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School: .... Campus: ....

Academic Year: .... Subject Name: .... Subject Code: ....

Semester: .... Program: .... Branch: .... Specialization: ....

Date: ....

Applied and Action Learning

(Learning by Doing and Discovery)

Name of the Experiement : Dive into Ethereum – Clients and EVM

Objective/Aim:

Understand how Ethereum works by exploring different Ethereum clients (Geth, Nethermind, Erigon) and interacting with the Ethereum Virtual Machine (EVM).

Perform basic testnet operations using an Ethereum client and observe how transactions are processed inside the EVM.

Apparatus/Software Used:

a. MetaMask Wallet
b. Brave Web Browser
c. Geth (Go-Ethereum) Client
d. Ethereum Sepolia Testnet
e. Terminal / Command Prompt

Theory/Concept:

Ethereum Clients

Ethereum clients are software programs that implement the Ethereum protocol. They allow users to interact with the blockchain by:

- Synchronizing blockchain data
- Validating blocks and transactions
- Executing smart contracts
- Broadcasting transactions

Common clients include:

- Geth (Go-Ethereum) – Most widely used
- Nethermind – High-performance .NET client
- Erigon – Optimized for fast sync

Ethereum Virtual Machine (EVM)

The EVM is the computation engine of Ethereum. It:

- Executes smart contract bytecode
- Maintains state (balances, storage, contract code)
- Processes opcodes (ADD, PUSH, CALL, etc.)
- Ensures every node executes transactions deterministically

Procedure:

1. Install & Run Geth Client

1. Download Geth from the official Go-Ethereum website.
2. Open Terminal / CMD.
3. Start Geth in light sync mode:
4. geth --sepolia --syncmode light

2. Connect MetaMask to Local Geth Node

1. Open MetaMask.
2. Add a new network:
    - RPC URL: http://127.0.0.1:8545
    - Chain ID: Sepolia (11155111)
3. Save network.

3. Check Client Sync & Logs

1. In the terminal, observe:
    - New blocks syncing
    - Peer connections
    - Transaction pool activity

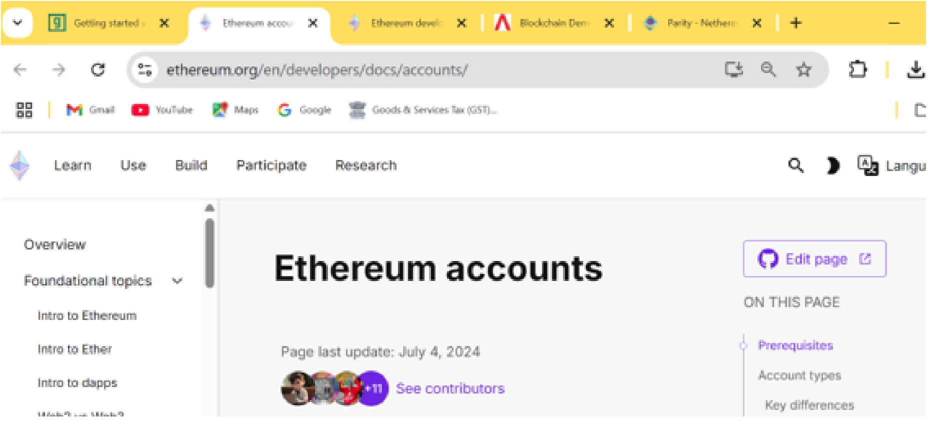
4. Interact with EVM Using Geth Console

1. Open an interactive console:
2. geth attach http://127.0.0.1:8545
3. Query block details:
4. eth.getBlock("latest")
5. Check your MetaMask address balance:
6. eth.getBalance("0xYourAddress")
7. Send a simple testnet transaction (from MetaMask).

