

# Blockchain Lab

ODD SEMESTER 2022, 2023

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## Lab Objectives :

1. To explore Blockchain concepts.
2. To implement public and private Blockchain.
3. To create applications using Blockchain.

## Lab Outcomes (LO)

LOs	Description
LO 1	Creating Cryptographic Hash using Merkle Tree
LO 2	Design Smart Contract using Solidity
LO 3	Implementing Ethereum Blockchain using Geth
LO 4	Demonstrate the concept of Blockchain in real-world Applications

## List of Experiments:

Sr No	Title of Experiment	Ref Books	LO	Bloom's levels
1	<a href="#">Cryptography in Blockchain, Merkle root tree hash</a>	T1,T3, R1,R2	LO1	BL3
2	<a href="#">Create a Blockchain using Python</a>	T1,T3, R1,R2	LO4	BL3, BL4
3	<a href="#">Create a Crypto Currency using Python for the blockchain implemented in Experiment No. 2</a>	T1,T3, R1,R2	LO1	BL3, BL4
4	<a href="#">Hands on Solidity Programming Assignments for creating Smart Contracts</a>	T2,T3	LO2	BL3, BL4
5	<a href="#">Deploying a Voting/Ballot Smart Contract</a>	T2,T3	LO2	BL4
<b>Mini Project in Ethereum (Case Study can be extended / pick new domain to implement Blockchain)</b>				
6	<a href="#">Creating Smart Contract and performing transactions using Solidity and Remix IDE</a>	T1, T2, T3, R1,R2, R3	LO1, LO2, LO3, LO4	BL1, BL2, BL3, BL4, BL5, BL6
7	<a href="#">Implement the embedding wallet (Metamask) and transaction using Solidity</a>			
8	<a href="#">Implement the Blockchain platform Ganache</a>			
9	<a href="#">Implement a Private Ethereum Blockchain using Geth</a>	T3,R3	LO4	BL2, BL3
10 *	<a href="#">Explore the Cryptocurrency Landscape</a>	T3,R3	LO4	BL2, BL3
<b>Indirect Assessment</b>				
11 *	<a href="#">Hyperledger : Demo</a>	T3,R3	LO4	BL2, BL3

**Note:** \* indicates newly added experiments this year.

**List of Experiments with Date of Preparation and Submission schedule**

Sr No	Title of Experiment	Date of Preparation	Date of Submission
1	<a href="#">Cryptography in Blockchain, Merkle root tree hash</a>	3rd week of July 2023	4th week of July 2023
2	<a href="#">Create a Blockchain using Python</a>	4th week of July 2023	1st week of August 2023
3	<a href="#">Create a Crypto Currency using Python for the blockchain implemented in Experiment No. 2</a>	1st week of August 2023	2nd week of August 2023
4	<a href="#">Hands on Solidity Programming Assignments for creating Smart Contracts</a>	2nd week of August 2023	3rd week of August 2023
5	<a href="#">Deploying a Voting/Ballot Smart Contract</a>	3rd week of August 2023	4th week of August 2023
6	<a href="#">Creating Smart Contract and performing transactions using Solidity and Remix IDE</a>	4th week of August 2023	5th week of August 2023
7	<a href="#">Implement the embedding wallet (Metamask) and transaction using Solidity</a>	3rd week of September 2023	5th week of September 2023
8	<a href="#">Implement the Blockchain platform Ganache</a>	2nd week of October 2023	3rd week of October 2023
9	<a href="#">Implement a Private Ethereum Blockchain using Geth</a>	3rd week of September 2023	5th week of September 2023
10 *	<a href="#">Explore the Cryptocurrency Landscape</a>	5th week of August 2023	3rd week of September 2023
11 *	<a href="#">Hyperledger: Demo</a>	1st week of October 2023	2nd week of October 2023

**Software Tools used:** Remix IDE, Geth, Ganache, Metamask, Colab notebook, Java, Python, Solidity, Flask, Postman

### **Text Books**

1. [Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.](#)
2. [Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhilash K. A and Meena Karthikeyan, Universities press](#)
3. [Blockchain enabled Applications, Vikram Dhillon, Devid Metcalf, Max Hooper, Apress](#)
4. [Building Blockchain Projects, Narayan Prusty, Packt](#)
5. [Mastering Blockchain, Second Edition: Distributed ledger technology, decentralization, and smart contracts explained, 2nd Edition, Imran Bashir](#)
6. [Mastering Blockchain \(Third Edition\) - A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, Imran Bashir Packt Publication.](#)

