ALBUKHARY INTERNATIONAL UNIVERSITY

SCHOOL OF COMPUTING & INFORMATICS

BACHELOR OF COMPUTER SCIENCE (HONS)

Course Code	**CCS2323**	**Course Name**	**Software Secured Development**
Lecturer	**Assoc. Prof. Ts. Dr. Leelavathi Rajamanickam**		
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Assessment	**Project**	**Weightage**	**20%**
Title	**Secure Student Portal**		

No	**Name**	**Student ID**
1	**Ameer Khan Wadan**	**AIU22102277**
2	**Reem Bekdash**	**AIU22102281**

1.0 Executive Summary

The project is about coming up with a Secure Student Portal that can handle sensitive student information, grades, course-registration, and payment history. Against the backdrop of rising cybersecurity risks, it is the objective of this project to offer a safe, dependable and expandable platform that safeguards the confidentiality, integrity, and availability of all information.
The Security Threats identified that could pose risks to the portal are spoofing, tampering, denial of service (DoS) and information disclosure. In order to overcome these risks, the system is well authenticated, there are authorization factors and data encryption. In addition to this, the portal will be subjected to hard core security testing like penetration testing, fuzzing and threat modeling to ensure that all the weaknesses have been remedied.The personal information of students, grades, payment records and the rest of the System Assets is mapped to the CIA Triad (Confidentiality, Integrity, and Availability) with care. Security controls have been mutually agreed upon on each of the assets to prevent unauthorized access, accuracy, and availability of data particularly during peak seasons such as registration/payment due dates.

Coding The project relies on safe code concepts such as input validation, SQL injections and session protection. Protection of sensitive records also includes the use of parameterized queries and data encryption as part of database security. Memory safety practices and error handling exist in order to allow us to be able to assure the soundness of the system.

In order to resolve these security threats, an extensive risk management system has been implemented that includes incident response, security audits and after-deployment testing. The objective of the risk management plan is to determine possible risks, their effects, and the mitigation mechanism that will enable the system to withstand internal and external attacks.The project is grounded in the industry best practices of building a secure system and aligning it with the rules, including GDPR and FERPA. This portal attempts to provide a safe and efficient platform to both the students and the administrators through active security measures throughout the software development process.

2.0: Security Analysis & Requirements

2.1: Spoofing:

In spoofing, the attacker pretends to be a legitimate system or user, allowing them to gain unauthorized access. This may include the attacker stealing credentials, spoofing IP addresses, or social engineering their victims into providing their login details. This is especially harmful when attackers access sensitive systems or data since they can then impersonate or steal information without detection.

2.2: Tampering:

Tampering refers to the unauthorized alteration of data or system elements. This can involve a change in the information stored, a modification to configuration files, or a change in software functionality. Hacking has the potential to undermine the system's integrity, resulting in security breaches, misinformation or problems. One such instance would be the hacker who would tamper with grades or financial statements that would cause havoc or financial losses to the institution.

2.3: Repudiation:

Repudiation occurs when a user refuses to execute an action that they are accountable for, making it difficult to confirm that activities run on a system are genuine. This is an acute issue when adequate logs or audit trails are not in place. One such user might not be willing to view confidential information or perform unauthorized modifications. The system will lack sufficient logging and evidence to determine whether the user's actions were legitimate.

2.4: Information Disclosure:

Information disclosure refers to the unauthorized release of sensitive information to individuals who are not authorized to access it. This would include the violations where attackers access the personal, academic, or financial information of users. Disclosure of information may have serious negative implications for the organization's reputation, potentially breaching privacy laws and creating legal liabilities.

2.5: Denial of Service (DoS):

This is a type of attack where an attacker bombards a system with a large number of requests or other malicious traffic, making the system unusable to legitimate users. These attacks are particularly perilous during critical times, such as registration, exams, and payment deadlines. They have the potential to lead to major interruptions, affecting student and faculty access to the system, as well as causing harm to the institution's credibility and trustworthiness.

