



## Research Paper

# BLOCK - CHAIN BASED UNIVERSITY STUDENT MARKS MANAGEMENT

Divya Alwala

*M.Tech (CS) Student**Dept. of Computer Science and Engineering,**JNTUH University College of Engineering Science and Technology,**Hyderabad, Telangana, India**Email: [divyaalwala2000@gmail.com](mailto:divyaalwala2000@gmail.com)*

**Abstract:** Educational institutions require secure, transparent, and tamper-resistant systems to manage academic records, examination data, and student results while ensuring accountability and data integrity. Conventional marks management systems primarily rely on centralized databases, making them susceptible to unauthorized modifications, security breaches, limited traceability, and single points of failure. The proposed blockchain-based university student marks management framework utilizes academic information collected from institutional administrative records, including student details, faculty information, academic structures, subject allocations, examination schedules, marks, and result data. The workflow incorporates secure user authentication using SHA-256 hashing, AES-based encryption of sensitive marks data, role-based access control, blockchain transaction validation, and smart contract execution for academic operations. Ethereum blockchain, Solidity smart contracts, Flask, Web3.py, MetaMask, and Ganache are integrated to implement secure record management, immutable storage, result publication, audit trail generation, and academic analytics. Performance evaluation is conducted using blockchain transaction processing, encryption efficiency, data integrity verification, access control validation, audit traceability, and result dissemination correctness. Experimental results demonstrate reliable storage of academic records, secure handling of examination information, accurate result processing, comprehensive audit logging, and effective protection against unauthorized modifications while maintaining complete transaction transparency. The proposed architecture significantly enhances the security, reliability, transparency, and trustworthiness of university examination and academic record management systems.

**“Index Terms:** Blockchain, Ethereum, Smart Contracts, Academic Record Management, AES Encryption, SHA-256 Hashing”.

## 1. INTRODUCTION

Educational institutions are increasingly adopting digital technologies to manage academic records, examination processes, and student performance information efficiently. As the volume of academic data continues to expand, ensuring the confidentiality, integrity, transparency, and availability of educational records has become a critical requirement for universities and higher

education institutions. Traditional record management practices are gradually being replaced by digital platforms that support faster information processing and improved administrative efficiency. At the same time, emerging technologies such as blockchain have gained considerable attention for providing decentralized, immutable, and transparent data management capabilities that strengthen trust in

institutional operations. The integration of blockchain into educational environments offers promising opportunities to establish secure academic ecosystems capable of preserving the authenticity of student records while enhancing accountability and operational reliability across administrative processes [1]. Blockchain-based academic management has therefore emerged as a significant direction for improving the security and transparency of educational information systems [2].

Despite the widespread adoption of computerized academic management systems, most existing solutions continue to depend on centralized database architectures that remain vulnerable to unauthorized modifications, data breaches, insider manipulation, limited auditability, and single points of failure. These limitations reduce confidence in the authenticity of examination records and complicate the verification of academic achievements throughout a student's educational lifecycle. Existing approaches frequently emphasize isolated functionalities such as certificate verification or credential management while providing limited support for comprehensive examination administration, secure marks management, controlled result publication, and complete academic traceability. Furthermore, inadequate access control mechanisms and insufficient transparency in administrative operations restrict institutional accountability and create challenges in maintaining trustworthy academic records across multiple stakeholders [3]. Addressing these shortcomings requires a secure and transparent framework capable of protecting sensitive educational information while ensuring reliable record management and verification throughout the academic process [4].

The primary objective is to establish a comprehensive and secure university student marks management framework that enhances the protection, transparency, and integrity of academic information throughout its lifecycle.

The proposed framework is designed to facilitate efficient management of academic structures, faculty information, student registrations, subject allocation, examination scheduling, marks administration, result publication, and academic progression within a unified environment. It also aims to provide authenticated access for different categories of users, maintain permanent records of academic activities, strengthen institutional accountability, and ensure reliable verification of educational information. By integrating secure record preservation with transparent administrative processes, the framework supports effective academic governance while improving the consistency, accessibility, and reliability of university examination management systems [5]. In addition, the architecture promotes secure collaboration among administrators, faculty members, and students by providing trustworthy management of academic operations throughout the educational lifecycle [6].