5. Observe How EVM Executes the Transaction

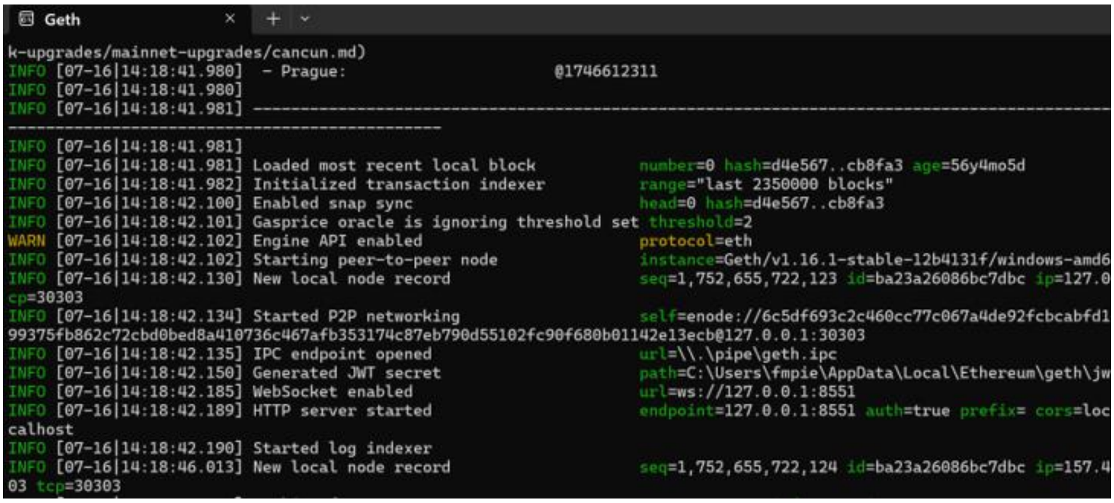
1. View the transaction hash on Sepolia Etherscan.
2. Check:
    - Gas used
    - Status
    - Input data
3. In Geth console run:
4. eth.getTransaction("0xYourTxHash")
5. eth.getTransactionReceipt("0xYourTxHash")
6. Note how the EVM processed the bytecode.

Geth Installation Process :

