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An Annual Magazine from Department of Information Technology

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Northern India Institute of Technology

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Late Babu Banarasi Das Ji
(1912 – 1985)
Ex Chief Minister, Govt. of Uttar Pradesh

"To provide an open opportunity to the young generation for evolving their core competencies and to build their career as world class professionals with broad based foundation, in-depth knowledge & versatile personality to meet the challenges of Global Economy…" – Babuji's Vision

Hon'ble Founder

Late Dr. Akhilesh Das Gupta

(1961 – 2017)

Ex-Member of Parliament (Rajya Sabha)

Hon'ble Founder & Ex-Chairman, BBD Group

"We not only make technocrats at BBD, we churn out citizens of the world, perfect in all respect, be it leadership, competence, confidence, communication, moral or knowledge…" – *Dr. Akhilesh Das Gupta's Vision*

A distinguished political leader, philanthropist, educationist and social worker, Dr. Akhilesh Das is the pride of Lucknow city. He has established himself as a worthy son of his illustrious father Late Babu Banarasi Das Ji.

Public Life

He has obtained MBA, LLB & Ph.D. (Human Resource Management) degrees; Dr. Akhilesh Das decided to follow his father's footprints by choosing Social Service as his primary goal. In his distinguished public life spanning well over three decades, Dr. Das was first elected as the Mayor of Lucknow in year 1993

and became one of the youngest Mayors of the world. Subsequently, he was elected as a ***Member of Parliament (Rajya Sabha)*** *in November 1996 and was re-elected for a second term in November 2002 till November 2008. Dr. Das has been elected again as a Member of Parliament (Rajya Sabha) for a third consecutive term in 2008 till 2014.*

Dr. Das has been a member of many important parliamentary committees and National level apex advisory & statutory bodies including the AIMS. He has been a member of the Executive Committee of AICTE. He had been the Chairman Parliamentary Standing Committee for Industries. He also served with distinction as the Union Minister of State for Steel and made a place for himself as one of the foremost National leaders.

Contribution to Sports

Dr. Akhilesh Das was an enthusiastic sports person. He underwent an exhaustive training in England as a Junior Badminton player. Later, he represented and captained the U.P. State Badminton team for many years and won many National & International tournaments including the National Doubles Championship. His love for other sports is no less. He has been instrumental in organizing and facilitating many National level tournaments in various sports. He was the president of the U.P. Olympic Association & Chairman of Badminton Association of India.

Contribution to the Cause of Education

*As a social thinker, Dr. Das realized the need of Quality Technical & Professional education for the overall growth and upliftment of the masses and development of the State of Uttar Pradesh. Accordingly, Babu Banarasi Das Educational Society (****BBDES****) was founded through which the torch for higher professional education was lit in Lucknow, the Capital of U.P. The first institution in the series, Babu Banarasi Das Institute of Technology & Management (****BBDITM****), Lucknow was established in 1998 and Babu Banarasi Das Northern Indian Institute of Technology (****BBDNIIT****), Lucknow in 1999, Dr. Akhilesh Das Gupta Institute of Technology & Management (****ADGITM****), New Delhi in 2003, Babu Banarasi Das Engineering College (****BBDEC****), Lucknow in 2009 and Babu Banarasi Das University (****BBDU****), Lucknow in 2011.*

Hon'ble Chairperson, BBD Group

Mrs. Alka Das

A lady with spirit, determination and zeal, Mrs. Alka Das has been the driving force behind her husband Dr. Akhilesh Das. She is the daughter of Late Justice D. P. Gupta, who held high positions in the State of Rajasthan, as its Governor and Chief Justice. She was brought up on Gandhian ideals and philanthropic traditions.

Mrs. Das is a Management expert and a legal luminary who has a long involvement with issues of social justice and women empowerment in our country. She is a legal consultant to several reputed organizations and an active Social Worker. She is connected with many National Social & Educational Organizations. She is also a Life Member of the "Rajasthan High Court Bar Association". The establishment of Northern India Engineering College, Lucknow was an initiative taken by her to provide quality professional education to match the International Standards.

As a Co-founder of Babu Banarasi Das Group of Educational Institutions, Mrs. Das has made a fertile attempt to nurture a generation of self-made and highly motivated students with an inbuilt commitment to do something constructive for the Country.

Hon'ble President, BBD Group

Mr. Viraj Sagar Das

Vice- President, Badminton Association of India
President, Uttar Pradesh Olympic Association

"Education is the most powerful weapon which you can use to change the world" *– Nelson Mandela*

Babu Banarasi Das Educational Group has its roots lying deep in quality education practices that equip each student with broad outlooks to prepare them for this futuristic world. We are committed to providing the education that fulfils the needs of today's world. Today, education is not limited to textbook courses and its practical implementation. Education has been through a major transformation where apart from the syllabus, it has become imperative to inculcate some extra skills in the students so that they could truly succeed in their lives. We encourage our students to perform well in their academics and also to take active participation in all the co-curricular activities in order to develop interpersonal skills, take up challenges, and be self-dependent and most importantly, have a good time while learning.

Vision of the Institute

"To establish a multi-disciplinary environment with excellence in technical education and research for developing competent professionals who meet the challenges of industrial and societal development with human values and ethics."

Mission of the Institute

M1. *To provide an excellent environment with supporting infrastructure to prepare globally competent professionals acceptable to industry and society*

M2. *To inculcate a spirit of research, innovation and entrepreneurship by exposing multi-disciplinary approach*

M3. *To motivate aspiring graduates to solve real life problems with zeal of lifelong learning*

M4. *To imbibe a healthy environment which helps to develop intellectual capabilities among graduates to transform them into professionals with human values and ethics*

About the Department

The Department of Information Technology offers Bachelor's degree in Information Technology. This degree program prepares graduates for successful, profitable and lifelong careers in IT and ITES fields. Information Technology students study software systems through innovative classroom instructions, supported by laboratories equipped with the state of-the-art hardware and software. The department ensures that the students are introduced to both fundamental and advanced knowledge in areas such as Networking technology, Computer Security and software engineering, Cloud Computing, Data Analytics etc.

Salient Features of the department are as follows.

- State of the Art Computing Facilities
- ICT in Teaching and Learning
- Teacher as Mentor
- Research & Publications with Social Impact
- Supportive Learning for Placements
- Professional Development for Industrial Engagement

Various activities conducted by the department for the students are as follows.