2.1.1: System Assets and Their Mapping to CIA Triad:

Assets	Confidentiality	Integrity	Availability
Student Personal Data **(e.g., Name, Address, Contact information)**	The personal data of students should be kept confidential to prevent identity theft, fraud, or misuse. Only authorized personnel should access this data for legitimate purposes.	The information must be protected from unauthorized modifications. Personal data should remain accurate and truthful throughout its lifecycle.	This data should be readily available to students, faculty, and staff when needed, ensuring the smooth functioning of student services such as address changes or contact updates.
Grades, Transcripts **(Academic Records)**	Only authorized individuals, such as students, faculty, and designated admins, should have access to academic records to prevent unauthorized viewing or tampering.	Academic records must be accurate and reflect the true performance of the student, ensuring no unauthorized changes occur.	The system must ensure that grades are available when necessary, such as during grade release periods or academic advising, without delay.
Course Registration Data	Registration data should be kept private to protect students' academic preferences and prevent exposure to unauthorized parties, such as parents or third parties.	The course registration data should be protected from unauthorized changes or corruption, ensuring that students' course choices are properly recorded.	The system must be available throughout the registration period, ensuring that students can access and complete their course registrations without delays or interruptions.
Payment Data **(Fee Payment, Payment Records)**	Payment information, such as card numbers and transaction details, must remain confidential to prevent financial fraud and unauthorized access to sensitive financial data.	Transaction data must be accurate and tamper-proof. Any changes to payment records should be logged and validated to maintain the system's integrity.	The payment system should remain operational, especially during peak times like registration and payment deadlines, to ensure that students can make payments without hindrance.

Username, Password	Login credentials should be stored securely to prevent unauthorized access to the portal. The system must enforce strong password policies and secure password storage.	Password integrity must be maintained to prevent unauthorized users from gaining access through compromised credentials.	Students and faculty should have reliable access to the portal when required, with minimal downtime or delays caused by security checks.
Faculty and Administrator Access Rights	Access to sensitive administrative features should be secured, ensuring only authorized users can perform administrative actions, such as grade posting or course management.	Unauthorized users should not be able to alter permissions or access controls that could affect the availability or security of the system.	Faculty and administrators need continuous access to perform their duties, such as grade posting, course management, and other essential administrative functions.
System Logs and Audit Trails	Logs must be kept confidential, especially when they contain sensitive data, such as user access patterns or transaction records. Unauthorized access to logs could reveal vulnerabilities or system weaknesses.	Logs should accurately reflect system activities and be tamper-proof. They should provide reliable evidence in case of a dispute or investigation.	Logs must be available to authorized personnel, such as system administrators, especially in the event of a security breach, to help identify and resolve issues quickly.

2.2.1: Functional security requirements:

2.2.2: Authentication

Requirement: The system should force all users to identify themselves using a secure system (i.e., username and password) with further security features (i.e., MFA) to perform sensitive tasks.

Explanation: To ensure that a portal is not accessed by unauthorized individuals, it is essential to restrict access to only those with the necessary authorization. Multi-Factor Authentication (MFA) is an additional security system that allows users to enter two or more authentication options, such as a password and a one-time code sent to their mobile phone.

2.2.3: Authorization

The system should also incorporate the requirement of Role-based access control (RBAC) to help restrict user access to the system depending on their roles and responsibilities.
RBAC grants access to the data and functions that the user needs and nothing more. When involving faculty members, the grade can only be given to the faculty in the context of their courses, but admins have access to the entire capabilities of the system.

2.2.5: Data Encryption

Personal information, grades, payment records, and sensitive data should be encrypted during their storage on the server as well as when they are being transmitted over the network.

2.2.6: Rationale:

Data encryption means that an attacker who might get access to the system or intercept the communication cannot read the sensitive data. Data in transmission and stored data protection should be TLS and AES encryption, respectively.