### **Sample Codes :**

1. [Blockchain Applications: A Hands-On Approach, by Arshdeep Bahga, Vijay Madisetti, Paperback – 31 January 2017.](#)
2. [Solidity Programming Essentials: A beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, RiteshModi, Packt publication](#)
3. [Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN, 2nd Edition by Andreas M. Antonopoulos, June 2017, Publisher\(s\): O'Reilly Media, Inc. ISBN: 9781491954386](#)

### **Online Resources**

1. <https://medium.com/@agrawalmanas09/how-to-setup-private-ethereum-blockchain-on-windows-10-machine-ab497e03d6b8>
2. <https://www.edureka.co/blog/ethereum-private-network-tutorial>
3. <https://medium.com/publicaio/a-complete-guide-to-using-metamask-updated-version-cd0d6f8c338f>
4. <https://docs.aws.amazon.com/blockchain-templates/latest/developerguide/blockchain-templates-create-stack.html>

### **Implemented Blockchain Use Cases for Reference**

1. [DigiLocker - Jai Singhal](#)

**Lab - 1:**

**Experiment No: 1**

**Dated: 3rd week of July 2023**

**AIM: Cryptography in Blockchain, Merkle root Tree Hash**

**Lab Objectives:** To explore Blockchain concepts.

**Lab Outcomes (LO):** Creating Cryptographic Hash using Merkle Tree (LO1)

**Task to be performed :**

1. Make a copy of this [Google Colab Notebook](#)
2. Try to solve the errors in each of the 4 Programs
3. In the 4th Program - Constructing a Merkle Tree Root Hash, modify the code as follows:
  - Update the transactions list with valid entries.  
eg : transactions = ['A -> B : \$10', 'B -> C : \$5', 'C -> A : \$2']  
Sample Transactions to be considered  
T1 : Alice → Bob : \$200;      T2 : Bob → Dave : \$500;      T3 : Dave → Eve : \$100  
T4 : Eve → Alice : \$300;      T5 : Roo → Bob : \$50
  - Hash the transactions before combining them in the for loop
  - Print all the intermediate hash during the construction of the Merkle Tree Root Hash
4. Upload your working code with Input & Output used for execution in the [Google Form](#)

**Tools & Libraries used :**

- Python Libraries: **hashlib**

**Instructions :** [\(Prepare for viva for the following topics\)](#)

1. Cryptographic Hash functions in Blockchain
2. What is a Merkle Tree?
3. What is a Cryptographic Puzzle and explain the Golden Nonce
4. How does a Merkle Tree work?
5. Benefits of Merkle Tree
6. Use cases of Merkle Tree

**Outcome :**

1. Understood the concept of hashing, Cryptographic Puzzle to find nonce, Merkle Tree and its relevance.
2. Implemented programs
  - To find the Golden Nonce while solving the Cryptographic Puzzle
  - To construct a Merkle Tree for the given transactions
3. Prepare a document with Aim, Tasks performed, Program, Output and Conclusion.
4. Submit the hardcopy **by the 4th week of July 2023**  
(As per the instructions, submit a hard copy of the same).

**Lab - 2:**

**Experiment No: 2**

**Dated: 4th week of July 2023**

**AIM: Create a Blockchain using Python**

**Lab Objectives:** To implement public and private Blockchain.

**Lab Outcomes (LO):** Demonstrate the concept of Blockchain in real-world Applications (LO4)

**Task to be performed :**

1. Make a copy of this [Google Colab Notebook](#)
2. Try to solve the errors in given Program
3. After successful execution of the Program in Colab Notebook.
  - **Add a method, create\_Transactions**
  - Mine the block only when the transaction list is not null.
  - Remove the transactions from the list of transactions before mining.
  - **Modify the method, proof\_of\_work() to search for the golden nonce**
  - Cryptographic Puzzle is to have “000” leading zeros in the Block Hash
4. Download the code - [blockchain.py](#)
5. **Update the code to incorporate the changes in step 3 to the code in step 4.**
6. Follow the steps in [Manual](#) to demonstrate the working of Blockchain using Flask and Postman.

