

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

Semester-VI

Course Title: Computer Maintenance & Troubleshooting

(Course Code:4360701)

Diploma programmer in which this course is offered	Semester in which offered
Computer Engineering	6 th Semester

1. RATIONALE

Personal computer systems have changed dramatically since the release of the original IBM PC in 1981. The role of the PC technician had to evolve to address improvements in hardware like motherboard technologies, micro processing power, RAM memory, flash memory, audio, video, printing, and networking. This course focuses on providing a solid foundation in current PC hardware, while the course labs provide a hands-on look inside the PC. In addition, the course reviews legacy computer system hardware, as well as looking at emerging technologies. This course will be helpful for students to get employment in the computer maintenance and related hardware industry as well as self-employment.

2. COMPETENCY

The aim of this course is to develop required skills in students so they are acquiring following competency:

- **Do Preventive Maintenance and troubleshooting of computer system and its peripherals.**

3. COURSE OUTCOMES (COs)

The theory and practical experiences and relevant soft skills associated with this course are to be taught and implemented so that the students demonstrate the following course outcomes:

- I. **Evaluate the evolution of computer system on hardware technology advancement basis.**
- II. **Classify various types of motherboards and its components.**
- III. **Examine working of processor and BIOS.**
- IV. **Classify hard disk and various types of peripheral devices.**
- V. **Test and troubleshoot various faults related to computer hardware and its peripherals.**

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
L	T	P		Theory Marks		Practical Marks		Total Marks
			C	CA	ESE	CA	ESE	
3	0	2	4	30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the Cos

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

Sr. No.	Practical Outcomes (Pros)	Unit No. (CO)	Approx Hrs. required
1	Identify basic parts/components of a Personal computer and laptop Prepare a Chart of your observation.	1	2
2	Observe various types of ports and its connecting devices of front & back side of the PC.	1	2
3	Explore major components of motherboard including north bridge, south bridge, co-processor, chipset etc.	2	2
4	Test power supply (SMPS) and identify different connectors with various voltage levels.	2	2
5	Study the architecture of Multi Core processors.	3	2
6	Elaborate BIOS settings in detailed.	3	2
7	Demonstrate physical structure of Hard disk.	4	2
8	Demonstrate Logical structure of Hard disk.	4	2
9	Illustrate formatting and partitioning of Hard disk.	4	2
10	Classify various types of secondary storage devices.	4	2
11	Test and troubleshoot working of Laser printer.	4	2
12	Experiment various troubleshooting strategies.	5	2
13	Perform Power on Self-Test (POST).	5	2
14	Disassembling of PC for troubleshooting purpose.	5	2

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Various Preventive and Maintenance toolkit.	ALL
2	Computer, laptop system and various peripherals.	ALL
3	Trainer kit of motherboard, keyboard, mouse, HDD, Display unit etc.	2,3,4,5,8,11
4	Bootable OS.	12

7. AFFECTIVE DOMAIN OUTCOMES

This course will be helpful for students to get employment in the computer maintenance industry as well as self-employment

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)	Topics and Sub-topics
Unit-1 Introduction to PC Hardware	1.1 Describe features of personal computer. 1.2 List & identify the components of computer system 1.3 Introducing the front & Back Panel of the PC.	1.1.1 Introduction of PC and its basic terminology – Hardware(H/W), Software(S/W), Firmware(F/W), PC Block diagram, Types of computer system (Micro Computer, Mainframe, Mini Computer, Work station, Super Computer). 1.2.1 List and Identify components of PC / laptop and specify its importance. 1.2.2 Prepare latest specification of PC/laptop. 1.3.1 List and Identify various types of ports and connectors found in PC/laptop with their purpose.
Unit-2 Motherboard & SMPS	2.1 Introduction of motherboard 2.2 Different types of motherboards 2.3 Chipsets 2.4 Bus slots 2.5 Describe Power Supply Unit - SMPS	2.1.1 Motherboard: Introduction, Functional Block Diagram, Components, Layout Connection 2.2.1 Motherboard: Types (AT, ATX, LPX, NLX, BTX) Form factor and features 2.3.1 Chipset: Definition, North bridge, South bridge 2.4.1 Expansion buses: Definition, Bus Architecture (ISA, PCI, PCI-E, PCI-X, AGP, USB, PCMCIA, VESA, VESA Local bus, IEEE 1394) 2.5.1 SMPS: Block Diagram, Components and pin assignments
Unit-3 Processor & BIOS	3.1 Study the architecture of various types of Multi Core processors. 3.2 Describe Co-Processor 3.3 Explain the level and purpose of Cache Memory 3.4 BIOS	3.1.1 Processor: Introduction of basic processor fundamentals like Common Features, Types, Basic Structure of CPU, Different level of cache, system bus, clock speed, packaging 3.1.2 Multiple Core Processor: Concepts, Dual core, Quad core, Multi core processor, diagram & working advantage of multi core processor 3.2.1 Co-Processor: Concepts, diagram & working, types, applications processor v/s coprocessor 3.3.1 Cache Memory: Memory types, Level of Cache memory, significance of Cache Memory

		<p>3.4.1 BIOS Components-BIOS ROM, BIOS CMOS Memory</p> <p>3.4.2 Bios Functions Function and features (CMOS setup)</p>
<p>Unit-4 Hard disk& I/O Devices</p>	<p>4.1 Describe Hard disk and it's interfacing</p> <p>4.2 Describe structure of Hard disk</p> <p>4.3 Explain disk performance parameters.</p> <p>4.4 Input Devices</p> <p>4.5 Output Devices</p> <p>4.6 Other Secondary storage devices</p>	<p>4.1.1 Hard Disk introduction and characteristics.</p> <p>4.1.2 Hard Disk Interfaces: IDE, Serial ATA(SATA), SCSI, USB, RAID, SSD</p> <p>4.2.1 Physical structure of Hard disk</p> <p>4.2.2 Logical Structure of Hard disk: Heads, Tracks, Sectors, Cylinders, Cluster, Landing Zone, MBR, Zone bit recording.</p> <p>4.2.3 Disk Partitioning</p> <p>4.3.1 Disk Performance parameters: Seeks & Latency, Data Transfer Rate, File system</p> <p>4.4.1 Keyboard: Block diagram, types, working principle, types of switches.</p> <p>4.4.2 Mouse: Operation & working principle and its types.</p> <p>4.4.3 Scanner: Types, Working principle</p> <p>4.5.1Printer: Types of Printers Laser Printers-working principles, construction and process of printing Inkjet Printers- working principles, construction and process of printing</p> <p>4.5.2 Monitor: Types of Monitors, LED Monitors- working principle and construction LCD Monitors- working principle and construction</p> <p>4.6.1 Introduction to CD, DVD, USB</p>

Unit-5 Troubleshooting & Preventive Maintenance	5.1 Explain POST Sequence 5.2 Explain Troubleshooting 5.3 Discuss Preventive Maintenance 5.4 Layman Check 5.5 PC Disassembling	5.1.1 POST: Functions, IPL Hardware, Test Sequence, Error messages with codes. 5.2.1 Troubleshooting: Basics, Troubleshooting by visual inspection, Systematic Troubleshooting procedure 5.2.2 Various peripheral devices troubleshooting: <ul style="list-style-type: none"> • Motherboard • Keyboard • Mouse • Printer • Hard Disk Drive • Monitor 5.3.1 PC Preventive Maintenance Requirements 5.3.2 Preventive Maintenance tools: Hardware Tool-Multi-meter, Software Tools-Diagnostic software, Disk utility software etc. 5.4.1 List of Layman checks 5.5.1 Disassembling PC component
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9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN:

Unit No	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to PC Hardware	6	2	2	4	8
II	Motherboard & SMPS	10	8	6	4	18
III	Processor & BIOS	8	6	6	2	14
IV	Hard disk & I/O Devices	12	8	6	4	18
V	Troubleshooting & Preventive Maintenance	6	2	2	8	12
		42	26	22	22	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different

taxonomy levels (of R, U and A) in the question paper may vary slightly from the above table.

10. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities like:

- i) Survey of computer system, laptops, servers, processor, coprocessor available in the market to get awareness of the technology being used and their specifications.
- ii) Prepare comparative charts as outcome of survey done.
- iii) Seminar presentation on various peripherals and its working.
- iv) Industry visit to a company or workshop where Computer hardware maintenance are carried out.
- v) Prepare charts for various types of CPU and input/output devices available in market.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

The course activities should include Lectures and Practical Exercises with sufficient Handson as per teaching scheme. Following instructional strategies should be Followed to cover the content:

- i. Concepts should be introduced in input sessions using multimedia projector.**
- ii. More focus should be given on Practical work through laboratory sessions.**
- iii. Discussion sessions and/or Demonstrations.**
- iv. Power point presentation to explain construction and functioning of various devices and components.**
- v. Debate/Group Discussions for comparison of various peripherals and computer systems.**

12. SUGGESTED MICRO/MINI PROJECT LIST

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-project is 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 she/he contributes to the projects of the industry. In special situations where groups have to 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 ought to submit a micro-project by the end of the semester to develop the industry-oriented Cos

A suggestive list of micro-projects is given here. This has to match the competency and the Cos Similar micro-projects could be added by the concerned course teacher:

Project Idea 1: Disassembling PC and troubleshoot.

Project Idea 2: SMPS: List down the components and measure different output voltages from SMPS.

Project Idea 3: Computer Motherboard: Prepare brief report on motherboard component and form factors.

Project Idea 4: Processor: Prepare small report of different microprocessor on industry-based survey.

Project Idea 5: Computer Specification: Prepare small report on major specification of different types of computers which is available in your LAB.

Project Idea 6: Troubleshooting of PC and its peripherals

13. SUGGESTED LEARNING RESOURCES:

Sr No	Title of Book	Author	Publication
1	IBM PC & Clones: Hardware Trouble Shooting and Maintenance	Govinda Rajalu	Tata McGraw Hill Education Private Limited
2	The complete PC Upgrade & Maintenance Guide	Mark Minasi	BPB Publications
3	PC Systems, Installation and Maintenance, Second Edition	R. P. Beales	Routledge
4	Computer Installation and Servicing	D Balasubramanian	Tata McGraw Hill Education Private Limited

14. SOFTWARE/LEARNING WEBSITES

Software: Microsoft windows operating system from XP/vista/7/8 to latest version available in market, Windows server, Linux/ubuntu/centos, server operating system

<http://www.gcflearnfree.org/computerbasics/15/print>

<http://www.more.net/sites/default/files/training/BTTmain.pdf>

<http://www.computerhope.com/issues/ch000248.htm>

<http://computer.howstuffworks.com/computer-hardware-channel.htm>

15. PO-COMPETENCY-CO MAPPING:

Semester VI (DCE)	Computer Maintenance & Troubleshooting (Course Code:4360701)						
	POs						
Competency & Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
Competency	Do Preventive Maintenance and troubleshooting of computer system and its peripherals.						
CO1 Evaluate the evolution of computer system on hardware technology advancement basis.	2	1	-	-	-	-	1
CO2 Classify various types of motherboards and its components.	2	2	1	1	-	-	1

CO3 Examine working of processor and BIOS.	2	1	1	1	-	-	-
CO4 Classify hard disk and various types of peripheral devices.	2	1	1	1	-	-	1
CO5 Test and troubleshoot various faults related to computer hardware and its peripherals.	2	2	2	2	1	1	2
	2	1.4	1.25	1.25	1	1	1.25

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Mr. S. B. Prasad	Government Polytechnic Gandhinagar	9879237924	sbprasad011@gmail.com
2.	Jiger P. Acharya	Government Polytechnic Ahmedabad	9429462026	jigeracharya@gmail.com
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**

Semester -VI

Course Title: Basics of Information Security

(Course Code: 4360702)

Diploma programme in which this course is offered	Semester in which offered
Computer Engineering	6 th semester

