

**D Y PATIL COLLEGE OF ENGINEERING, AKURDI**

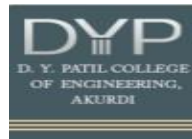
**LP-VI LABROTARY**

**SUBJECT CODE: 314458**

**FOURTH YEAR**

**SEMESTER - VIII**

**LAB MANUAL**



**DEPARTMENT OF INFORMATION TECHNOLOGY**

---

**SAVITRIBAI PHULE UNIVERSITY, PUNE**

---

### Vision of Institute:

Empowerment through Knowledge.

### Mission of Institute:

To educate the students to transform them as professionally competent and quality conscious engineers by providing conducive environment for teaching, learning, and overall personality development, culminating the institute into an international seat of excellence.

### Vision of Department

Developing globally competent IT professional for sustainable growth of humanity.

### Mission of Department

- M1** Build a strong foundation and techniques for problem-solving and inculcate communication skills as an integral component of Information Technology
- M2** Develop competency skills in the faculty members and students to serve the societal challenges and needs in lieu of its multidisciplinary applications in the field of Information Technology
- M3** Encourage development of strong technical skills and knowledge and to encourage students to undergo research in the field of Information Technology
- M4** Nurture students to become ethical and committed lifelong IT professionals
- M5** Empower students with strong decision-making skills and technical competency to accomplish start-up ideas in the field of IT Engineering

### The Program Educational Objectives (PEOs):

The Program Educational Objectives (PEOs) are as follows:

1. **Core Competency:** To provide graduates with a solid foundation in Mathematics, Science, Engineering fundamentals required to solve complex Software Engineering Problem.
2. **Breadth:** To impart the knowledge and skills in the field of Information Technology; and to comprehend, analyze, design and create novel products and solutions for the real-time and Complex Engineering problems of any domain with innovative approaches.
3. **Professionalism:** To inculcate in graduates, professional and ethical values, effective communication skills, teamwork, multidisciplinary approach, and ability to relate engineering issues in broader social context.
4. **Learning Environment:** To provide graduates with an academic environment that makes them aware of excellence in leadership, presentation, time management and ethics leading them to become Responsible and competent professionals prepared to address challenges in the field of IT at global level.
5. **Attainment:** To empower graduates with an attitude and skills of Research, Entrepreneur and Higher education in the field of Information Technology.

## Program Specific Outcomes

As a successful Graduate of Information Technology students will

1. Apply design methodologies ,application development tools, engineering skills in software Engineering Domains and IT Application Areas like cloud computing, Big Data, Software Testing, Mobile Application Development.
2. Aspire to Pursue Higher Education in the Specialization fields of IT engineering and management programs like Data Science, Cyber Security.
3. Formulate their decision making skills, IT Engineering skills and knowledge to implement their own startup ideas as an entrepreneur in fields like Cyber Security, Mobile Application Development.
4. Devise to design, implement and evaluate IT based software systems to serve the needs of society or IT industries.

## Program outcomes

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods Including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- 6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- 7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- 8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- 9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- 11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- 12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

<p align="center"><b>Savitribai Phule Pune University, Pune</b>  <b>Final Year Information Technology (2019 Course)</b>  <b>414455: Lab Practice VI (Blockchain Technology)</b></p>		
<b>Teaching Scheme:</b>	<b>Credit Scheme:</b>	<b>Examination Scheme:</b>
<b>Practical (PR): 02 hrs/week</b>	<b>01 credit</b>	<b>OR: 50 Marks</b> <b>TW: 25 Marks</b>
<b>Prerequisites:</b> Programming skills: javascript, react.js		
<b>Course Objectives:</b> 1. To acquaint students with the basic skills required for adopting to crypto currency & block chain 2. To acquire knowledge about consensus algorithms and its working.		
<b>Course Outcomes:</b> On completion of the course, students will be able to– 1.To implement small blockchain experimentations. 2. Identify Consensus mechanism for Blockchain Application.		
<b>Guidelines for Instructor's Manual</b>		
The instructor's manual is to be developed as hands - on resource and reference. The instructor's manual need to include prologue (about university/program/ institute/ department/foreword/ preface etc), University syllabus, conduction & Assessment guidelines, topics under consideration - concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.		
<b>Guidelines for Student's Lab Journal</b>		
The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment.		
<b>Guidelines for Lab /TW Assessment</b>		
Faculty member should frame Practical Assignments based on given list of assignments. Students will submit term work in the form of journal containing handwritten write-ups/ source code and output. Staff incharge should maintain a record of continuous assessment and produced at the time of examination		
<b>Guidelines for Laboratory Conduction</b>		
The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. Use of open-source software is to be encouraged. All the assignments should be conducted on Latest version of open-Source Operating Systems, tools and Multi-core CPU supporting Virtualization and Multi-Threading.		
<b>Guidelines for Practical Examination</b>		
Both internal and external examiners should jointly set problem statements. During practical assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation of the problem statement.		
<b>List of Laboratory Assignments</b>		
1. <b>Assignment No.1</b> To setup a crypto wallet a) i) hosted wallets ii) self-custody wallet iii) hardware wallets (optional) and evaluate each of these.		