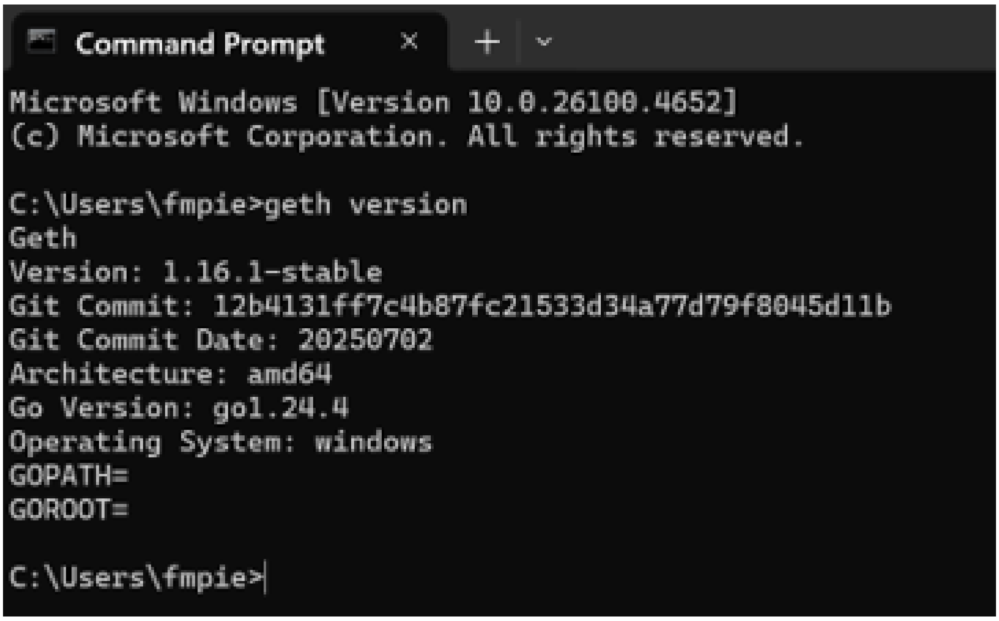


Ethereum accounts

Page last update: July 4, 2024



```
k-upgrades/mainnet-upgrades/cancun.md)
INFO [07-16|14:18:41.980]  - Prague:                      @1746612311
INFO [07-16|14:18:41.980]
INFO [07-16|14:18:41.981] ------------------------------------------------------------------------------------------
----------------------------------------------
INFO [07-16|14:18:41.981]
INFO [07-16|14:18:41.981] Loaded most recent local block           number=0 hash=d4e567..cb8fa3 age=56y4mo5d
INFO [07-16|14:18:41.982] Initialized transaction indexer          range="last 2350000 blocks"
INFO [07-16|14:18:42.100] Enabled snap sync                        head=0 hash=d4e567..cb8fa3
INFO [07-16|14:18:42.101] Gasprice oracle is ignoring threshold set threshold=2
WARN [07-16|14:18:42.102] Engine API enabled                       protocol=eth
INFO [07-16|14:18:42.102] Starting peer-to-peer node               instance=Geth/v1.16.1-stable-12b4131f/windows-amd6
INFO [07-16|14:18:42.130] New local node record                    seq=1,752,655,722,123 id=ba23a26086bc7dbc ip=127.0
cp=30303
INFO [07-16|14:18:42.134] Started P2P networking                   self=enode://6c5df693c2c460cc77c067a4de92fcbcabfd1
99375fb862c72cbd0bed8a410736c467afb353174c87eb790d55102fc90f680b01142e13ecb@127.0.0.1:30303
INFO [07-16|14:18:42.135] IPC endpoint opened                      url=\\.\pipe\geth.ipc
INFO [07-16|14:18:42.150] Generated JWT secret                     path=C:\Users\fmpie\AppData\Local\Ethereum\geth\jw
INFO [07-16|14:18:42.185] WebSocket enabled                        url=ws://127.0.0.1:8551
INFO [07-16|14:18:42.189] HTTP server started                      endpoint=127.0.0.1:8551 auth=true prefix= cors=loc
calhost
INFO [07-16|14:18:42.190] Started log indexer
INFO [07-16|14:18:46.013] New local node record                    seq=1,752,655,722,124 id=ba23a26086bc7dbc ip=157.4
03 tcp=30303
```



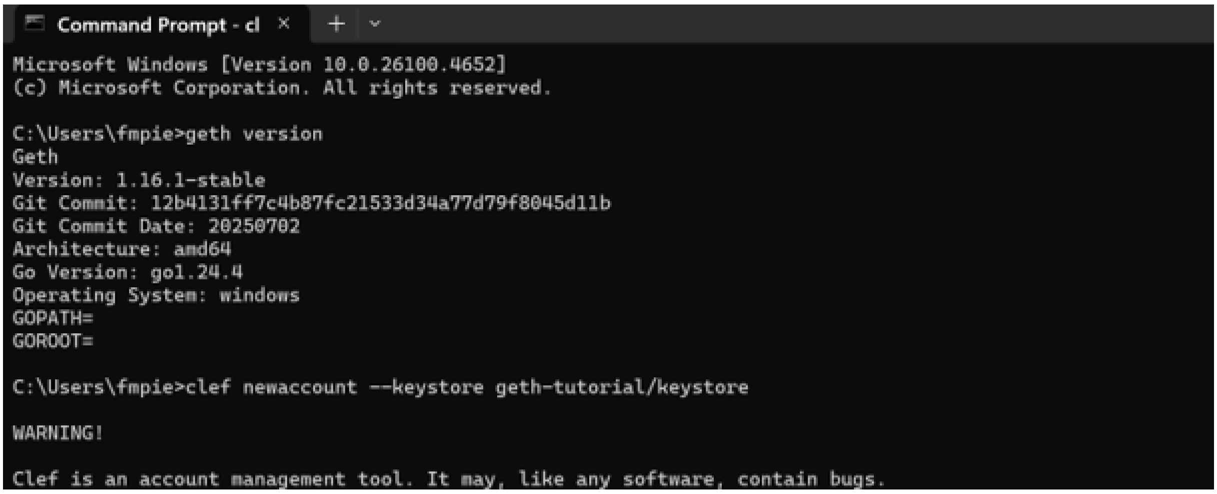
```
Microsoft Windows [Version 10.0.26100.4652]
(c) Microsoft Corporation. All rights reserved.

C:\Users\fmpie>geth version
Geth
Version: 1.16.1-stable
Git Commit: 12b4131ff7c4b87fc21533d34a77d79f8045d11b
Git Commit Date: 20250702
Architecture: amd64
Go Version: go1.24.4
Operating System: windows
GOPATH=
GOROOT=

C:\Users\fmpie>
```

