

## Blockchain Exp - 3

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

### Theory:

#### 1. Blockchain Overview

Blockchain is a **distributed and decentralized ledger** that stores information in a series of linked blocks.

Each block contains:

- Transaction data
- Timestamp
- Previous block's hash
- Its own unique hash (digital fingerprint)

Once data is recorded in a blockchain, it becomes **immutable** because altering one block would require recalculating all subsequent blocks.

#### 2. Mining

Mining is the process of:

1. Collecting pending transactions into a block.
2. Performing a computational puzzle (Proof-of-Work) to find a valid hash.
3. Adding the new block to the blockchain.  
Broadcasting it to all connected peers.

Miners are rewarded with cryptocurrency for successfully mining a block.

#### 3. Multi-Node Blockchain Network

In this lab, we simulate **three independent blockchain nodes** ([5001](#), [5002](#), [5003](#)).

Each node:

- Runs on a separate port.
- Maintains its own copy of the blockchain.
- Can connect with peers to share and validate blocks.

#### 4. Consensus Mechanism

We use the **Longest Chain Rule**:

- If multiple versions of the chain exist, the **longest valid chain** is chosen.
- This ensures all nodes agree on a single transaction history.

#### 5. Transactions & Mining Reward

Each transaction has:

- Sender
- Receiver
- Amount

When mining a block:

- Pending transactions are added to the block.
- A **reward transaction** is added automatically to pay the miner.

## 6. Chain Replacement

When /replace\_chain is called:

1. Node requests chains from peers.
2. If it finds a longer and valid chain, it replaces its own.
3. This keeps the blockchain consistent across all nodes.

## Tools & Libraries Used

- **Python 3.x**
- **Flask** – Web framework for API endpoints  
pip install Flask
- **Requests** – For HTTP communication between nodes  
pip install requests==2.18.4
- **Postman** – For testing API requests
- Python Standard Libraries:
  - `datetime`
  - `jsonify`
  - `hashlib`
  - `uuid4`
  - `urlparse`
  - `request`