The adoption of a secure blockchain-enabled academic management framework offers significant benefits for higher education institutions by improving data integrity, transparency, operational efficiency, and trust in examination administration. Immutable academic records minimize opportunities for unauthorized modifications while strengthening confidence in institutional decision-making and academic verification processes. Enhanced accountability through comprehensive audit capabilities enables educational organizations to monitor administrative activities more effectively and maintain reliable historical records for future validation. The proposed framework also supports the modernization of digital education infrastructure by establishing a scalable and dependable platform for secure academic record management. Its implementation has the potential to improve institutional governance, simplify verification procedures, reduce administrative complexity, and strengthen confidence among students, faculty members, employers, and

regulatory authorities, thereby contributing to the long-term advancement of secure educational information management systems [7] [8] [9] [10]

## 2. LITERATURE REVIEW

Blockchain technology has emerged as a promising solution for improving the security, transparency, and reliability of educational information systems. Saadati *et al.* proposed a blockchain-based learning management system that supports self-regulated learning by providing secure academic interactions and trustworthy educational data management. Their framework demonstrated improved learner engagement and data integrity; however, its primary focus remained on learning activities rather than comprehensive university examination and marks administration [11]. Similarly, Sudha *et al.* introduced a blockchain-based student information management system that enhanced the security and authenticity of student records through decentralized storage. Although the system improved data reliability, it offered limited functionality for examination scheduling, marks publication, and complete academic lifecycle management [12]. Tran *et al.* presented a blockchain-powered university ecosystem emphasizing secure communication, sustainable educational services, and connected institutional infrastructure. While the architecture strengthened institutional collaboration and security, it provided only limited support for detailed academic record workflows and result management [13].

Verification and protection of academic credentials have also attracted significant attention in blockchain-enabled educational environments. Shakan *et al.* developed a blockchain framework for verifying university student and graduate information, ensuring reliable authentication of academic credentials and reducing document forgery. Nevertheless, the framework primarily concentrated on credential verification without addressing secure examination management or continuous

academic record maintenance [14]. Samanta *et al.* proposed a blockchain-enabled smart contract framework for university examination systems that improved examination security, transparency, and automation of administrative procedures. Despite these advantages, the framework emphasized examination processing and offered limited support for broader academic management functions such as faculty administration, subject allocation, and student progression [15]. Yang *et al.* introduced a consortium blockchain framework for managing student status information across educational institutions, enhancing secure data sharing and institutional collaboration. However, the proposed framework focused mainly on student status management rather than comprehensive marks administration and result dissemination [16].

Recent developments have expanded blockchain applications toward academic credit management and secure educational record preservation. Mali *et al.* presented a blockchain-based Academic Bank of Credit system that securely manages student credits and academic progression while improving transparency and portability of educational achievements. Although effective for credential management, it does not comprehensively support examination scheduling, marks processing, and institutional analytics [17]. Balobaid *et al.* proposed an education record management framework integrating blockchain with encryption techniques to strengthen confidentiality and protect academic records from unauthorized access. The architecture demonstrated enhanced security but lacked extensive support for complete academic workflows and role-based administrative operations [18]. Deenmahomed *et al.* developed a blockchain-based framework for examination, transcript, and certificate management that improved record authenticity and simplified academic document verification. However, the system focused primarily on

document generation and validation rather than integrated academic administration throughout the student lifecycle [19].

More recently, Chinnasamy *et al.* introduced a blockchain-based educational document management framework incorporating role-based access control and intelligent decision support to strengthen document security and administrative efficiency. The framework demonstrated improved access management and secure record preservation but remained centered on educational document handling instead of complete university marks management and examination operations [20]. Collectively, these contributions demonstrate the growing adoption of blockchain technology in higher education for improving security, transparency, and trustworthiness. Nevertheless, existing solutions generally focus on specific academic functions such as credential verification, student information management, examination security, or document preservation, while providing limited support for an integrated academic lifecycle. The current framework addresses these limitations by providing a unified environment for secure academic structure management, faculty and student administration, examination scheduling, encrypted marks management, result publication, audit traceability, and role-based access control, thereby improving the reliability, transparency, and operational efficiency of university academic record management.

### 3. PROPOSED FRAMEWORK

The proposed framework is designed to provide a secure, transparent, and tamper-resistant platform for managing university academic records and examination processes using blockchain technology. The system utilizes institutional academic data, including student information, faculty records, subject assignments, examination schedules, marks, and published results, to support comprehensive academic lifecycle management. The overall workflow follows a structured pipeline for secure data acquisition,

validation, storage, and controlled access while ensuring efficient processing of academic transactions. Ethereum blockchain, Solidity smart contracts, Web3.py, and Flask are integrated to enable decentralized record management, automated execution of academic operations, and seamless interaction between users and the blockchain network. AES encryption is employed to protect sensitive marks information, whereas SHA-256 hashing secures user authentication credentials. Role-based access control ensures that only authorized administrators, faculty members, and students can perform designated operations, while immutable blockchain transactions provide complete audit traceability and accountability. The framework is evaluated using transaction verification, data integrity validation, access control assessment, audit traceability, and result processing accuracy. This integrated architecture enhances security, reliability, transparency, and operational efficiency while providing trustworthy management of university examination records and academic data.