Step 1: Generating accounts:

clef newaccount --keystore geth-tutorial/keystore



```
Microsoft Windows [Version 10.0.26100.4652]
(c) Microsoft Corporation. All rights reserved.

C:\Users\fmpie>geth version
Geth
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Go Version: go1.24.4
Operating System: windows
GOPATH=
GOROOT=

C:\Users\fmpie>clef newaccount --keystore geth-tutorial/keystore

WARNING!

Clef is an account management tool. It may, like any software, contain bugs.
```
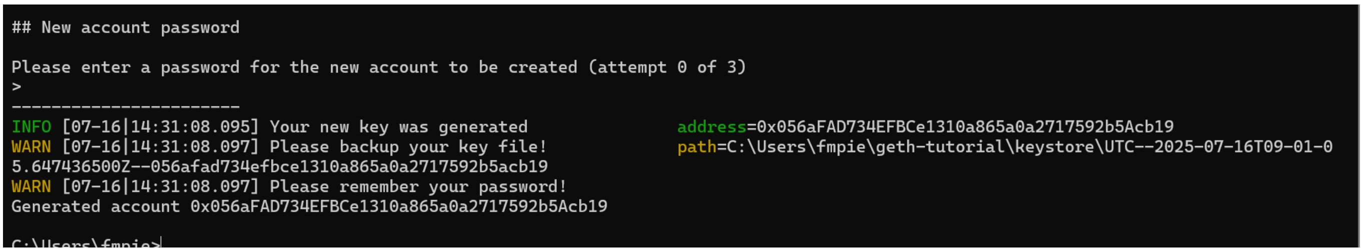
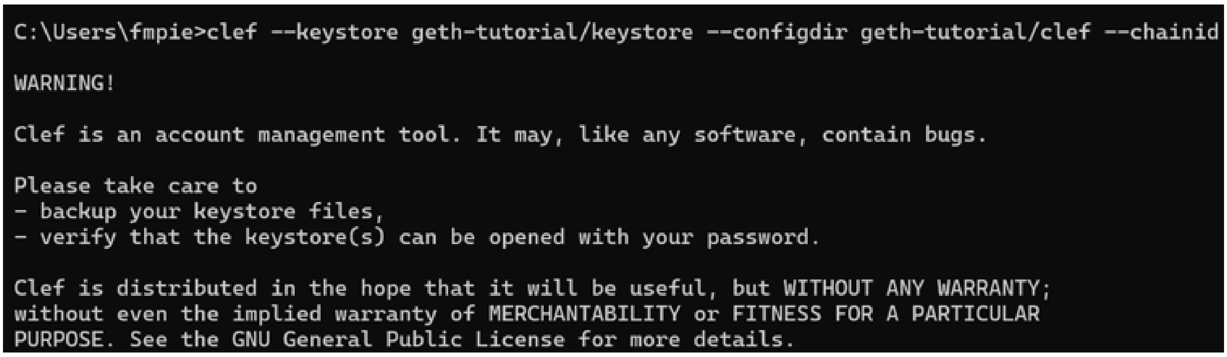



```
## New account password

Please enter a password for the new account to be created (attempt 0 of 3)
>
-----------------------
INFO [07-16|14:31:08.095] Your new key was generated               address=0x056aFAD734EFBCe1310a865a0a2717592b5Acb19
WARN [07-16|14:31:08.097] Please backup your key file!             path=C:\Users\fmpie\geth-tutorial\keystore\UTC--2025-07-16T09-01-0
5.6474365007Z--056afad734efbce1310a865a0a2717592b5acb19
WARN [07-16|14:31:08.097] Please remember your password!
Generated account 0x056aFAD734EFBCe1310a865a0a2717592b5Acb19

C:\Users\fmpie>
```

Step 2: Start Clef:

