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                                  # Generate a unique id that is in hex
from urllib.parse import urlparse                       # 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 transacction 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 trqnsaction to the list of trnsactions
    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
```

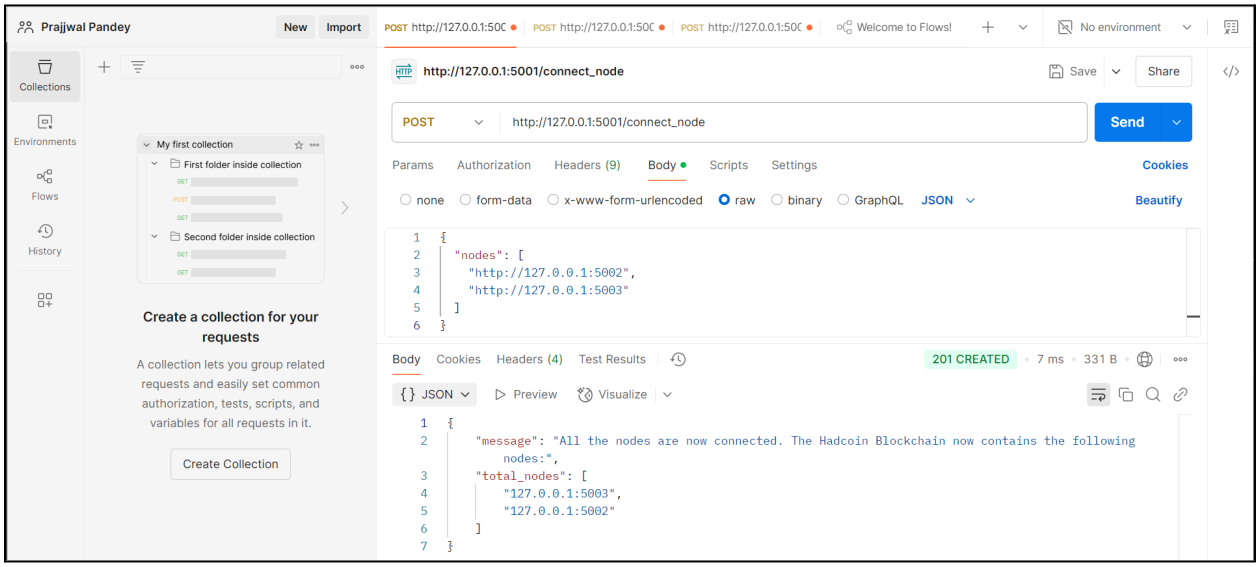
```
app = Flask(__name__)

# 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.',
```

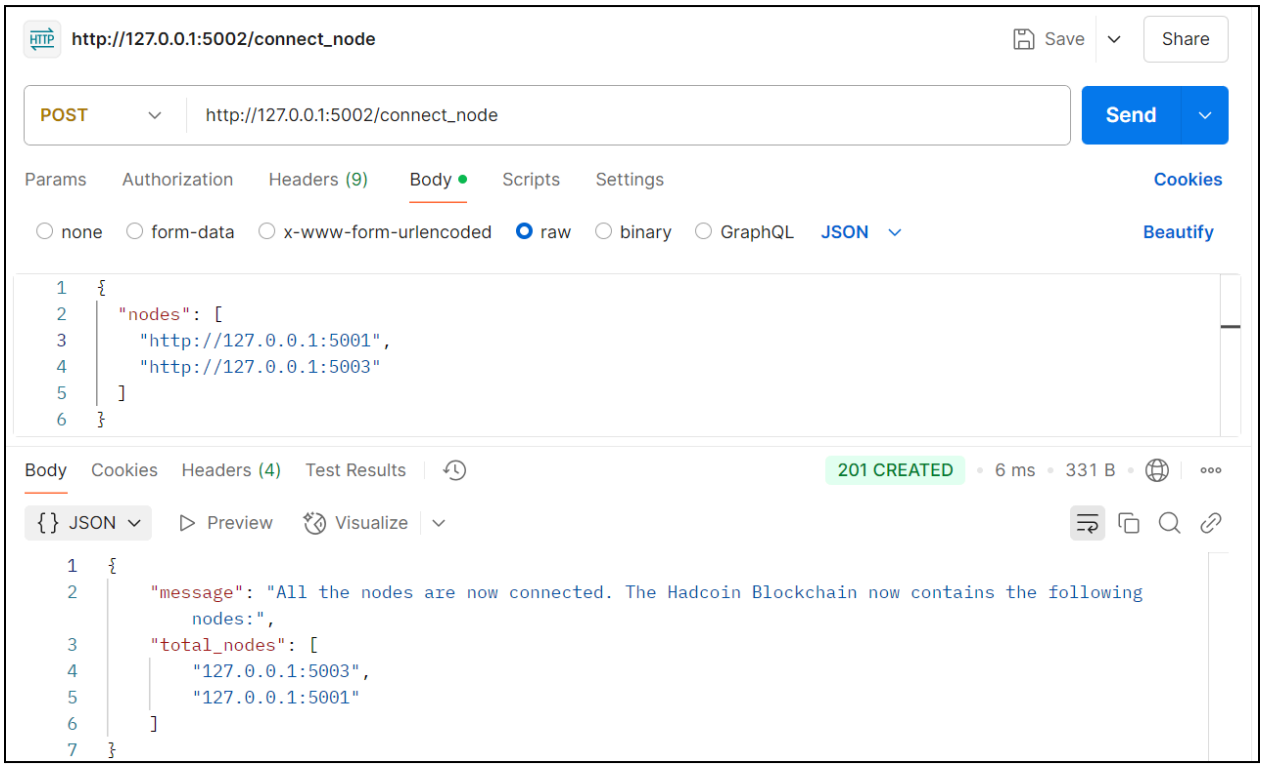
```