2.2.7: Input Validation

The system should verify the validity of all user inputs to prevent malicious activities, such as SQL injection and cross-site scripting (XSS) attacks.

2.2.8: Rationale:

The sanitization and validation of all input data aid in the prevention of attacks by malicious attackers through the injection of attack scripts or SQL statements into the system. This plays a crucial role in ensuring that the system remains secure.

2.2.9: Session Management

The system must properly control user sessions to prevent certain attacks, such as session fixation or session hijacking.
Session management is the process by which a user is tracked and secured after logging in. There should be timeouts to log out the user after inactivity automatically, and session data should be encrypted using secure cookies to ensure it is not hijacked.

2.2.10: Logging and Monitoring

The system must maintain a detailed record of all user activities, particularly those of a critical nature, such as grade or payment record changes.
Logs are critical when auditing the activity of the system and tracking suspicious behaviour. Access to sensitive data should be monitored, and alerts should be provided in case of potential breaches.

2.3.1: Non-Functional security requirements:

2.3.2: Availability

The portal must be online 99.9% of the time, particularly at such critical times as registration and payment dates.
High availability means that the system will be up even when there is high traffic. It needs to have load balancing and fail over mechanisms to ensure that the increased demand can be handled without the system being brought down.

2.3.3: Scalability

The system should be capable of supporting the growing number of users without affecting the security performance.
The system must be capable of supporting an increased load as the number of users increases without affecting security. This needs dynamic and reliable authentication, infrastructure that can dynamically adapt to the demands.

2.3.4: Resilience

The system should be able to come back on its feet in case of failure or breach.
When there is a security breach or system failure, backup systems and incident response mechanisms must provide the ability to restore critical data to the system and recover normal operations in the shortest amount of time possible.

2.3.5: Performance

Security features are not to adversely affect the user experience.
The system must promote a smooth user experience even though it is providing security. As an example, the encryption and validation must not directly slow down the registration or logging-in time.

2.3.6: Compliance

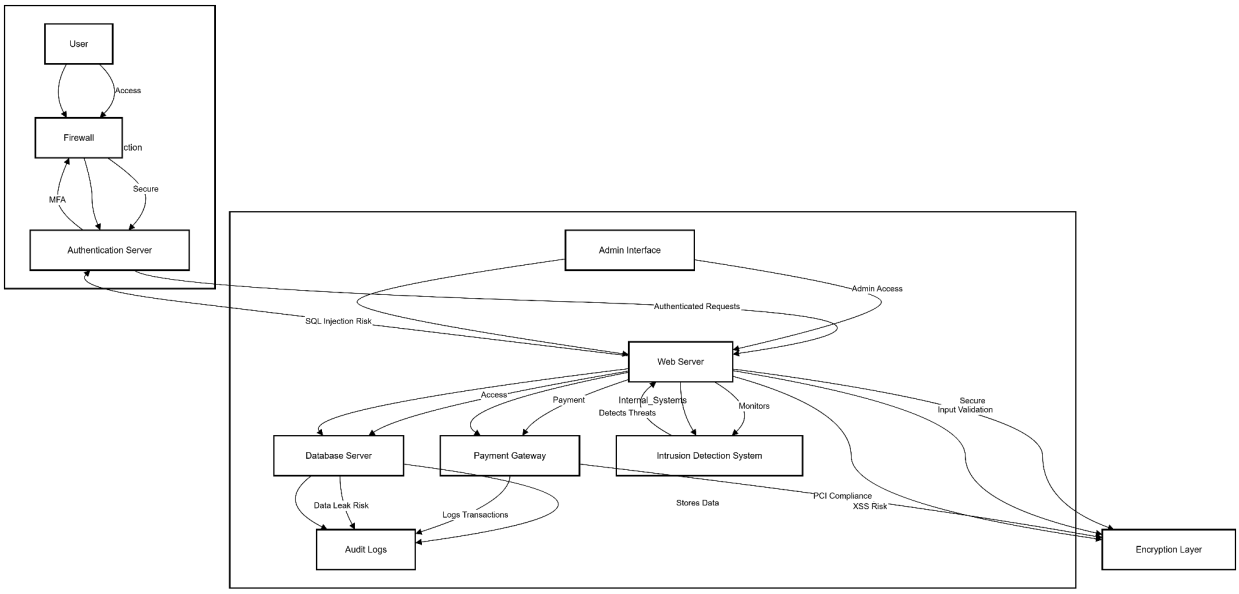
The system should be able to adhere to the applicable data protection regulations and laws including GDPR, FERPA.

