# GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**
Semester -VI

**Course Title: Introduction to NO SQL**
(Course Code: 4360704)

| Diploma Programme in which this course is offered | Semester in which offered |
|---|---|
| Computer Science & Engineering | 6th semester |

## 1. RATIONALE

This course aims to introduce students to fundamental concepts and practical applications of various NoSQL databases, essential for modern data management within computer engineering.

## 2. COMPETENCY

Students will acquire foundational knowledge and practical skills in utilizing diverse NoSQL databases for managing and manipulating data in computer engineering contexts.

## 3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associatedwith this competency are to be developed in the student to display the following COs:

a) Analyze the impact of the CAP theorem on various NoSQL databases, highlighting the trade-offs between consistency, availability, and partition tolerance in database systems.
b) Apply MongoDB's features and basic CRUD operations to design and manipulate data structures effectively, demonstrating proficiency in utilizing a document-oriented database.
c) Demonstrate Cassandra's data model and query language (CQL), showcasing the ability to create and manage distributed data tables efficiently.
d) Identify the significance of graph databases, illustrating their practical applications in solving complex relationship-oriented problems.
e) Utilize Redis data structures and functionalities to implement efficient caching strategies, showcasing the role of Redis in enhancing data retrieval performance.

## 4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme(In Hours) | | | Total Credits (L+T/2+P/2) | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | Total Marks |
| L | T | P | C | CA | ESE | CA | ESE | |
| 0 | 0 | 4 | 2 | 0 | 0 | 25 | 25 | 50 |

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** -Continuous Assessment; **ESE** -End Semester Examination.*

## 5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the subcomponents of the COs.....These PrOs need to be attained to achieve the COs.

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|---|---|---|---|
| 1 | Introduction and Types of NoSQL Databases | 1 | 4 |
| 2 | Introduction and Installation of MongoDB | 2 | 4 |
| 3 | Basic CRUD Operations with MongoDB | 2 | 10 |
| 4 | Introduction and Setup of Cassandra | 3 | 4 |
| 5 | Data Modeling and Simple Queries with Cassandra | 3 | 10 |
| 6 | Introduction to Neo4j Graph Databases | 4 | 4 |
| 7 | Basic Graph Queries and Implementations with Neo4j | 4 | 10 |
| 8 | Redis Basics: Introduction and Key-Value Operations | 5 | 10 |
| | **Total** | | **56** |

***Note***

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency..*

| S. No. | Sample Performance Indicators for the PrOs | Weightage in % |
|---|---|---|
| 1 | Analyze given problem and find possible solution methods | 20 |
| 2 | Select appropriate algorithm/method to solve the problem | 20 |
| 3 | Implement proper solution to solve the problem | 40 |
| 4 | Test the solutions by different inputs | 20 |
| **Total** | | **100** |

## 6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

| S. No. | Equipment Name with Broad Specifications | PrO. No. |
|---|---|---|
| 1 | Computers with necessary software installations for each database system. | All |

## 7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this competency.

a) Appreciation for Diverse Data Management Approaches
b) Respect for Data Diversity
c) Critical Thinking about Database Selection
d) Ethical Considerations in Data Management

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

## 8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher-level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher-level UOs could be included by the course teacher to focus on the attainment of COs and competency.

| Unit | Unit Outcomes (UOs) (4 to 6 UOs at Application andabove level) | Topics and Sub-topics |
|---|---|---|
| **Unit – I NoSQL Fundamentals** | 1a. Describe CAP Theorem for NoSQL<br>1b. Compare different types of NoSQL Databases<br>1c. Summarize the factors influencing database choice | 1.1 Introduction to NoSQL databases<br>1.2 Types of NoSQL databases<br>1.3 CAP theorem<br>1.4 Consistency in NoSQL<br>1.5 Availability and Partition Tolerance<br>1.6 Comparisons between MongoDB, Cassandra, Neo4j and Redis<br>1.7 Use cases for different NoSQLdatabases<br>1.8 Factors influencing choice ofdatabase |

| | | |
|---|---|---|
| **Unit – II Introductio nto MongoDB** | 2a. Install and connect to MongoDB successfully<br>2b. Perform basic CRUD operations & data modeling in MongoDB<br>2c. Implement Indexing, Query Optimization & Sharding in MongoDB<br>2d. Describe Aggregation framework and Replica Sets | 2.1 Introducing MongoDB<br>2.2 MongoDB features and advantages<br>2.3 Installing MongoDB<br>2.4 Connecting to MongoDB<br>2.5 Basic CRUD operations<br>2.6 Data modeling in MongoDB<br>2.7 Indexing and Query Optimization<br>2.8 Aggregation Framework<br>2.9 Replica Sets<br>2.10 Sharding in MongoDB |
| **Unit– III Introductio nto Cassandra** | 3a. Explore data model in Cassandra & CQL<br>3b. Install and configure Cassandra to perform basic operations<br>3c. Perform monitoring, troubleshooting, performance tuning and optimization<br>3d. Implement Compaction strategies | 3.1 Overview of Cassandra<br>3.2 Data model in Cassandra<br>3.3 CQL (Cassandra Query Language)<br>3.4 Installing and configuringCassandra<br>3.5 Basic operations and maintenance<br>3.6 Monitoring and troubleshooting<br>3.7 Cassandra architecture<br>3.8 Performance tuning and optimization<br>3.9 Compaction strategies |
| **Unit– IV Neo4j an dGraph Databases** | 4a. Describe the basics of graph databases and graph theory<br>4b. Install Neo4j successfully to perform basic graphoperations<br>4c. Explore Cypher Query Language and Graph algorithms<br>4d. Describe Neo4j optimization techniques | 4.1 Basics of graph databases<br>4.2 Graph theory fundamentals<br>4.3 Use cases for graph databases<br>4.4 Installing Neo4j<br>4.5 Cypher Query Language<br>4.6 Basic graph operations<br>4.7 Graph algorithms and their applications<br>4.8 Neo4j optimization techniques<br>4.9 Real-world graph database scenarios |
| **Unit– V Redis Essential s** | 5a. Describe Redis data structures<br>5b. Perform basic commands and operations in Redis<br>5c. Explore transactions in Redis and caching strategies<br>5d. Integrate Redis with other technologies | 5.1 Overview of Redis<br>5.2 Redis data structures<br>5.3 Use cases for Redis<br>5.4 Basic commands and operations<br>5.5 Advanced features of Redis<br>5.6 Transactions in Redis<br>5.7 Using Redis in real-worldscenarios<br>5.8 Redis and caching strategies<br>5.9 Integrating Redis with other technologies |