- Value Added Courses
- Career Oriented Add-On Courses
- Special Training for Competitive Examination
- Expert Lectures for Industry Interaction
- Report Writing & Paper Presentation
- Personality Development & Soft Skill Training

Vision of the Department

"To be a dynamic and premier center for imparting transformative education with quality teaching-learning to excel students in the field of Information Technology and to meet the expectations of the industry and society with moral values and ethics."

Mission of the Department

M1: To provide cutting edge knowledge based education through compatible infrastructure to develop professionals who cater the need of Industry and society at large.

M2: To motivate graduates for achieving excellence in academics, industry and entrepreneurship to serve the society.

M3: To inspire students for transformation in industry and society with their noble values and professional ethics.

Program Educational Objectives (PEOs)

The Program Educational Objectives of the U.G. program in the Department of Information Technology are:

After 4 years of completing this program, the students:

PEO-1: Graduates will be able to apply procedural and programmatic knowledge with innovative skills to provide solutions in a technology-driven era.

PEO-2: Graduates will possess professional competency to be employable, entrepreneur and inclination towards higher education with a zeal for life-long learning.

PEO-3: Graduates will be a valuable asset for society by exhibiting their professional engineering quality with moral values and ethics.

Program Specific Objectives (PSOs)

PSO-1: The graduates should have ability to provide engineering solutions in the field of Image Processing, Machine Learning, Cloud Computing and Data Sciences using available IT tools and techniques.

PSO-2: The graduates should have ability to employ inter-disciplinary approaches to design and develop IT solutions for real world problems.

Program Outcomes (POs)

Information Technology (IT) Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental context and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life Long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadcast of technological change.

Message from the Director (Engg.)

It gives me immense pleasure to present **Volume 6, Issue I (2025)** of the **Department of Information Technology Annual Magazine**. This magazine is a reflection of the enthusiasm, creativity, and intellectual spirit of our faculty and students who have voluntarily contributed their knowledge, ideas, and experiences. Their efforts showcase the department's commitment to academic excellence, innovation, and continuous learning.

I congratulate the editorial team and all the contributors for their dedication in bringing out this publication. I am confident that this magazine will inspire readers to explore new ideas, strengthen their technical and creative abilities, and continue striving for excellence. I extend my best wishes to the Department of Information Technology for its continued success in academics, research, and innovation.

Regards
Prof. (Dr.) V. K. Singh
Director (Engg.)
Babu Banarasi Das Northern India Institute of Technology, Lucknow

Message from Head of Department

I am happy to note that the Department of Information Technology is releasing its Annual Department Magazine **"techno inspire@IT"** for 2025.

Over the years the college magazine has provided an opportunity for students to portray their topics of interest and share their ideas. I feel extremely happy to speak to you through this Magazine, as Department of Information Technology of Babu Banarasi Das Northern India Institute of Technology bringing out the annual departmental magazine for the academic year 2022-23. Publishing a magazine is indeed a tedious and herculean task. In recent years, when our students are concerned more about their academic excellence, they have to be coaxed, persuaded and encouraged to exhibit their writing talents. The response of the students in contributing articles to the magazines was really overwhelming. The student's articles contributed for the college magazine has shown their intellectual insight and their excellent command on language. Once again, my message is: "Aim always High", as high as the sky to be good citizens and leaders of our beloved country.

Regards
Prof. (Dr.) Bhawesh Kumar Thakur
Head, Department of Information Technology
Babu Banarasi Das Northern India Institute of Technology, Lucknow

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Faculty Contribution

AI Agents: The Next Evolution of Software Systems

By Dr. Bhawesh Kumar Thakur

AI Agents: The Next Evolution of Software Systems

Introduction

Artificial Intelligence (AI) has rapidly evolved from rule-based systems to machine learning, deep learning, and more recently, **Generative AI** powered by Large Language Models (LLMs). While chatbots such as ChatGPT, Gemini, and Claude have demonstrated remarkable capabilities in generating human-like responses, the next significant leap in AI is the emergence of **AI Agents**. Unlike traditional AI applications that merely respond to user prompts, AI agents possess the ability to **reason, plan, make decisions, use external tools, and execute complex tasks autonomously**.

AI agents are poised to redefine software systems by transforming them from passive applications into intelligent collaborators capable of performing multi-step workflows with minimal human intervention. Gartner has identified Agentic AI as one of the most influential strategic technology trends, predicting that autonomous AI systems will significantly reshape enterprise operations over the coming years.

What are AI Agents?

An AI agent is an intelligent software entity that can perceive its environment, understand user objectives, formulate action plans, interact with digital tools, learn from feedback, and execute tasks autonomously to achieve predefined goals.

Unlike conventional software, which follows explicitly programmed instructions, AI agents combine several advanced AI capabilities:

• Natural Language Understanding • Reasoning and Decision Making • Long-term Memory	• Planning • Tool Usage (APIs, databases, search engines) • Learning from interactions

Rather than answering a single question, an AI agent can receive a goal such as:

"Prepare a report comparing India's AI policies with those of the European Union."

The agent can independently:

• Search reliable sources • Collect relevant information • Summarize documents • Generate tables and charts	• Draft a professional report • Cite references • Refine the final output

This level of autonomy represents a major advancement over traditional software applications.

Evolution of Software Systems

Software systems have evolved through several technological generations.

Era	Characteristics
Traditional Software	Fixed rules and deterministic programming
Intelligent Software	Machine learning-based predictions
Generative AI	Human-like content generation
Agentic AI	Autonomous planning, reasoning, and execution

Traditional software executes predefined instructions, whereas AI agents dynamically determine *how* to accomplish a task by selecting appropriate tools and adapting to changing circumstances.

Architecture of an AI Agent

A modern AI agent typically consists of the following components:

1. Perception Layer

- Accepts user inputs through text, voice, images, or documents.

2. Reasoning Engine

- Utilizes Large Language Models to interpret requests and formulate strategies.

3. Planning Module

- Breaks complex objectives into smaller executable tasks.

4. Memory

- Maintains conversation history and stores relevant contextual information.

5. Tool Integration

- Connects with APIs, databases, web browsers, calculators, enterprise software, and cloud services.

6. Execution Engine

- Performs actions and monitors outcomes before delivering results.

This architecture enables AI agents to function similarly to knowledgeable digital assistants rather than simple software applications.

