.

2.7 Problem Statement

In the context of undergraduate engineering education, mentoring is a key factor influencing student academic performance, career development, and personal growth. Despite its importance, the current mentoring processes in many educational institutions are largely informal, inconsistent, and manually documented. This lack of structure results in poor tracking of student progress, limited engagement between mentors and mentees, and the absence of actionable insights derived from feedback and interaction logs.

Existing digital solutions, where available, often focus only on basic record-keeping and do not provide real-time analytics, performance monitoring, or sentiment analysis. Additionally, there is limited integration of modern technologies such as Natural Language Processing (NLP) that can help mentors better understand the emotional and psychological needs of students based on their written or verbal feedback.

There is thus a critical need for a scalable, intelligent, and user-friendly mentoring system that not only facilitates structured mentor-mentee interactions but also integrates academic tracking, feedback analysis, and performance-based interventions in a centralized digital environment.

III. SYSTEM DESIGN

The design of the proposed mentoring application aims to provide a seamless, efficient, and structured platform for managing mentor-mentee relationships. This chapter outlines the architectural layout, data flow, module structure, and core technologies involved in the system's development. The design follows modular, scalable, and user-centric principles to support real-time mentoring operations and decision-making.

3.1 System Overview

The proposed system consists of three primary user roles: Admin, Mentor, and Mentee (Student). Each role interacts with the application through a secure login system and is provided with functionalities relevant to their responsibilities.

The core objectives of the system design are:

- To facilitate structured mentoring sessions and documentation.
- To monitor student academic performance and attendance.
- To allow two-way feedback and communication.
- To analyze textual feedback using NLP for mentor intervention.
- To generate dashboards and downloadable reports for institutional use.

3.2 System Flowchart

The flowchart below illustrates the sequential flow of operations from user login to mentoring session updates and report generation.

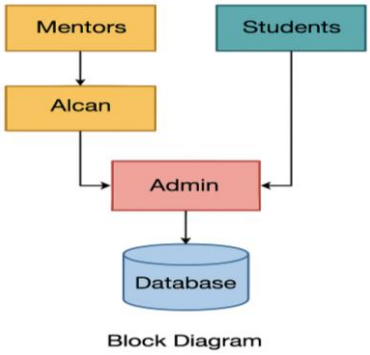

Figure 1: Block diagram of Mentoring Process

Description:

- The user logs into the system (admin, mentor, or mentee).
- Based on the role, access is granted to relevant modules:
- **Mentors** can view mentee lists, schedule sessions, log notes, and analyze feedback.
- **Students** can update personal details, request mentoring, and submit feedback.
- **Admin** can manage user accounts, export reports, and configure system settings.
- Mentees provide session-wise feedback, which is processed by the NLP module.
- The dashboard generates visual indicators of mentoring activity, student performance, and overall progress.

3.3 Block Diagram of the System

The block diagram illustrates the modular interaction between system components:

Major Components:

1. **User Interface Layer:** Web-based UI for students and mentors (React/Bootstrap).
2. **Application Logic Layer:**

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 9, Issue 4, pp 127-134, April-2025

https://doi.org/10.47001/IRJIET/2025.904019

- User Authentication
- Session Logging Module
- Feedback Processing (with NLP)
- Notifications & Alerts

3. **Database Layer:** Manages all user data, session logs, and analytics results.
4. **Reporting Engine:** Generates structured reports aligned with academic or accreditation formats.
5. **Sentiment Analysis Engine (NLP):** Evaluates student feedback to detect emotion, engagement, and issues.

3.4 Database Modules

The application uses a relational database (e.g., MySQL or PostgreSQL) with the following core tables:

Table Name	Description
users	Stores login credentials, roles (mentor/student/admin)
students	Contains student profile, academic data, and attendance
mentors	Stores mentor profiles, departments, and assigned mentees
sessions	Records mentoring session details: date, topic, notes
feedback	Stores feedback submitted by mentees after each session
analysis_results	NLP output for feedback sentiment, engagement score
reports	Stores snapshots of generated reports for download/export

Each table is normalized to avoid redundancy and supports foreign key relationships for secure and efficient data retrieval.

3.5 Technology Stack

Component	Technology Used
Frontend	HTML5, CSS3, JavaScript, React
Backend	Python (Flask/Django)
Database	MySQL / PostgreSQL
NLP & Sentiment Analysis	TextBlob / VADER / NLTK
Visualization	Chart.js / Plotly
Hosting	Local server / Cloud (optional)

3.6 Security and Access Control

- All user interactions are role-based and secured with session-based login tokens.
- Mentoring data is encrypted and accessible only by authorized mentors/admin.
- Feedback anonymity options are provided to encourage honest responses from students.