**Code :**

```
# Module 2 - Create a Cryptocurrency

# To be installed:
# Flask==0.12.2: pip install Flask==0.12.2
# Postman HTTP Client: https://www.getpostman.com/
# requests==2.18.4: pip install requests==2.18.4

# Importing the libraries
import datetime
import hashlib
import json
from flask import Flask, jsonify, request
import requests
from uuid import uuid4
from urllib.parse import urlparse # Generate a unique id that is in hex
# To parse url of the nodes

# Part 1 - Building a Blockchain

class Blockchain:

    def __init__(self):
        self.chain = []
        self.transactions = [] # Adding transactions before they are
added to a block
        self.create_block(proof = 1, previous_hash = '0')
        self.nodes = set() # Set is used as there is no order to be
maintained as the nodes can be from all around the globe

    def create_block(self, proof, previous_hash):
        block = {'index': len(self.chain) + 1,
                 'timestamp': str(datetime.datetime.now()),
                 'proof': proof,
                 'previous_hash': previous_hash,
                 'transactions': self.transactions} # Adding transactions to make the
blockchain a cryptocurrency
        self.transactions = [] # The list of transaction should become
empty after they are added to a block
        self.chain.append(block)
        return block
```

```
def get_previous_block(self):
    return self.chain[-1]

def proof_of_work(self, previous_proof):
    new_proof = 1
    check_proof = False
    while check_proof is False:
        hash_operation = hashlib.sha256(str(new_proof**2 -
previous_proof**2).encode()).hexdigest()
        if hash_operation[:4] == '0000':
            check_proof = True
        else:
            new_proof += 1
    return new_proof

def hash(self, block):
    encoded_block = json.dumps(block, sort_keys = True).encode()
    return hashlib.sha256(encoded_block).hexdigest()

def is_chain_valid(self, chain):
    previous_block = chain[0]
    block_index = 1
    while block_index < len(chain):
        block = chain[block_index]
        if block['previous_hash'] != self.hash(previous_block):
            return False
        previous_proof = previous_block['proof']
        proof = block['proof']
        hash_operation = hashlib.sha256(str(proof**2 - previous_proof**2).encode()).hexdigest()
        if hash_operation[:4] != '0000':
            return False
        previous_block = block
        block_index += 1
    return True

# This method will add the transaction to the list of transactions
def add_transaction(self, sender, receiver, amount):
    self.transactions.append({'sender': sender,
                             'receiver': receiver,
                             'amount': amount})
    previous_block = self.get_previous_block()
```

```

        return previous_block['index'] + 1 # It will return the block index to
which the transaction should be added

# This function will add the node containing an address to the set of nodes created in init
function
def add_node(self, address):
    parsed_url = urlparse(address) # urlparse will parse the url from the
address
    self.nodes.add(parsed_url.netloc) # Add is used and not append as it's
a set. Netloc will only return '127.0.0.1:5000'

# Consensus Protocol. This function will replace all the shorter chain with the longer chain in
all the nodes on the network
def replace_chain(self):
    network = self.nodes # network variable is the set of nodes all
around the globe
    longest_chain = None # It will hold the longest chain when we
scan the network
    max_length = len(self.chain) # This will hold the length of the chain
held by the node that runs this function
    for node in network:
        response = requests.get(f'http://{node}/get_chain') # Use get_chain method
already created to get the length of the chain
        if response.status_code == 200:
            length = response.json()['length'] # Extract the length of the chain from
get_chain fiunction
            chain = response.json()['chain']
            if length > max_length and self.is_chain_valid(chain): # We check if the length is
bigger and if the chain is valid then
                max_length = length # We update the max length
                longest_chain = chain # We update the longest chain
            if longest_chain: # If longest_chain is not none that means it
was replaced
                self.chain = longest_chain # Replace the chain of the current node
with the longest chain
                return True
            return False # Return false if current chain is the longest
one

# Part 2 - Mining our Blockchain

# Creating a Web App

```

```
app = Flask(__name__)

# Creating an address for the node on Port 5000. We will create some other nodes as well on
different ports
node_address = str(uuid4()).replace('-', "") # 

# Creating a Blockchain
blockchain = Blockchain()

# Mining a new block
@app.route('/mine_block', methods = ['GET'])
def mine_block():
    previous_block = blockchain.get_previous_block()
    previous_proof = previous_block['proof']
    proof = blockchain.proof_of_work(previous_proof)
    previous_hash = blockchain.hash(previous_block)
    blockchain.add_transaction(sender = node_address, receiver = 'Richard', amount = 1) #
Hadcoins to mine the block (A Reward). So the node gives 1 hadcoin to Abcde for mining the
block
    block = blockchain.create_block(proof, previous_hash)
    response = {'message': 'Congratulations, you just mined a block!',
                'index': block['index'],
                'timestamp': block['timestamp'],
                'proof': block['proof'],
                'previous_hash': block['previous_hash'],
                'transactions': block['transactions']}
    return jsonify(response), 200

# Getting the full Blockchain
@app.route('/get_chain', methods = ['GET'])
def get_chain():
    response = {'chain': blockchain.chain,
                'length': len(blockchain.chain)}
    return jsonify(response), 200

# Checking if the Blockchain is valid
@app.route('/is_valid', methods = ['GET'])
def is_valid():
    is_valid = blockchain.is_chain_valid(blockchain.chain)
    if is_valid:
        response = {'message': 'All good. The Blockchain is valid.'}
    else:
```

```

        response = {'message': 'Houston, we have a problem. The Blockchain is not valid.'}
        return jsonify(response), 200

# Adding a new transaction to the Blockchain
@app.route('/add_transaction', methods = ['POST'])          # Post method as we have
to pass something to get something in return
def add_transaction():
    json = request.get_json()                            # This will get the json file from
postman. In Postman we will create a json file in which we will pass the values for the keys in
the json file
    transaction_keys = ['sender', 'receiver', 'amount']
    if not all(key in json for key in transaction_keys):      # Checking if all keys are
available in json
        return 'Some elements of the transaction are missing', 400
    index = blockchain.add_transaction(json['sender'], json['receiver'], json['amount'])
    response = {'message': f'This transaction will be added to Block {index}'}
    return jsonify(response), 201                          # Code 201 for creation

# Part 3 - Decentralizing our Blockchain

# Connecting new nodes
@app.route('/connect_node', methods = ['POST'])          # POST request to register
the new nodes from the json file
def connect_node():
    json = request.get_json()
    nodes = json.get('nodes')                            # Get the nodes from json file
    if nodes is None:
        return "No node", 400
    for node in nodes:
        blockchain.add_node(node)
    response = {'message': 'All the nodes are now connected. The Hadcoin Blockchain now
contains the following nodes:',
                'total_nodes': list(blockchain.nodes)}
    return jsonify(response), 201

# Replacing the chain by the longest chain if needed
@app.route('/replace_chain', methods = ['GET'])
def replace_chain():
    is_chain_replaced = blockchain.replace_chain()
    if is_chain_replaced:
        response = {'message': 'The nodes had different chains so the chain was replaced by the
longest one,'}