**Tools & Libraries used :**

- [Flask](#) : pip install Flask
- Download **Postman** from <https://www.postman.com/>
- Python Libraries : **datetime, jsonify, hashlib**

**Instructions :** (Prepare for viva for the following topics)

1. What is a Blockchain?
2. Process of Mining
3. How to check the validity of blocks in a Blockchain

**Outcome :**

1. Understood the concept of mining in Blockchain.
2. Implemented programs
  - Mine a Block
  - Display the chain in the Blockchain
  - Check whether the chain is valid
3. Prepare a document with Aim, Tasks performed, Program, Output and Conclusion.
4. Submit the hardcopy **by the 1st week of August 2023**  
(As per the instructions, submit a hard copy of the same).

**Lab - 3:**

**Experiment No: 3**

**Dated: 1st week of August 2023**

**AIM:** Create a Cryptocurrency using Python and perform mining in the Blockchain created.

**Lab Objectives:** To implement public and private Blockchain.

**Lab Outcomes (LO):** Demonstrate the concept of Blockchain in real-world Applications (LO4)

**Task to be performed :**

1. Download the code from folder, [Lab 3](#)
2. Install requests in the virtual environment created in the Lab 2. ([Follow the instructions](#))
3. Run the files - **hadcoin\_node\_5001.py**, **hadcoin\_node\_5002.py**, **hadcoin\_node\_5003.py** in 3 different terminals.
4. Open Postman, from each node - invoke **connect\_node()** and pass the peers as POST requests.
5. Perform the following functions
  - Add Transactions - invoke **add\_transactions()** as a POST request.
  - mining - **mine\_block()**,
  - fetch the chain - **get\_chain()**,
  - replace the longest chain - **replace\_chain()**
6. Modify the code such that transactions are removed after they are added to the block.

**Tools & Libraries used :**

- Install [Flask](#) : pip install Flask
- Download **Postman** from <https://www.postman.com/>
- Python Libraries : **datetime, jsonify, hashlib, uuid4, urlparse, request**
- **Install requests** : pip install requests==2.18.4

**Instructions :** (Prepare for viva for the following topics)

1. Challenges in P2P networks
2. How transactions are performed on the network?
3. Explain the role of mempools
4. Write briefly about the libraries and the tools used during implementation.

**Outcome :**

1. Understood the challenges in P2P networks, how transactions are performed and how a miner mines a block to be added in a blockchain.
2. Implemented a Cryptocurrency in Python using Flask, Postman and Python libraries such as datetime, jsonify, hashlib, uuid4, urlparse, request.
3. Successfully mined the blocks among a P2P network with 3 nodes.
4. Performed transactions via the network.
5. Successfully updated the block across the network
6. Prepare a document with Aim, Tasks performed, Program, Output and Conclusion.
7. Submit the hardcopy **by the 2nd week of August 2023**  
(As per the instructions, submit a hard copy of the same).



**Lab - 4:**

**Experiment No: 4**

**Dated: 2nd week of August 2023**

**AIM: Hands on Solidity Programming Assignments for creating Smart Contracts**

**Lab Objectives:** To explore Blockchain concepts.

**Lab Outcomes (LO):** Design Smart Contract using Solidity (LO2)

**Task to be performed :**

1. Go to **LearnETH** Tutorials provided by [Remix IDE](#)
2. Explore through Solidity Basics Course
3. Complete all the 19 Assignments provided with the Course

**Tools & Libraries used :**

- Remix IDE

**Instructions :** (Prepare for viva for the following topics)

1. Primitive Data Types, Variables, Functions - pure, view
2. Inputs and Outputs to Functions
3. Visibility, Modifiers and Constructors
4. Control Flow : if-else, loops
5. Data Structures : Arrays, Mappings, structs, enums
6. Data Locations
7. Transactions : Ether and wei, Gas and Gas Price, Sending Transactions

**Outcome :**

1. Understood the basics of Solidity Programming in writing Smart Contracts and Deploying them on the Remix VM.
2. Successfully performed the Assignments given in the Tutorial.
3. Prepare a document with Aim, Tasks performed, Program, Output and Conclusion.
4. Submit the hardcopy **by the 3rd week of August 2023**  
(As per the instructions, submit a hard copy of the same).