- b) Understand the basic operations in the wallet on bitcoin such as 1) buy 2) sell 3) send 4) receive 5) exchange 6) mining.

**2. Assignment No.2**

- 1) Create a local Ethereum network using Hardhat or any other tool, build a smart contract that lets you send a 🌊 (wave) to your contract and keep track of the total # of waves. Compile it to run locally.
- 2) Connect to any Ethereum wallet eg. Metamask. Deploy the contract with testnet. Connect wallet with your webapp. Call the deployed contract through your web app. Then store the wave messages from users in arrays using structs

**3. Assignment no.3**

Prepare your build system and Building Bitcoin Core.

- a. Write Hello World smart contract in a higher programming language (Solidity).
- b. Solidity example using arrays and functions

**4. Assignment no.4**

Deploy a simple contract to the Ethereum blockchain.

**5. Assignment no.5**

Polling / voting system using Solidity, Ethereum and a data structure hashmap(optional)

**Online References**

- <https://buildspace.so/p/build-solidity-web3-app/lessons/welcome>
- <https://www.theinsaneapp.com/2022/05/best-web3-projects.html>
- <https://www.coinbase.com/learn/tips-and-tutorials/how-to-set-up-a-crypto-wallet>

## Assignment No: 01-a

**Title:** Crypto wallet

**Objective:**

- To study about crypto wallets.
- To setup a wallet on the browser.

**Problem Statement:**

To setup a crypto wallet

i) hosted wallets ii) self-custody wallet iii) hardware wallets (optional) and evaluate each of these

**Theory / Procedure / Diagrams:**

A cryptocurrency wallet refers to a physical medium, device, service, or application that maintains private and/or public passwords for crypto transactions. In addition to the basic purpose of storing keys, it also makes the owner of the digital pseudonymous.

A crypto wallet is used to interact with a blockchain network. The three major types of crypto wallets are hardware, software, and paper wallets. Based on their work, they can be further classified as cold or hot wallets. Software-based wallets are more accessible and more convenient, whereas hardware ones are the most secure. Paper wallets are printed out on paper and are now unreliable and obsolete. Crypto wallets don't store the currency but act as a tool of interaction with blockchain, i.e., generating the necessary information to receive and send money via blockchain transactions.

The information comprises pairs of private and public keys. Based on these keys, an alphanumeric identifier called address is generated. In essence, this address specifies the location to which coins can be sent to the blockchain. The address can be shared to receive funds, but private keys are to be never disclosed. The private key can be used on any wallet for accessing the cryptocurrency. If the private key is known, funds are accessible on any device. Also, coins are just transferred from one address to another, never leaving the blockchain.

**1. Hosted Wallet:**

A Hosted wallet is an online service where a user's bitcoins are stored, and they can send and receive bitcoins from this service. Coinbase, Bit flyer, and Mt Gox are examples of hosted wallets. A hosted crypto wallet is a digital wallet in which your private keys are stored. In exchange, the wallet takes care of the backup and security of your funds. a hosted wallet as "an

account-based software program for storing cryptographic keys controlled by an identifiable third party. These parties receive, store, and transmit cryptocurrency transactions on behalf of their accountholders; the accountholder generally does not have access to the cryptographic keys themselves. “In comparison to other crypto wallets, a hosted wallet is more similar to regular banking apps — you can always regain access to your assets, even if you have forgotten your password, mnemonic phrase or lost your phone. Other types of wallets do not provide this possibility. In the event that you lose access to your credentials or a device on which the wallet is installed, you will lose your funds.