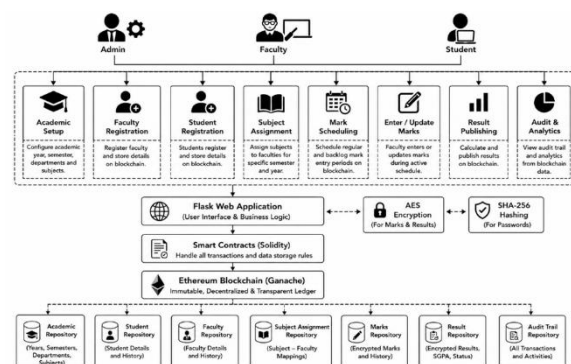


Fig.1 Proposed Architecture

#### a) Modules:

##### 1. User Authentication and Credential Validation:

Before any academic operation is performed, the system validates user credentials and verifies the identity of administrators, faculty members, and students. This authentication process ensures that only authorized users can access system resources according to their assigned roles. By preventing unauthorized access and protecting sensitive academic

information, the validation mechanism strengthens system security, preserves data integrity, and establishes a trusted environment for managing examination records and institutional academic activities.

**2. Academic Data Validation:** The system validates academic information, including student records, faculty details, departments, subjects, and examination schedules, before storing them within the blockchain environment. This validation process ensures that all submitted information is complete, accurate, and consistent with institutional requirements. Maintaining high-quality academic records minimizes inconsistencies, prevents incorrect data entry, and supports reliable management of examinations, result processing, and long-term academic record maintenance across the institution.

**3. Password Hashing:** User authentication credentials undergo cryptographic hashing before storage to prevent exposure of original passwords and strengthen account security. The hashing process converts sensitive credential information into irreversible representations that can be securely verified during authentication without revealing the original values. This approach significantly reduces the risk of credential theft, unauthorized account access, and identity compromise while enhancing the overall security and reliability of the academic management system.

**4. Marks Data Encryption:** Sensitive examination marks and result information are encrypted before being stored within the blockchain infrastructure. Encryption protects confidential academic data from unauthorized disclosure during storage and retrieval operations while ensuring that only authorized entities can access the original information. This security mechanism preserves student privacy, strengthens data confidentiality, and safeguards examination records against malicious access without affecting the integrity of academic transactions.

**5. Role-Based Access Control:** The system classifies authenticated users into administrator, faculty, and student roles before granting access to academic services. Each user receives permissions corresponding only to authorized institutional responsibilities, ensuring controlled execution of academic operations. This preprocessing step minimizes unauthorized modifications, enhances operational accountability, and establishes secure separation of responsibilities throughout the examination, grading, result publication, and academic record management processes.

**6. Blockchain Transaction Preparation:** Validated and secured academic information is prepared as blockchain transactions before permanent storage. Each transaction undergoes integrity verification and is structured to maintain consistency across decentralized records while preserving traceability of all academic operations. This preparation process ensures reliable transaction recording, prevents unauthorized alterations, and supports transparent management of examination records through immutable blockchain-based storage and comprehensive audit capabilities.

#### **b) Methods/Technologies:**

**Ethereum Blockchain:** Ethereum Blockchain provides a decentralized and immutable ledger for securely storing academic records and transactions. It ensures data integrity, transparency, and traceability by maintaining permanent transaction histories, thereby preventing unauthorized modifications and enhancing the reliability, accountability, and long-term trustworthiness of academic information management.

**Smart Contracts:** Smart Contracts automate academic operations by executing predefined rules and validating authorized activities without manual intervention. They improve operational consistency, transparency, and efficiency while ensuring secure execution of institutional policies, reducing administrative complexity, and

maintaining tamper-resistant management of academic records and transactions.

### Advanced Encryption Standard (AES):

Advanced Encryption Standard (AES) secures sensitive academic information by transforming confidential data into encrypted form before storage. This approach preserves data confidentiality, prevents unauthorized disclosure, and ensures that protected information remains accessible only to authorized entities while maintaining computational efficiency and strong security.

### SHA-256 Hashing Algorithm:

SHA-256 Hashing Algorithm strengthens authentication security by converting user credentials into irreversible fixed-length hash values. This mechanism protects passwords from unauthorized disclosure, supports secure identity verification, and enhances the overall reliability of access control through robust cryptographic protection.

**Web3.py Integration:** Web3.py Integration establishes secure communication between the application layer and the blockchain network, enabling reliable transaction execution and retrieval of blockchain records. It ensures synchronized interaction with decentralized storage, facilitating transparent academic operations while improving system reliability, consistency, and operational efficiency.

## 4. EXPERIMENTAL RESULTS

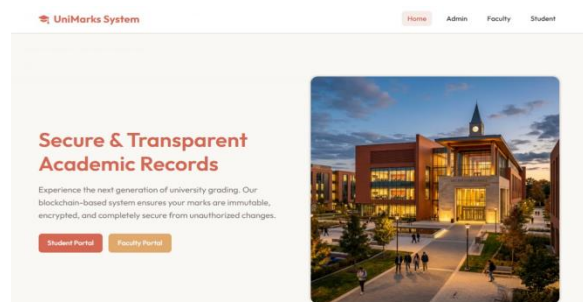


Fig.5.1 Home Page



Fig.5.2 Admin Login Page.