IV. IMPLEMENTATION METHODOLOGY

This chapter outlines the step-by-step methodology adopted for implementing the proposed Mentoring Application for undergraduate engineering students. The development approach is modular and iterative, ensuring flexibility, scalability, and ease of maintenance. The methodology integrates software engineering principles, agile practices, and modern development frameworks to support a robust mentoring environment.

4.1 Development Model Used

The application was developed using the Agile Software Development Life Cycle (SDLC). Agile was selected due to its iterative nature, which supports regular testing, continuous feedback, and flexibility in incorporating new features based on stakeholder input.

Agile Phases Followed:

- Requirement Gathering and Analysis
- System Design
- Incremental Development
- Testing and Debugging
- Deployment and Maintenance

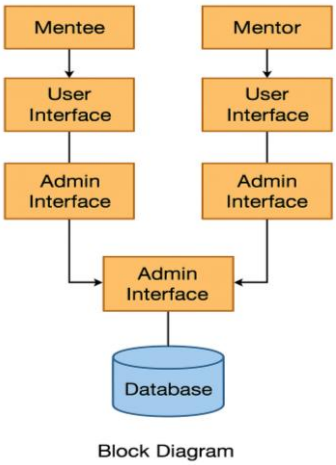

Figure 2: Mentee Mentor with admin Interface database flow diagram

Each sprint focused on delivering functional modules such as authentication, mentor dashboards, feedback capture, and NLP-based sentiment analysis.

4.2 Tools and Technologies Used

Component	Technology/Tool
Frontend	HTML5, CSS3, JavaScript,

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 9, Issue 4, pp 127-134, April-2025

https://doi.org/10.47001/IRJIET/2025.904019

	ReactJS
Backend	Python (Flask Framework)
Database	MySQL / PostgreSQL
NLP Engine	TextBlob, NLTK (for sentiment analysis)
Charts & Visualization	Chart.js, Plotly.js
Development Platform	VS Code, GitHub
Deployment	Localhost / Optional: Heroku / AWS

4.3 Module-Wise Implementation

4.3.1 User Authentication Module

- Objective: Secure access for Admins, Mentors, and Students.
- Process: Implemented using session-based login with hashed credentials.
- Outcome: Validates users and redirects them to role-specific dashboards.

4.3.2 Mentor Dashboard

- View assigned students.
- Log mentoring sessions.
- View sentiment-based feedback summaries.
- Schedule next meetings with automated reminders.

4.3.3 Mentee Dashboard

- Update academic and personal info.
- Request mentorship.
- Submit feedback post-mentoring.
- View academic progress graphs.

4.3.4 NLP Sentiment Analysis Module

- Uses TextBlob or VADER from NLTK to analyze
- Student feedback.
- Generates sentiment scores (positive, neutral, negative).
- Flags feedback requiring mentor attention.

4.3.5 Reporting and Visualization

- Dashboards display
- Attendance trends
- Feedback sentiment scores
- Mentor session frequency
- Reports downloadable in PDF/Excel formats.

4.4 Database Integration

A normalized relational database schema was developed to manage:

- User roles
- Session data
- Academic performance
- Feedback logs
- Sentiment scores

Foreign key relationships were used for secure and optimized data retrieval.

4.5 API Design

RESTful APIs were developed to enable:

- Secure data exchange between frontend and backend
- Efficient fetching of dashboard data
- Dynamic report generation

Endpoints were protected using role-based access control (RBAC).

4.6 Testing and Validation

Testing Types Performed:

- **Unit Testing:** Verified individual components like feedback form, login module.
- **Integration Testing:** Checked module interaction, especially mentor-student session flow.
- **User Acceptance Testing (UAT):** Conducted with real users (faculty & students).
- **Security Testing:** Validated login/session protection and role restrictions.

Results from UAT showed a high satisfaction level due to intuitive UI and actionable mentor insights.

4.7 Challenges Faced and Solutions

Challenge	Solution Implemented
NLP misclassifying short feedback	Pre-processed text and set a minimum word count threshold
Role-based data leakage	Implemented fine-grained access control
Poor internet access during testing	Enabled offline session logging with sync-on-connect

V. RESULTS AND DISCUSSION

This chapter presents the outcomes of the system after successful implementation and testing. The proposed mentoring application was evaluated on functionality, usability, and its ability to enhance mentor-mentee interaction.