1. RATIONALE

Present computing era is based on the internet; Information security is crucial for safeguarding sensitive data and protecting individuals, organizations, and nations from a wide range of threats. The rationale for information security is multifaceted and encompasses various aspects of our digital world. Protecting Confidentiality, Preserving Integrity, Ensuring Availability, Mitigating Risks, Protecting Privacy. This course aims at learning basic cryptography techniques and applying security mechanisms for operating systems as well as private and public networks to protect them from various threats.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching-learning experiences:

- **Evaluate and apply diverse cryptographic techniques to safeguard networked systems, integrating foundational knowledge of basic information systems and principles of cyber security.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes:

- a) Describe fundamentals of information security.
- b) Demonstrate substitution, transposition technique and symmetric cryptography algorithm.
- c) Demonstrate the public key encryption with public key cryptography.
- d) Apply measures to protect the network communication from attacks using firewalls and intrusion detection systems.
- e) Describe the basics of cyber security, cyber attacks, cyber crime.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	CA	ESE	CA	ESE	
3	-	2	4	30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

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.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Execute Basic TCP/IP utilities and commands. (eg: ping, ipconfig, tracert, arp, tcpdump, whois, host, netstat, nslookup, ftp, telnet etc...)	I	02
2	Write a Program to implement Caesar Cipher for basic encryption and decryption. (Any of the Language C/C++/Java/Python)	II	02
3	Write a Program to implement Hill Cipher for basic encryption techniques. (Any of the Language C/C++/Java/Python)	II	04
4	Write a Program to implement the Play-Fair Cipher Technique for encryption. (Any of the Language C/C++/Java/Python)	II	02
5	Write a Program to implement the Rail Fence Technique for encryption. (Any of the Language C/C++/Java/Python)	II	02
6	Write a Program to implement RSA algorithm for asymmetric key encryption. (Any of the Language C/C++/Java/Python)	III	02
7	Demonstrate traffic analysis of different network protocols using tools. i.e. Wireshark.	IV	04
8	Simulate the concept of Virtual LAN using Cisco Packet Tracer.	IV	02
9	Simulate the concept of demilitarized zone network (DMZ) using Cisco Packet Tracer.	IV	02
10	Simulate the working of Firewall using Cisco Packet Tracer.	IV	02
11	Study cyber security fundamentals, including common threats and mitigation strategies.	V	02

12	Study of Kali Linux Operating System for cybersecurity.	V	02
Total			28

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	Regularity	20
2	Problem Analysis	20
3	Development of the Solution	20
4	Testing of the Solution	20
5	Mock viva test	20
Total		100

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

1. Hardware: Computer System with latest configuration and laptops
2. Software: C/C++/Java(Compiler), Python Interpreter, Wireshark, Cisco Packet Tracer, Kali Linux

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) Work as an Information Security Analyst.
- b) Follow ethical practices.
- c) Complying with procedures.
- d) Work collaboratively in a team.
- e) Workforce capable of preventing and mitigating cyber-attacks.

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 and above level)	Topics and Sub-topics
Unit – I Introduction to Information Security	1.a Describe basic concept of Information Security and security attacks	1.1 Introduction to Information Security 1.2 Need for Security 1.3 Security Attacks : Active, Passive and Denial of Service 1.4 Security Basics : Confidentiality, Integrity and Availability 1.5 Services and Mechanisms
Unit – II Conventional and Symmetric Cryptography	2.a Encrypt and Decrypt the given text using different substitution methods. 2.b Describe the given technique of cryptography using an example.	2.1 Introduction: Plain text, Cipher text, Cryptography, Cryptanalysis, Cryptology, Encryption and Decryption. 2.2 Substitution and Transposition Techniques: Monoalphabetic Cipher, Caesar Cipher, Polyalphabetic Cipher, Playfair Cipher, Hill Cipher, One Time Pad, Rail fence 2.3 Steganography: Introduction, Types of steganography techniques 2.4 Symmetric Cryptography : Data Encryption Standard- Structure, Advantages and Disadvantages
Unit– III Public key Cryptography	3.a Describe Public-Key Cryptography and its applications. 3.b Describe the RSA algorithm with its working. 3.c Describe digital signature and working of Public Key Infrastructure	3.1 Public-Key Cryptography : Principles of public-key cryptosystems, Applications of Public-key cryptosystems 3.2 The RSA algorithm: Description of the Algorithm, Computational aspects, Security of RSA. 3.3 Public key infrastructures : basics digital signatures, digital certificates, certificate authorities, registration authorities, steps for obtaining a digital certificate, steps for

		verifying authenticity and integrity of a certificate
Unit– IV Network Security	<p>4.a Describe the security topologies.</p> <p>4.b Explain function of Firewall and different types of Firewall.</p> <p>4.c Distinguish various types of IDS with advantages and disadvantages.</p>	<p>4.1 Security topologies – security zones, DMZ, Internet, Intranet, VLAN, Security implication, Tunneling.</p> <p>4.2 Firewalls: Need of Firewall, Working of Firewall, Types of Firewall: Packet Filtering, Stateful Inspection, Application Level Gateway, Circuit-Level Gateway and Next-Generation Firewall</p> <p>4.3 Intrusion detection systems (IDS): Intruders, Components of IDS, Host based IDS: Host based IDS, Advantages and Disadvantages of HIDS, Network based IDS: Network IDS, advantages and disadvantages of NIDS</p>
Unit– V Cyber Security	<p>5.a Describe basic concepts of cyber security and Network threats.</p> <p>5.b Describe Cyber crime and problems associated with computer crime</p>	<p>5.1 Introduction to Cyber Security, Cyber Threats, Types of Cyber Attacks, Vulnerabilities, Intruders and Hackers, Threats: Worms, Virus, Ad- ware, Spy-ware, Trojans and covert channels, Backdoors, Bots, IP Spoofing, ARP spoofing, Session Hijacking</p> <p>5.2 Cyber Crimes, Types of Cybercrime, Hacking, Attack vectors, Cyberspace and Criminal Behavior, Traditional Problems Associated with Computer Crime</p>

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Information Security	06	4	2	2	8
II	Conventional and Symmetric Cryptography	12	2	6	12	20
III	Public key Cryptography	10	2	8	6	16

IV	Network Security	10	4	6	6	16
V	Cyber Security	04	4	4	2	10
Total		42	16	26	28	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from the above table.

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:

- Visit to an Internet Service Provider.
- Study measures are taken by small computer industries.
- Seminars on various security tools, algorithms from the course content.
- Seminars on current threats of system/network.

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:

- Massive open online courses (**MOOCs**) may be used to teach various topics/subtopics.
- Guide student(s) in undertaking micro-projects.
- 'L' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- 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.
- 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-project 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 have to 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 ought to submit a micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

- **Project idea 1:** Build a password strength checker. This project helps beginners to learn about information security, as it can be done with a little bit of coding knowledge. You can use existing password strength algorithms or create your own.
- **Project idea 2:** Create a simple steganography tool that allows users to hide text or an image within another image.
- **Project idea 3:** Write a white paper on a cybersecurity topic. Writing a white paper is a great way to share your knowledge with others and establish yourself as an expert in the field.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Cryptography and Network Security Principles and Practices	Williams Stallings	Pearson Education, Third Edition
2	Principles of Computer Security CompTIA Security+ and Beyond Lab Manual	Vincent Nestler, Gregory White, Wm. Arthur Conklin, Matthew Hirsch, Corey Schou	Tata-McGraw Hill
3	Cryptography and Network Security Principal and Practices	Atul Kahate	Tata-McGraw-Hill
4	Cryptography and Network Security	B A Forouzan	Tata-McGraw-Hill
5	Computer Security Basics	Deborah Russell G.T. Gangenisr	O'Reilly publication
6	Computer Security	Dieter Gollman	Wiley India Education,

14. SOFTWARE/LEARNING WEBSITES

- <https://www.sans.org/information-security/>
- <https://nptel.ac.in/>
- <https://www.coursera.org/>
- <https://www.w3schools.com/cybersecurity/>
- Software: Wireshark Traffic Analysis/Packet Sniffing Tool, Snort Packet Sniffing tool

15. PO-COMPETENCY-CO MAPPING

Semester VI	Basics of Information Security(Course Code: 4360702)
	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 <ul style="list-style-type: none"> Evaluate and apply diverse cryptographic techniques to safeguard networked systems, integrating foundational knowledge of basic information systems and principles of cyber security. 							
Course Outcomes							
CO a) Describe fundamentals of information security.	3	-	-	-	3	-	3
CO b) Demonstrate substitution, transposition technique and symmetric cryptography algorithm.	3	2	3	2	-	2	3
CO c) Demonstrate the public key encryption with public key cryptography.	3	3	3	3	-	3	3
CO d) Apply measures to protect the network communication from attacks using firewalls and intrusion detection systems.	3	3	3	3	-	3	3
CO e) Describe the basics of cyber security, cyber attacks, cyber crime.	3	2	2	3	3	-	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	Ms. Manisha P. Mehta (HOD)	Government Polytechnic Himmatnagar	manishamehtain@gmail.com
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

Semester -VI

Fundamentals of IoT

(Course Code: 4360703)

Diploma programmer in which this course is offered	Semester in which offered
Computer Engineering	6 th Semester

1. RATIONALE

IoT (Internet of Things) is rooted in the transformative impact that IoT technologies are having on various industries and daily life. The course aims to provide students with a solid foundation in the principles, technologies, and applications of IoT, recognizing its significance as a key driver of technological innovation and societal advancement.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching-learning experiences:

- **Analyse and design the IoT System using the Sensor, the Actuator and Arduino board.**

3. COURSE OUTCOMES (COs)

The student will develop underpinning knowledge, adequate design and programming skills competency for implementing various IoT applications using Arduino to attain the following course outcomes.

- Explain the basic concept of IoT
- Apply different Sensors and Actuators in IoT Application as required
- Develop sketch for the IoT application using the Arduino Uno board.
- Explain Messaging and Transport protocols for IoT communication used in the IoT Applications
- Illustrate the working of real world IoT applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	CA	ESE	CA	ESE	
3	-	2	4	30	70	25	25	150

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

5. SUGGESTED PRACTICAL EXERCISES:

Sr. No.	Practical
1	Study of Arduino Uno board technical specifications and pins.
2	Study of various Sensors and actuators for IoT applications.
3	Develop IoT based application using Arduino board to blink the on-board LED at one second interval.
4	Develop IoT based application using Arduino board to turn ON and OFF the 3 LEDs (Red, Green, Blue) based on the 3 Pushbutton switches.
5	Develop IoT based application using Arduino board to implement automated traffic signal system using different colour LED.
6	Develop IoT based application using Arduino board to read analog input from a potentiometer and control the brightness of an LED.
7	Develop IoT based application using Arduino board from DHT sensor to measure temperature and humidity.
8	Develop IoT based application using Arduino board and ultrasonic sensor to measure distance and display it on the Serial Monitor.
9	Develop IoT based application using Arduino board and PIR sensor to detect presence/movement and turn on an LED automatically.
10	Develop an IoT based application using Arduino board to control servo motors back and forth across 180 degrees.
11	Develop an IoT based application using an Arduino board to print "Hello IoT" on a 16x2 LCD display.
12	Develop IoT based application using Arduino board and relay to implement smart appliance control.

* Some assignments/presentations for different topics can be arranged to attain other COs for Continuous Assessment for Practical Components.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Computer system with operating system: Windows 7 or higher Ver., macOS, and Linux, with 4GB or higher RAM, Python versions: 2.7.X, 3.6.X	All PrOs
2	Arduino Uno, clock speed of 16 MHz, 14 digital I/O pins, 6 analog input pins, UART for serial communication, voltage regulator (7v to 12v), USB connector with RESET Button.	
3	LEDs, Humidity and Temperature Sensor, Ultrasonic Sensor, Light Sensor, Servo motor, 16x2 LCD display, PIR Sensor, Potentiometer, relay etc. ESP8266 (Wi-Fi) board	

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 fulfil the development of this competency.