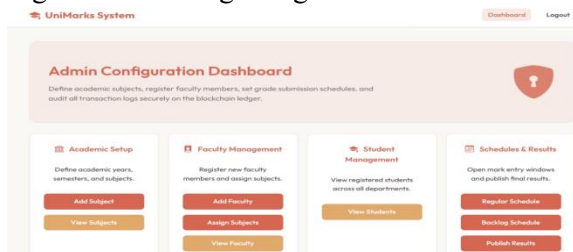


Fig.5.3 Admin Dashboard.

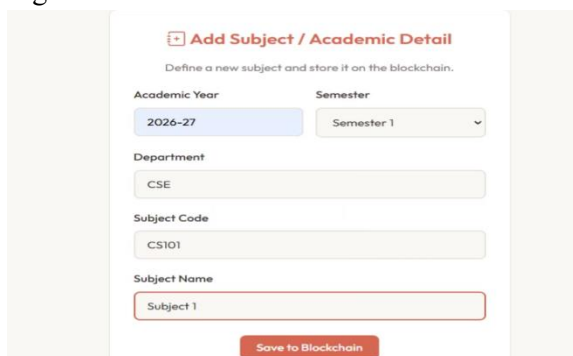


Fig.5.4 Academic Structure Management.

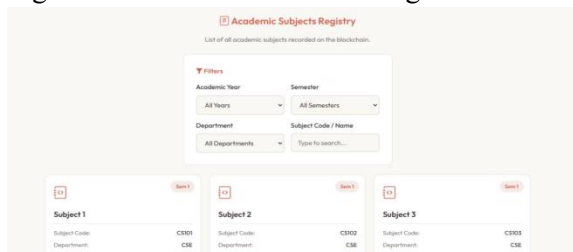


Fig.5.5 Academic Subject Registry.

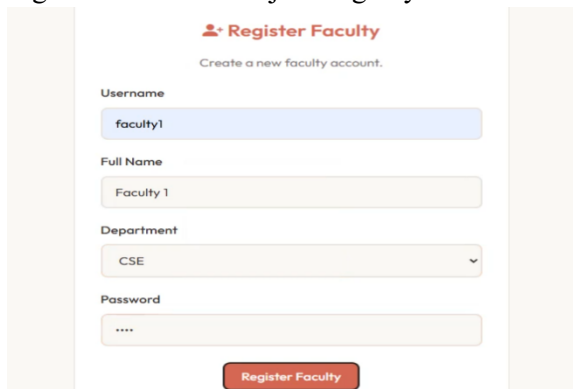


Fig.5.6 Faculty Registration.



**Registered Faculty List**  
Directory of all university professors and instructors.

| Faculty ID  | Department | Username |
|-------------|------------|----------|
| FAC20260001 | CSE        | faculty1 |
| FAC20260002 | CSE        | faculty2 |
| FAC20260003 | CSE        | faculty3 |

Fig.5.7 Registered Faculty List.



**Assign Subject to Faculty**  
Select faculty and subject from academic setup. No manual typing needed.

Select Faculty  
Faculty 1 (FAC20260001) - CSE

Select Subject (from Academic Setup)  
CS101 - Subject 1 | CSE | Year 2026-27 | Sem 1

Available years: 2026-27 | Semesters: 1

**Assign Subject**

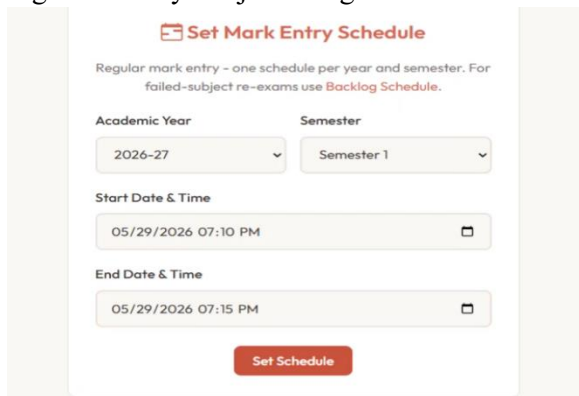
Fig.5.8 Assign Subject to Faculty.



**Faculty Subject Assignments**  
Subjects linked to respective faculty instructors on the blockchain.

| Subject   | Subject Code | Assigned Faculty | Academic Year |
|-----------|--------------|------------------|---------------|
| Subject 1 | CS101        | FAC20260001      | 2026-27       |
| Subject 2 | CS102        | FAC20260002      | 2026-27       |
| Subject 3 | CS103        | FAC20260003      | 2026-27       |

Fig.5.9 Faculty Subject Assignments.