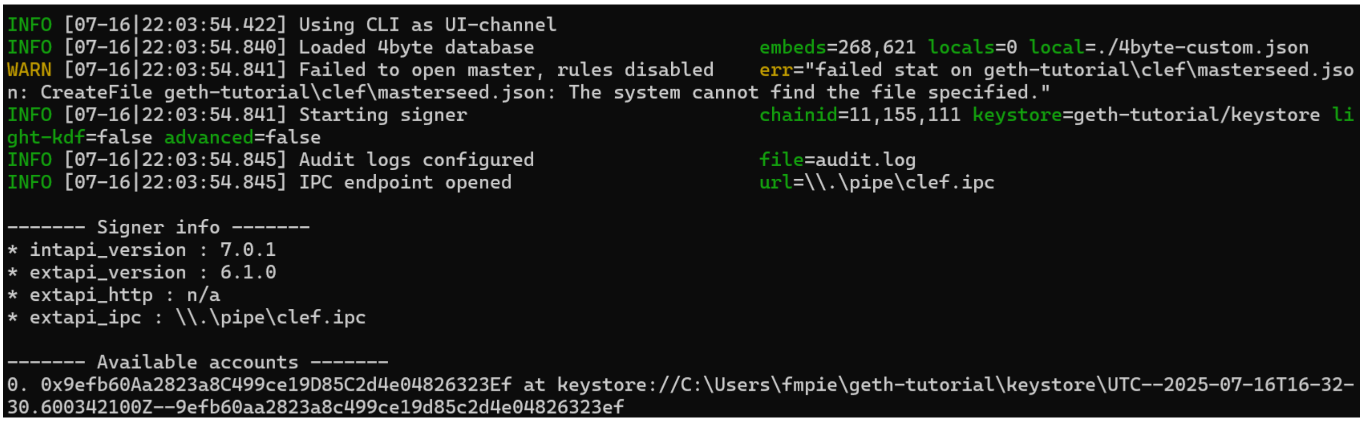
clef --keystore geth-tutorial/keystore --configdir geth-tutorial/clef --chainid 11155111



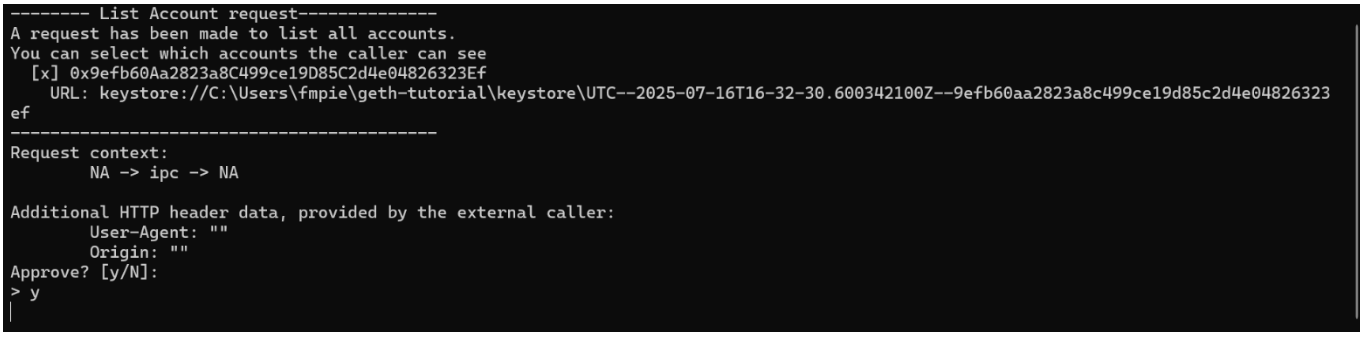
```
C:\Users\fmpie>clef --keystore geth-tutorial/keystore --configdir geth-tutorial/clef --chainid

WARNING!

Clef is an account management tool. It may, like any software, contain bugs.

Please take care to
- backup your keystore files,
- verify that the keystore(s) can be opened with your password.

Clef is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY;
without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR
PURPOSE. See the GNU General Public License for more details.
```

Step 3: Start Geth:

geth --sepolia --datadir geth-tutorial --authrpc.addr localhost --authrpc.port 8551 --authrpc.vhosts localhost --authrpc.jwtsecret geth-tutorial/jwtsecret --http --http.api eth,net --signer=geth-tutorial/clef/clef.ipc --http



```
INFO [07-16|22:03:54.422] Using CLI as UI-channel
INFO [07-16|22:03:54.840] Loaded 4byte database                    embeds=268,621 locals=0 local=./4byte-custom.json
WARN [07-16|22:03:54.841] Failed to open master, rules disabled    err="failed stat on geth-tutorial\clef\masterseed.jso
n: CreateFile geth-tutorial\clef\masterseed.json: The system cannot find the file specified."
INFO [07-16|22:03:54.841] Starting signer                          chainid=11,155,111 keystore=geth-tutorial/keystore li
ght-kdf=false advanced=false
INFO [07-16|22:03:54.845] Audit logs configured                    file=audit.log
INFO [07-16|22:03:54.845] IPC endpoint opened                      url=\\.\pipe\clef.ipc

------- Signer info -------
* intapi_version : 7.0.1
* extapi_version : 6.1.0
* extapi_http : n/a
* extapi_ipc : \\.\pipe\clef.ipc

------- Available accounts -------
0. 0x9efb60Aa2823a8C499ce19D85C2d4e04826323Ef at keystore://C:\Users\fmpie\geth-tutorial\keystore\UTC--2025-07-16T16-32-
30.600342100Z--9efb60aa2823a8c499ce19d85c2d4e04826323ef
```