This makes system comply with law on data protection. In GDPR, the issue is that the user must consent to the processing of their data; in FERPA, educational records of students must be handled in the strictest way possible.

2.3.7: Security Audits

The system should be periodically exposed to security audits in order to aid in identifying vulnerabilities and ensure best practices are being observed.
The rationale is that security issues must be detected in advance and handled through penetration tests and periodic vulnerability checks. This will help in improving the reliability and safety of the system over the long-term.

3: Secure Architecture & Design



4 : Secure Coding Guidelines & Database Security

4.1.1: Secure Coding Guidelines

4.1.2: Authentication

The system has to ensure the users log in in a secure manner i.e. with username and password and other security functions such as Multi-Factor Authentication (MFA) when performing sensitive operations.
MFA is required to make sure that only authorized persons can access the portal. Should a password be compromised, then the second layer of authentication must prevent the attacker gaining entry into the system without this added element.

4.1.3: Input Validation

All user inputs to the system must be authenticated to avoid any malicious intentions like SQL injection and cross site scripting (XSS) attacks.
System security will not be enforced unless malicious inputs are not checked properly. The system must not accept the unexpected characters and only accept the valid and expected data that should be processed. Parameterized queries can be used to avoid SQL injection, and XSS can be stopped by filtering any form of user-generated content.
Example: Instead of:

```
SELECT * FROM users WHERE username = '" + userInput + "';
```

use:

```
PreparedStatement ps = con.prepareStatement("SELECT * FROM users WHERE
username = ?");
ps.setString(1, userInput);
```

4.1.4: Error Handling

system internals are not to be disclosed in error messages. Generic error messages such as an error occurred, please try again later should be presented to the user only.
The hints to the hackers on how to subvert the system can be given by displaying detailed error messages, such as stack traces or database names. This is safeguarded by generic error messages, but comprehensive logs must be maintained elsewhere in a secure area to enable administrators to diagnose problems.

4.2: Database Security Measures

4.2.1: Preventing SQL Injection

Be resistant to SQL injection by using parameterized queries/stored procedures. SQL injection is a vulnerability in which an attacker can inject malicious SQL queries by use of user input. With

parameterized queries, the system will never interpret any of the user input as executable code, thereby securing the database against injection attacks.

4.2.2: Preventing Command Injection

When the system executes shell commands, any input sent to the command should be checked against a whitelist of permitted values. Command injection gives the attackers an ability to run arbitrary commands on the server. Verifying user input helps to verify that only safe commands are run.

4.2.3: Data Protection

AES-256 should be used to encrypt sensitive data (e.g. payment details, private student information) at rest, and TLS 1.3 should be used to encrypt sensitive data during transit. Encryption helps in the way that an attacker cannot read the data even after accessing this data. Data should be encrypted with TLS 1.3 when being transferred, and data stored in the database should be encrypted with AES-256.

4.2.4: Memory Safety Practices

When programming in lower-level languages like C/C++, do not forget to do a boundary check and do not use dangerous functions, such as strcpy or gets.
The vulnerabilities, related to memory, such as a buffer overflow, might cause major problems, such as unauthorized code execution. Protections i.e. Address Space Layout randomization (ASLR) and Data execution prevention (DEP) are usually offered by modern compilers to help control these threats.