**Set Mark Entry Schedule**  
Regular mark entry - one schedule per year and semester. For failed-subject re-exams use **Backlog Schedule**.

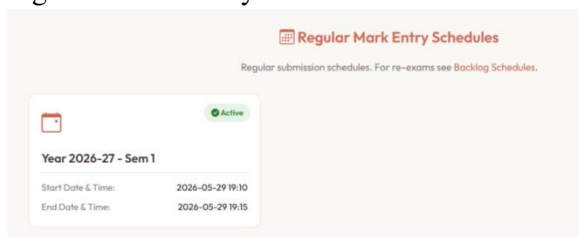
Academic Year: 2026-27 Semester: Semester 1

Start Date & Time: 05/29/2026 07:10 PM

End Date & Time: 05/29/2026 07:15 PM

**Set Schedule**

Fig.5.10 Mark Entry Schedule Creation.



**Regular Mark Entry Schedules**  
Regular submission schedules. For re-exams see **Backlog Schedules**.

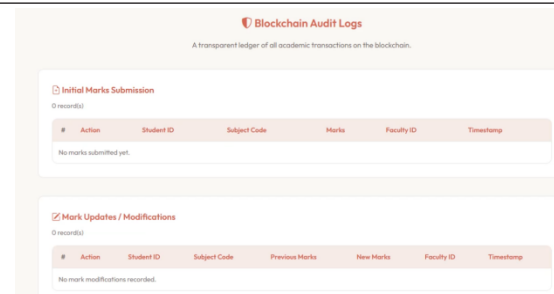
Active

Year 2026-27 - Sem 1

Start Date & Time: 2026-05-29 19:10

End Date & Time: 2026-05-29 19:15

Fig.5.11 Regular Mark Entry Schedules.



**Blockchain Audit Logs**  
A transparent ledger of all academic transactions on the blockchain.

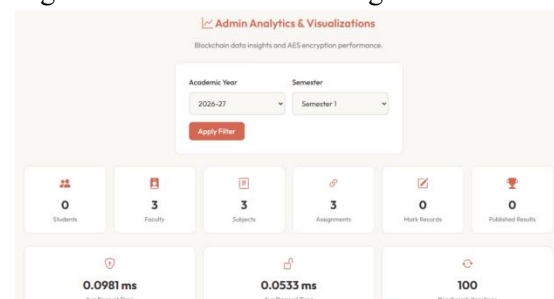
**Initial Marks Submission**  
0 record(s)

| #                       | Action | Student ID | Subject Code | Marks | Faculty ID | Timestamp |
|-------------------------|--------|------------|--------------|-------|------------|-----------|
| No marks submitted yet. |        |            |              |       |            |           |

**Mark Updates / Modifications**  
0 record(s)

| #                               | Action | Student ID | Subject Code | Previous Marks | New Marks | Faculty ID | Timestamp |
|---------------------------------|--------|------------|--------------|----------------|-----------|------------|-----------|
| No mark modifications recorded. |        |            |              |                |           |            |           |

Fig.5.12 Blockchain Audit Logs.



**Admin Analytics & Visualizations**  
Blockchain data insights and AES encryption performance.

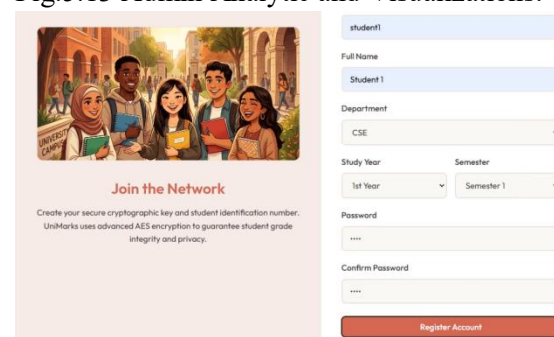
Academic Year: 2026-27 Semester: Semester 1

**Apply Filter**

| Students | Faculty | Subjects | Assignments | Mark Records | Published Results |
|----------|---------|----------|-------------|--------------|-------------------|
| 0        | 3       | 3        | 3           | 0            | 0                 |

| Avg Encrypt Time | Avg Decrypt Time | Benchmark Iterations |
|------------------|------------------|----------------------|
| 0.0981 ms        | 0.0533 ms        | 100                  |

Fig.5.13 Admin Analytic and Visualizations.



**Join the Network**  
Create your secure cryptographic key and student identification number. UniMarks uses advanced AES encryption to guarantee student grade integrity and privacy.

student1

Full Name: Student 1

Department: CSE

Study Year: 1st Year Semester: Semester 1

Password: \*\*\*\*

Confirm Password: \*\*\*\*

**Register Account**

Fig.5.14 Student Login Page.