**Lab - 5:**

**Experiment No: 5**

**Dated: 3rd week of August 2023**

**AIM: Deploying a Voting/Ballot Smart Contract**

**Lab Objectives:** To explore Blockchain concepts.

**Lab Outcomes (LO):** Design Smart Contract using Solidity (LO2)

**Task to be performed :**

1. Open [Remix IDE](#)
2. Under **Workspaces**, open **contracts** folder
3. Open **Ballot.sol**, contract.
4. Understand **Ballot.sol** contract.
5. Deploy the contract by changing the Proposal name from **bytes32** → **string**

**Refer :** <https://www.youtube.com/watch?v=GB3hiiNNDjk>

**Tools & Libraries used :**

- **Ethers**
- To convert **bytes32** to **string** : <https://web3-type-converter.onbrn.com/>

**Instructions :** (Prepare for viva for the following topics)

1. What is the relevance of require statements in the functions of Solidity Programs?
2. Understand the keywords mapping, storage and memory
3. Why bytes32 instead of string?

**Outcome :**

1. Understood the logic of Ballot contract in Solidity.
2. Successfully performed the deployment of the contract.
3. Prepare a document with Aim, Tasks performed, Program, Output and Conclusion.
4. Submit the hardcopy **by the 4th week of August 2023**  
(As per the instructions, submit a hard copy of the same).



**Lab - 6:**

**Experiment No: 6**

**Dated: 4th week of August 2023**

**AIM:** Creating Smart Contracts and performing transactions using Solidity and Remix IDE

**Lab Objectives:** To explore Blockchain concepts.

**Lab Outcomes (LO):** Design Smart Contract using Solidity (LO2)

**Task to be performed:**

1. Based on the **topic selected for the Mini Project draft at least 2 smart contracts** that will ensure the working of the proposed system.
2. Deploy the contract and check the working of the same.

**Instructions :** (Prepare for viva for the following topics)

1. What is a Smart Contract?
2. Significance of smart Contracts in Ethereum Blockchain

**Outcome :**

1. Understood the working of the proposed system and designed smart contracts for the same
2. Successfully performed the deployment of the contract.
3. Prepare a document with the Aim, Tasks performed, Program, Output and Conclusion.
4. Submit the hard copy **by the 5th week of August 2023**  
(As per the instructions, submit a hard copy of the same).

**Lab - 7:**

**Experiment No: 7**

**Dated: 3rd week of September 2023**

**AIM: Implement the embedding wallet (Metamask) and transaction using Solidity**

**Lab Objectives:** To explore Blockchain concepts.

**Lab Outcomes (LO):** Design Smart Contract using Solidity (LO2)

**Task to be performed:**

**[\[Follow the GitHub repository for the experiment\]](#)**

1. Set Up MetaMask:
  - a. Install MetaMask
  - b. Create or Import an Account:
  - c. Fund Your Wallet : [Sepolia Testnet](#) (0.5 ETH per day) / [RSK Testnet](#) (0.05 RBTC per day)
2. Connect the Sepolia Testnet / RSK Testnet to Remix IDE
3. Create a Simple Solidity Smart Contract **based on the MiniProject chosen**
4. Compile and Deploy the Smart Contract.
5. Check the transaction details on the RSK Explorer
6. Interact with the smart contract

**Instructions :** (Prepare for viva for the following topics)

1. What is a Metamask?
2. What is a test net?
3. List the steps to connect a Metamask with a Remix IDE for performing transactions.

**Outcome :**

1. Understood the steps for embedding the Metamask wallet with Remix IDE and perform transactions
2. Successfully performed the transactions on the Remix IDE via the account from Metamask Wallet
3. Prepare a document with the Aim, Tasks performed, Program, Output, and Conclusion.
4. Submit the hard copy **by the 5th week of September 2023**  
(As per the instructions, submit a hard copy of the same)

**Lab - 8:**

**Experiment No: 8**

**Dated: 5th week of September 2023**

**AIM: Implement the Blockchain platform Ganache**

**Lab Objectives:** To explore Blockchain concepts.

**Lab Outcomes (LO):** Design Smart Contract using Solidity (LO2)

**Task to be performed:**

**[\[Follow the GitHub repository for the experiment\]](#)**

1. Install Ganache
2. Connect Ganache Accounts with Metamask
3. Connect Remix IDE with Metamask
4. Create a Simple Solidity Smart Contract **based on the MiniProject chosen**
5. Compile and Deploy the Smart Contract via Ganache Accounts added to Metamask.
6. Check the transaction details on the Ganache Environment
7. Interact with the smart contract

**Instructions :** (Prepare for viva for the following topics)

1. What is a Ganache?
2. List the steps involved in connecting Ganache Environment with a Metamask and Remix IDE for performing transactions.

