Blockchain Lab

EVEN SEMESTER 2023-24 : D20B

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**Lab Objectives:**

1. To develop and deploy smart contracts on local Blockchain
2. To deploy the smart contract on test networks.
3. To deploy and publish smart contracts on Ethereum test network.
4. To design and develop crypto currency.
5. To deploy chain code on permissioned Blockchain
6. To design and develop a Full-fledged DApp using Ethereum/Hyperledger

**Lab Outcomes (LO)**

| **LOs** | **Description** |
| --- | --- |
| LO1 | Develop and test smart contract on local Blockchain |
| LO2 | Develop and test smart contracts on Ethereum test networks. |
| LO3 | Write and deploy smart contract using Remix IDE and Metamask |
| LO4 | Design and develop Cryptocurrency. |
| LO5 | Write and deploy chain code in Hyperledger Fabric. |
| LO6 | Develop and test a Full-fledged DApp using Ethereum/Hyperledger Fabric |

**List of Experiments:**

| **Sr No** | **Title of Experiment** | **Ref**  **Books** | **LO’s** | **Bloom’s levels** |
| --- | --- | --- | --- | --- |
| 1 | 1. [Cryptography in Blockchain, Create Merkle tree](#bookmark=id.3znysh7) | T1,T3, R1,R2 | LO1,  LO4 | BL3, BL4 |
| 1. [Create a Blockchain using Python](#bookmark=id.2et92p0) |
| 2 | Create a metamask wallet, mine test ethers, perform cryto transactions and study explorer etherscan.io and bitcoin explorer. | T1,T3, R1,R2 | LO1 | BL1, BL2, BL3 |
| 3\* | Implement peer-to-peer network and Create crypto currency (consensus algorithm). | T1,T3, R1,R2 | LO1,  LO4 | BL3, BL4 |
| 4 | 1. Create Smart Contract using Solidity and Remix IDE. | T2,T3 | LO2 | BL3, BL4 |
| 1. Create Transactions using Solidity and Remix IDE |
| 5 | Develop private Blockchain platform ethereum using Geth. | T2,T3 | LO3 | BL2, BL3 |
| 6\* | Create ERC 20 Token | T2,T3 | LO1 | BL2, BL3 |
| 7\* | Case study on any one application using Permissioned Blockchain/Hyperledger Fabric | T2,T3 | LO4 | BL3, BL4 |
| 8 and 9 | Creating a blockchain Application (Mini – Project) | T1, T2, T3,  R1,R2, R3 | LO1-LO6 | BL1, BL2, BL3, BL4, BL5, BL6 |

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

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

**Lab - 1 : Experiment No : 1a Dated :**

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

***Lab Objectives :*** To realize the basic techniques to build intelligent systems

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

***Task to be performed :* Write a program in any language to create a Merkle Tree as a Binary Tree Data Structure using SHA-256**

Hint : Consider SHA256 to hash the transactions.

Input : Given the following transactions

T1 : Alice gave Rs. 200 to Bob

T2 : Bob gave Rs. 500 to Dave

T3 : Dave gave Rs. 100 to Eve

T4 : Eve gave Rs. 300 to Alice

T5 : Roo gave Rs. 50 to Bob

Output : Display the Hash at each step of merging till the Merkle Root

***Tools & Libraries used*** :

* Python Libraries : **hashlib**

***Instructions :*** [(Write theory for the following topics by referring to the PDF linked )](https://drive.google.com/file/d/1MERIb_UIOOXzvQ4VhdDirnv418JlJ68S/view?usp=sharing)

1. Cryptographic Hash functions in Blockchain
2. How does a Merkle Tree work ?
3. What is a Merkle Root ?
4. Benefits of Merkle Tree
5. Why is it essential for Blockchain ?
6. Use cases of Merkle Tree

***Outcome :***

1. Understood the concept of Merkle Tree, its relevance.
2. implemented Merkle Tree as a Binary Tree Data Structure using SHA-256
3. Attach the Theory, Program and Output (As per the instructions, submit a hard copy of the same).