            'new_chain': blockchain.chain}
    else:
        response = {'message': 'All good. The chain is the largest one.',
            'actual_chain': blockchain.chain}
    return jsonify(response), 200

# Running the app
app.run(host = '0.0.0.0', port = 500*)
```

Output :

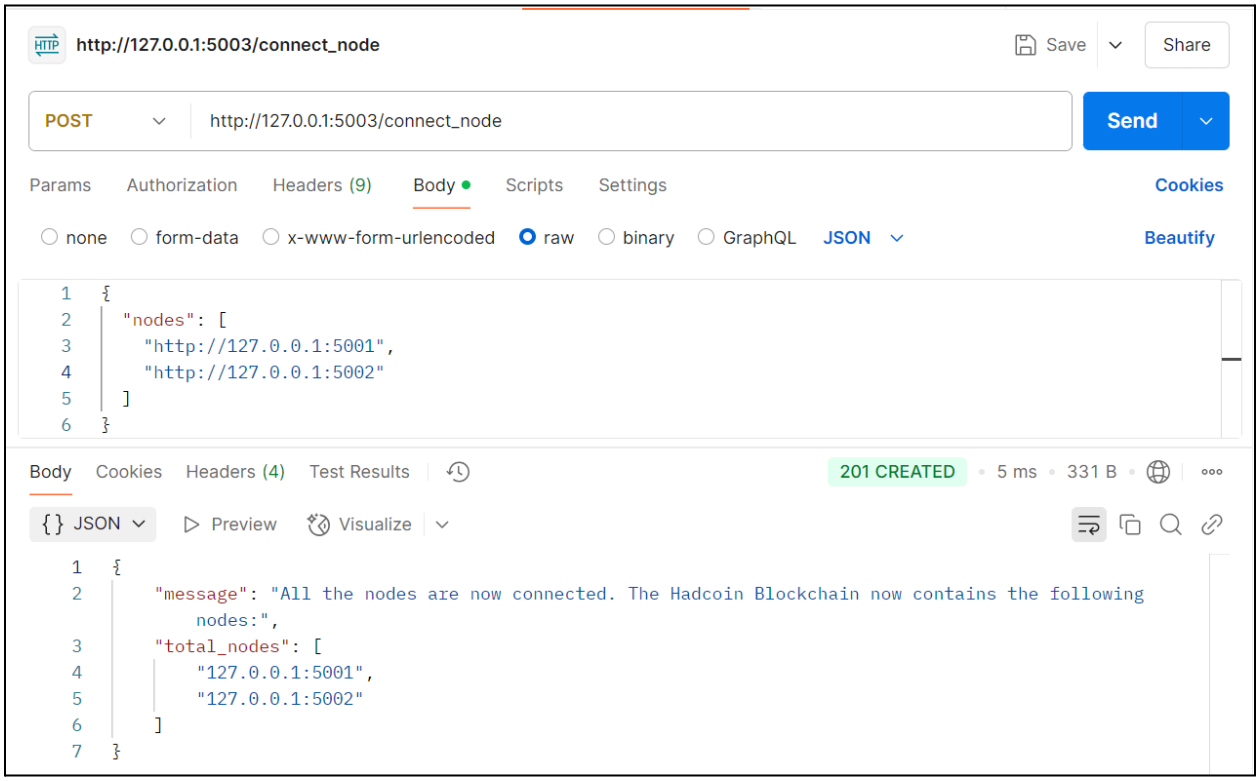
1. Connecting nodes: Node 1 -> 2,3



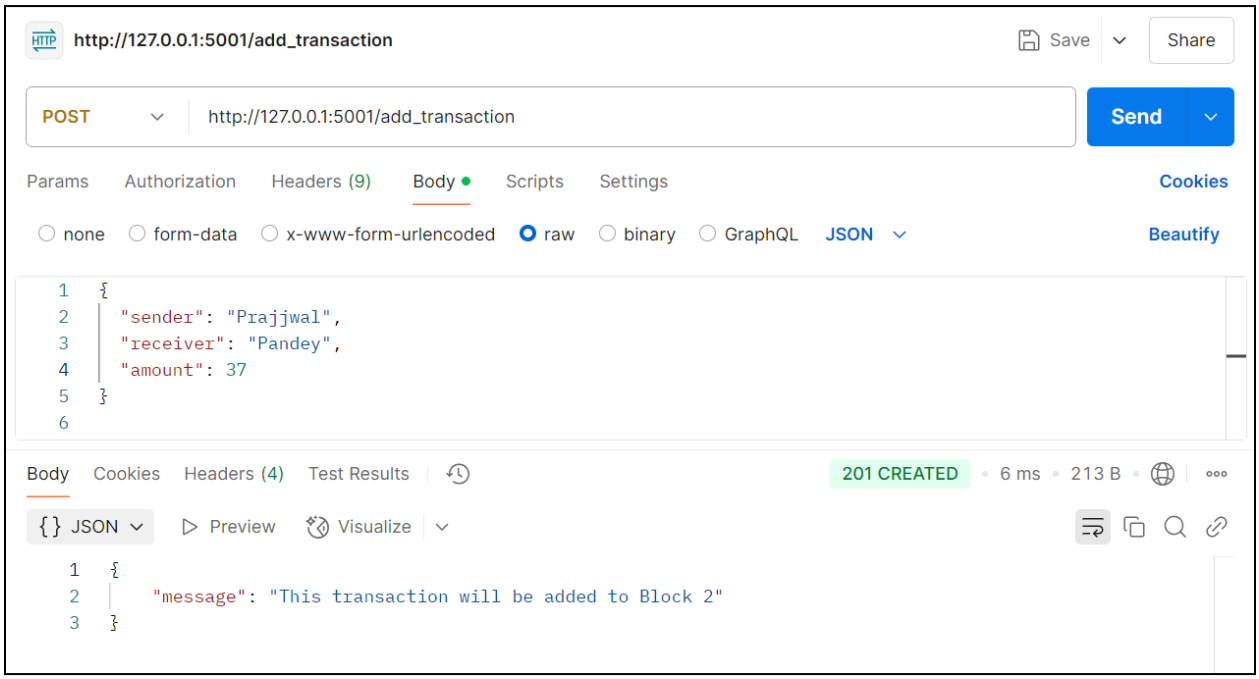
Node 2 -> 1,3



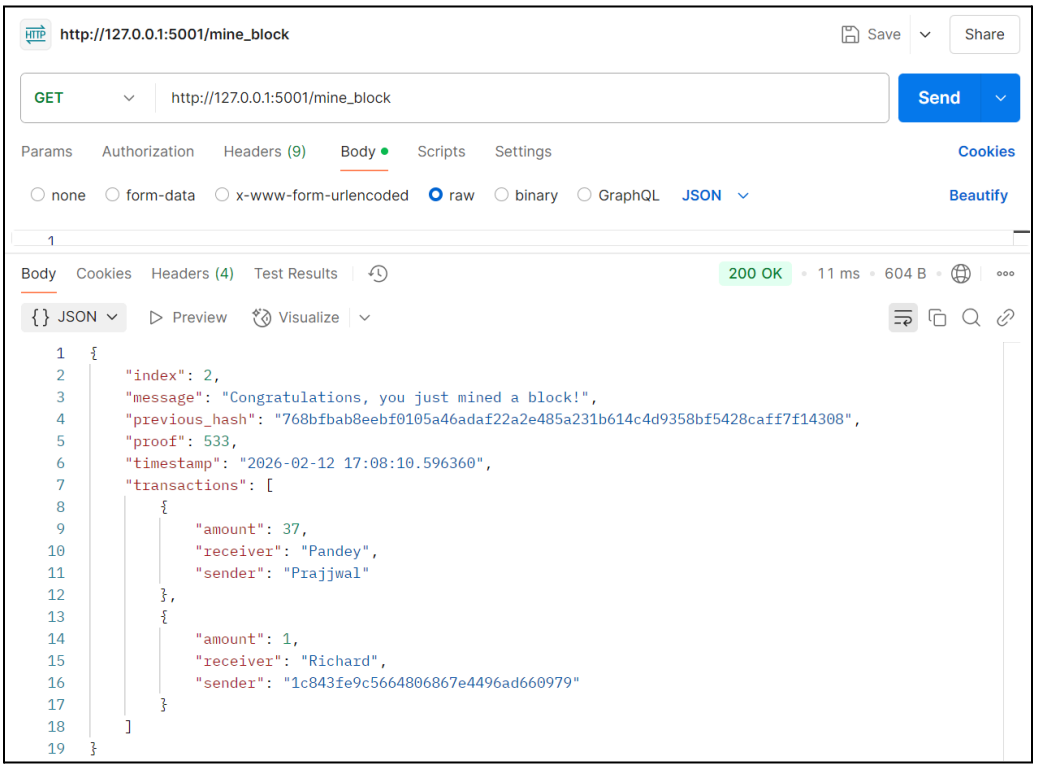
Node 3 -> 1,2



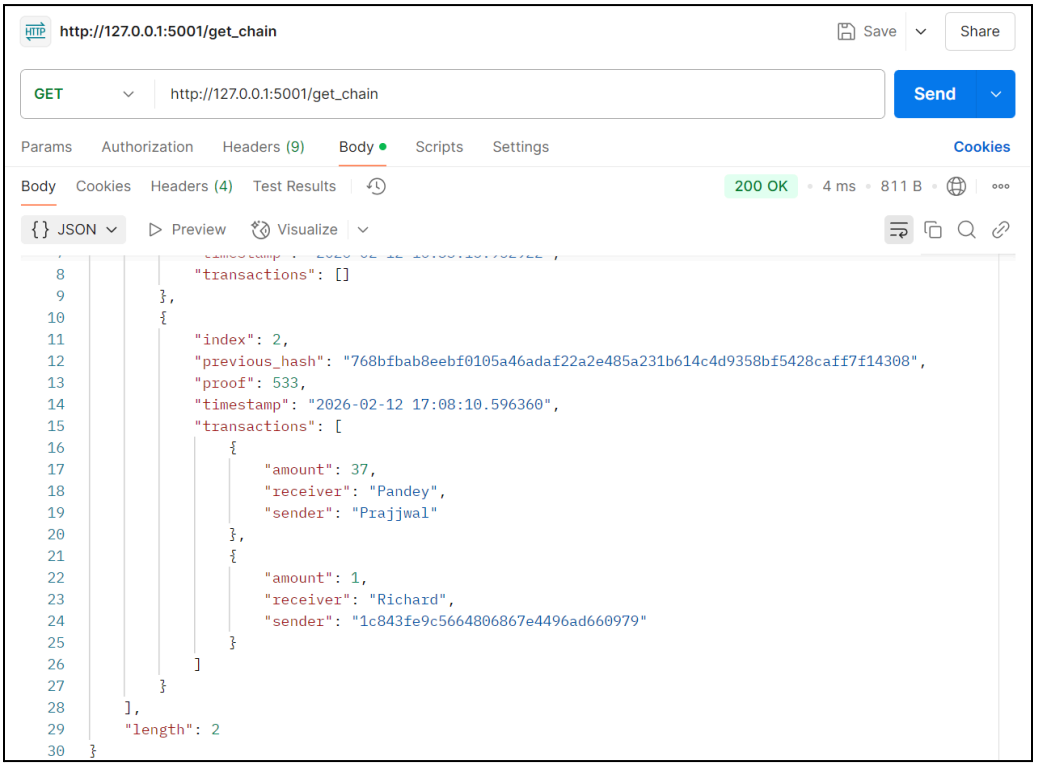
2. Adding transaction from node 1



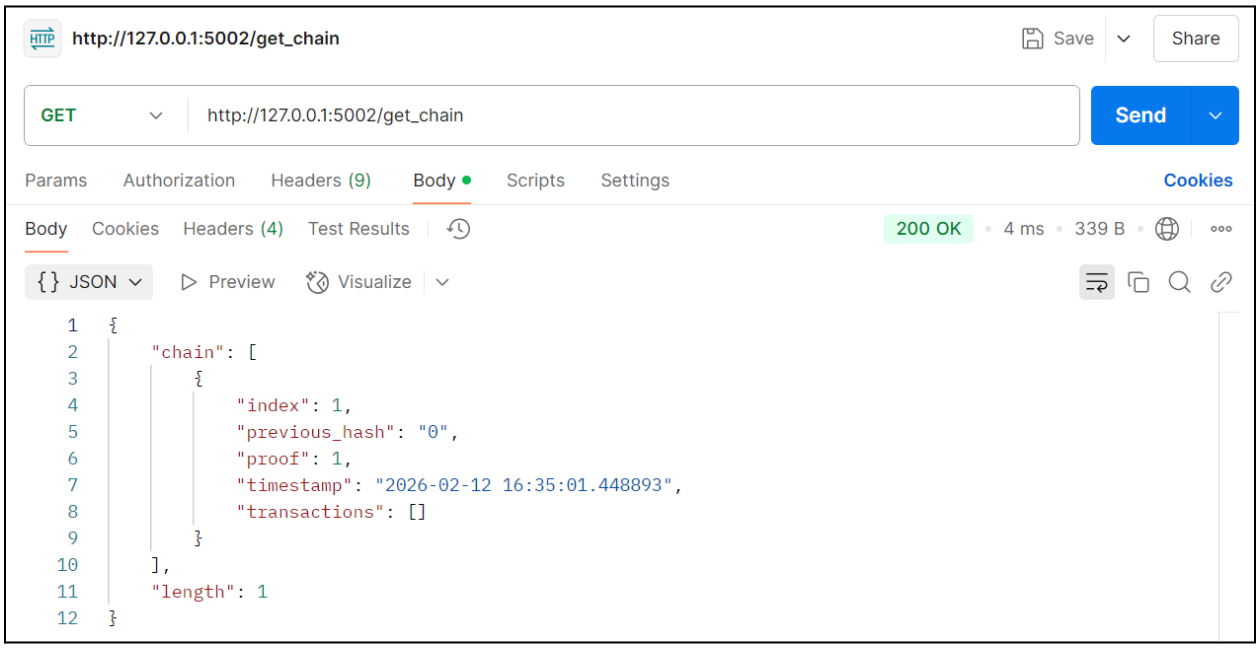