- a. Understanding of IoT concepts.
- b. Hardware and sensor knowledge
- c. Follow ethical practices.

8. UNDERPINNING THEORY:

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit-I: Introduction to IoT	1.1 Explain definition and Characteristics of IoT 1.2 Explain the IoT Architecture 1.3 Explain the challenges involved in developing an IoT system.	1.1 IoT Definition 1.2 IoT Characteristics 1.3 IoT Applications 1.4 Key Components of IoT System Things/Device, Gateway, Cloud/Server, Analytics, User Interface 1.5 Architecture of IoT 1.5.1 Sensing Layer 1.5.2 Network Interface Layer 1.5.3 Data Processing Layer 1.5.4 Application Layer 1.6 IoT Challenges 1.6.1 Design Challenges (Connectivity, Power Requirements, Complexity, Storage and Computational Capability, Data Extraction from complex environment) 1.6.2 Security Challenges (Security & Personal Safety, Privacy)
Unit-II: Sensors & Actuators	2.1 Distinguish the sensors and their working 2.2 Distinguish the Actuators and their working 2.3 Choose appropriate sensor based on the requirement	2.1 Voltage Considerations for Sensors 2.2 Sensors (working) PIR Motion Sensor, Sharp IR Distance Sensor, LDR Sensor, Gyro Sensor, Ultrasonic Distance Sensor, DHT Sensor 2.3 Need of ADC Chip while using Analog Sensors 2.4 Actuators (working) 2.4.1 Servo Motor 2.4.2 Solenoid 2.4.3 Stepper Motor 2.5 Need of Relay while using Actuators

<p>Unit III: Programming with Arduino Uno</p>	<p>3.1 Illustrate the Arduino Uno board</p> <p>3.2 Apply basic programming skills to develop the code for the Arduino Uno board.</p> <p>3.3 Practice the built-in, library and user defined functions in the program.</p> <p>3.4 Interface different sensors and actuators with Arduino board</p>	<p>3.1 ARDUINO UNO board Block diagram</p> <p>3.2 Sketch Structure</p> <p>3.3 Data types & Built in Constants</p> <p>3.4 Operators: Arithmetic, Bitwise, Compound, Comparison, and Boolean</p> <p>3.5 Control statements and Loops</p> <p>3.6 Functions and library functions</p> <p>3.6.1 User defined functions</p> <p>3.6.2 Library functions: I/O Functions: digitalRead, digitalWrite, pinMode, analogRead, analogWrite, analogReference. Char functions: isAlpha, isAlphaNumeric, isDigit, isHexadecimalDigit, isSpace, isWhitespace, isUpperCase, isLowerCase. Math Functions: abs, constrain, max, min, pow, sqrt</p> <p>3.7 LED Blinking using Arduino</p> <p>3.8 Serial Communication Functions: Serial, available, begin, end, print, println, write, read, readBytes, readString.</p>
<p>Unit-IV: IoT Communication Protocols</p>	<p>4.1 Explain the message passing protocols.</p> <p>4.2 Paraphrase transport protocols</p> <p>4.3 Differentiate different sensor network topologies</p>	<p>4.1 Messaging Protocols</p> <p>4.1.1 MQTT</p> <p>4.1.2 CoAP</p> <p>4.1.3 XMPP</p> <p>4.2 Transport Protocols</p> <p>4.2.1 Introduction of BLE</p> <p>4.2.2 Introduction to Li-Fi</p> <p>4.3 Basics of Sensor Network Topologies</p> <p>4.3.1 Point to Point Topology</p> <p>4.3.2 Mesh topology</p> <p>4.3.3 Ring topology</p> <p>4.3.4 Star Topology</p>
<p>Unit-V: Applications of IoT</p>	<p>5.1 Recognize the need of IoT in real- world problems</p> <p>5.2 Apply various components of IoT to solve a real world problem.</p>	<p>5.1 Overview, Block Diagram and Working of the following real world IoT applications</p> <p>5.1.1 Smart Home automation</p> <p>5.1.2 Agricultural System</p> <p>5.1.3 Smart Parking</p>

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN:

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	Introduction to IoT	8	6	8	0	14
2	Sensors and Actuators	9	4	10	0	14
3	Programming with Arduino Uno	10	0	7	10	17
4	IoT Protocols	10	6	12	0	18
5	Applications of IoT	5	0	0	7	7
Total		42	16	37	17	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from the above table.

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

- Undertake micro-projects in teams.
- Give a seminar on any relevant topics.
- Visit any Industry with IoT in your area and learn the IoT systems used in Industry.
- Students are encouraged to register themselves in various MOOCs such as: Swayam, edx, Coursera, Udemy etc to further enhance their learning.
- Undertake Swayam MOOC online course: "Introduction to Internet of Things": https://onlinecourses.nptel.ac.in/noc24_cs35/preview

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:

- Massive open online courses (**MOOCs**) may be used to teach various topics/subtopics.
- Guide student(s) in undertaking micro-projects.
- 'L' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- About **15-20% 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.
- With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.

12. SUGGESTED PROJECT LIST

1. Smart Agriculture System
2. Weather Reporting System
3. Home Automation System
4. Face Recognition Bot
5. Smart Garage Door
6. Smart Alarm Clock
7. Air Pollution Monitoring System
8. Smart Parking System
9. Smart Traffic Management System
10. Smart Cradle System
11. Smart Gas Leakage Detector Bot
12. Streetlight Monitoring System
13. Smart Anti-Theft System
14. Liquid Level Monitoring System
15. Night Patrol Robot
16. Internet of Things with Android and Arduino
17. Automatic Street Lighting system using IoT
18. Smart Building Project using PIR
19. Smart Water Monitoring System using IoT
20. Cloud-ready temperature sensor with the Arduino Uno
21. An IoT Temperature Monitor for Balcony Garden
22. Smart Irrigation System using IoT
23. Temperature & Humidity Sensing using IoT
24. IoT Remote Soil Moisture Monitor
25. IoT based smart alert system for Heart Patients

13. SUGGESTED LEARNING RESOURCES

Sr	Title	Authors	Publisher	Year
1	Internet of Things: Architecture and Design Principles	Rajkamal	McGraw Hill Education	2017
2	IoT Fundamentals Networking Technologies, Protocols and Use Cases for Internet of Things	David Hanes, Gonzalo salgueiro	Cisco Press	2017
3	Designing the Internet of Things	Adrian McEwen, Hakim Cassimally	John Wiley and Sons, Ltd.	2014

14. SOFTWARE/LEARNING WEBSITES

- Swayam MOOC online course for the introduction to internet of Things:
https://onlinecourses.nptel.ac.in/noc24_cs35/preview
- Tutorials point online learning portal:
https://www.tutorialspoint.com/internet_of_things/index.htm
- Arduino tutorial: <https://www.arduino.cc/reference/en/>

- Online Simulator for Arduino: <https://www.tinkercad.com/dashboard>

15. PO-COMPETENCY-CO MAPPING:

Semester VI	Fundamentals of IoT (Course Code: 4360703)						
	POs						
Competency & Course Outcomes	PO1 Basic & Discipline specific knowledge	PO2 Problem Analysis	PO3 Design/ developme nt of solutions	PO4 Engineering Tools, Experimentat ion and Testing	PO5 Engineering practices for society, sustainability & environment	PO6 Project Managemen t	PO7 Life-long learning
Competency	Analyse and design the IoT System using the Sensor, the Actuator and Arduino board.						
Course Outcomes: CO1: Explain the basic concept of IoT	2	2	-	-	-	-	1
CO2: Apply different Sensors and Actuators in IoT Application as required	3	3	3	3	1	-	1
CO3: Develop sketch for the IoT application using the Arduino Uno board.	3	3	3	3	2	2	1
CO4: Explain Messaging and Transport protocols for IoT communication used in the IoT Applications.	2	1	1	1	-	-	1
CO5: Illustrate the working of real world IoT applications.	2	2	2	2	1	1	1

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
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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 Engineering	6 th 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 associated with this competency are to be developed in the student to display the following COs:

- Analyze the impact of the CAP theorem on various NoSQL databases, highlighting the trade-offs between consistency, availability, and partition tolerance in database systems.
- Apply MongoDB's features and basic CRUD operations to design and manipulate data structures effectively, demonstrating proficiency in utilizing a document-oriented database.
- Demonstrate Cassandra's data model and query language (CQL), showcasing the ability to create and manage distributed data tables efficiently.
- Identify the significance of graph databases, illustrating their practical applications in solving complex relationship-oriented problems.
- 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				Total Marks
				Theory Marks		Practical 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 and above level)	Topics and Sub-topics
Unit – I NoSQL Fundamentals	1a. Describe CAP Theorem for NoSQL 1b. Compare different types of NoSQL Databases 1c. Summarize the factors influencing database choice	1.1 Introduction to NoSQL databases 1.2 Types of NoSQL databases 1.3 CAP theorem 1.4 Consistency in NoSQL 1.5 Availability and Partition Tolerance 1.6 Comparisons between MongoDB, Cassandra, Neo4j and Redis 1.7 Use cases for different NoSQL databases 1.8 Factors influencing choice of database

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

Note: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' 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 have to 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 ought to 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 with place, 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 for Connected 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

- <https://www.ibm.com/topics/nosql-databases>
- <https://www.coursera.org/lecture/nosql-databases/introduction-to-nosql-VdRNp>
- <https://www.geeksforgeeks.org/introduction-to-nosql/>
- <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 Acquire foundational knowledge and practical skills in utilizing diverse NoSQL databases for managing and 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

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3	Mr. Sanjay A. Valaki – Lect. (Comp)	Government Polytechnic Himmatnagar	sanjay.valaki@gmail.com
4	Mr. Hardik N. Talsania - Lect. (Comp)	R. C. Technical Institute Ahmedabad	hardik.n.talsania@gmail.com

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**

Semester - VI

Course Title: Network Forensics

(Course Code: 4360705)

Diploma programme in which this course is offered	Semester in which offered
Computer Engineering	6 th semester

1. RATIONALE

This course provides a foundational understanding of computer networks, emphasizing protocols, structures, and networking necessity. Exploring various network types and components ensures a comprehensive grasp of critical elements. Transitioning to the OSI model and TCP/IP protocol suite establishes a conceptual framework for network structures. The course introduces Network Forensics, addressing myriad threats and vulnerabilities. Students gain hands-on digital forensics skills through evidence identification, data acquisition, and preservation techniques. Inclusion of wireless network fundamentals and security challenges anticipates evolving technologies, addressing legal and privacy aspects, and future trends like blockchain, AI, and IoT forensics, prepares students for the dynamic field's ethical, legal, and technological dimensions.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching-learning experiences:

- Demonstrate comprehensive ability in network forensics process and its legal aspects.