## **2.Self Custody Wallet:**

Self-custodial crypto wallets provide you with direct access to public blockchains. The best wallets, like the Bitcoin.com Wallet, allow you customize the fees you pay to public blockchain miners and validators. This means, for example, that you can choose to pay less for transactions when you're not in a hurry (or more if you're in a rush!). Finally, because self-custodial wallets provide direct access to blockchains, they also enable you to interact with smart contracts. That means, for example, you can access decentralized finance products that enable you to earn passive income.

## **3.Hardware Wallets:**

A hardware wallet is a special type of bitcoin wallet which stores the user's private keys in a secure hardware device.

They have major advantages over standard software wallets:

Private keys are often stored in a protected area of a microcontroller, and cannot be transferred out of the device in plaintext immune to computer viruses that steal from software wallets can be used securely and interactively, private keys never need to touch potentially-vulnerable software much of the time, the software is open source, allowing a user to validate the entire operation of the device hardware wallet could fail to protect your Bitcoin:

1. Malware swaps recipient Bitcoin addresses: a hardware wallet won't protect you from being tricked into sending Bitcoin to the wrong address. For example, malware on a PC could monitor for high value transactions and then swap out the recipient's authentic Bitcoin address for an address controlled by the attacker. When the stakes are high, multi factor (e.g., over the phone) confirmation of a recipient's Bitcoin address is recommended.

2. Insecure RNG (Random Number Generator): hardware wallets rely on the security of an RNG, often embedded in hardware, to generate your wallet's private keys securely.

Unfortunately, it is notoriously difficult to verify the true randomness of the RNG. An insecure



RNG may create wallet keys that can later be recreated by an attacker, by generating psuedo-randomness that would seem statistically indistinguishable from true randomness yet still be predictable to an advanced attacker. An RNG may become insecure as a result of malicious weakening or an unintentional mistake. This failure mode is common to any wallet generation procedure in which the true randomness of the source of entropy being used can not be verified.

3. Imperfect implementation: the security of all computing devices relies on the quality of their implementation. Hardware wallets are no exception. Bugs at the software, firmware or hardware level may allow attackers to break into a hardware wallet and gain unauthorized access to secrets. Even if the design is perfect, proving the security of a hardware or software implementation is a very hard, mostly unsolved problem. To date, no wallet in existence is implemented using provably correct software.

Set up a wallet-Metamask:

Metamask is an self hosted wallet. MetaMask is a decentralized wallet with vast features and Web3 applications that make it a central hub for NFT and Web3 enthusiasts who desire to build decentralized applications on the Ethereum blockchain.