```

```
'new_chain': blockchain.chain}  
else:  
    response = {'message': 'All good. The chain is the largest one.',  
                'actual_chain': blockchain.chain}  
return jsonify(response), 200  
  
# Running the app  
app.run(host = '0.0.0.0', port = 500*)
```

**Output :****1. Connecting nodes: Node 1 -> 2,3**

POST http://127.0.0.1:5001/connect\_node

```

1 {
2   "nodes": [
3     "http://127.0.0.1:5002",
4     "http://127.0.0.1:5003"
5   ]
6 }

```

Body Cookies Headers (4) Test Results

```

1 {
2   "message": "All the nodes are now connected. The Hadcoin Blockchain now contains the following
3   nodes:",
4   "total_nodes": [
5     "127.0.0.1:5003",
6     "127.0.0.1:5002"
7   ]
}

```

201 CREATED 7 ms 331 B

**Node 2 -> 1,3**

POST http://127.0.0.1:5002/connect\_node

```

1 {
2   "nodes": [
3     "http://127.0.0.1:5001",
4     "http://127.0.0.1:5003"
5   ]
6 }

```

Body Cookies Headers (4) Test Results

```

1 {
2   "message": "All the nodes are now connected. The Hadcoin Blockchain now contains the following
3   nodes:",
4   "total_nodes": [
5     "127.0.0.1:5003",
6     "127.0.0.1:5001"
7   ]
}

```

201 CREATED 6 ms 331 B

### Node 3 -> 1,2

HTTP [http://127.0.0.1:5003/connect\\_node](http://127.0.0.1:5003/connect_node)

**POST** [http://127.0.0.1:5003/connect\\_node](http://127.0.0.1:5003/connect_node)

Save Share

Params Authorization Headers (9) Body Scripts Settings Cookies

Body (raw JSON)

```

1 {
2   "nodes": [
3     "http://127.0.0.1:5001",
4     "http://127.0.0.1:5002"
5   ]
6 }
```

Beautify

Body Cookies Headers (4) Test Results 201 CREATED 5 ms 331 B

{ } JSON Preview Visualize

```

1 {
2   "message": "All the nodes are now connected. The Hadcoin Blockchain now contains the following
3   nodes:",
4   "total_nodes": [
5     "127.0.0.1:5001",
6     "127.0.0.1:5002"
7   ]
}
```

### 2. Adding transaction from node 1

HTTP [http://127.0.0.1:5001/add\\_transaction](http://127.0.0.1:5001/add_transaction)