3. COURSE OUTCOMES (COs)

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

- a) Identify the significance and principles underlying networking concepts and protocols.
- b) Demonstrate the application of network forensics in addressing different types of network attacks and vulnerabilities.
- c) Describe the principles and methodologies involved in conducting network forensics analysis.
- d) Comprehend wireless basics, authentication types, and attacks on wireless networks.
- e) Describe the legal challenges, privacy laws, and future trends in network forensics.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	CA	ESE	CA	ESE	
3	-	2	4	30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

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	Execute Basic TCP/IP utilities and commands. (eg: ping, ipconfig, tracert, arp, tcpdump, whois, host, netstat, nslookup, ftp, telnet etc...)	I	2
2	Design and implement small network using bus, star, mesh and hybrid topology with IP address scheme (eg. packet Tracer)	I	2
3	Simulate the configuration of DHCP (eg. packet Tracer)	I	2
4	Simulate the configuration of DNS (eg. packet Tracer)	I	2
5	Study different types of vulnerabilities of Web Applications and Networks.	II	2
6	Study Wireshark tool for Network Packet Capturing.	III	4
7	Analysis of Internet Protocol using Wireshark.	III	2
8	Analysis of TCP Protocol using Wireshark.	III	2
9	Analysis of DHCP Protocol using Wireshark.	III	2
10	Analysis of DNS Protocol using Wireshark.	III	2
11	Study different authentication techniques in Wireless Networks.	IV	2
12	Study different attacks on Wireless Networks.	IV	2

13	Study application of Artificial Intelligence in Network Forensics.	V	2
Total			28

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	Regularity	20
2	Problem Analysis	20
3	Development of the Solution	20
4	Testing of the Solution	20
5	Mock viva test	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	Hardware: Computer System with latest configuration and laptops	All
2	Software: Wireshark, Cisco Packet Tracer, Linux, Windows	

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) Follow ethical & safety practices.
- b) Work as a leader/a team member.
- c) Follow standard configuration.
- d) Motivation and Attitude towards learning

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)	Topics and Sub-topics
Unit - I Basics of Networking Concepts and Protocols	1.a Describe basic concept of Internet networking and its components	1.1. Basics of Computer Networks- Definition of Network, Need of Networks, Protocol. 1.2. Types of Networks- LAN, MAN, WAN 1.3. Network Components- Twisted Pair Cable, Coaxial cable, Fiber Optic Cables, Network Interface Card, HUB, Switch, Router 1.4. OSI model and TCP/IP protocol suite 1.5 Introduction Network Protocols- IP, TCP, UDP, DHCP, DNS
Unit - II Introduction to Network Forensics and Network Threats	2.a Explain Network Forensics and its importance 2.b Explain Network threats and vulnerabilities 2.c Explain Types of Network Forensics Investigations	2.1 Overview of Network Forensics: Definition, Process of Network Forensics, Importance, Advantages and Disadvantages, Application of Network Forensics. 2.2 Network threats and vulnerabilities: Types of network attacks- eavesdropping, spoofing, modification, Cross-site scripting, DNS Spoofing, Routing Table Page Poisoning, ARP Poisoning, Web Jacking. Social Engineering Attacks and its types. 2.3 Types of network forensics investigations: Incident Response and Proactive Investigations
Unit - III Network Forensics Analysis	3.a Describe the process of evidence handling 3.b Explain data acquisition methods 3.c Explain data preservation techniques 3.d Explain Network Traffic Analysis methods	3.1 Identifying sources of evidence- Digital devices, Network traffic, Cloud environments, Steps for handling evidence. 3.2 Data acquisition methods- Network traffic capture, Log file analysis, Memory acquisition, List Packet capture tools 3.3 Introduction to Data Preservation Technique- Write-blocking, Data encryption, Data hashing, Metadata preservation 3.4 Network Traffic Analysis Methods- Flow analysis, Packet analysis, Deep packet inspection (DPI), Network behavior analysis
Unit - IV	4.a Describe Wireless Networks and security challenges	4.1 Introduction to Wireless Networks: Basics of wireless (IEEE 802.11) communication and security challenges.

Wireless Network Forensics	4.b Explain Attacks on Wireless Networks	4.2 Types of Authentications: WEP, WPA and WPA-2 Encryption. 4.3 Attacks on Wireless networks: Man-in-the-middle (MITM), Brute-Force, Evil Twin, Rogue access points, Phishing, Wireless Jamming (Denial-of-Service Attacks), Wireless Eavesdropping.
Unit - V Legal Aspects and Future Trends	5.a Explain Legal challenges, Digital Personal Data Protection Act, 2023 5.b Explain the future trends in network forensics	5.1 Legal challenges in network forensics: Authorization, Privacy, Data Preservation, Disclosure, Cross-Border Investigations. 5.2 Digital Personal Data Protection Act,2023: Introduction, Data, Data Fiduciary, Data Principal, Data Processor, Personal Data Breach, Need of DPDP, Key Features of DPDP 5.3 Future Trends: Role of Artificial intelligence in Intrusion Detection, Role of Artificial intelligence in network forensics, Introduction to Internet of Things (IoT) forensics, components and challenges

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	Basics of Networking Concepts and Protocols	06	04	04	02	10
II	Introduction to Network Forensics and Network Threats	08	06	06	02	14
III	Network Forensics Analysis	10	04	08	08	20
IV	Wireless Network Forensics	10	04	08	04	16
V	Legal Aspects and Future Trends	08	06	04	00	10
Total		42	24	30	16	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from the above table.

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) Undertake micro-projects in teams
- b) Give a seminar on any relevant topics.
- c) Students are encouraged to register themselves in various MOOCs such as: Swayam, edx, Coursera, Udemy etc to further enhance their learning.
- d) Prepare charts to explain use/process of the identified topic.
- e) Arrange visits to cybersecurity operations centers or relevant facilities, providing students with exposure to professional network forensic environments.
- f) Organize workshops where students can interact with network forensic experts, participate in live demonstrations, and ask questions to deepen their understanding.
- g) Form small groups for collaborative projects, such as creating a network forensic analysis report for a specific scenario or designing a network security solution.
- h) Use simulation tools to create controlled network security scenarios, challenging students to identify and respond to security incidents.

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) Diagnosing Essential Missed Learning concepts that will help students.
- d) '**L' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- e) 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.
- f) With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- g) Utilize multimedia resources such as videos, interactive simulations, and virtual labs to cater to diverse learning styles and enhance understanding.
- h) Implement regular quizzes, assessments, and progress checks to ensure ongoing comprehension and engagement throughout the course.
- i) Invite guest speakers who are experts in network forensics to share their experiences, insights, and practical tips with students.
- j) Encourage students to analyze and solve problems based on actual incidents.

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-project 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 have to 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 ought to submit a micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

Project 1 : Conducting a security assessment on a LAN/Wi-Fi network.

Project 2 : Evaluation of Network Forensic Tools.

Project 3 : Research and prepare brief presentations on future trends in network forensics (malware analysis, blockchain impact, AI integration, IoT forensics).

Project 4 : Study the Digital Personal Data Protection Act (2023) regulations and conduct a seminar on their impact on network forensics.

Project 5 : Simulate a network attack scenario (e.g., Man-in-the-Middle attack) in a controlled environment.

Project 6 : Research a real-world legal case related to network forensics and Present the case, highlighting the legal and ethical considerations.

Project 7 : Construct a small-scale network, implement different components, and assess their performance under diverse conditions.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Learning Network Forensics	Samir Datt	PACKT Publications, Year: 2016 ISBN: 9781782174905
2	Digital Forensic: The Fascinating World of Digital Evidences	Nilakshi Jain, Dhananjay R. Kalbande	WILEY Publications, ISBN: 9788126565740
3	Network Forensics	Ric Messier	Wiley, ISBN: 9781119328285
4	Network Forensics: Tracking Hackers through Cyberspace	Sherri Davidoff, Jonathan Ham	Pearson
5	Hands-On Network Forensics	Nipun Jaswa	PACKT Publications ISBN 9781789344523

14. SOFTWARE/LEARNING WEBSITES

- <https://www.lucidchart.com/blog/cloud-computing-basics>
- <https://www.forcepoint.com/cyber-edu/cloud-security>
- <https://forensicscontest.com/>

- d. https://www.sans.org/in_en/
- e. <https://nptel.ac.in/>
- f. <https://www.udemy.com/>
- g. <https://www.cybrary.it/>

15. PO-COMPETENCY-CO MAPPING

Semester VI	Network Forensics (Course Code: 4360705)						
	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 Demonstrate comprehensive ability in network forensics process and its legal aspects.							
Course Outcomes							
CO a) Identify the significance and principles underlying networking concepts and protocols.	3	1	2	2	-	1	2
CO b) Demonstrate the application of network forensics in addressing different types of network attacks and vulnerabilities.	3	2	2	-	-	1	2
CO c) Describe the principles and methodologies involved in conducting network forensics analysis.	3	2	2	3	-	3	2
CO d) Comprehend wireless basics, authentication types, and attacks on wireless networks.	3	2	2	2	-	2	2
CO e) Describe the legal challenges, privacy laws, and future trends in network forensics.	3	-	-	-	2	-	2

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	Smt. Manisha P. Mehta HOD, Computer	Government Polytechnic, Himmatnagar	manishamehtain@gmail.com
2	Mr. Punit Saswadkar Lecturer (Computer)	Government Polytechnic, Gandhinagar	psgpg20@gmail.com
3	Mr. Naresh A. Patel Lecturer (Computer)	K. D. Polytechnic, Patan	napcool37@gmail.com

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

Semester -VI

Course Title: Software Testing

(Course Code: 4360706)

Diploma programme in which this course is offered	Semester in which offered
Computer Engineering	6 th semester

1. RATIONALE

Software testing is an indispensable process in the software development life cycle, serving as a critical quality assurance measure. Its primary objective is to identify and rectify defects, ensuring that the software meets specified requirements and functions as intended. Through a systematic and rigorous examination of the software, testing helps detect errors, inconsistencies, and potential vulnerabilities, thereby enhancing the reliability and robustness of the final product. By validating each component and feature, software testing contributes to the overall improvement of software quality, fosters user satisfaction, and reduces the likelihood of post-deployment issues. Additionally, it provides stakeholders with confidence in the software's performance, functionality, and security, ultimately supporting the delivery of a high-quality and dependable product.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching-learning experiences:

- **Proficient in identifying and resolving software defects through comprehensive testing methodologies and tools to ensure the delivery of high-quality and reliable software products.**

3. COURSE OUTCOMES (COs)

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

The student will develop underpinning knowledge, adequate software testing skills of competency for testing various applications using different testing techniques to attain the following course outcomes.

- Describe importance of Software Testing to enhance the quality of software products.
- Apply black-box and white-box testing techniques effectively.
- Develop effective test cases based on specifications, utilizing appropriate templates and methodologies.
- Apply bug identification skills to create a comprehensive defect report for the software application.
- Utilize popular testing tools (e.g., Selenium, JUnit, TestNG) for creating and executing automated test scripts.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	CA	ESE	CA	ESE	
3	-	2	4	30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

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	A). Create a glossary of at least five software testing terminologies with explanations. B). Describe why both SDLC and STLC are essential in the software development process.	I	02
2	Enlist and present at least three popular testing methodology (e.g., Agile, Waterfall) with its advantages and disadvantages.	I	02
3	Write program and design test cases for the following Control and decision-making statement. 1) For... Loop 2) Switch...case 3) Do... While 4) If...else	II	02
4	Design test cases for different tasks (OTP Verification, Image upload, Age verification in Registration) in any software modules using Equivalence partitioning, boundary value analysis, and decision table testing techniques of Black Box Testing.	II	02
5	A) Identify system specification & design test cases for Sales Invoice Management. B) Design Test Cases for Flight Ticket Booking system.	II	04
6	Develop test scenarios and test cases for the login functionality of a social media application.	III	02

7	Develop an RTM and measure testing metrics for any two dynamic web pages of an e-commerce website.	III	02
8	Execute test cases for a travel booking app and prepare a test summary report.	III	02
9	Prepare defect report after executing test cases for registration page.	IV	02
10	Prepare defect report after executing test cases for Withdrawn of amount from ATM Machine.	IV	02
11	A) Install and set up the Selenium WebDriver and necessary drivers (e.g., ChromeDriver, GeckoDriver) on your system. B) Install JUnit, TestNG using an IDE (Integrated Development Environment) like Eclipse or IntelliJ.	V	02
12	Design and run test script for a registration page using Selenium tool and JUnit.	V	02
13	Design and run test script for a Login page and home page using Selenium tool and TestNG.	V	02
Total			28

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	Test Planning	20
2	Design Test Case	25
3	Execute Test Cases	20
4	Preparation of Defect report	20
5	Answer to questions and documentation	15
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	Computer system with operating system: Windows 7 or higher Ver., macOS, and Linux, with 4GB or higher RAM	All
2	Microsoft office or any Open-source spreadsheet package.	All
3	CODE Editor (Notepad++, VS Code, Sublime), JAVA IDE (Eclipse, NetBeans, IntelliJ)	All
4	Testing frameworks (e.g. Selenium, JUnit, TestNG)	XI, XII, XIII

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) Work as a test engineer.
- b) Follow ethical practices.