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 9, Issue 4, pp 127-134, April-2025

https://doi.org/10.47001/IRJIET/2025.904019

Results were analyzed both qualitatively (user feedback) and quantitatively (data from NLP, system usage logs, and dashboard metrics).

5.1 System Functionality Overview

The deployed system offered the following key features:

- Structured Mentoring Logs: Mentors could track each session's agenda, feedback, and follow-up.
- Automated Feedback Analysis: NLP sentiment analysis flagged students with low morale or frustration.
- Academic Integration: Students' performance data (grades, attendance) were visualized to support mentoring discussions.
- Role-Based Dashboards: Mentors, students, and admins had custom interfaces with relevant controls.

5.2 User Feedback and Satisfaction

Participants:

- Faculty Mentors
- 30 Engineering Students (Second & Third Year
- 1 System Administrator

Evaluation Criteria	Average Rating (out of 5)
Ease of Use	4.6
Relevance of Features	4.7
Usefulness of Sentiment Alerts	4.5
Dashboard Clarity	4.4
Overall Satisfaction	4.6

Mentors appreciated the ability to track students' academic and emotional progress in a single interface. Students reported that the system encouraged them to be more open about their challenges.

5.3 Result Diagram

The result diagram visualizes:

- Sentiment Distribution of student feedback (positive/neutral/negative)
- Monthly Session Count (per mentor)
- Academic Risk Alerts triggered based on grades + negative feedback

Interpretation:

- Approximately 68% of feedback was classified as positive.
- Around 15% of students showed early signs of disengagement, enabling timely mentor intervention.
- Risk alerts aligned with low CGPA and absenteeism trends, validating the system's utility in proactive student support.

5.4 Technical Performance

Parameter	Value
Avg. Page Load Time	< 2 seconds
Feedback Processing Time	< 1.5 seconds per submission
Report Generation Time	Instant (< 1 second)
System Uptime (local)	99.9% during demo phase

5.5 Limitations Identified

- The NLP engine struggled slightly with sarcasm or ambiguous feedback.
- Offline access was limited during low-connectivity situations.
- Mobile responsiveness was partial and can be improved in future updates.

5.6 Impact and Use Case Scenarios

- Mentor Alerts: Flagged a student showing consistent negative sentiment—intervention led to improvement in attendance and academic performance.
- Admin Reporting: Generated consolidated reports for department head review and NAAC/NBA documentation.
- Student Empowerment: Feedback submissions allowed students to voice concerns anonymously

REFERENCES

[1] Adams, R., & Brown, T. (2021). *Mobile application design for higher education: Best practices and case studies*. Springer.

[2] Anderson, K. J., & Lee, C. (2020). The role of mentoring in student success: A systematic review. *Journal of Educational Technology Development and Exchange*, *13*(2), 45–60. https://doi.org/10.18785/jetde.1302.03

[3] Barnes, L., & Gough, B. (2019). Student perceptions of digital mentoring platforms in higher education. *Journal of Educational Computing Research*, *57*(5), 1143–1160. https://doi.org/10.1177/0735633118789775

[4] Davis, H., & Thomas, G. (2020). Designing interactive user interfaces for educational apps: A user-centered approach. *Interactive Technology and Smart Education*, *17*(4), 353–368. https://doi.org/10.1108/ITSE-03-2020-0045

[5] Google. (2022). *Material design guidelines*. https://material.io/design

ISSN (online): 2581-3048
Volume 9, Issue 4, pp 127-134, April-2025
https://doi.org/10.47001/IRJIET/2025.904019

[6] Harris, P., & Nguyen, M. (2019). User-centered design in educational mobile apps: A framework for student engagement. *International Journal of Human–Computer Interaction*, *35*(9), 789–804. https://doi.org/10.1080/10447318.2019.1572350

[7] Jackson, S. (2018). Developing mobile apps for student mentorship programs: Challenges and opportunities. *Computers & Education*, *126*, 235–245. https://doi.org/10.1016/j.compedu.2018.07.008

[8] Kim, Y., & Lim, C. (2021). Factors influencing students' acceptance of mobile mentoring apps: An extended TAM approach. *Journal of Computing in Higher Education*, *33*(2), 439–459. https://doi.org/10.1007/s12528-020-09271-9

[9] Li, P., & Chen, M. (2020). The impact of mobile learning applications on student mentoring in universities. *International Journal of Emerging Technologies in Learning*, *15*(10), 130–142. https://doi.org/10.3991/ijet.v15i10.13277