***Note**: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom'sTaxonomy' to accelerate the attainment of the COs and the competency.*

## 9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Not Applicable

## 10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student- related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Hands-on practical sessions in a lab environment
b) Database manipulation exercises
c) Simple application development using NoSQL databases

## 11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/subtopics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

## 12. SUGGESTED MICRO-PROJECTS

***Only one micro-project*** is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups haveto be formed for micro-projects, the number of students in the group should ***not exceed three.*** The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain a dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student oughtto submit a micro-project by the end of the semester to develop the industry-oriented COs.

For Micro-Project, a **'Capstone Project'** can be given, wherein student(s) need to submit the following:

(a) Project Planning & Requirements
(b) Implementation using MongoDB, Cassandra, Neo4j, and Redis
(c) Project presentation and documentation

## 13. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Book | Author | Publication withplace, year and ISBN |
|---|---|---|---|
| 1 | MongoDB: The Definitive Guide | Kristina Chodorow and Shannon Bradshaw | O'Reilly, 2019 |
| 2 | NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence | Pramod J. Sadalage and Martin Fowler | Pearson Education, 2013 |
| 3 | Cassandra: The Definitive Guide | Jeff Carpenter and Eben Hewitt | O'Reilly, 2020 |
| 4 | Graph Databases: New Opportunities forConnected Data | Ian Robinson, Jim Webber, and Emil Eifrem | O'Reilly, 2015 |
| 5 | Redis in Action | Josiah L. Carlson | Manning Publications ,2013 |

## 14. SOFTWARE/LEARNING WEBSITES

a. https://www.ibm.com/topics/nosql-databases
b. https://www.coursera.org/lecture/nosql-databases/introduction-to-nosql-VdRNp
c. https://www.geeksforgeeks.org/introduction-to-nosql/
d. https://www.javatpoint.com/nosql-databases

## 15. PO-COMPETENCY-CO MAPPING

| Semester VI | Introduction to NO SQL (Course Code: 4360704) | | | | | | |
|---|---|---|---|---|---|---|---|
| | POs and PSOs | | | | | | |
| Competency & Course Outcomes | PO 1 Basic & Discipline specific knowledge | PO 2 Problem Analysis | PO 3 Design/ development of solutions | PO 4 Engineering Tools, Experimentation &Testing | PO 5 Engineering practices for society, sustainability & environment | PO 6 Project Management | PO 7 Life-long learning |
| **Competency**<br>Acquire foundational knowledge and practical skills in utilizing diverse NoSQL databases for managingand manipulating data in computer engineering contexts | | | | | | | |

| Course Outcomes | | | | | | | |
|---|---|---|---|---|---|---|---|
| CO a) Analyze the impact of the CAP theorem on various NoSQL databases, highlighting the trade-offs between consistency, availability, and partition tolerance in database systems | 3 | 3 | 2 | 2 | 2 | 2 | 3 |
| CO b) Apply MongoDB's features and basic CRUD operations to design and manipulate data structures effectively, demonstrating proficiency in utilizing a document-oriented database. | 3 | 3 | 3 | 2 | 2 | 2 | 3 |
| CO c) Demonstrate Cassandra's data model and query language (CQL), showcasing the ability to create and manage distributed data tables efficiently. | 3 | 3 | 3 | 2 | 2 | 2 | 3 |
| CO d) Identify the significance of graph databases, illustrating their practical applications in solving complex relationship-oriented problems. | 3 | 3 | 3 | 2 | 2 | 2 | 3 |
| CO e) Utilize Redis data structures and functionalities to implement efficient caching strategies, showcasing the role of Redis in enhancing data retrieval performance. | 3 | 3 | 2 | 2 | 2 | 2 | 3 |

Legend: '**3**' for high, '**2**' for medium, '**1**' for low or '**-**' for the relevant correlation of each competency, CO, with PO/ PSO

## 16. COURSE CURRICULUM DEVELOPMENT

**COMMITTEE GTU Resource Persons**

| Sr. No. | Name and Designation | Institute | Email |
|---|---|---|---|
| 1 | Mrs. Manisha P. Mehta – Head (Comp) | Government Polytechnic Himmatnagar | manishamehtain@gmail.com |
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