**Outcome :**

1. Understood the steps for embedding the Metamask wallet with Remix IDE and perform transactions
2. Successfully performed the transactions on the Remix IDE via the account from Metamask Wallet
3. Prepare a document with the Aim, Tasks performed, Program, Output, and Conclusion.
4. Submit the hard copy **by the 1st week of October 2023**  
(As per the instructions, submit a hard copy of the same)

**Lab - 9 :**

**Experiment No : 9**

**Dated : 3rd week of September 2023**

**AIM: Implement the Private Ethereum Blockchain using Geth**

**Lab Objectives:** To explore Blockchain concepts.

**Lab Outcomes (LO):** Demonstrate the concept of Blockchain in real-world Applications (LO4)

**Task to be performed :**

- To install and set up an Ethereum network to create a private Ethereum blockchain for development and testing purposes.
- Follow the instructions in this manual to [set up a Private Ethereum Network](#)
  - a. Choosing a network ID
  - b. Choosing a consensus Algorithm
  - c. Creating a Genesis Block
  - d. Initializing the Geth Database
  - e. Setting up Networking
  - f. Running the member nodes
  - g. Running a Signer (In Clique)

Note : Download the [genesis file](#) and edit the account details (ie. Public Keys of the peers in the network)

**Instructions :** (Write the Theory in the following format. Refer to [Go Ethereum](#))

1. What is Geth?
2. Significance of a Private Ethereum Network
3. Steps for creating a Private Ethereum Network

**Outcome :**

- Understood the relevance of a Private Ethereum Network
- Understood how to set up the Private Ethereum Network
- Performed transactions between the nodes in the network
- Checked the status of transactions in the Transaction pool
- Prepare a document with Aim, Tasks performed, Program, Output and Conclusion.
- Submit the hardcopy **by the 4th week of September 2023**  
(As per the instructions, submit a hard copy of the same).

**Lab - 10:**

**Experiment No: 10**

**Dated: 5th week of August 2023**

**AIM: Explore the Cryptocurrency Landscape**

**Lab Objectives:** To implement public and private Blockchain.

**Lab Outcomes (LO):** Demonstrate the concept of Blockchain in real-world Applications (LO4)

**Task to be performed :**

1. **Data Collection:**
  - a. Gather data from various sources (any 3), including cryptocurrency exchanges, financial data APIs, news platforms, social media APIs, and regulatory websites.
  - b. Collect historical price data, market capitalization, trading volume, news articles, social media posts, and regulatory updates for all.
2. **Technological Analysis:**
  - a. Study and document advancements in blockchain technology, consensus mechanisms, scalability solutions, interoperability protocols, and privacy features.
  - b. Analyze the technical roadmaps of prominent cryptocurrencies.  
(Roadmap image and a paragraph of analysis as submission)
3. **Market Trends and Adoption:**
  - a. Classify cryptocurrencies based on use cases (e.g., store of value, utility tokens, etc.).
  - b. Analyze adoption metrics, including merchant acceptance, wallet downloads, transaction volumes, and active addresses.

**Tools & Libraries used :** Internet

**Instructions :** (Prepare for viva for the following topics)

1. Cryptocurrency Landscape
2. Advancements in the Blockchain Technology

**Outcome :**

1. Understood the Cryptocurrency Landscape
2. Performed a Technological Analysis on the Advancements in Blockchain technology
3. Successfully classified the Cryptocurrencies based on use cases.
4. Prepare a document with Aim, Tasks performed, Program, Output and Conclusion.
5. Submit the hardcopy **by the 2nd week of September 2023**  
(As per the instructions, submit a hard copy of the same).