Key Characteristics of AI Agents

Modern AI agents possess several distinguishing features:

• Goal-oriented decision making • Autonomous task execution • Multi-step reasoning • Context awareness	• Continuous learning • Collaboration with humans • Tool orchestration • Adaptability to dynamic environments

These capabilities allow AI agents to solve problems that previously required continuous human supervision.

Applications across Industries

Healthcare

AI agents assist physicians by analyzing medical records, scheduling appointments, recommending treatment options, monitoring patients, and supporting clinical decision-making.

Education

Educational AI agents can serve as personalized tutors by generating learning materials, evaluating assignments, answering student queries, and recommending customized learning paths.

Software Development

AI coding agents help developers by:

- Writing source code
- Detecting bugs
- Generating documentation
- Refactoring legacy software
- Conducting automated testing

This significantly improves software development productivity.

Finance

Banks increasingly deploy AI agents for:

- Fraud detection
- Customer service
- Financial advisory
- Risk assessment
- Automated compliance monitoring

Manufacturing

Industrial AI agents monitor production equipment, predict failures, optimize supply chains, and improve operational efficiency.

AI Agents in Higher Education

Higher educational institutions can leverage AI agents for both academic and administrative activities.
Faculty members can utilize AI agents for:

- Preparing lecture notes
- Designing quizzes
- Creating laboratory exercises
- Reviewing research literature
- Assisting in proposal writing
- Conducting plagiarism analysis
- Automating routine documentation

AI agents thus become intelligent academic assistants rather than replacements for educators.

Popular AI Agent Frameworks

Several open-source frameworks have accelerated the development of AI agents:

- LangChain
- LangGraph
- AutoGen
- CrewAI
- OpenAI Agents SDK
- Semantic Kernel
- Haystack

These frameworks simplify the creation of multi-agent systems capable of solving complex real-world problems through coordinated collaboration.

Challenges and Ethical Considerations

Despite their enormous potential, AI agents present several challenges.

Reliability

Agents may occasionally generate inaccurate information or make incorrect decisions if their reasoning is flawed.

Privacy

AI agents frequently process sensitive organizational and personal data, requiring strong data governance policies.

Security

Autonomous systems interacting with external tools increase cybersecurity risks if not properly controlled.

Transparency

Users should understand how AI agents reach conclusions, making Explainable AI increasingly important.

Human Oversight

Critical decisions involving healthcare, finance, education, or law should always remain under human supervision.

Responsible AI development must emphasize accountability, fairness, transparency, and compliance with ethical standards.

The Future of AI Agents

Industry experts envision a future where multiple specialized AI agents collaborate to complete sophisticated tasks. Instead of using separate applications for scheduling meetings, analyzing data, generating reports, and communicating with stakeholders, a coordinated team of AI agents may seamlessly perform these activities.

Emerging trends include:

- Multi-agent collaboration
- Personalized enterprise assistants
- Autonomous scientific research
- AI-driven software engineering
- Smart cities powered by agentic systems
- Digital employees for organizations

The evolution toward Agentic AI is expected to fundamentally transform how organizations design, develop, and use software systems.

Conclusion

AI agents represent the next major milestone in the evolution of software systems. By integrating reasoning, planning, memory, learning, and autonomous execution, these intelligent systems extend beyond traditional automation to become capable digital collaborators. As organizations continue their digital transformation journey, AI agents will increasingly support decision-making, improve productivity, and create innovative solutions across healthcare, education, finance, manufacturing, and software engineering.

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Quantum Computing and the Future of Encryption Preparing for the Post-Quantum Era

By Dr. Kamal Kumar Srivastava

Introduction

The digital revolution has transformed the way we communicate, conduct business, and store information. Every online transaction—from internet banking and e-commerce to cloud computing and social media—relies on one fundamental technology: **encryption**. Encryption ensures that sensitive information remains confidential, authentic, and secure against unauthorized access.

For decades, classical cryptographic algorithms such as RSA, Diffie–Hellman, and Elliptic Curve Cryptography (ECC) have protected digital communications. These algorithms underpin secure websites (HTTPS), online payments, digital signatures, virtual private networks (VPNs), and government communication systems. Their security is based on the computational difficulty of mathematical problems such as integer factorization and the discrete logarithm problem.

However, a revolutionary technology known as **Quantum Computing** has the potential to disrupt this foundation. Unlike conventional computers, quantum computers exploit the principles of quantum mechanics to perform certain computations exponentially faster than classical machines. Although large-scale quantum computers are still under development, researchers worldwide are preparing for a future in which quantum computers could break many of today's widely used encryption systems.

This transition has given rise to the field of **Post-Quantum Cryptography (PQC)**—cryptographic techniques designed to remain secure even against quantum attacks. As governments, industries, and academic institutions prepare for the post-quantum era, understanding the relationship between quantum computing and encryption has become increasingly important for IT professionals, researchers, and students.

Understanding Quantum Computing

A classical computer processes information using **bits**, where each bit can be either **0** or **1**. Quantum computers, however, use **quantum bits (qubits)** that exploit the unique properties of quantum mechanics.

The three fundamental principles that distinguish quantum computing are:

1. Superposition: A qubit can exist in multiple states simultaneously, allowing a quantum computer to process many possibilities in parallel.

2. Entanglement: Two or more qubits can become interconnected such that the state of one instantly influences the other, regardless of distance. This enables highly efficient information processing.

3. Quantum Interference: Quantum algorithms amplify correct computational paths while suppressing incorrect ones, leading to dramatic improvements in solving specific classes of problems.

Together, these properties provide enormous computational power for certain applications that are impractical for today's supercomputers.

Why Encryption Matters

Encryption converts readable information (plaintext) into an unreadable format (ciphertext), ensuring that only authorized users possessing the correct cryptographic key can access the original data.

Modern encryption serves three essential purposes:

- **Confidentiality** – Protects sensitive information from unauthorized access.
- **Integrity** – Ensures that data has not been modified during transmission.
- **Authentication** – Verifies the identity of communicating parties.

Most secure internet communications rely on two categories of cryptography:

- **Symmetric-key cryptography**, where the same key is used for encryption and decryption (e.g., AES).
- **Public-key cryptography**, where different keys are used for encryption and decryption (e.g., RSA and ECC).

While symmetric encryption remains relatively resistant to quantum attacks, public-key cryptography faces significant challenges.