5: Security Testing & Risk Management

5.1: Security Testing Plan

5.1.1: Penetration Testing

Simulate the actual world attacks and expose the vulnerability through the penetration testing.
Penetration testing is one way of finding the cracks before the attackers can utilize them. Attacks that could be simulated include weak passwords, SQL and session hijacking.
Tools: Vulnerability testing web applications using testing tools like the Burp Suite and the OWASP ZAP.

5.1.2: Fuzz Testing

Test the system to make sure it can tolerate unforeseen input.Fuzzing is useful to identify vulnerabilities associated with buffer overflow and misuse of errors when the malformed data is introduced into the system input.
Tools: Agile: Automated fuzzing with American Fuzzy Lop (AFL) or with Peach Fuzzer.

5.1.3: Threat Modeling

Systematically determine threats and eliminate them using threat modeling with STRIDE.
The model that enables the systematic study of the system and the identification of weaknesses that may occur is the STRIDE model (Spoofing, Tampering, Repudiation, Information Disclosure, DoS, Elevation of Privilege).

5.1.4: Security Testing Checklist

Category	Test Item	Description	Status
Authentication	Multi-Factor Authentication	Verify MFA is enforced for all users.	☐ Pass / ☐ Fail
Input Validation	SQL Injection protection	Test forms with injection payloads.	☐ Pass / ☐ Fail
Session Mgmt	Session timeout	Idle sessions auto-expire (e.g., 15 mins).	☐ Pass / ☐ Fail
Data Protection	TLS encryption	All data in transit uses TLS 1.3.	☐ Pass / ☐ Fail
Logging	Audit trail completeness	Verify all critical actions are logged.	☐ Pass / ☐ Fail

5.2: Black-box vs White-box Fuzzing

The tester remains unaware of the inner mechanisms of the system thus, modeling what an external attacker may do to the system. It can be useful to test exposed endpoints, like a login form or a payment form.
Example: test the log-in page by entering random values and check whether there is any unwanted behaviour.

5.2.1: White-box Fuzzing

The tester can see the source code and can thoroughly test it. It assists in establishing weak points in the code that it might not make available to the outside world.
Example: Backend: Backend functions are processing input, and thus, they are expected to safely process malicious input.

5.3: Risk Management Framework

5.3.1: Risk Identification

Risk: Hackings, payment card fraud, denial-of-service attack, fake transactions.

5.3.2: Risk Assessment

- Unauthorized Grade Change: Medium probability, high effects.
- DoS on Registration: High impact, high probability.

5.3.3: Risk Mitigation

- Use RBAC: Limit access to academic records to authorized personnel only.
- Deploy Load Balancers: Mitigate DoS by balancing traffic across multiple servers.

5.3.4: Incident Response

An Incident Response Plan (IRP) is very important, and it includes:

- **Detection:** Recognize an unfamiliar situation.
- **Containment:**Wall the attack.
- **Destroy:** Get rid of evil things.
- **Recovery:** Recover back-ups.

5.3.5: Post-Deployment Monitoring

Logs have to be analyzed in real-time with continuous monitoring with SIEM (e.g., Splunk or ELK Stack). Vulnerability scans and penetration tests are to be conducted on a quarterly basis.

6: Conclusion

In this report, the creation of the Secure Student Portal is described with a focus on how sensitive data is secured by using such security characteristics as multi-factor authentication (MFA), role-based access control (RBAC), and data encryption. The portal will provide confidentiality, integrity, and availability of both student and faculty information by mitigating the main security risks of spoofing, tampering, and the denial of service (DoS).Secure coding rules, input validation and database security practices are reinforced in the system. Penetration testing and fuzz testing are testing strategies where vulnerabilities would be identified and an entire risk management model would be created so that any threat could be properly responded to.
Last but not the least, the Secure Student Portal is to be as secure as possible and offer a safe and reliable location to students and faculty, in addition to meeting regulatory data protection regulations like the GDPR and FERPA.

7: References

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