**Lab - 2 : Experiment No : 1b Dated :**

**AIM : Create Blockchain using Python**

***Lab Objectives :***

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

***Task to be performed :***[*(*Write a program in Python to perform the following tasks by referring to the tutorial attached)](https://drive.google.com/file/d/1dNPlk0Bmel0ztwcHYyqEr8073VQUD6_A/view?usp=sharing)**The Experiment has to be performed wrt the Mini Project**

1. Building a Blockchain
2. Create POW/POS/POB/POET etc.
3. Mining the Blockchain

***Tools & Libraries used*** :

* [***Flask***](https://flask.palletsprojects.com/en/2.1.x/quickstart/#about-responses): pip install Flask
* Download ***Postman*** from <https://www.postman.com/>
* Python Libraries : **datetime, jsonify, hashlib**

***Instructions :*** (Write theory for the following topics )

1. Blockchain Structure
2. Properties of Blockchain
3. Significance of nonce
4. Mining Difficulty - golden nonce
5. Write briefly about the libraries and the tools used during implementation.

***Outcome :***

1. Understood the structure of a Blockchain, mining difficulty and how a miner mines a block to be added in a blockchain.
2. Implemented a Blockchain in Python using Flask, Postman and Python libraries such as datetime, jsonify and hashlib.
3. Attach the Theory, Program and Output (As per the instructions, submit a hard copy of the same).

**Lab - 3 : Experiment No : 2 Dated :**

**AIM :** Create metamask wallet, mine test ethers, perform cryto transactions and study parameters of explorer etherscan.io and bitcoin explorer.

***Lab Objectives :***

***Lab Outcomes (LO)* :** To study the concept of Blockchain in real world Application (LO1)

***Task to be performed :*** *(*Write a program in Python to perform the following tasks by referring to the tutorial attached)

1. Create metamask wallet
2. mine test ethers
3. Perform transactions between accounts and peers.
4. study parameters of explorer etherscan.io and bitcoin explorer and differences between them

***Tools & Libraries used*** :

* Install metamask: https://metamask.io/
* mine test ethers from <https://sepolia-faucet.pk910.de/> or any other test ethers
* explorer:
  + <https://etherscan.io/>
  + <https://www.blockchain.com/explorer>

***Instructions :*** (Write theory for the following topics )

1. What is matamask
2. What are different types of wallet and give examples of each
3. What are different types of accounts
4. Why transaction fee is important.
5. What is GAS, Gas price, Transaction fee and unit to measure gas price
6. Explain Block structure of bitcoin blockchain

***Outcome :***

1. Understood what is wallet
2. How transactions happens on blockchain network
3. Understood the importance of Transaction fee and unit to measure gas price
4. Attach the Theory, Program and Output (As per the instructions, submit a hard copy of the same).

**Lab - 4 : Experiment No : 3 Dated :**

**AIM :** Implement peer-to-peer network and implement Mining using block chainusing Python

***Lab Objectives :***

***Lab Outcomes (LO)* :** Demonstrate the concept of Blockchain in real world Application (LO1)

***Task to be performed :*** *(*Write a program in Python to perform the following tasks by referring to the tutorial attached)

1. Update the Blockchain created in the previous experiment
2. Create a decentralized network
3. Perform transactions among the peers.
4. Mining the Blockchain

***Tools & Libraries used*** :

* Install [***Flask***](https://flask.palletsprojects.com/en/2.1.x/quickstart/#about-responses): 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 :*** (Write theory for the following topics )

1. Challenges in P2P networks
2. How transactions are performed on the network?
3. Explain the role of mempools

***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. Attach the Theory, Program and Output (As per the instructions, submit a hard copy of the same).

**Lab - 5 :                                  Experiment  No : 4                         Dated :**

**AIM:**Create Smart Contract using Solidity and Remix IDE and Create Transactions using Solidity and Remix IDE

***Lab Objectives:***To deploy and publish smart contracts on Ethereum test network.

***Lab Outcomes (LO):***Develop and deploysmart contracts on Ethereum test network. (LO3)

***Task to be performed:****(*Write a Smart Contract on a test network for bank account of a customer for following operations: Deposit money, withdraw money and show balance by referring to the Remix-IDE tutorial)

1. Preparing Your Smart Contract Development Environment in Remix-IDE.
2. Creating Your Smart Contract File:Perform transactions among the peers.
3. Write the contract code.
4. Compile the contract.
5. Deploy smart contracts.
6. Interact with the deployed contract (testing).

***Tools & Libraries used***:

●        [Remix-IDE](https://remix-project.org/) and metamask

***Instructions :***(Write theory for the following topics )

1. What is a smart contract?
2. What are the Advantages and limitations of Smart contract?
3. Explain the life cycle of smart contract?
4. What are the risks of using smart contract?