Quantum Threat to Current Encryption

The security of widely used public-key algorithms depends on mathematical problems that are extremely difficult for classical computers.

For example:

- RSA relies on the difficulty of factoring very large integers.
- Diffie–Hellman depends on solving discrete logarithm problems.
- Elliptic Curve Cryptography (ECC) relies on the elliptic curve discrete logarithm problem.

For classical computers, solving these problems may require thousands or even millions of years for sufficiently large keys.

Quantum computers, however, can exploit **Shor's Algorithm**, introduced by mathematician Peter Shor in 1994, to solve these problems dramatically faster. A sufficiently powerful quantum computer could potentially break RSA and ECC in practical time, threatening secure communication across banking, healthcare, defense, and digital commerce.

Another important quantum algorithm is **Grover's Algorithm**, which accelerates brute-force key searches. Although Grover's algorithm does not completely break symmetric encryption, it effectively halves the security level of symmetric keys. Fortunately, increasing key sizes—for example, using AES-256 instead of AES-128—can mitigate this risk.

Post-Quantum Cryptography

Recognizing the future threat posed by quantum computing, researchers have developed **Post-Quantum Cryptography (PQC)**. PQC refers to cryptographic algorithms designed to operate on classical computers while remaining secure against both classical and quantum attacks. Unlike quantum cryptography, PQC does not require quantum hardware. Instead, it relies on mathematical problems believed to be resistant to quantum algorithms.

Major families of PQC include:

Lattice-Based Cryptography: Widely regarded as the leading candidate for future encryption because of its strong security and computational efficiency.

Code-Based Cryptography: Based on the difficulty of decoding random linear codes.

Hash-Based Cryptography: Primarily used for digital signatures with strong security guarantees.

Multivariate Cryptography: Uses systems of multivariable polynomial equations for secure communications.

Isogeny-Based Cryptography: An emerging approach using mathematical properties of elliptic curves, although several proposed schemes have since been shown to have vulnerabilities.

NIST Standardization Initiative

To prepare for the quantum era, the **National Institute of Standards and Technology (NIST)** initiated an international competition in 2016 to identify quantum-resistant cryptographic algorithms.

Following extensive evaluation, NIST selected several algorithms for standardization. Among the first standardized algorithms are:

- **CRYSTALS-Kyber** for public-key encryption and key establishment.
- **CRYSTALS-Dilithium** for digital signatures.
- **SPHINCS+** as a hash-based digital signature scheme.
- **FALCON** as an alternative digital signature algorithm for applications requiring compact signatures.

These standards are expected to play a critical role in securing future digital infrastructure.

Applications of Quantum Computing

While quantum computing presents challenges for cybersecurity, it also offers enormous opportunities across multiple sectors.

Healthcare: Quantum computing can accelerate drug discovery, protein folding analysis, and personalized medicine.

Artificial Intelligence: Quantum machine learning may enable faster optimization and enhanced model training for complex AI applications.

Financial Services: Financial institutions could use quantum algorithms for portfolio optimization, fraud detection, and risk analysis.

Logistics: Quantum optimization techniques can improve transportation routes, supply chains, and resource allocation.

Climate Science: Quantum simulations may help researchers better understand climate systems and develop sustainable technologies.

Challenges in the Transition

Transitioning to post-quantum cryptography is a complex process.

Legacy Systems: Many organizations rely on hardware and software that cannot easily support new cryptographic algorithms.

Performance: Some PQC algorithms require larger keys and signatures, increasing storage and communication overhead.

Long-Term Data Protection: Sensitive information encrypted today may remain valuable for decades. Adversaries may already be storing encrypted data with the expectation of decrypting it once powerful quantum computers become available—a threat often described as **"Harvest Now, Decrypt Later."**

Global Migration: Governments, financial institutions, healthcare providers, and cloud service providers must coordinate large-scale migration efforts to ensure interoperability and security.

India's Quantum Mission

India has recognized the strategic importance of quantum technologies through the **National Quantum Mission (NQM)**. Approved by the Government of India, the mission aims to strengthen research and innovation in quantum computing, quantum communication, quantum sensing, and quantum materials.

The initiative supports the development of indigenous quantum technologies, promotes collaboration among academia, industry, and government laboratories, and seeks to prepare India for leadership in the emerging quantum economy. For students and researchers in Information Technology, the National Quantum Mission presents exciting opportunities in research, innovation, and entrepreneurship.

Preparing the Next Generation of IT Professionals

The emergence of quantum computing demands a new set of skills for future IT professionals. Students should develop a strong foundation in:

- Cryptography and network security
- Quantum computing fundamentals
- Quantum algorithms
- Post-quantum cryptography
- Artificial Intelligence and Machine Learning
- Cloud computing and cybersecurity
- Mathematical foundations including linear algebra and probability

Universities should also encourage interdisciplinary learning by integrating quantum technologies into engineering and computer science curricula.

The Road Ahead

Although large-scale fault-tolerant quantum computers capable of breaking today's public-key cryptography are not yet available, experts agree that organizations must begin preparing now. Migrating to quantum-resistant cryptographic systems is expected to take many years because of the complexity of updating digital infrastructure. Governments, standards organizations, technology companies, and academic institutions are already collaborating to ensure a secure transition. The future of cybersecurity will depend not only on advances in quantum computing but also on our ability to design resilient cryptographic systems that can withstand emerging computational capabilities.

Conclusion

Quantum computing represents one of the most transformative technological developments of the 21st century. Its unprecedented computational power promises breakthroughs in medicine, artificial intelligence, logistics, and scientific research. At the same time, it challenges the cryptographic foundations that secure today's digital world.

The transition to **Post-Quantum Cryptography** is not merely a technological upgrade—it is a strategic necessity. Organizations that begin preparing today will be better positioned to safeguard sensitive information, maintain trust, and ensure business continuity in the quantum era.

For students, researchers, and faculty in the Department of Information Technology, quantum computing offers an exciting frontier for learning, innovation, and interdisciplinary research. By understanding both the opportunities and the cybersecurity implications of quantum technologies, the next generation of IT professionals can contribute to building a secure and resilient digital future.

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Serverless Computing Explained: Building the Next Generation of Cloud Applications

Dr. Ram Pratap

Introduction

The rapid evolution of cloud computing has transformed the way organizations develop, deploy, and manage software applications. Traditional application deployment required organizations to purchase physical servers, configure operating systems, manage infrastructure, and ensure continuous maintenance. Cloud computing simplified this process by introducing virtual machines and managed services. The next major evolution is **Serverless Computing**, a cloud computing model where developers focus entirely on writing application code while the cloud provider automatically provisions, manages, scales, and maintains the underlying infrastructure.