3. Mining a Block (Only on 5001)



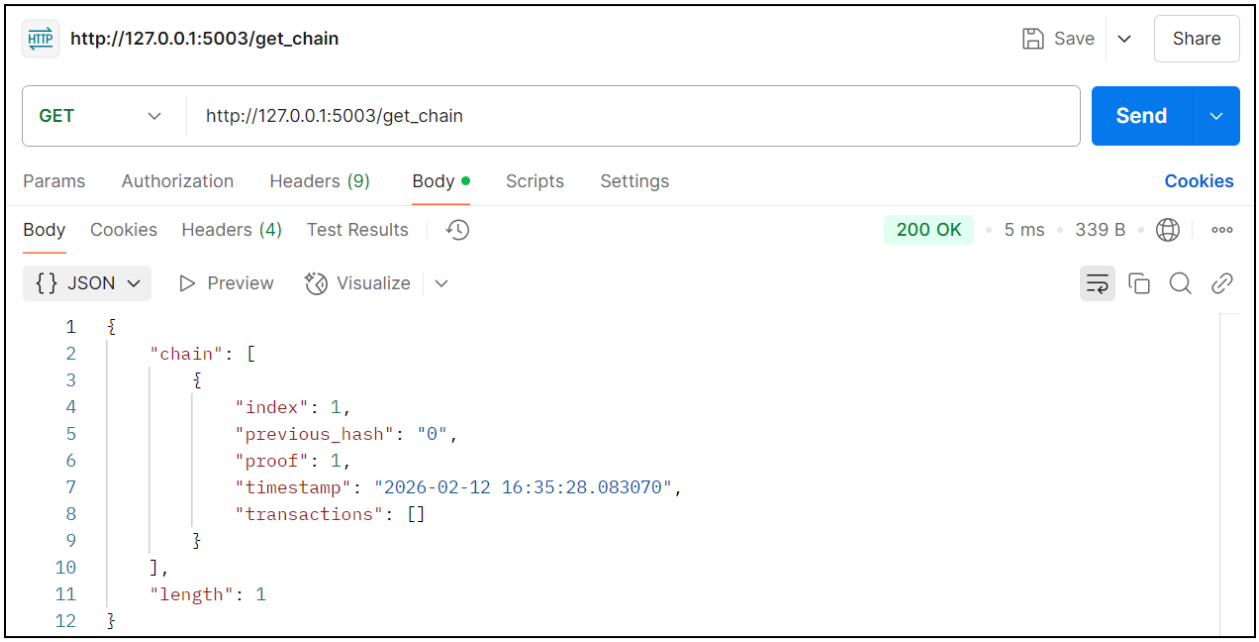
4. Checking chain length difference: Node 1



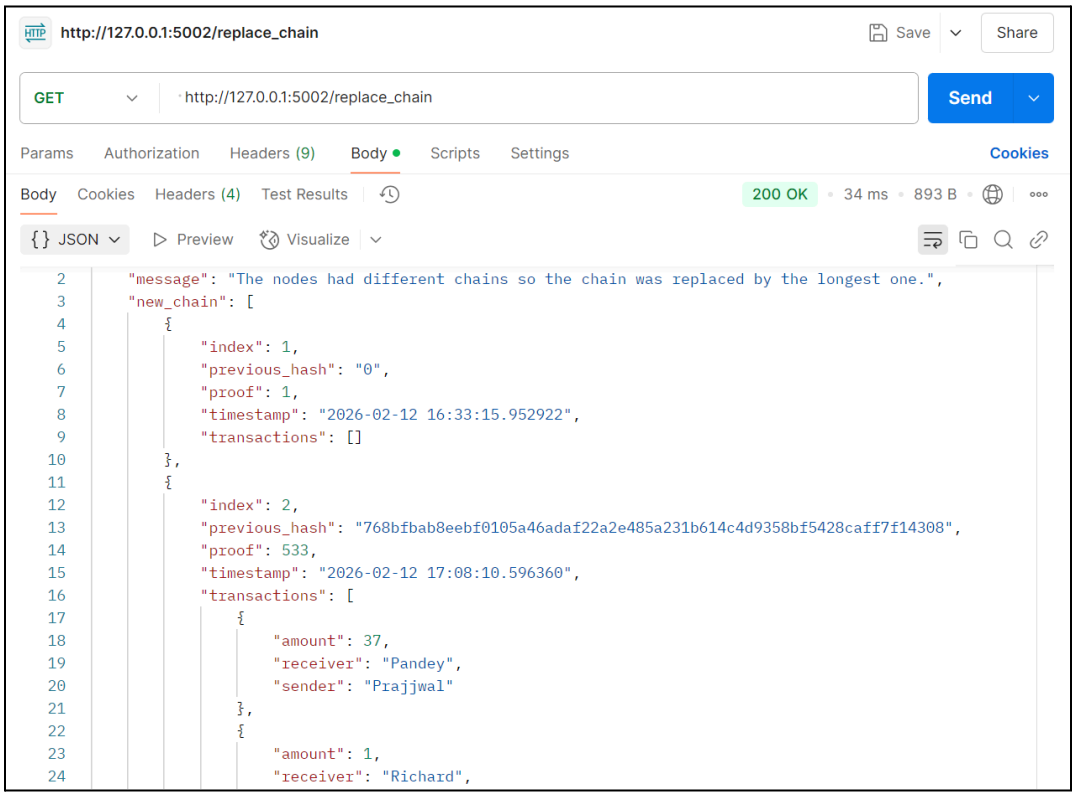
Node 2


http://127.0.0.1:5002/get_chain
Save
Share
GET
http://127.0.0.1:5002/get_chain
Send
Params
Authorization
Headers (9)