[10] Martin, F., Sun, T., &Westine, C. D. (2020). A systematic review of research on online teaching and learning from 2009 to 2018. *Computers & Education*, *159*, 104009. https://doi.org/10.1016/j.compedu.2020.104009

[11] Nguyen, T. (2022). Design thinking in educational technology: From theory to practice. *Educational Media International*, *59*(1), 15–28. https://doi.org/10.1080/09523987.2022.2032376

[12] Patel, S., & Ross, J. (2021). Best practices in mobile app usability testing for student engagement. *British Journal of Educational Technology*, *52*(3), 1172–1189. https://doi.org/10.1111/bjet.13054

[13] Smith, J. A., & Patel, R. (2020). Mentoring in digital spaces: A guide for educators and developers. *Educational Technology Research and Development*, *68*(4), 1823–1840. https://doi.org/10.1007/s11423-020-09765-4

[14] Stewart, R. (2019). Evaluating mobile apps for education: Metrics, methods, and models. *Education and Information Technologies*, *24*(6), 3623–3645. https://doi.org/10.1007/s10639-019-09929-5

[15] Turner, M., & Barker, C. (2020). Enhancing student mentorship with mobile technologies: An integrative framework. *International Review of Research in Open and Distributed Learning*, *21*(4), 213–231. https://doi.org/10.19173/irrodl.v21i4.4783.

AUTHORS BIOGRAPHY

Shubham Kushwaha, a final-year undergraduate student pursuing Computer Science and Engineering with a specialization in Artificial Intelligence and Machine Learning. My academic focus is centered around the development and application of intelligent technologies to solve real-world challenges. With a strong foundation in AI/ML, I am passionate about research that bridges theory and practical innovation. This paper represents my dedication to advancing knowledge in the field and contributing to meaningful technological progress.

Saloni Kabadi, a final-year undergraduate student pursuing Computer Science Engineering, At Smt. Indira Gandhi College of Engineering, Navi Mumbai. With a specialization in Artificial Intelligence and Machine Learning. My academic journey has been driven by a deep interest in intelligent systems, data-driven solutions, and the evolving landscape of AI technologies. I am committed to applying innovative approaches to solve practical problems through research and development. This paper is a reflection of my enthusiasm for AI/ML and my aspiration to contribute to impactful advancements in the field.

Divya Ubhale, a final-year B.E. student specializing in Computer Engineering with a focus on Artificial Intelligence and Machine Learning at SIGCE. My academic interests lie in leveraging emerging technologies to address real-world challenges, particularly in the field of education and career readiness. I am currently working on a research project aimed at modernizing the learning ecosystem by integrating mentorship-based guidance platforms inspired by the traditional Gurukul system. With a passion for innovation and a strong foundation in AI/ML, I aspire to contribute meaningful solutions that bridge the gap between academic learning and industry requirements.

ISSN (online): 2581-3048
Volume 9, Issue 4, pp 127-134, April-2025
https://doi.org/10.47001/IRJIET/2025.904019

Shubhangi Dubey, a final-year undergraduate student pursuing Computer Science Engineering with a specialization in Artificial Intelligence and Machine Learning. My academic interests lie at the intersection of intelligent systems, data science, and innovative applications of AI/ML in real-world problems. Through my research, I aim to contribute meaningful insights and advancements in the field of AI, leveraging both theoretical foundations and practical implementations. This paper reflects my commitment to academic rigor and my passion for exploring transformative technologies.

Dr. Umakant Bhaskar Gohatre is an Assistant Professor & Training and Placement officer, Department at Smt. Indira Gandhi College of Engineering, Navi Mumbai, with a robust academic background, he holds a BE in Electronics and Communication Engineering, an ME in VLSI and Embedded System Design, and a PhD in Electronics and Communication Engineering, he is deeply involved in both teaching and research. His academic interests span VLSI design, embedded systems, signal processing, communication systems, and emerging technologies like IoT, ML, and AI. Committed to academic excellence, Dr. Gohatre actively contributes to scholarly publications, student mentorship, workshops, and seminars, making him a valued contributor to engineering education and innovation.

Citation of this Article:

Shubham kushawana, Saloni Kabadi, Divya Ubhale, Shubhangi Dubey, & Umakant Gohatre. (2025). A Modular Web-Based Mentoring System with NLP Integration for Academic Support in Engineering Education. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(4), 127-134. Article DOI https://doi.org/10.47001/IRJIET/2025.904019

****