Despite its name, *serverless* does not mean that servers do not exist. Instead, servers are fully managed by cloud service providers, allowing developers to concentrate on business logic rather than infrastructure management. Serverless computing has become one of the most influential paradigms in modern software engineering and is widely adopted by organizations such as Netflix, Airbnb, Coca-Cola, Capital One, and Samsung for building scalable and cost-efficient applications.

What is Serverless Computing?

Serverless computing is a cloud execution model in which the cloud provider dynamically allocates computing resources whenever application code is executed. Resources are automatically scaled according to workload demand and released immediately after execution.

The two primary categories of serverless services are:

- **Function as a Service (FaaS):** Developers deploy individual functions that execute in response to specific events.
- **Backend as a Service (BaaS):** Cloud providers offer ready-to-use backend services such as databases, authentication, storage, messaging, and APIs.

Unlike traditional servers that remain active continuously, serverless functions execute only when triggered, making the model highly efficient and economical.

Architecture of Serverless Computing

A typical serverless architecture consists of the following components:

1. **Client Application** ○ Mobile app ○ Web application ○ IoT device	2. **API Gateway** ○ Receives client requests ○ Performs authentication ○ Routes requests to serverless functions	3. **Serverless Functions** ○ Business logic ○ Data processing ○ Authentication ○ File processing	4. **Cloud Services** ○ Database ○ Object Storage ○ Notification Service ○ AI/ML Services ○ Monitoring

The execution flow follows an event-driven architecture where every event invokes one or more functions.

How Serverless Computing Works

The workflow of serverless computing involves the following steps:

1. A client sends a request through an application.
2. The API Gateway receives the request.
3. An event is generated.
4. The cloud platform launches the required function.
5. The function executes the business logic.
6. Data is retrieved or stored in cloud databases.
7. The function returns the response.
8. Resources are automatically released after execution.

This entire process typically completes within milliseconds.

Function as a Service (FaaS)

Function as a Service is the core technology behind serverless computing.

Each function is:

- Stateless
- Independent

- Event-driven
- Short-lived
- Automatically scalable

Common triggering events include:

- HTTP requests
- File uploads
- Database updates
- Message queues
- IoT sensor events
- Scheduled jobs
- Authentication events

Popular FaaS platforms include:

- AWS Lambda
- Microsoft Azure Functions
- Google Cloud Functions
- IBM Cloud Functions
- Oracle Functions

Backend as a Service (BaaS)

Backend as a Service provides fully managed backend components without requiring developers to build them from scratch.

Examples include:

- User Authentication
- Cloud Databases
- Cloud Storage
- Push Notifications
- Email Services
- Analytics
- Logging
- AI APIs

This significantly reduces application development time.

Characteristics of Serverless Computing

Some important characteristics include:

Automatic Scaling

Applications automatically scale from a few users to millions without manual intervention.

Pay-as-you-Go Pricing

Organizations pay only for actual execution time rather than idle infrastructure.

Event-Driven Execution

Functions execute only when specific events occur.

High Availability

Cloud providers deploy applications across multiple data centers, ensuring continuous availability.

Fault Tolerance

Failures are automatically handled through redundancy and retries.

Reduced Operational Overhead

Developers do not manage operating systems, patches, load balancing, or server maintenance.

Advantages of Serverless Computing

Reduced Infrastructure Management

System administrators spend less time configuring servers, enabling developers to focus on innovation.

Cost Efficiency

Organizations are billed based on actual function execution rather than continuously running servers.

Faster Development

Pre-built cloud services reduce coding effort and shorten development cycles.

Elastic Scalability

Applications automatically handle sudden spikes in user traffic.

Improved Reliability

Major cloud providers offer high availability, backup, disaster recovery, and security services.

Faster Deployment
Applications can be updated within minutes using Continuous Integration and Continuous Deployment (CI/CD) pipelines.

Limitations of Serverless Computing

Despite numerous advantages, serverless computing has certain limitations.

Cold Start Delay
Functions that have not been executed recently may require additional startup time before processing requests.

Execution Time Limits
Most cloud providers restrict maximum execution duration for individual functions.

Vendor Lock-in
Applications may become dependent on provider-specific services, making migration challenging.

Debugging Complexity
Monitoring distributed serverless applications requires advanced observability tools.

Stateless Nature
Persistent data must be stored externally using databases or object storage services.

Popular Serverless Platforms

Platform	Provider	Major Feature
AWS Lambda	Amazon Web Services	Mature ecosystem with extensive integrations
Azure Functions	Microsoft Azure	Strong support for enterprise and .NET applications
Google Cloud Functions	Google Cloud	Excellent integration with Google Cloud services
IBM Cloud Functions	IBM	Based on Apache OpenWhisk
Oracle Functions	Oracle Cloud	Enterprise cloud integration

Real-World Applications

Serverless computing is widely used in several domains.

E-Commerce
- Order processing
- Payment validation
- Inventory management
- Recommendation systems

Healthcare
- Electronic Health Records
- Medical image processing
- Telemedicine applications
- Health monitoring

Banking
- Fraud detection
- Transaction processing
- Credit scoring
- Customer authentication

Internet of Things (IoT)
- Smart home automation
- Industrial monitoring
- Smart agriculture
- Wearable health devices

Artificial Intelligence
- Image recognition
- Chatbots
- Speech processing
- Recommendation engines

Security Considerations

Although infrastructure security is managed by cloud providers, application developers remain responsible for securing their code and data. Key security practices include:

- Identity and Access Management (IAM)
- Encryption of data at rest and in transit
- Secure API authentication

- Environment variable protection
- Least privilege access control
- Continuous monitoring and logging
- Regular vulnerability assessments

This follows the cloud provider's **shared responsibility model**, where infrastructure security is handled by the provider while application-level security remains the developer's responsibility.

Future Trends

Serverless computing continues to evolve alongside emerging technologies.
Some important future trends include:

- AI-powered serverless platforms
- Edge serverless computing
- Serverless machine learning
- Multi-cloud serverless deployment
- Kubernetes-based serverless frameworks
- Event-driven microservices
- Green cloud computing with optimized resource utilization

As digital transformation accelerates, serverless architectures are expected to become a standard approach for cloud-native application development.