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.

9. 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)	Topics and Sub-topics
Unit – I Introduction to Software Testing	1a Describe the fundamental concepts of software testing. 1b Discuss how the V Model facilitates the integration of verification and validation activities. 1c Differentiate between SDLC and STLC. 1d Discuss how testing approaches may vary across different SDLC models (e.g., Waterfall, Agile).	1.1 Software testing and its importance. 1.2 Software Testing terminologies. 1.3 Verification and Validation (V Model), Quality Assurance, Quality Control. 1.4 Software development life cycle (SDLC) and testing phases 1.5 STLC – Software Testing Life Cycle in details, SDLC vs STLC 1.6 Types of testing (manual vs. automated) 1.7 Testing principles, processes,

		and methodologies.
Unit – II Software Testing Techniques and Levels	<p>2a Describe Functional testing various Techniques.</p> <p>2b Describe Non-Functional testing various Techniques.</p> <p>2c Differentiate black-box and white-box testing approaches.</p> <p>2d Comparative analysis of Static Testing, Dynamic Testing, Smoke Testing, Sanity Testing, regression testing.</p>	<p>2.1 Introduction of Black-box testing and white-box testing</p> <p>2.2 Black Box Testing: Equivalence partitioning, boundary value analysis, and decision table testing</p> <p>2.3 White box testing: Statement Coverage, Branch Coverage, Test of Conditions, Path Coverage</p> <p>2.4 Unit testing, integration testing, system testing, acceptance testing</p> <p>2.5 Static Testing, Dynamic Testing, Smoke Testing, Sanity Testing, regression testing, Static vs. dynamic testing, Smoke Vs Sanity Testing</p> <p>2.6 Various type of Non-Function Testing</p>
Unit-III Software Testing Management	<p>3a create a comprehensive test plan in the software development.</p> <p>3b Develop test cases based on specified requirements and design documents.</p> <p>3c design test scenarios that cover multiple test cases and user interactions.</p> <p>3d utilize various matrices to improve the testing process.</p>	<p>3.1 Test Planning: Preparing a Test Plan, Deciding Test Approach, Setting Up Criteria for Testing, Identifying Responsibilities, Staffing, Resource Requirements, Test Deliverables, Testing Tasks.</p> <p>3.2 Test cases: Designing Test cases, Developing Test Cases, Writing Test cases, Test Case Templates, Types of Test Cases, Test Case Specification.</p> <p>3.3 Test Reporting: Executing Test Cases, Preparing Test Summary Report, Test Data</p> <p>3.4 Test Scenarios, Difference between Test Scenarios and Test Cases.</p> <p>3.5 Requirements Traceability Matrix (RTM), Metrics and measurements in software testing.</p>
Unit– IV Defect Management	<p>4a Describe defect management process and its critical role.</p> <p>4b Elaborate Defect Life Cycle.</p>	<p>4.1 Defect Classification, Defect Prioritization and Severity</p> <p>4.2 Defect Management Process</p>

	<p>4c Create customize defect templates based on specific project requirements.</p> <p>4d Apply defect prevention techniques effectively to minimize the occurrence of defects.</p>	<p>4.3 Defect Life Cycle Workflow and Stages, Defect Template</p> <p>4.4 Roles and responsibilities of participants of Defect Triage Process, Step in Defect Triage Process, Activities performed during Defect Triage Process, Defect Resolution Process</p> <p>4.5 Defect Prevention Process, Estimate Expected Impact of Defect, Techniques for Finding Defects, Reporting a Defect.</p>
Unit– V Testing Automation Tools	<p>5a Illustrate importance of testing automation.</p> <p>5b Acquire a working knowledge of popular test automation tools.</p> <p>5c Develop skills in maintaining and updating automated test scripts for application.</p>	<p>5.1 Introduction to test automation.</p> <p>5.2 Benefits and challenges of test automation</p> <p>5.3 Overview of popular testing tools (e.g., Selenium, JUnit, TestNG)</p> <p>5.4 Creating and executing automated test scripts.</p>

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

10. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Software Testing	06	02	04	04	10
II	Software Testing Techniques and Levels	12	04	10	04	18
III	Software Testing Management	08	02	04	08	14
IV	Defect Management	08	04	04	06	14
V	Testing Automation Tools	08	02	04	08	14
Total		42	14	26	30	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from the above table.

11. 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) Develop a test plan for a given software project.
- b) Identify test objectives, scope, resources, and schedule.
- c) Learn to log and manage defects using a bug tracking system.
- d) Perform exploratory testing on a given application without predefined test cases.
- e) Practice boundary value analysis and equivalence partitioning.
- f) Develop automated test scripts for a specific functionality using a chosen test automation tool.

12. 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.11**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- f) Guide students for various open-source software testing tools editors.

13. 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-project is 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 have to 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 ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

- a) User Authentication Testing for a Web Application
- b) Data Validation Testing for a Database Management System (DBMS)

- c) Integration Testing for a Payment Gateway
- d) Functional Testing of a Travel Booking Website
- e) Automated Testing for a Task Management Tool
- f) Accessibility Testing for a Healthcare Application
- g) GUI Testing for an Inventory Management System
- h) Usability Testing for a News Aggregation Website
- i) Performance Testing for a Document Management System
- j) Integration Testing for a Chat Application
- k) Automated Testing for a Voting System

14. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Software Testing: Principles, Techniques and Tools	S Limaye M. G.	McGraw Hill Education; 1st edition ISBN-10 : 9780070139909
2	Software Testing Principles and Practice	Srinivasan Desikan	Pearson Education ISBN-10 : 9788177581218
3	Software Testing Concepts and Tools	Nageshwara Rao Pusuluri	DreamTech, ISBN 10: 8177227122
4	Software Testing Tools	Dr. K.V.K.K. Prasad	Wiley- Dreamtech Press, ISBN 10: 8177225324

15. SOFTWARE/LEARNING WEBSITES

1. https://onlinecourses.nptel.ac.in/noc18_cs42/
2. <https://www.guru99.com/software-testing.html>
3. <http://www.softwaretestinghelp.com>
4. [Tools QA](#)
5. [Software Testing in Continuous Delivery | Atlassian](#)
6. [The Complete 2023 Software Testing Bootcamp | Udemy](#)
7. [Software Testing - Testing Tutorials, Testing Tools, Testing Softwares, Testing Jobs, Testing Techniques \(onestoptesting.com\)](#)

16. PO-COMPETENCY-CO MAPPING

Semester VI	Software Testing (Course Code: 4360706)						
	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 <ul style="list-style-type: none"> Proficient in identifying and resolving software defects through comprehensive testing methodologies and tools to ensure the delivery of high-quality and reliable software products. 							
Course Outcomes							
CO a). Describe importance of Software Testing to enhance the quality of software products.	2	1	-	1	-	-	1
CO b). Apply black-box and white-box testing techniques effectively.	2	3	2	2	1	1	1
CO c). Develop effective test cases based on specifications, utilizing appropriate templates and methodologies.	2	2	2	2	-	1	1
CO d). Apply bug identification skills to create a comprehensive defect report for the software application.	3	2	3	2	1	1	1
CO e). Utilize popular testing tools (e.g., Selenium, JUnit, TestNG) for creating and executing automated test scripts.	2	2	2	3	2	2	2

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

17. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Email
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**Competency-focused Outcome-based Green Curriculum-2023 (COGC-2021)**
Semester-VICourse Title: **Introduction to Data Analysis**
(Course Code: 4360707)

Diploma programme in which this course is offered	Semester in which offered
Computer Engineering	Six

1. RATIONALE

The Introduction to Data Analysis course is designed to address the increasing importance of data-driven decision-making in various fields. In a world inundated with diverse data sources, this course provides students with foundational knowledge and practical skills. It covers the sources and classifications of data, introduces Big Data platforms, emphasizes the need for data analytics, and explores the evolution of analytic scalability. By incorporating modern analytic tools and the Data Analytics Lifecycle, the course ensures students are equipped to navigate real-world analytical challenges, preparing them for roles where data-driven insights are paramount.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop various types of related skills leading to the achievement of the following competency

- **Develop programs to build Data Analysis Applications.**

3. COURSE OUTCOMES (COs)

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

The practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

- Discuss various concepts of data analysis.
- Utilize Python toolkits to read, manipulate, extract and analyze data.
- Apply various Statistical analysis techniques.
- Use various data visualization libraries for effective interpretations and insights of data.
- Summarize fundamental concept of big data analysis.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme		Total Credits		Examination Scheme (In Hours) (CI+T/2+P/2)						
Theory Marks		Practical		Marks	Total	CI	T	P	C	CA
ESE	CA	ESE	Marks							
3	0	2	4	70	30	25		25		150

Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: CI-ClassRoom Instructions; 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) that are the sub-components of the COs. *Some of the PrOs marked “*” are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Data Analysis Using Microsoft Excel: Predicting the number of umbrellas sold based on rainfall using Simple Linear Regression.	I	2
2	Write a Python program that scrapes the details from the given website using BeautifulSoup and Requests.	II	2
3	Write a Pandas program to implement following operations: <ul style="list-style-type: none"> ● Use the loc function to display rows where 'Survived' is 1. ● Use the iloc function to display the value in the first row and second column. ● Display the top 3 passengers with the largest 'Age'. ● Show the 3 Passengers with the Smallest 'Age'. 	II	2
4	Write a program in Python that uses Principal Component Analysis (PCA) to reduce the dimensionality of a dataset.	II	2
5	Implement a Python program that takes a dataset with numerical features and applies min-max scaling to normalize the values between 0 and 1.	II	2
6	Load any multivariate dataset into a Pandas DataFrame and perform basic data analysis, including summary statistics, and correlation analysis.	III	2
7	Apply Descriptive Statistics in Python to Analyze Passenger Demographics on the Titanic, Including Mean, Median, and Mode.	III	2
8	Calculate and Interpret Pearson’s Correlation Coefficient for Examining the Relationship Between Fare and Passenger Class on the Titanic dataset.	III	2
9	Explore Different Probability Distributions (Normal, Poisson, Exponential, Bernoulli) Using the Titanic Dataset to Analyze Survival Probabilities.	III	2
10	Create a Python script that uses Matplotlib to generate simple line charts, bar charts, and scatter plots from sample data. Customize the appearance of these plots, including labels, colors, and annotations.	IV	2

11	Utilize Seaborn to create a bar plot to visualize the average income across different regions in the "tips" dataset.	IV	2
12	Generate a Seaborn strip plot to visualize the distribution of total bill amounts within different days of the week in the "tips" dataset.	IV	2
13	Develop an interactive line chart with Plotly to showcase the trend in sepal lengths over time using the "iris" dataset.	IV	2
14	Explore data visualization tools like Tableau, Power BI, or QlikView. Install and explore the tool's capabilities by loading a large dataset and creating interactive visualizations.	V	2
	Total		28

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	Correctness of program	30
2	Readability and documentation of the program/Quality of input and output displayed (messaging and formatting)	10
3	Code efficiency	20
4	Debugging ability	20
5	Program execution/answer to sample questions	20
	Total	100

6. MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Computer with latest configuration with windows or unix os	All
2	Python Anaconda	2 To 13
3	Data visualization tools like Tableau, Power BI, or QlikView	14
4	Microsoft Excel	1

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 fulfil the development of this competency.

- a) Follow safety practices.
- b) Practice good housekeeping.
- c) Demonstrate working as a leader/a team member.
- d) Maintain tools and equipment
- e) Follow ethical practices.