Body
Scripts
Settings
Cookies
Body
Cookies
Headers (4)
Test Results
200 OK
4 ms
339 B
JSON
Preview
Visualize
{
"chain": [
{
"index": 1,
"previous_hash": "0",
"proof": 1,
"timestamp": "2026-02-12 16:35:01.448893",
"transactions": []
}
],
"length": 1
}

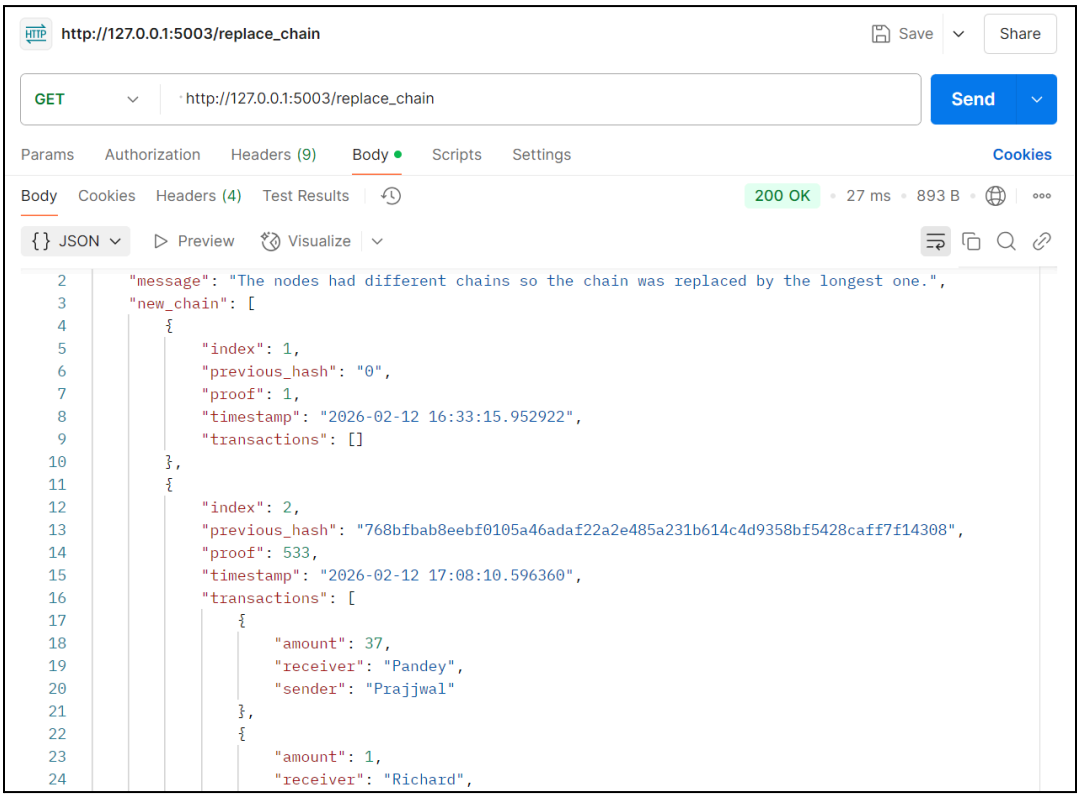