Conclusion

Serverless computing represents a significant advancement in cloud computing by abstracting infrastructure management and enabling developers to focus on creating innovative applications. Through automatic scaling, event-driven execution, and pay-per-use pricing, it delivers cost efficiency, agility, and operational simplicity. While challenges such as cold starts, execution limits, and vendor lock-in remain, ongoing advancements in cloud platforms continue to address these issues.

As organizations increasingly adopt cloud-native architectures, serverless computing is poised to play a central role in powering scalable web applications, IoT ecosystems, artificial intelligence solutions, and digital services. For students, researchers, and software professionals, understanding serverless computing is essential to building the next generation of intelligent, resilient, and efficient applications.

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Smart Healthcare Using IoT: Transforming the Future of Patient Care

By Praveen Sachan

Introduction

Healthcare is undergoing a remarkable digital transformation with the adoption of the **Internet of Things (IoT)**. Smart healthcare leverages interconnected devices, sensors, cloud computing, and artificial intelligence (AI) to collect, transmit, and analyze health-related data in real time. This technology enables continuous patient monitoring, early disease detection, remote healthcare services, and personalized treatment, ultimately improving healthcare outcomes while reducing costs.

According to the International Data Corporation (IDC), billions of IoT devices are expected to be connected worldwide, with healthcare emerging as one of the fastest-growing application domains. The integration of IoT into healthcare is reshaping traditional medical practices by making healthcare more accessible, efficient, and patient-centric (Islam et al., 2015).

Understanding IoT in Healthcare

The **Internet of Things (IoT)** refers to a network of physical devices embedded with sensors, processors, communication modules, and software that enable them to collect and exchange data over the Internet.

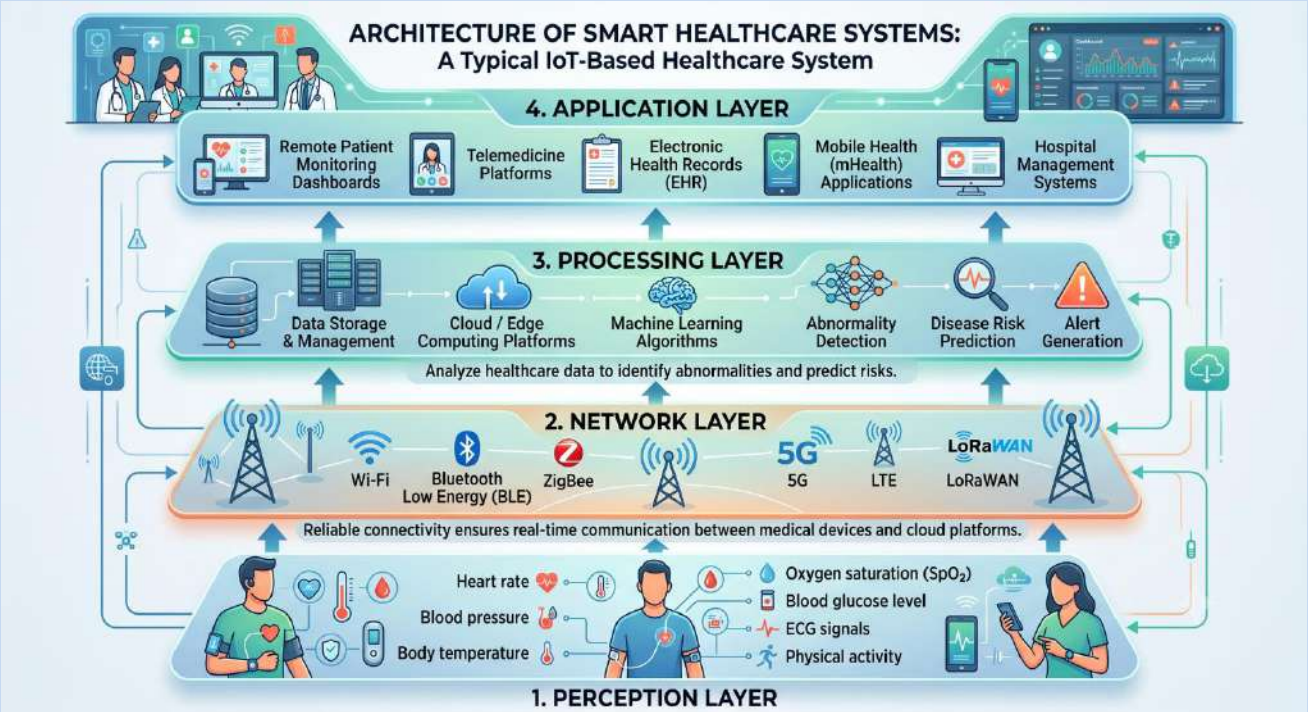
In a smart healthcare ecosystem, IoT devices include:

- Wearable fitness bands
- Smartwatches
- Continuous glucose monitors
- ECG monitoring devices
- Blood pressure monitors
- Pulse oximeters
- Smart inhalers
- Implantable medical devices

These devices continuously monitor physiological parameters and securely transmit the collected data to healthcare providers for analysis and timely intervention.

Architecture of Smart Healthcare Systems

A typical IoT-based healthcare system consists of four layers:



Key Technologies Enabling Smart Healthcare

Several emerging technologies work together to make IoT-based healthcare effective:

- **Wearable Sensors:** Continuously capture vital signs and physical activity.
- **Cloud Computing:** Provides scalable storage and computational resources for healthcare data.
- **Edge Computing:** Processes critical information closer to the data source, reducing latency.
- **Artificial Intelligence (AI):** Detects anomalies, predicts diseases, and supports clinical decision-making.
- **Big Data Analytics:** Identifies health trends and enables personalized treatment.
- **Blockchain:** Enhances the security and integrity of electronic health records.

Applications of IoT in Smart Healthcare

Remote Patient Monitoring: Patients with chronic diseases such as diabetes, hypertension, and cardiovascular disorders can be monitored continuously from home. Healthcare professionals receive real-time alerts if abnormal conditions are detected, reducing unnecessary hospital visits.

Telemedicine: IoT enables virtual consultations by allowing physicians to access real-time patient data collected through connected devices. This improves healthcare accessibility, particularly in rural and underserved areas.