**POST** [http://127.0.0.1:5001/add\\_transaction](http://127.0.0.1:5001/add_transaction)

Save Share

Params Authorization Headers (9) Body Scripts Settings Cookies

Body (raw JSON)

```

1 {
2   "sender": "Prajjal",
3   "receiver": "Pandey",
4   "amount": 37
5 }
```

Beautify

Body Cookies Headers (4) Test Results 201 CREATED 6 ms 213 B

{ } JSON Preview Visualize

```

1 {
2   "message": "This transaction will be added to Block 2"
3 }
```

### 3. Mining a Block (Only on 5001)

```

1 {
2   "index": 2,
3   "message": "Congratulations, you just mined a block!",
4   "previous_hash": "768bfbab8eebf0105a46adaf22a2e485a231b614c4d9358bf5428caff7f14308",
5   "proof": 533,
6   "timestamp": "2026-02-12 17:08:10.596360",
7   "transactions": [
8     {
9       "amount": 37,
10      "receiver": "Pandey",
11      "sender": "Prajjwal"
12    },
13    {
14      "amount": 1,
15      "receiver": "Richard",
16      "sender": "1c843fe9c5664806867e4496ad660979"
17    }
18  ]
19 }

```

### 4. Checking chain length difference: Node 1

```

1 [
2   {
3     "index": 0,
4     "previous_hash": "genesis",
5     "proof": 0,
6     "timestamp": "2026-02-12 17:08:10.596360",
7     "transactions": []
8   },
9   {
10    "index": 1,
11    "previous_hash": "768bfbab8eebf0105a46adaf22a2e485a231b614c4d9358bf5428caff7f14308",
12    "proof": 533,
13    "timestamp": "2026-02-12 17:08:10.596360",
14    "transactions": [
15      {
16        "amount": 37,
17        "receiver": "Pandey",
18        "sender": "Prajjwal"
19      },
20      {
21        "amount": 1,
22        "receiver": "Richard",
23        "sender": "1c843fe9c5664806867e4496ad660979"
24      }
25    ]
26  },
27  {
28    "length": 2
29  }
30 ]

```

## Node 2

The screenshot shows the Postman application interface. At the top, it displays the URL `http://127.0.0.1:5002/get_chain`. Below the URL, there is a search bar with the same URL and a "Send" button. The main area has tabs for "Params", "Authorization", "Headers (9)", "Body", "Scripts", and "Settings". The "Body" tab is selected, showing a JSON response. The response content is:

```
1 {  
2   "chain": [  
3     {  
4       "index": 1,  
5       "previous_hash": "0",  
6       "proof": 1,  
7       "timestamp": "2026-02-12 16:35:01.448893",  
8       "transactions": []  
9     },  
10   ],  
11   "length": 1  
12 }
```

At the bottom right of the response area, there are several icons for sharing and copying the data.

## Node 3

The screenshot shows the Postman application interface. At the top, it displays the URL `http://127.0.0.1:5003/get_chain`. Below the URL, there is a search bar with the same URL and a "Send" button. The main area has tabs for "Params", "Authorization", "Headers (9)", "Body", "Scripts", and "Settings". The "Body" tab is selected, showing a JSON response. The response content is identical to Node 2's:

```
1 {  
2   "chain": [  
3     {  
4       "index": 1,  
5       "previous_hash": "0",  
6       "proof": 1,  
7       "timestamp": "2026-02-12 16:35:28.083070",  
8       "transactions": []  
9     },  
10   ],  
11   "length": 1  
12 }
```

At the bottom right of the response area, there are several icons for sharing and copying the data.