Node 3


http://127.0.0.1:5003/get_chain
Save
Share
GET
http://127.0.0.1:5003/get_chain
Send
Params
Authorization
Headers (9)
Body
Scripts
Settings
Cookies
Body
Cookies
Headers (4)
Test Results
200 OK
5 ms
339 B
JSON
Preview
Visualize
{
"chain": [
{
"index": 1,
"previous_hash": "0",
"proof": 1,
"timestamp": "2026-02-12 16:35:28.083070",
"transactions": []
}
],
"length": 1
}

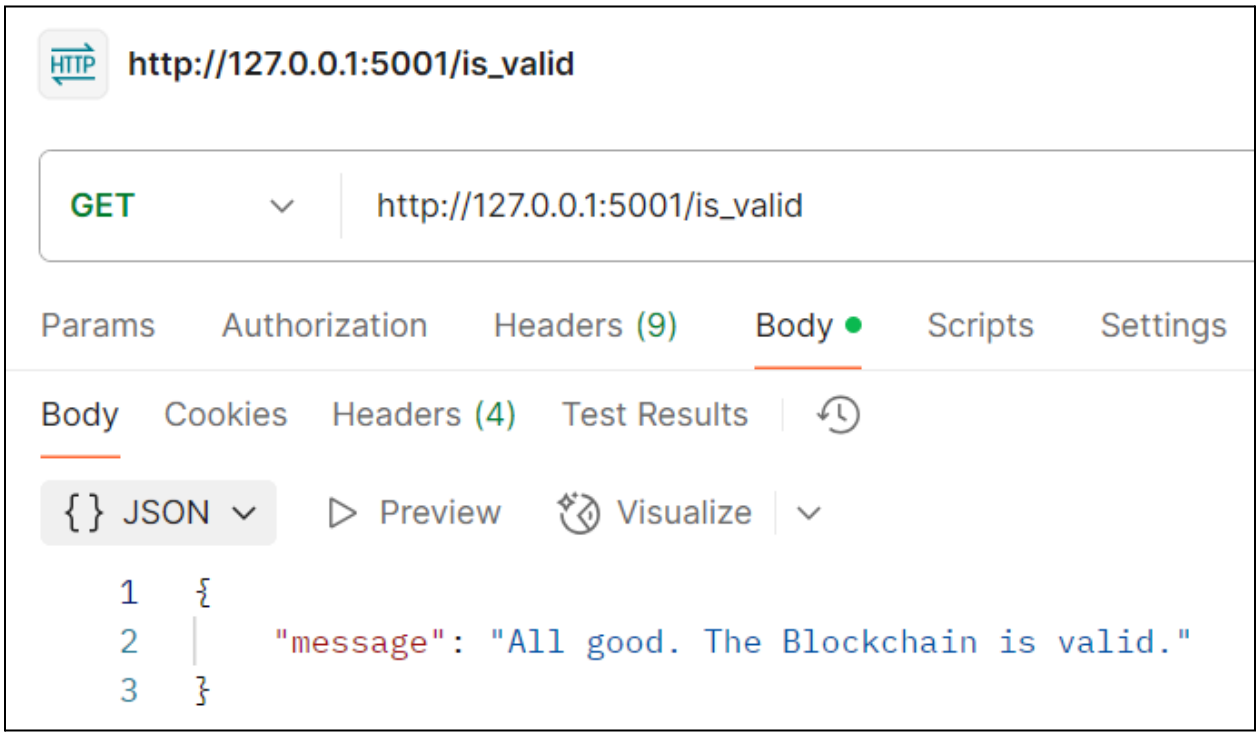
5. Replace Chain (Consensus Mechanism) : Node 2



Node 3



6. Final Validation



7. Terminal Activity

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.