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

The major Underpinning Theory is formulated as given below and only higher level UOs of *Revised Bloom's taxonomy* are mentioned for development of the COs and competency in the students by the teachers. (Higher level UOs automatically includes lower level UOs in them). If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit –1: Introducti on to Data Analysis	1a. Demonstrate an understanding of diverse data sources and their nature. 1b. Differentiate between the analytic process and reporting methodologies. 1c. Apply data analysis in various real-world applications. 1d. Navigate through various phases of the data analytics lifecycle, including discovery, data preparation, model planning, model building, communicating results, and operationalization.	Overview of Data Analysis 1.1 Sources and nature of data, classification of data (structured, semi-structured, unstructured), 1.2 Characteristics of data, 1.3 Introduction to Big Data platform, 1.4 Need of data Analysis 1.5 Evolution of analytic scalability 1.6 Analytical process 1.7 Analysis vs. reporting 1.8 Modern data analysis tools 1.9 Applications of data analysis. 1.10 Key roles for successful analysis 1.11 Various phases of data analytics lifecycle – discovery, data preparation, model planning, model building, communicating results, and operationalization

<p>Unit– 2: Python libraries for Data Analysis and Data extraction</p>	<p>2a. Demonstrate proficiency in utilizing the Python toolkit for data analysis.</p> <p>2b. Develop the ability to scrape relevant data from the web for analysis purposes.</p> <p>2c. Acquire the skill of cleaning and munging data to ensure data quality and accuracy.</p> <p>2d. Apply dimensionality reduction methods to simplify complex datasets while preserving essential information.</p>	<p>Toolkits Using Python</p> <p>2.1 NumPy - Difference between array and list, N dimension array - 1D array, 2D array, 3D array, Zeros matrix, Ones matrix, Identity matrix, Reshape, Working with random number, Stacking - Vertical stacking, horizontal stacking, Working with RGB Image, image as a numpy array.</p> <p>2.2 Pandas - Working with Dataframes Read csv and xlsx file, Analyze the basic dataset characteristics, Perform different merge and sort operations with multiple dataframes. Handle missing values in Dataframe, Analyze the DataFrame with loc and iloc, nlargest(), nsmallest(), add or remove an attribute from the DataFrame.</p> <p>Working With Data</p> <p>2.3 Reading Files</p> <p>2.4 Scraping the Web – Purpose, Legality and Ethical Considerations, Overview of popular libraries (Beautiful Soup, Requests, Selenium)</p> <p>2.5 BeautifulSoup (Purpose and Use Cases, Parsing HTML, Working with HTML tags, Accessing tag attributes, Simple HTML Parsing Example, Extracting Data from Web Pages),</p> <p>2.6 Requests (Basics of sending GET/POST requests, accessing response content, and authenticating with Requests)</p> <p>2.7 Response Status Codes</p> <p>2.8 Cleaning and Munging</p> <p>2.9 Manipulating Data</p> <p>2.10 Rescaling</p> <p>2.11 Data Normalization and Transformation</p> <p>2.12 Dimensionality Reduction</p>
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<p>Unit– 3: Statistical Analysis</p>	<p>3a. Apply regression modeling techniques to analyze relationships between variables. 3b. Conduct multivariate analysis for a comprehensive examination of multiple variables simultaneously. 3c. Apply basics of descriptive statistics including measures of central tendency such as mean, median, and mode. 3d. Analyse and apply various correlation techniques to uncover meaningful insights and relationships within datasets. 3d. Analyse and apply different probability distribution analysis techniques.</p>	<p>3.1 Regression modeling 3.2 Multivariate analysis 3.3 Apply basics of descriptive statistics including measures of central tendency such as mean, median, and mode Different correlation techniques: 3.4 Pearson’s Correlation Coefficient, 3.5 Methods of Least Squares, 3.6 scatterplots and other graphical techniques to identify the correlation between variables, 3.7 Different probability distributions such as Normal, Poisson, Exponential, Bernoulli.</p>
<p>Unit–4: Data Visualization</p>	<p>4a. Understand the fundamentals of data visualization and its role in effective communication of insights. 4b. Create basic visualizations using the Matplotlib library for Python. 4c. Customize Matplotlib plots and Utilize Seaborn for advanced and enhanced data visualization 4d. Implement interactive data visualization techniques using Plotly. 4e. Demonstrate proficiency in creating advanced plots, including Violin plots and Box plots, for a comprehensive analysis of data distributions and outliers.</p>	<p>4.1 Introduction to Data Visualization 4.2 Importance of Data Visualization 4.3 Basic Data Visualization with matplotlib 4.4 Customizing matplotlib plots 4.5 Data visualization with Seaborn 4.6 Interactive data visualization with ploty 4.7 Time series data visualization 4.8 Advance plots: Yiolin plots, Box plots</p>

Unit-5: Recent Trends in Big Data Analysis	5a. Demonstrate an understanding of recent trends in data collection and analysis techniques. 5b. Evaluate various data visualization tools for their effectiveness in handling large datasets. 5c. Apply visualization techniques specifically designed for big data to derive meaningful insights. 5d. Recognize pre-attentive attributes in data visualization for enhanced understanding. 5e. Anticipate and discuss the future progress of big data visualization, considering advancements and emerging technologies in the field.	5.1 Recent Trends in various data collection and analysis techniques 5.2 Data visualization tools – Power BI, Tableau - Data transformation, data summarization, bar charts, line charts, pie charts. 5.3 Visualizing Big Data 5.4 Pre-attentive Attributes 5.5 Challenges of Big Data Visualization 5.6 Potential Solution 5.7 Future Progress of big data visualization
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Note: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Data Analysis	06	4	4	2	10
II	Python libraries for Data Analysis and Data extraction	12	2	8	8	18
III	Statistical Analysis	08	2	8	8	18
IV	Data Visualization	10	2	6	8	16
V	Recent Trends in Big Data Analysis	06	4	2	2	8
Total		42	14	28	28	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

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 small

reports (of 1 to 5 pages for each activity). For micro project report should be as per suggested format, for other activities students and teachers together can decide the format of the report. Students should also collect/record physical evidences such as photographs/videos of the activities for their (student's) portfolio which will be useful for their placement interviews:

- a) Undertake micro-projects in teams.
- b) Prepare charts to explain use/process of the identified topic.
- c) <https://www.codechef.com/> , in this website very elementary programs are available, students are expected to solve those programs
- d) <https://code.org/>, an hour of code may be organized and students are encouraged to participate
- e) Students are encouraged to register themselves in various MOOCs such as: Swayam, edx, Coursera, Udemy etc to further enhance their learning.
- f) List the applications which are developed using C
- g) Encourage students to participate in different coding competitions like hackathon, online competitions on codechef etc.
- h) Encourage students to form a coding club at institute level and can help the slow learners

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/sub topics.
- b) Guide student(s) in undertaking micro-projects.
- c) Managing Learning Environment
- d) Diagnosing Essential Missed Learning concepts that will help for students.
- e) Guide Students to do Personalized learning so that students can understand the course material at his or her pace.
- f) Encourage students to do Group learning by sharing so that teaching can easily be enhanced.
- g) **'CI' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- h) 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.
- i) With respect to **section No.11**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- j) Guide students on how to address issues on environment and sustainability using the knowledge of this course

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-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, 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 dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total work load on each student due to the micro-project should be about **16 (sixteen) student engagement hours** (i.e., about one hour per week) during the course. The students ought to submit micro-project by the end of the semester (so that they develop the industry-oriented COs).

A suggestive list of micro-projects is given here. This should relate highly with competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher:

- a) Collect data from a public API (e.g., Twitter API) or web scraping, then use Python (NumPy, Pandas) to perform basic analysis and present insights.

- b) Create a regression model to predict a numerical outcome based on a dataset (e.g., housing prices based on various features)
- c) Analyze and visualize time series data (e.g., stock prices) using Matplotlib and Seaborn. Explore trends, seasonality, and anomalies.
- d) Develop an interactive data dashboard using Plotly to visualize and explore a dataset. Include dropdowns, sliders, and other interactive elements.
- e) Explore and visualize a large dataset using Big Data visualization tools (e.g., Apache Superset, Tableau). Highlight challenges and potential solutions.
- f) Perform sentiment analysis on a collection of text data (e.g., customer reviews) using NLTK. Visualize the sentiment distribution.
- g) Implement a Bayesian model on a dataset with uncertainty estimates. Visualize the posterior distribution and make inferences.
- h) Apply dimensionality reduction techniques (e.g., PCA) to a high-dimensional dataset and visualize the reduced features.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Data Science and Analytics	Jain V.K	Khanna Publishing House, Delhi
2	Big Data and Hadoop	Jain V.K	Khanna Publishing House, Delhi
3	Data Mining Concepts and Techniques	Jiawei Han and Jian Pei	Morgan Kaufmann, Third Edition 2011, ISBN- 978-9380931913
4	Data Analytics	Anil Maheshwari	McGrawHil, Standard Edition-2023, ISBN- 978-9355324559
5	Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools	Davy Cielen, Arno D.B. Meysman, et al., Minning	McGrawHil, Standard Edition-2022, ISBN- 978-9355322142
6	Data Science From Scratch: First Principles with Python	Joel Grus , SPD	Shroff/O'Reilly Second Edition, 2019, ISBN-978-9352138326
7	Big Data Glossary	Pete Warden	O'Reilly
8	Data Science and Big Data Analytics	David Dietrich, Barry Heller, Beibei Yang	EMC Education Series, John Wiley

14. SUGGESTED LEARNING WEBSITES

- a) <https://www.anaconda.com>
- b) <https://www.python.org>
- c) <https://www.w3schools.com>
- d) https://swayam.gov.in/nd1_noc19_cs60/preview
- e) <https://nptel.ac.in/courses/106106139/>
- f) <https://www.tutorialspoint.com>

15. PO-COMPETENCY-CO MAPPING

Semester II	Introduction to Data Analysis (Course Code:4360707)									
	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 Lifelong learning	PSO 1	PSO 2	PSO 3 (If needed)
Competency Use <i>Data Analysis in various engineering applications</i>										
Course Outcomes										
CO a) Discuss various concepts of data analysis	3	2	2	2	-	-	1			
CO b) Utilize Python toolkits to read, manipulate, extract and analyze data	2	2	2	2	-	-	1			
CO c) Apply various Statistical analysis techniques	2	2	2	2	-	-	1			
CO d) Use various data visualization libraries for effective interpretations and insights of data.	2	2	2	2	-	-	1			
CO e) Summarize fundamental concept of big data analysis.	2	2	2	2	-	-	1			

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

S. No.	Name and Designation	Institute	Contact No.	Email
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GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)
Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-VI
Course Title: Introduction to Game Development (Elective)
(Course Code: 4360708)

Diploma programme in which this course is offered	Semester in which offered
Computer Engineering	Sixth

1. RATIONALE

Creating and developing interactive experiences, usually in the form of games, is what it means to be a game designer. The rules, mechanics, and general structure of a game are created by game designers, who also have the responsibility of influencing the player's experience and involvement. This course is designed to introduce students to the elements and structure of game design and development. The areas of major emphasis in the course are game methodology, programming, game genres, game theory and 2D interactive experiences, and immersive environments. Students will apply both creative and technical skills to design and refine in addition to implementing the adventure. The appropriate use of technology is an integral part of this course.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop various types of related skills leading to the achievement of the following competency:

- Develop Games and Implementation of basic 2D games, including the game methodology, programming, game genres, game theory.

3. COURSE OUTCOMES (COs)

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

The practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

- a) Describe Game Essentials, Types of Games and Stages of Design process.
- b) Comprehend how a concept turns into a game, and game world.
- c) Illustrate the game development interface.
- d) Develop game using scripting with C# Programming Language.
- e) Demonstrate 2D Games by using Unity IDE .