## 5. Replace Chain (Consensus Mechanism) : Node 2

```

2   "message": "The nodes had different chains so the chain was replaced by the longest one.",
3   "new_chain": [
4     {
5       "index": 1,
6       "previous_hash": "0",
7       "proof": 1,
8       "timestamp": "2026-02-12 16:33:15.952922",
9       "transactions": []
10    },
11    {
12      "index": 2,
13      "previous_hash": "768bfbab8eebf0105a46adaf22a2e485a231b614c4d9358bf5428caff7f14308",
14      "proof": 533,
15      "timestamp": "2026-02-12 17:08:10.596360",
16      "transactions": [
17        {
18          "amount": 37,
19          "receiver": "Pandey",
20          "sender": "Prajjwal"
21        },
22        {
23          "amount": 1,
24          "receiver": "Richard",
25        }
26      ]
27    }
28  ]
29}

```

## Node 3

```

2   "message": "The nodes had different chains so the chain was replaced by the longest one.",
3   "new_chain": [
4     {
5       "index": 1,
6       "previous_hash": "0",
7       "proof": 1,
8       "timestamp": "2026-02-12 16:33:15.952922",
9       "transactions": []
10    },
11    {
12      "index": 2,
13      "previous_hash": "768bfbab8eebf0105a46adaf22a2e485a231b614c4d9358bf5428caff7f14308",
14      "proof": 533,
15      "timestamp": "2026-02-12 17:08:10.596360",
16      "transactions": [
17        {
18          "amount": 37,
19          "receiver": "Pandey",
20          "sender": "Prajjwal"
21        },
22        {
23          "amount": 1,
24          "receiver": "Richard",
25        }
26      ]
27    }
28  ]
29}

```

## 6. Final Validation

The screenshot shows a Postman interface with the following details:

- HTTP Method:** GET
- URL:** http://127.0.0.1:5001/is\_valid
- Headers:** (9)
- Body:** (JSON) { "message": "All good. The Blockchain is valid." }
- Test Results:** (4)

## 7. Terminal Activity

```
(venv) PS C:\Users\prajj\Downloads\Lab_3_Create a Cryptocurrency-20260211T182232Z-1-001\Lab_3_Create a Cryptocurrency> python hadcoin_node_5001.py
>>
File "C:\Users\prajj\Downloads\Lab_3_Create a Cryptocurrency-20260211T182232Z-1-001\Lab_3_Create a Cryptocurrency\hadcoin_node_5001.py", line 164, in connect_node
    nodes = json.get('nodes')                                     # Get the nodes from json file
AttributeError: 'NoneType' object has no attribute 'get'
127.0.0.1 - - [12/Feb/2026 16:50:52] "POST /connect_node HTTP/1.1" 500 -
127.0.0.1 - - [12/Feb/2026 16:54:03] "POST /connect_node HTTP/1.1" 201 -
127.0.0.1 - - [12/Feb/2026 17:06:56] "POST /add_transaction HTTP/1.1" 201 -
127.0.0.1 - - [12/Feb/2026 17:07:55] "POST /mine_block HTTP/1.1" 405 -
127.0.0.1 - - [12/Feb/2026 17:08:18] "GET /mine_block HTTP/1.1" 200 -
127.0.0.1 - - [12/Feb/2026 17:11:22] "GET /get_chain HTTP/1.1" 200 -
127.0.0.1 - - [12/Feb/2026 17:15:11] "GET /get_chain HTTP/1.1" 200 -
127.0.0.1 - - [12/Feb/2026 17:16:11] "GET /get_chain HTTP/1.1" 200 -
127.0.0.1 - - [12/Feb/2026 17:17:08] "GET /is_valid HTTP/1.1" 200 -
```

**Conclusion:** In this experiment, we successfully created a basic cryptocurrency using Python and Flask and implemented mining in a multi-node blockchain network. We demonstrated how transactions are added, stored temporarily, and included in a block during the mining process using a Proof-of-Work mechanism. By running three separate nodes, we simulated a peer-to-peer network and applied the Longest Chain Rule to maintain consensus across all nodes. The experiment helped us understand blockchain structure, decentralized networking, mining rewards, and chain synchronization in a practical manner.