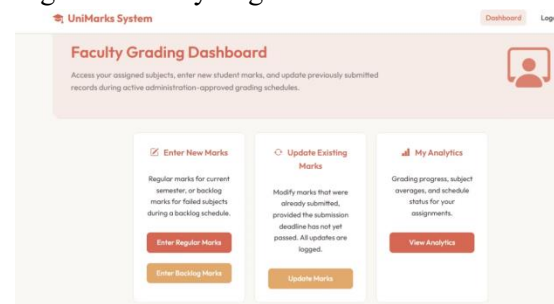
**Faculty Login**  
Enter or update student marks securely.

Faculty Username: faculty1

Password: \*\*\*\*

**Login to Faculty Portal**

Fig.5.15 Faculty Login.



**UniMarks System** Dashboard Logout

**Faculty Grading Dashboard**  
Access your assigned subjects, enter new student marks, and update previously submitted records during active administration-approved grading schedules.

| Enter New Marks                                                                                                                                                | Update Existing Marks                                                                                                                         | My Analytics                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Regular marks for current semester or backlog marks for failed subjects during a backlog schedule.<br><b>Enter Regular Marks</b><br><b>Enter Backlog Marks</b> | Modify marks that were already submitted, provided the submission deadline has not yet passed. All updates are logged.<br><b>Update Marks</b> | Grading progress, subject averages, and schedule status for your assignments.<br><b>View Analytics</b> |

Fig.5.16 Faculty Grading Dashboard.

**Enter Student Marks**

Regular entry for the student's **current semester** only. Passed subjects are hidden. For failed subjects use **Enter Backlog Marks**.

Select Student  
Student 1 (STU20260001) - CSE, Sem 1

Select Assigned Subject  
Subject 1 (CS101) - Year 2026-27, Sem 1

1 subject(s) available for regular entry.

Marks Obtained (Out of 100)  
80

Submit Marks to Blockchain

Fig.5.17 Enter Student Marks.

**Update Existing Marks**

Modify marks for subjects that are not yet passed. Passed subjects cannot be updated. Backlog subjects appear when their semester schedule is active.

Select Previous Record to Update  
Student: STU20260001 - Subject 3 (Sem 1, 2026-05-29 19:12:41)

New Marks (Out of 100)  
65

Update Marks on Blockchain

Fig.5.18 Update Existing Marks.

**Publish Final Results**

Calculate and publish results for a specific semester.

Academic Year  
2026-27

Semester  
Semester 1

Calculate & Publish

Fig.5.19 Publish Final Results.

**Published Results Summary**

Student 1

Student ID: STU20260001

SGPA / Outcome: 8.67

Grade: A+

Fig.5.20 Published Results Summary.

**Marks Published**

| # | Action    | Student ID  | Subject Code | Marks | Faculty ID  | Timestamp           |
|---|-----------|-------------|--------------|-------|-------------|---------------------|
| 1 | Submitted | STU20260001 | CS101        | 80    | FAC20260001 | 2026-05-29 19:15:03 |
| 2 | Submitted | STU20260001 | CS102        | 90    | FAC20260002 | 2026-05-29 19:12:21 |
| 3 | Submitted | STU20260001 | CS103        | 65    | FAC20260003 | 2026-05-29 19:12:44 |
| 4 | Submitted | STU20260001 | CS103        | 65    | FAC20260003 | 2026-05-29 19:12:57 |

**Mark Updates / Modifications**

| # | Action   | Student ID  | Subject Code | Previous Marks | New Marks | Faculty ID  | Timestamp           |
|---|----------|-------------|--------------|----------------|-----------|-------------|---------------------|
| 1 | Modified | STU20260001 | CS103        | 30             | 65        | FAC20260003 | 2026-05-29 19:12:57 |

Fig.5.21 Marks Published.

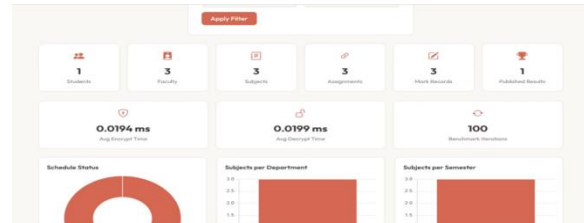


Fig.5.22 Academic Analytic.

**Promote Students**

After results are published, all students move to the next semester (failed subjects stay as backlog). Sem 8 → degree CGPA on blockchain.

Academic Year (reference): 2026-27

Published Semester: Semester 1

Promote All Students

Fig.5.23 Promote Students.

**Student Login**

View your official academic results securely.

Student Username  
student1

Password  
\*\*\*

Login to Student Portal

Don't have an account?  
Create Student Account

Fig.5.24 Student Login.

**Student Portal Dashboard**

View your individual subject marks and check overall semester results. All records are securely encrypted and verified on the blockchain.