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	CA	ES E	CA	ESE	
3	-	2	5	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

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

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the subcomponents of the Course Outcomes (Cos). Some of the PrOs marked ‘*’ are compulsory, as they are crucial for that particular CO at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1.	Explore various games (any 5) and identify components of each game.	I	02
2.	Develop a fun game by using scratch.	I	02
3.	Study game development by exploring major genres, player dynamics, platform considerations, game concepts, and the role of storyboards in shaping narratives.	II	02
4.	Set-up of Unity development environment and basic introduction to tools, navigation and interface.	III	04
5.	Develop a game scene which contains multiple game objects, apply transform on them and do lights and camera settings.	III	02
6.	Create C# program that demonstrates the use of OOPS concept along with functions and multithreading.	IV	02
7.	Set up your scripting environment in Unity by creating a basic script and move object.	IV	02
8.	Use C# script with methods of Transform, Time, Mathf, and Random classes for dynamic and engaging game elements to develop a small game.	V	04
9.	Develop a 2D game project in Unity that incorporates essential elements like scenes, game objects, lights, camera, basic 2D physics- Collider, and Rigidbody.	V	04
10.	Develop any 2D game by using various features of Unity game engine.	V	04
			28 Hrs.

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. Care must be taken in assigning and assessing study reports as it is a first year study report. Study report, data collection and analysis report must be assigned in a group. Teacher has to discuss the type of data (which and why) before the group starts their market survey.

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.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Correctness of program & approach to implement logic	30
2	Readability and Documentation of the program/Quality of input and output displayed (messaging and formatting)	10
3	Use Game Development concepts to implement efficient program	20
4	Debugging Ability	20
5	Program execution/answer to sample questions	20
Total		100

6. MAJOR EQUIPMENTS/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Computer system with operating system: Windows 7 or higher Ver., macOS, and Linux, with 4GB or higher RAM	All
2	Unity IDE	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 course competency.

- a) Work as a leader/a team member.
- b) Creating games fuels creativity in virtual worlds.
- c) Developing games sharpens problem-solving skills.

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

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Units	Unit Outcomes (UOs)	Topics & Sub-Topics
Unit – 1: Introduction to Game	<ol style="list-style-type: none"> 1. Describe the technological developments that contributed to the modern game industry 2. Define what a game is and name the key components of a game 3. Research, compare, and categorize different game platforms and game hardware 4. List software commonly used in game development 5. Define the various roles on a game development team 	<ol style="list-style-type: none"> 1.1 History of game, Video Games and Development, Conventional Games Versus Video Games, Games for Entertainment, Key Components of Video Games 1.2 The Structure of a Video Game, Stages of the Design Process, Game Design Team Roles, Game Design Documents, The Anatomy of a Game Designer, Programming Languages, Game Engines, Freeware and Commercial Game Engines 1.3 Introduction to Game designing tools-scratch, Love 2d, Unity
Unit – 2: Game Design Pipeline	<ol style="list-style-type: none"> 1. Classify the game genres. 2. As per game designer point of view, Describe understanding of a player. 3. Classify the platforms where to publish the game. 4. Explain the steps a game design team moves through from idea, to concept, to game design document 5. Describe gameplay mechanics. 	<ol style="list-style-type: none"> 2.1 The Major Genres: What Is a Genre? , Classic Game Genres, Understanding Your Player : Domains of Play, Demographic Categories, Gamer Dedication , Understanding Your Machine - The platforms where to publish the game: Home Game Consoles , Personal Computers , Portable Devices, Other Devices 2.2 Game Concepts - Define the story : Getting an Idea, From Idea to Game Concept, Storyboards, Level Design : Key Design Principles, Layouts, The Level Design Process, Pitfalls of Level Design 2.3 Gameplay mechanics - Making Games Fun, The Hierarchy of Challenges, Skill, Stress, and Absolute Difficulty, Commonly Used Challenges

		2.4 Costs of the game , Making and maintenance, Create a game design document.
Unit 3 - Introduction to Unity Game Engine	<ol style="list-style-type: none"> 1. List advantages of Unity Game Engine. 2. Describe unity interface. 3. Create a gameplay in unity game engine 4. Create a scene in unity. 5. Publish a game by using unity. 	<ol style="list-style-type: none"> 3.1. Basics of Unity and it's installation 3.2. The benefits and Advantages of using Unity 3.3. Introduction to Tools & navigation, asset 3.4. Unity's interface, Scene view, Game view 3.5. Scenes - Creating, loading, and saving Scenes, Work with multiple scenes in Unity, Scene Templates 3.6. GameObjects, Prefabs, input, transform, Lights and Camera in Unity 3.7. Game publishing using Unity
Unit 4 - Introduction to C# programming in Unity	<ol style="list-style-type: none"> 1. Create a game by using scripting feature of Unity 2. Identify the different components in a simple script 3. Make a script by using C# for unity game engine 	<ol style="list-style-type: none"> 4.1. Setting Up Your Scripting Environment 4.2. Scripting concepts - Constants and variables, Conditional and looping statements, Arrays, operators 4.3. Object Oriented Programming Concepts - classes, namespace, inheritance, encapsulation 4.4. Basics of function creation and Multithreading 4.5. Create Scripts to handle gameobjects in Unity
Unit 5- Unity Game Engine for Developing 2D Games	<ol style="list-style-type: none"> 1. Use different classes to create a game. 2. Use sprite editor to create a sprite in unity 3. Explore 2D physics in unity 4. Apply various features of unity for 2D game development. 	<ol style="list-style-type: none"> 5.1. Introduction to 2D Game system in unity 5.2. Important Classes : GameObject, , MonoBehaviour, Transform, Vectors, ScriptableObject, Time, Mathf, Random 5.3. Manage sprite , basics of sprite editor 5.4. 2D Physics - overview of Rigidbody and Colliders 5.5. 2D Game Project

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Game	10	4	7	4	15
II	Game Design Pipeline	10	4	7	4	15
III	Introduction to Unity Game Engine	6	2	3	7	12
IV	Introduction to C# Programming in Unity	8	3	7	4	14
V	Unity Game Engine for Developing 2D Games	8	3	4	7	14
Total		42	16	28	26	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

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 small reports (of 1 to 5 pages for each activity). For micro project reports should be as per suggested format, for other activities students and teachers together can decide the format of the report. Students should also collect/record physical evidences such as photographs/videos of the activities for their (student's) portfolio which will be useful for their placement interviews:

- a) Undertake micro-projects in teams.
- b) <https://code.org/>, an hour of code may be organized and students are encouraged to participate
- c) Students are encouraged to register themselves in various MOOCs such as: Swayam, edx, Coursera, Udemy etc. to further enhance their learning.
- d) List the applications which are developed using Unity IDE and other Game developing IDE Tool.
- e) Encourage students to participate in different coding competitions like hackathon, online competitions on code chef etc.
- f) Encourage students to form a coding club at institute level and can help the slow learners.

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) Managing Learning Environment
- d) Diagnosing Essential Missed Learning concepts that will help students.

- e) Guide Students to do Personalized learning so that students can understand the course material at his or her pace.
- f) Encourage students to do Group learning by sharing so that teaching can easily be enhanced.
- g) **‘L’ in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- h) 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.
- i) With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- j) Guide students on how to address issues on environment and sustainability using the knowledge of this course.

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-project are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, 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 work load on each student due to the micro-project should be about **16 (sixteen) student engagement hours** (i.e., about one hour per week) during the course. The students ought to submit micro-project by the end of the semester (so that they develop the industry-oriented COs).

A suggestive list of micro-projects is given here. This should relate highly with competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher:

- a) Using a chessboard and the types of pieces and moves available in chess, devise a cooperative game of some kind for two people, in which they must work together to achieve a victory condition. (You do not need to use the starting conditions of chess, nor all the pieces.) Document the rules and the victory condition.
- b) Examine a number of games that are apparently marketed to a specific demographic such as girls or very young children. Document the design features that they seem to have in common. Be sure
- c) To address both the types of challenges they include and the details of their aesthetics—color palettes, typefaces, and screen layouts, for example.
- d) Create a 2D endless runner game where the player controls a character that must dodge obstacles to survive and achieve the highest score possible.
- e) Create a classic Memory Match game where players have to flip over cards to find matching pairs. The objective is to match all pairs within the fewest attempts possible.

- f) 2D Platformer : From iconic classics like "Super Mario Bros." and "Sonic the Hedgehog" to modern indie gems like "Hollow Knight" and "Celeste," 2D games have seen a remarkable evolution. Developers have continually pushed the boundaries of creativity and storytelling within the 2D realm, ensuring that this genre remains relevant and captivating in today's gaming landscape.
- g) Street Racing Game: This is a single player racing game and can be played on any platform. Talking about the gameplay, the user has to dodge other cars and score points. The more you play, more you'll score.
- h) Raining Cubes : Develop a game where players catch falling cubes with a moving platform. Along the way, you will get a basic understanding of the Unity game engine and some of its features.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Fundamentals of Game Design	Ernest adams	Third edition , New Riders Publication, 2015. ISBN: 9780133435726
2	Game development Essentials	Jeannie Novak	third edition ,Delmar Cengage Learning , 2011, ISBN: 978-1111307684
3	Unity 5 from Zero to Proficiency (beginner): A Step-by-step Guide to Coding Your First Game	Patrick Felicia	LPF Publishing; 3rd edition . 2015 ISBN: 9781091872028
4	Unity Game Development Cookbook by Paris	Buttfield-Addison, Jon Manning, and Tim Nugent	O'Reilly Media , 2019 ISBN : 978-1-491-99915-8
5	Learning C# by Developing Games with Unity 3D Beginner's Guide	Terry Norton	Packt Publishing Limited, 2013, ISBN: 978-1849696586

14. SOFTWARE/LEARNING WEBSITES

- <https://docs.unity3d.com/Manual/UnityManual.html>
- [Programming for Games \(The Smart Way\) \(gamedesigning.org\)](http://gamedesigning.org)
- [C# Unity Developer 2D Coding: Learn to Code Video Games | Udemy](https://www.udemy.com/course/unitycourse2)
- [Introduction to Game Design | Coursera](https://www.coursera.org/course/unitycourse2)
- <https://www.udemy.com/course/game-design-fundamentals/>
- <https://www.udemy.com/course/unitycourse2>
- <https://www.youtube.com/watch?v=Hs9PwitP-Ss>

15. PO-COMPETENCY-CO MAPPING

Semester VI	Introduction to Game Development						
	POs						
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	Develop Games and Implementation of basic 2D games, including the game methodology, programming, game genres, game theory.						
Describe Game Essentials, Types of Games and Stages of Design process	3	1	1	2	-	1	1
Comprehend how a concept turns into a game, and game world	3	2	2	3	-	2	1
Illustrate the game development interface.	3	2	2	3	-	2	1
Develop game using scripting with C# Programming Language.	3	2	2	3	-	2	2
Demonstrate 2D Games by using Unity IDE	3	2	2	3	-	2	2

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE**GTU Resource Persons**

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Shri P. P. Kotak Principal	S & SS Gandhi College Surat	8200601748	kotakp2003@yahoo.com
2	Smt. M. P. Mehta Head of the Department	Government Polytechnic, Gandhinagar	987958273	manishamehtain@gmail.com
3	Ms. Darshita S. Pathak	A.V.P.T.I. Rajkot	9879251273	dsp.pathak@gmail.com
4	Mrs. Komalben P. Patel	Government Polytechnic Gandhinagar	9723349025	komalpatel.gpg@gmail.com
5	Ms. Archana Shah	Government Polytechnic Himmatnagar	7878433475	archanashah.gp@gmail.com

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)

Semester -VI

Course Title: Cloud Computing

(Course Code: 4360709)

Diploma programme in which this course is offered	Semester in which offered
Computer Engineering	6 th semester

1. RATIONALE

This course aims students to understand the hardware, software concepts and architecture of cloud computing. Students realize the importance of Cloud Virtualization, Abstractions and Enabling Technologies.