***Outcome :***

1. Understood how to Develop and deploysmart contracts on Ethereum test network.
2. How transactions happen and the importance of gas fee, transaction fee and gas limit.
3. Attach the Theory, Program and Output (As per the instructions, submit a hard copy of the same).

**Lab -6 :                                  Experiment  No : 5                 Dated :**

**AIM:**To install and set up an Ethereum network to create a private Ethereum blockchain for development and testing purposes.

***Lab Objectives:***To learn to setup private Ethereum blockchain using GETH.

***Lab Outcomes (LO):***Develop and deploysmart contracts on Ethereum test network (LO3)

***Task to be performed:****(*Write an application in GETH by referring to the https://cse.iitk.ac.in/users/dwivedi/Blockchain/geth.pdf)

1. Step - 1: Installing Geth on Ubuntu
2. Step - 2 : Check the version of Geth on the Terminal
3. Step - 3: Create a Private Ethereum Network

1. Create a folder named, private\_ethereum\_setup

2. Create 2 subfolders named node1 and node2 in the folder private\_ethereum\_setup 3. Create 2 accounts in the folder corresponding to node1 and node2

4. Create a genesis.json file in the folder, private\_ethereum\_setup

5. Initialize the nodes with the genesis file

6. For configuring the boot node

1. Step - 4: Establish a Peer-Peer Connection between the nodes along with the bootnode 1. On the first Terminal, Use boot.key to run the boot node

2. On the second Terminal, Run Node 1

3. On the third Terminal, Run Node 2

1. Step - 5 : Exploring the network by attaching JavaScript console to Node 1

1. Fetch network status

2. To list the nodes in the network

3. To list the nodes in the network

4. To fetch the number of blocks mined

5. To check the balance of the accounts

6. To check the balance of the accounts in ether

7. To fetch the details of the latest mined block

8. To fetch the details of a specific block

9. To check the account balance of the peer machine, provide their Public Key

10. Fetch the details of the peers in the network

11. Perform Transactions between peers in the network

12. Check the balances of sender and receiver 2

13. To check the details of the transaction on Node 1 Terminal

14. To get the details of the block in which the transaction is added

15. To check the contents in the Mempool - Transaction Pool

16. To check the status of the Mempool - Transaction Pool

17. To check the transactions initiated by a client, which are in the pool.

***Tools & Libraries used***:

●      GITH and metamask

***Instructions :***(Write theory for the following topics )

1. Explain Ethereum platform?
2. What is Dapps?
3. What is mempool?

***Outcome :***

1. Understood how to Install Geth.
2. Create a Private Ethereum Network
3. How to create a genesis block
4. How Perform Transactions between peers, and check balances.
5. Attach the Theory, Program and Output (As per the instructions, submit a hard copy of the same).

**Lab -7 :                                  Experiment  No : 6               Dated :**

**AIM:**Create ERC 20 token using Remix IDE/ truffle and ganache.

***Lab Objectives:***To learn to Create ERC 20 token.

***Lab Outcomes (LO):***. (LO4)

 Task to be performed: Create ERC20 Token

***Tools & Libraries used***:     Remix IDE and metamask/ truffle and ganache.

***Instructions: refer to the link :***[***https://vitto.cc/how-to-create-and-deploy-an-erc20-token-in-20-minutes/***](https://vitto.cc/how-to-create-and-deploy-an-erc20-token-in-20-minutes/)***or*** [***https://www.toptal.com/ethereum/create-erc20-token-tutorial***](https://www.toptal.com/ethereum/create-erc20-token-tutorial)

***Outcome:***

**Lab -8 :                                  Experiment  No : 7               Dated :**

**AIM:** Case study on any one application using permissioned blockchain/ Hyperledger Fabric

***Lab Objectives:***

***Lab Outcomes (LO):***. (LO5)

 Task to be performed:

***Tools & Libraries used***:    .

***Instructions: refer to the link***

**Lab - 9 and 10 :                                  Experiment  No : 8               Dated :**

**AIM:**Develop Decentralized Application using Ethereum/Hyperledger platform.

***Lab Objectives:***To learn to Develop Decentralized Application .

***Lab Outcomes (LO):*** (LO6)

 Task to be performed: Develop any Dapp.

***Tools & Libraries used***:    

***Instructions: Report has to be prepared***

***Outcome:***