View Subject Marks

View Final Results

My Analytics

Fig.5.25 Student Portal Dashboard.

**My Subject Marks**

Select a semester to view subject-wise marks from the blockchain.

Filter by Semester  
Semester 1

Showing marks for Semester 1

Subject 1: Semester: 1, Subject Code: CS101, Marks Obtained: 80 / 100, Grade Point: 9

Subject 2: Semester: 1, Subject Code: CS102, Marks Obtained: 90 / 100, Grade Point: 10

Subject 3: Semester: 1, Subject Code: CS103, Marks Obtained: 65 / 100, Grade Point: 7

Fig.5.26 Student Subject Marks.



Fig.5.27 Final Academic Result.

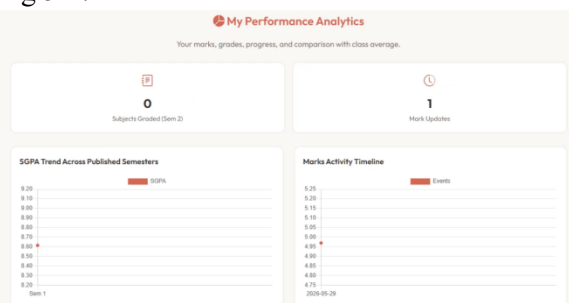


Fig.5.28 Student Performance Analytics.

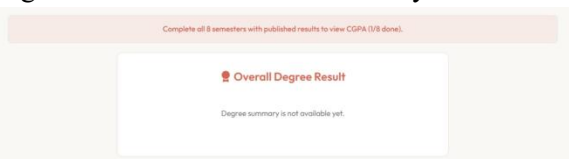


Fig.5.29 Overall Degree Result.

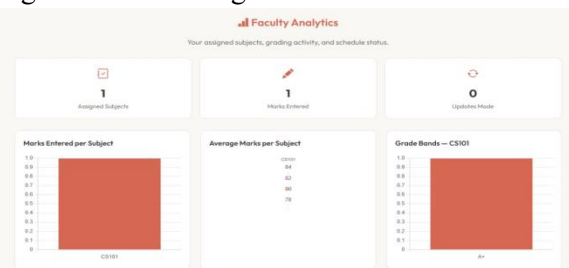


Fig.5.30 Faculty Analytics

## 5. CONCLUSION

**In conclusion**, the primary objective was to develop a secure, transparent, and tamper-resistant university student marks management framework capable of protecting academic records while ensuring reliable examination administration and result management. The framework utilizes institutional academic data, including student information, faculty records, subject allocations, examination schedules, marks, and published results, within a

decentralized blockchain environment. Ethereum Blockchain, Solidity Smart Contracts, Web3.py, AES encryption, SHA-256 hashing, and a Flask-based web application are integrated to provide secure authentication, encrypted data storage, immutable transaction recording, role-based access control, and automated academic operations. Performance evaluation demonstrates the effectiveness of the framework through successful blockchain transaction processing, secure access validation, audit traceability, encryption efficiency, and **100% data integrity** during academic record management. The integration of smart contracts with blockchain technology and secure cryptographic mechanisms enhances automation, accountability, and transparency while simplifying institutional administrative processes. The developed framework provides a dependable solution for secure academic record preservation, examination management, result publication, and audit tracking. By combining decentralized storage with robust security mechanisms, the system significantly improves operational reliability, institutional trust, and protection against unauthorized data manipulation, making it a practical and scalable solution for modern university academic management.

The framework can be further enhanced by integrating cloud-based blockchain platforms to improve scalability and support multi-university academic record sharing. Mobile application support can provide secure and convenient access for students and faculty members. QR code-based certificate verification can simplify credential authentication by employers and institutions. Artificial intelligence-driven analytics may assist in identifying academic performance trends and supporting institutional decision-making. Additionally, interoperability with national education repositories can enable secure, standardized, and efficient exchange of verified

academic records across educational organizations.