2. COMPETENCY

Demonstrate comprehensive understanding, practical proficiency, and effective communication in cloud computing concepts, architectures, deployment models, virtualization, and security measures, while collaborating to propose and implement real-world cloud solutions.

3. COURSE OUTCOMES (COs)

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

The student will develop underpinning knowledge of competency for implementing various applications using cloud computing to attain the following course outcomes.

- a) To describe the principles and paradigm of Cloud Computing
- b) To compare the Deployment models with reference to Cloud Computing
- c) To simulate the Service Model with reference to Cloud Computing
- d) To evaluate various virtualization technologies and methods
- e) To implement comprehensive security measures, ensuring the security and privacy of data

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	CA	ESE	CA	ESE	
3	-	2	4	30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

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	To study cloud architecture and cloud computing model.	1	2
2	Study and implementation of Infrastructure as a Service <ul style="list-style-type: none"> OpenStack Computing Components Install OpenStack on Ubuntu 18.04 with DevStack 	2	2
3	Study and implementation of Storage as a Service	2	2
4	Case Study: "Choosing the Right Cloud Deployment Model" <ul style="list-style-type: none"> Examine case studies of organizations adopting different cloud deployment models (public, private, hybrid, community). Analyze the advantages and disadvantages of each model. Discuss key drivers influencing the choice of a specific cloud deployment model. 	2	2
5	Case Study: "Comparative Analysis of Cloud Service Providers" <ul style="list-style-type: none"> Evaluate case studies of major cloud service providers (e.g., AWS, Azure, Google Cloud). Analyze their service models (SaaS, PaaS, IaaS) and advantages/disadvantages. Discuss the impact of cloud computing on users using real-world examples. 	3	2
6	Working and installation of Google App Engine	3	2
7	Working and installation of Microsoft Azure.	3	2
8	Design an Assignment to retrieve, verify, and store user credentials using Firebase Authentication, the Google App Engine standard environment, and Google Cloud Data store	3	2

9	Develop a hello world program web application and deploy it on the Google app engine.	3	2
10	Case Study: "Implementing Virtualization in Enterprise IT" <ul style="list-style-type: none"> Explore a case where an organization successfully implemented virtualization. Discuss the types of virtualization used (desktop, network, storage, data). Analyze the advantages and disadvantages experienced by the organization. 	4	2
11	Installation and Configuration of virtualization using KVM.	4	2
12	Case Study: "Data Security and Privacy in a Cloud-Based Healthcare System" <ul style="list-style-type: none"> Investigate a case where a healthcare organization adopted cloud computing. Discuss infrastructure security at the network, host, and application levels. Analyze data security, storage, and privacy issues in the context of sensitive healthcare data. 	5	2
13	"Migration to the Cloud: A Banking Sector Perspective" <ul style="list-style-type: none"> Explore how a traditional bank migrated its infrastructure to a public cloud. Analyze the security considerations and challenges faced during the migration. 	5	2
14	"Global Company's Hybrid Cloud Strategy" <ul style="list-style-type: none"> Examine a multinational corporation's use of a hybrid cloud model. Analyze how the organization balances data storage, compliance, and efficiency. 	5	2
	Total		28

Note

- i. More **Case Studies** 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	Describe basic concepts of Cloud Computing and its applications.	15

2	Describe cloud computing architecture and various cloud deployment models.	25
3	Describe various cloud service models and identify major cloud service providers.	20
4	Understand the introduction and working of virtualization, its types, advantages, and disadvantages.	25
5	Identify and address security and privacy issues in cloud computing.	15
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	Computer system with operating system: Windows 7 or higher VerIntel Core i7 processor 16GB RAM 512GB SSD	All
2	VMware -vSphere Version 7.0 Microsoft Hyper-V Integration with Windows Server OpenStack - Infrastructure as a Service (IaaS)	

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 Collaboration
- b) Ethical Awareness
- c) Communication Skills
- d) Leadership Qualities

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)	Topics and Sub-topics
Unit – I Introduction to Cloud Computing	1.1 Describe basic concept of Cloud Computing and its applications 1.2 Advantages and Disadvantages of Cloud Computing	1.1.1 cloud computing <ul style="list-style-type: none"> ● About cloud ● About computing ● Definition of cloud computing ● Central Ideas Behind Cloud Computing 1.1.2 Characteristics of Cloud Computing 1.1.3 Challenges of Cloud Computing 1.1.4 Novel Applications of cloud computing 1.1.5 Security risk of cloud computing 1.2.1 Advantages and Disadvantages of Cloud Computing
Unit – II Cloud Computing Architecture & Deployment Model	2.1 Describe cloud computing architecture 2.2 Describe various cloud deployment model 2.3 Compare and contrast different cloud deployment models, including public, private, hybrid, and community clouds.	2.1.1 Introduction Cloud Computing Architecture 2.1.2 Components of Cloud Computing Architecture <ul style="list-style-type: none"> ● Client Infrastructure ● Cloud access device ● Application ● Services ● Runtime cloud ● storage ● Infrastructure ● Security 2.2.1 Types of Cloud Deployment Model <ul style="list-style-type: none"> ● Public cloud: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages ● Private cloud: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages ● Hybrid cloud: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages ● Community cloud: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages 2.3.1 Key drivers to adopting the cloud

		<p>2.3.2 The impact of Cloud computing on Users</p> <p>2.3.3 A Comparative Analysis of Cloud Deployment Models</p>
<p>Unit – III Cloud Service Model & service providers</p>	<p>3.1 Describe various cloud service model</p> <p>3.2 Simulate the delivery of a cloud service using a specific service model</p> <p>3.3 Identify and discuss the impact of cloud computing on users and industries</p>	<p>3.1.1 Cloud Service Model</p> <ul style="list-style-type: none"> ● SaaS: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages ● PaaS: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages ● IaaS: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages <p>3.2.1 Difference between SaaS, PaaS, IaaS</p> <p>3.3.1 Service provider:</p> <ul style="list-style-type: none"> ● Amazon web service ● Microsoft Azure ● Google cloud platform ● IBM cloud service ● VMWare cloud ● Oracle cloud ● Red hat
<p>Unit– IV Virtualization</p>	<p>4.1 Demonstrate the working of virtualization technologies, including desktop, network, storage, data, hardware, and software virtualization</p> <p>4.2 Choose and justify the use of specific hypervisors (e.g., Type 1, Type 2) in various scenarios</p>	<p>4.1.1 Introduction of Virtualization</p> <p>4.1.2 Working of Virtualization</p> <p>4.1.3 Types of Virtualization</p> <ul style="list-style-type: none"> ● Desktop virtualization, ● Network Virtualization, ● Storage Virtualization, ● Data virtualization ● Hardware Virtualization ● Software Virtualization <p>4.1.4 Advantages and Disadvantage of Virtualization</p> <p>4.1.5 Characteristic and Applications of Virtualization</p> <p>4.2.1 Technologies of virtualization : Hypervisors</p> <ul style="list-style-type: none"> ● Type 1 Hypervisor ● Type 2 Hypervisor ● Choosing the right hypervisor

		(Xen, VMM)
Unit– V Security and Privacy Issues in Cloud Computing	5.1 Conduct a security risk assessment for a cloud infrastructure, identifying vulnerabilities and proposing mitigation strategies. 5.2 Perform a privacy impact assessment for a cloud-based application, considering data life cycle and key privacy concerns.	5.1.1 Infrastructure Security <ul style="list-style-type: none"> ● The Network level ● The Host level ● The Application Level 5.2.1 Data Security and storage 5.2.2 Privacy issue 5.2.3 Data Life Cycle 5.2.4 Key Privacy concern in the cloud 5.2.5 Protecting Privacy

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Cloud Computing	06	4	4	4	12
II	Cloud Computing Architecture & Deployment Model	10	4	5	7	16
III	Cloud Service Model & service providers	08	4	5	4	13
IV	Virtualization	10	5	6	6	17
V	Security and Privacy Issues in Cloud Computing	08	5	4	3	12
Total		42	22	24	24	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from the above table.

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) Create cloud computing concept map
- b) Arrange a debate on security risks
- c) Deployment model comparison
- d) Service model simulation
- e) Privacy policy analysis

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.11**, 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 have to be formed for micro-projects, the number of students in the group should **not exceed two**.

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 ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

1. Cloud Infrastructure Design for a Small Business:

Develop a detailed cloud infrastructure design for a small business, considering their specific needs, budget constraints, and growth expectations.

2. Multi-Cloud Strategy Implementation:

Design and implement a multi-cloud strategy for an organization, considering the use of multiple cloud service providers to optimize performance, cost, and reliability.

3. Cloud-Based Healthcare System:

Design a secure and scalable cloud-based healthcare system that includes data storage, processing, and sharing while ensuring compliance with healthcare regulations.

4. Cloud-Native Application Development:

Develop a cloud-native application with microservices architecture, containerization, and serverless components. Present the application's features and deployment strategy.

5. Disaster Recovery Plan for a Cloud Environment:

Create a comprehensive disaster recovery plan for a cloud-based infrastructure, considering data backup, redundancy, and failover strategies.

6. Cloud-Based E-Learning Platform:

Develop an e-learning platform hosted on the cloud, incorporating features such as content delivery, user authentication, and analytics for student progress.

7. Cloud Migration Project:

Plan and execute the migration of an on-premise infrastructure to the cloud. Document the challenges, strategies, and outcomes of the migration.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Cloud Computing: Concepts, Technology & Architecture	Thomas Erl , Ricardo Puttini , Zaigham Mahmood	Pearson Service Technology ISBN(9780133387520)
2	Cloud Computing for Dummies	Judith Hurwitz , Robin Bloor, Marcia Kaufman, Fern Halper	Wiley Publications ISBN(8126524871)
3	Cloud Computing Black Book	Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr. Deven Shah	Dreamtech Press ISBN(978-9351193944)
4	Cloud Computing: SaaS, PaaS, IaaS, Virtualization, Business Models, Mobile, Security and More	Kris Jamsa	Jones & Bartlett Learning ISBN (978-9380853772)
5	Cloud Computing: Master the Concepts, Architecture and Applications with Real-world examples and Case studies	Kamal Kant Hiran, Ruchi Doshi, Temitayo Fagbola, Mehul Mahrishi, Dr Maria-Alexandra Paun, Deepak Modi	BPB Publications ISBN (978-9388511407)

14. SOFTWARE/LEARNING WEBSITES

- a. https://www.tutorialspoint.com/cloud_computing/index.htm
- b. <https://www.geeksforgeeks.org/cloud-computing/>
- c. https://www.w3schools.com/aws/aws_cloudelements_cloudcomputing.php
- d. <https://www.w3schools.in/cloud-computing>
- e. <https://www.javatpoint.com/cloud-computing>
- f. https://onlinecourses.nptel.ac.in/noc21_cs14/preview
- g. <https://www.edx.org/learn/cloud-computing/ibm-introduction-to-cloud-computing>
- h. <https://www.coursera.org/specializations/cloud-computing>
- i. <https://aws.amazon.com/education/awseducate/>

15. PO-COMPETENCY-CO MAPPING

Semester II	Cloud Computing (Course Code: 4360709)						
	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, Experimentatio &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Manage ment	PO 7 Life-long learning
Competency Demonstrate comprehensive understanding, practical proficiency, and effective communication in cloud computing concepts, architectures, deployment models, virtualization, and security measures, while collaborating to propose and implement real-world cloud solutions.							
Course Outcomes							
a) To describe the principles and paradigm of Cloud Computing	2	-	-	-	-	-	1
b) To compare the Deployment models with reference to Cloud Computing	2	1	2	2	2	2	2
c) To simulate the Service Model with reference to Cloud Computing	2	2	1	2	2	2	2
d) To evaluate various virtualization technologies and methods	2	2	2	2	2	2	2
e) To implement comprehensive security measures, ensuring the security and privacy of data	2	2	1	1	2	2	2

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**

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