Elderly Care: Smart wearables equipped with fall detection, GPS tracking, and emergency alert systems improve the safety and independence of senior citizens.

Smart Hospitals: Hospitals use IoT to optimize operations by tracking medical equipment, monitoring intensive care units (ICUs), automating inventory management, and improving patient flow.

Disease Management: Continuous monitoring of physiological parameters helps in the early detection and management of chronic illnesses such as asthma, heart disease, and diabetes.

Emergency Response: IoT-enabled ambulance systems can transmit patient vital signs to hospitals before arrival, enabling doctors to prepare for immediate treatment and improving emergency care outcomes.

Benefits of IoT-Based Smart Healthcare

IoT offers numerous advantages for healthcare providers and patients:

- Continuous monitoring of patient health.
- Early detection of medical emergencies.
- Improved accuracy of diagnosis through real-time data.
- Reduced hospitalization and healthcare costs.
- Enhanced patient engagement and self-care.
- Better resource utilization in hospitals.
- Faster clinical decision-making.
- Improved quality of life for patients with chronic conditions.

These benefits contribute to more efficient and patient-centered healthcare delivery.

Challenges and Security Concerns

Despite its advantages, IoT-based healthcare faces several challenges.

Data Privacy: Healthcare information is highly sensitive and must be protected against unauthorized access.

Cybersecurity Threats: Connected medical devices may become targets for cyberattacks if not adequately secured.

Interoperability: Medical devices from different manufacturers often use different communication standards, making seamless integration difficult.

Reliability: Reliable network connectivity is essential for transmitting critical healthcare data without interruption.

Power Management: Wearable devices require energy-efficient hardware and battery optimization to support long-term operation.

To address these challenges, healthcare systems should implement strong encryption, secure authentication, regular software updates, and compliance with healthcare data protection regulations.

Future Trends

The future of smart healthcare is driven by innovations that combine IoT with emerging digital technologies:

- AI-assisted disease prediction and diagnosis.
- 5G-enabled real-time remote surgery.
- Digital twins for personalized healthcare simulation.
- Federated learning for privacy-preserving medical AI.
- Smart implants with continuous health monitoring.
- Edge AI for faster clinical decision support.
- Integration of IoT with robotic healthcare assistants.

These advancements will make healthcare more predictive, preventive, personalized, and accessible.

Conclusion

The Internet of Things is revolutionizing healthcare by enabling intelligent, connected, and data-driven medical systems. Through wearable sensors, cloud computing, artificial intelligence, and real-time communication, IoT supports continuous patient monitoring, remote diagnosis, and efficient healthcare management. Although challenges related to security, privacy, and interoperability remain, ongoing technological advancements continue to strengthen the adoption of smart healthcare solutions.

As healthcare systems evolve toward digital transformation, IoT will play a pivotal role in improving patient outcomes, enhancing operational efficiency, and delivering quality healthcare services anytime and anywhere. For students and future engineers, understanding IoT-based smart healthcare is essential to developing innovative technologies that will shape the future of medicine.

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Students Contribution

"Technology: Shaping the Future"

By Aditya Rathore
B.Tech, Information Technology, 2nd Year
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As a B.Tech student in the Information Technology (IT) branch, I believe technology is not just a subject we study but a powerful tool that transforms the world around us. From smartphones and cloud computing to artificial intelligence and cybersecurity, technology has become an essential part of our daily lives. It connects people, simplifies work, and creates opportunities that were unimaginable just a few decades ago.

The field of Information Technology is constantly evolving. Every year, new technologies emerge, making it necessary for students to keep learning and adapting. In college, we gain knowledge of programming languages, data structures, databases, networking, software development, cloud computing, and cybersecurity. These technical skills help us understand how modern digital systems work and prepare us for future careers in the IT industry.

However, being an IT student is about much more than writing code. It is about solving real-world problems through innovation and creativity. Every application we use, every website we visit, and every digital service we rely on is the result of someone's ideas, dedication, and technical expertise.

As future software engineers and IT professionals, we have the opportunity to develop solutions that improve healthcare, education, banking, transportation, and communication. One of the most exciting aspects of technology today is Artificial Intelligence (AI). AI is transforming industries by automating repetitive tasks, improving decision-making, and enabling smart applications. Similarly, cloud computing allows businesses to store and access data securely from anywhere in the world, while cybersecurity protects valuable information from digital threats. These advancements create endless possibilities for innovation and career growth.

Apart from technical knowledge, an IT student must also develop soft skills such as communication, teamwork, leadership, and problem-solving. Most software projects are developed by teams, where collaboration and effective communication are just as important as programming skills. Time management, critical thinking, and a willingness to learn continuously are qualities that help students succeed in both academics and professional life.

Technology also comes with responsibility. As future IT professionals, we must use our knowledge ethically and responsibly. Protecting user privacy, ensuring data security, and developing reliable software are essential duties. Technology should always be used to improve society rather than create harm. Ethical decision-making is as important as technical excellence.

The journey of an IT student is filled with challenges and opportunities. Learning new programming languages, debugging complex code, completing projects, and keeping up with the latest trends can sometimes be difficult. However, every challenge teaches us valuable lessons

and helps us become better engineers. Success in IT requires patience, dedication, and a passion for continuous learning.

In conclusion, Information Technology is shaping the future of the world. As B.Tech students, we have the privilege of learning skills that can create innovative solutions and make people's lives easier. By combining technical expertise with creativity, ethics, and determination, we can contribute to building a smarter, safer, and more connected world. Technology is not just our field of study—it is our opportunity to innovate, inspire, and create a better future for everyone.

"Artificial Intelligence: Shaping the Future"

By Anupam
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Artificial Intelligence (AI) is no longer just a concept from science fiction; it has become an essential part of our daily lives. From voice assistants and recommendation systems to self-driving vehicles and advanced healthcare, AI is transforming the way we live, learn and work.

For students, AI opens the door to endless opportunities. It helps us learn faster, solve complex problems, and develop innovative solutions. However, with great power comes great responsibility. AI should always be used ethically, ensuring fairness, privacy and transparency.

As future IT professionals, we must not only learn how to build intelligent systems but also understand their impact on society. The future belongs to those who combine technical skills with creativity, critical thinking and ethical values.

AI is not here to replace human intelligence – it is here to enhance it. By embracing AI with responsibility and innovation, we can create a smarter, more inclusive and better world for everyone.