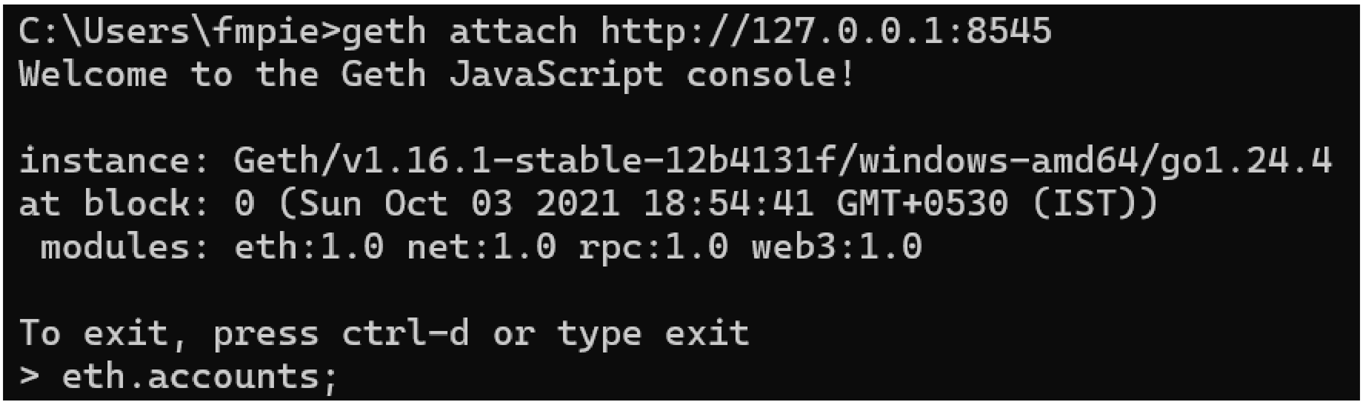
```
-------- List Account request--------------
A request has been made to list all accounts.
You can select which accounts the caller can see
  [x] 0x9efb60Aa2823a8C499ce19D85C2d4e04826323Ef
    URL: keystore://C:\Users\fmpie\geth-tutorial\keystore\UTC--2025-07-16T16-32-30.600342100Z--9efb60aa2823a8c499ce19d85c2d4e04826323
ef
-------------------------------------------
Request context:
        NA -> ipc -> NA

Additional HTTP header data, provided by the external caller:
        User-Agent: ""
        Origin: ""
Approve? [y/N]:
> y
```

Step 4: Interact with Geth:

geth attach http://127.0.0.1:8545

List of accounts:

eth.accounts;



```
C:\Users\fmpie>geth attach http://127.0.0.1:8545
Welcome to the Geth JavaScript console!

instance: Geth/v1.16.1-stable-12b4131f/windows-amd64/go1.24.4
at block: 0 (Sun Oct 03 2021 18:54:41 GMT+0530 (IST))
 modules: eth:1.0 net:1.0 rpc:1.0 web3:1.0

To exit, press ctrl-d or type exit
> eth.accounts;
```

Observation

Observation No.	Description
1	Geth successfully connected to the Sepolia network and synchronized recent blocks.
2	MetaMask interacted with the local Ethereum client without issues using the custom RPC.
3	The EVM executed the transaction deterministically and gas usage, sender/receiver details, and execution data were visible via Geth.

ASSESSMENT

Rubrics	Full Mark	Marks Obtained	Remarks
Concept	10		
Planning and Execution/ Practical Simulation/ Programming	10		
Result and Interpretation	10		
Record of Applied and Action Learning	10		
Viva	10		
Total	**50**		

Signature of the Student:

Signature of the Faculty:

Name :
Regn. No.