## REFERENCES

- [1] Caramihai, M., & Severin, I. (2023). A blockchain-based solution for diploma management in universities. *Sustainability*, 15(20), 15169.
- [2] Bhaskar, P., Tiwari, C. K., & Joshi, A. (2021). Blockchain in education management: present and future applications. *Interactive Technology and Smart Education*, 18(1), 1-17.
- [3] Chen, W., Bohloul, S. M., Ma, Y., & Li, L. (2022). A blockchain-based information management system for academic institutions: a case study of international students' workflow. *Information Discovery and Delivery*, 50(4), 343-352.
- [4] Ali, S. I. M., Farouk, H., & Sharaf, H. (2022). A blockchain-based models for student information systems. *Egyptian Informatics Journal*, 23(2), 187-196.
- [5] Murugesan, S., & Benakanahally Lakshminarasaiah, M. (2021, October). A survey on blockchain-based student certificate management system. In *Proceedings of the 14th International Conference on Theory and Practice of Electronic Governance* (pp. 44-50).
- [6] Ghani, R. F., Salman, A. A., Khudhair, A. B., & Aljobouri, L. (2022). Blockchain-based student certificate management and system sharing using hyperledger fabric platform. *Periodicals of Engineering and natural sciences*, 10(2), 207-218.
- [7] Dai, Q., & Zhu, N. (2022, March). University student status management system based on blockchain. In *The International Conference on Cyber Security Intelligence and Analytics* (pp. 752-757). Cham: Springer International Publishing.
- [8] Pondkule, P. M., & Kothari, S. (2025). Implementation of blockchain-based document management system for higher education organizations. *International Journal on Smart Sensing and Intelligent Systems*, 18(1).
- [9] Guerreiro, S., Ferreira, J. F., Fonseca, T., & Correia, M. (2022). Integrating an academic management system with blockchain: A case study. *Blockchain: Research and Applications*, 3(4), 100099.
- [10] Ayasrah, F. T. M., Shdough, A., & Al-Said, K. (2023). Blockchain-based student assessment and evaluation: a secure and transparent approach in Jordan's tertiary institutions. *Kurdish Studies*, 11(2), 2036-2049.
- [11] Saadati, Z., Zeki, C. P., & Vatankhah Barenji, R. (2023). On the development of blockchain-based learning management system as a metacognitive tool to support self-regulation learning in online higher education. *Interactive Learning Environments*, 31(5), 3148-3171.
- [12] Sudha, V., Kalaiselvi, R., & Sathya, D. (2021, October). Blockchain based student information management system. In *2021 International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (ICAECA)* (pp. 1-4). IEEE.
- [13] Tran, V. D., Ata, S., Tran, T. H., Lam, D. K., & Pham, H. L. (2023). Blockchain-powered education: A sustainable approach for secured and connected university systems. *Sustainability*, 15(21), 15545.
- [14] Shakan, Y., Kumalakov, B., Mutanov, G., Mamykova, Z., & Kistaubayev, Y. (2021). Verification of university student and graduate data using blockchain technology. *International Journal of Computers Communications & Control*, 16(5).
- [15] Samanta, A. K., Sarkar, B. B., & Chaki, N. (2021). A blockchain-based smart contract towards developing secured university examination system. *Journal of Data, Information and Management*, 3(4), 237-249.
- [16] Yang, J., Xiao, J., Wang, J., Liu, Y., Yang, W., Liao, Z., & Zhou, Q. (2022, October). Consortium blockchain-based student status management framework. In *International Conference on Mobile Networks and*

*Management* (pp. 18-31). Cham: Springer Nature Switzerland.

[17] Mali, M., Aherkar, S., Waykos, P., & Shukla, A. (2023, October). Blockchain-based academic bank of credit management system for higher education: An innovative approach to student credentialing and progression. In *2023 IEEE International Conference on Blockchain and Distributed Systems Security (ICBDS)* (pp. 1-5). IEEE.

[18] Balobaid, A. S., Alagrash, Y. H., Fadel, A. H., & Hasoon, J. N. (2023). Modeling of blockchain with encryption based secure education record management system. *Egyptian Informatics Journal*, 24(4), 100411.

[19] Deenmahomed, H. A., Didier, M. M., & Sungkur, R. K. (2021). The future of university education: Examination, transcript, and certificate system using blockchain. *Computer Applications in Engineering Education*, 29(5), 1234-1256.

[20] Chinnasamy, P., Subashini, B., Ayyasamy, R. K., Kiran, A., Pandey, B. K., Pandey, D., & Lelisho, M. E. (2025). Blockchain based electronic educational document management with role-based access control using machine learning model. *Scientific Reports*, 15(1), 18828.

[21] Liang, X., & Xu, S. (2021, January). Student performance protection based on blockchain technology. In *Journal of Physics: Conference Series* (Vol. 1748, No. 2, p. 022006). IOP Publishing.

[22] Harshavardhan, P., Sharath, M., & Rajyalaxmi, S. (2025). Privacy Protected Blockchain based Sharing and Verification of Student's Credentials. *Authorea Preprints*.

[23] Rasheed, Z., & Mimirinis, M. (2023). Integrating blockchain technology into a university graduation system. *Trends in Higher Education*, 2(3), 514-525.

[24] Upreti, M., Hardini, M., Rahmania, R., & Abianto, C. (2021). Blockchain based registration model for higher education. *Blockchain Frontier Technology*, 1(01), 68-73.

[25] Tariq, A., Haq, H. B., & Ali, S. T. (2022). Cerberus: A blockchain-based accreditation and degree verification system. *IEEE Transactions on Computational Social Systems*, 10(4), 1503-1514.