"AI can process data, but only humans can give it direction"

let us not fear Artificial Intelligence. Instead, let us learn it, shape it and use it to build a future where technology empowers humanity rather than replaces it.

"AI is not about creating a world without humans; it's about creating a world where humans can achieve more than ever before."

“Thoughts”

By Rohit Chouhan
B.Tech, Information Technology, 2nd Year
Babu Banarasi Das Northern India Institute of Technology

“College is not just where we prepare for a career; it is where we discover who we are capable of becoming.”

“Dream beyond limits, learn beyond classrooms, and create beyond expectations.”

“Don’t measure your college years by the marks you earned, but by the person you became.”

“Every ordinary day in college is quietly becoming a memory you will one day wish to relive.”

“Be the generation that doesn’t wait for change—be the generation that creates it.”

“Code Your Future”

By Saurabh Singh
B.Tech, Information Technology, 2nd Year
Babu Banarasi Das Northern India Institute of Technology

Believe. Learn. Build. Succeed.

In today’s rapidly changing world, technology is not just a part of our lives—it is shaping our future. As computer science and technology students, we are not merely learning how to write code; we are learning how to create solutions, solve problems, and build the future we dream of.

Every successful programmer, engineer, or entrepreneur once started with a simple first step. There were errors, failures, confusing concepts, and moments of doubt. But every error in a program teaches us something new, just as every failure in life makes us stronger.

“Your future is not something you find; it is something you create.”

Learning technology requires patience and consistency. A single line of code may not change the world, but thousands of lines written with dedication can create an application, a business, or even a solution that impacts millions of lives.

The journey is not always easy. Sometimes we compare ourselves with others and feel that we are behind. But everyone has a different journey. Instead of comparing your progress with someone else’s, focus on becoming better than you were yesterday.

As students, we have an incredible opportunity. We can learn new technologies, work on innovative projects, participate in competitions, collaborate with others, and turn our ideas into reality. The skills we develop today can become the foundation of our tomorrow.

So, **don't be afraid of errors. Don't be afraid of failure. Don't be afraid to start.**

Keep learning. Keep experimenting. Keep improving.

Your keyboard can be your tool, your imagination can be your power, and your determination can be your greatest strength.

So, don't just dream about your future—code it.

Believe in your idea. Build your skills. Create your opportunities. And code the future you want.

“The Hallways We Called Home”

By Shreyansh Dixit
B.Tech, Information Technology, 2nd Year
Babu Banarasi Das Northern India Institute of Technology

We came with maps of borrowed dreams,

And a left with roads we'd never planned.

Some were lessons lived inside the books,

The rest were written hand in hand.

The clocks moved fast, the nights moved slow,

Assignments chased, the mornings spun.

One day we'll miss the noisy halls,

And smile, "Those were the days we won.

"Quotes"

By Sumit Singh
B.Tech, Information Technology, 3rd Year
Babu Banarasi Das Northern India Institute of Technology

“We began with a simple ‘Hello World’
And a screen full of syntax errors,
we leave behind an architecture built on
late nights, shared coffee, creepy chats,
and logic that will outlive us.”

“Code is where ancient strategy meets future reality.”

“To the Engineers who debug in the dark, so there can live in the light.”

“Computers are incredibly fast, accurate and stupid. Human beings are incredibly slow, inaccurate and brilliant. Together they are powerful beyond imagination.”

“THE FIRST DAY”

By Mohd. Yusuf
B.Tech, Information Technology, 2nd Year
Babu Banarasi Das Northern India Institute of Technology

An IT Student’s First Encounter with Teachers, Labs & Technology

I entered as a stranger, with dreams in my eyes,

And found in IT a world where new horizons rise.

The teachers’ first words became my guiding light,

Turning fear into courage and doubt into sight.

Then came the labs, where silent screens came alive,

Where code met curiosity and new thoughts began to thrive.

Each error was a lesson, each problem a guide,

And technical support stood patiently by our side.

The teachers gave knowledge, but also gave a way,

To learn, to question, to grow every day.

What seemed like a classroom became more than a place—

It became the beginning of my journey and my space.

I came seeking knowledge, uncertain and new,

But left with a dream—and a purpose to pursue.

And if I am asked where my journey first grew,

I shall say: “It began here, with IT—and with you.”

“The Door at the End”

By Yash Bahri
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I walked through halls where every shadow knew my name,

Chasing a door that whispered, “You’ll never be the same.”

Behind it lay my failures, every fear I tried to hide,

I reached for the handle—but something stood inside.

“Turn back,” said the darkness, “your dreams are far too high.”

I almost believed it… then I heard my own reply:

“I’ve lost before, but losing taught me how to fight.”

The door slowly opened, flooding darkness with light.

I stepped inside, expecting a world I’d never seen—

But the greatest twist was this: the door was me.

“Ctrl + S Your College Memories”

By Yash Pansey
B.Tech, Information Technology, 2nd Year
Babu Banarasi Das Northern India Institute of Technology

Because assignments can be submitted again... but college memories can't.

Every engineering student knows the magical power of **Ctrl + S**. It saves your code after every three lines because trust issues with laptops are real! If only life had an auto save feature, we'd never lose our attendance, our sleep, or our sanity during exam week.

College isn't just about lectures and assignments—it's about asking, "Bhai, class hai aaj?" five minutes before it starts. It's about debugging for three hours only to realize the semicolon was missing. It's about surviving on chai, coffee, and hope while convincing yourself that "Kal se padhai pakka."

Every semester gives us unforgettable moments: the excitement of the first day, the panic of surprise quizzes, the happiness of hearing "Today's class is cancelled," and the legendary race to submit assignments at **11:59 PM**. Somehow, we always find time for friends, laughter, and making memories—even when deadlines are chasing us.

Engineering teaches us coding, teamwork, problem-solving, and one very important skill: looking busy whenever a professor walks by. We learn that Google is our unofficial tutor, YouTube is our backup professor, and the friend who says "Bas 5 minute aur" is never actually done in five minutes.

As we continue our journey at **BBDNIIT**, let's **Ctrl + S** every friendship, every fest, every canteen conversation, every late-night study session, and every achievement. One day, the classrooms will become memories, the assignments will be forgotten, but the people and moments will always stay with us.

So before graduation hits like an unexpected viva, remember to enjoy every moment.

Because code can be rewritten, CGPA can improve, but college memories are one-time commits.

Ctrl + S Your College Memories