How to use MetaMask: A step by step guide

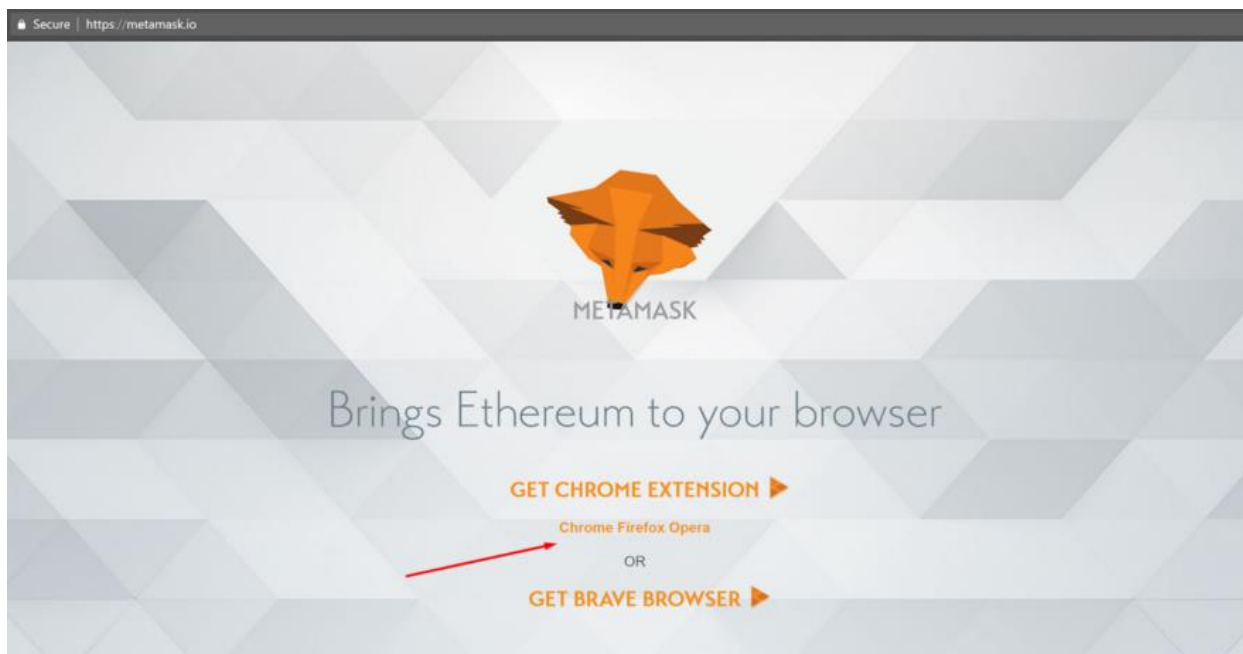
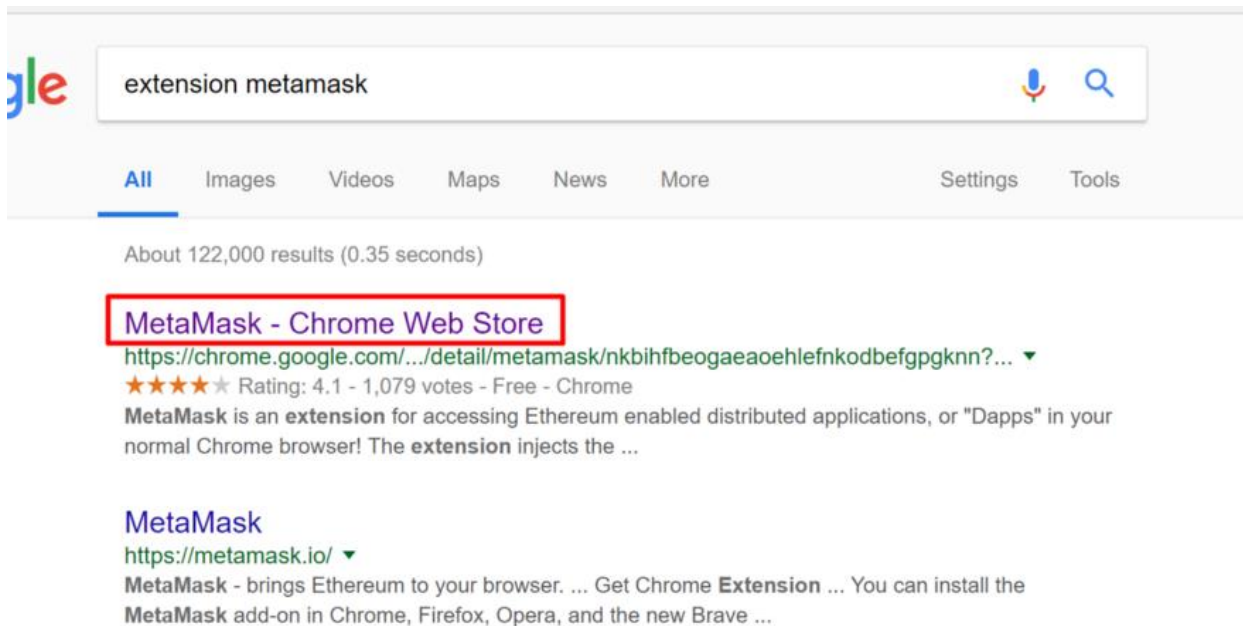
MetaMask is one of the most popular browser extensions that serves as a way of storing your Ethereum and other ERC-20 Tokens. The extension is free and secure, allowing web applications to read and interact with Ethereum's blockchain.



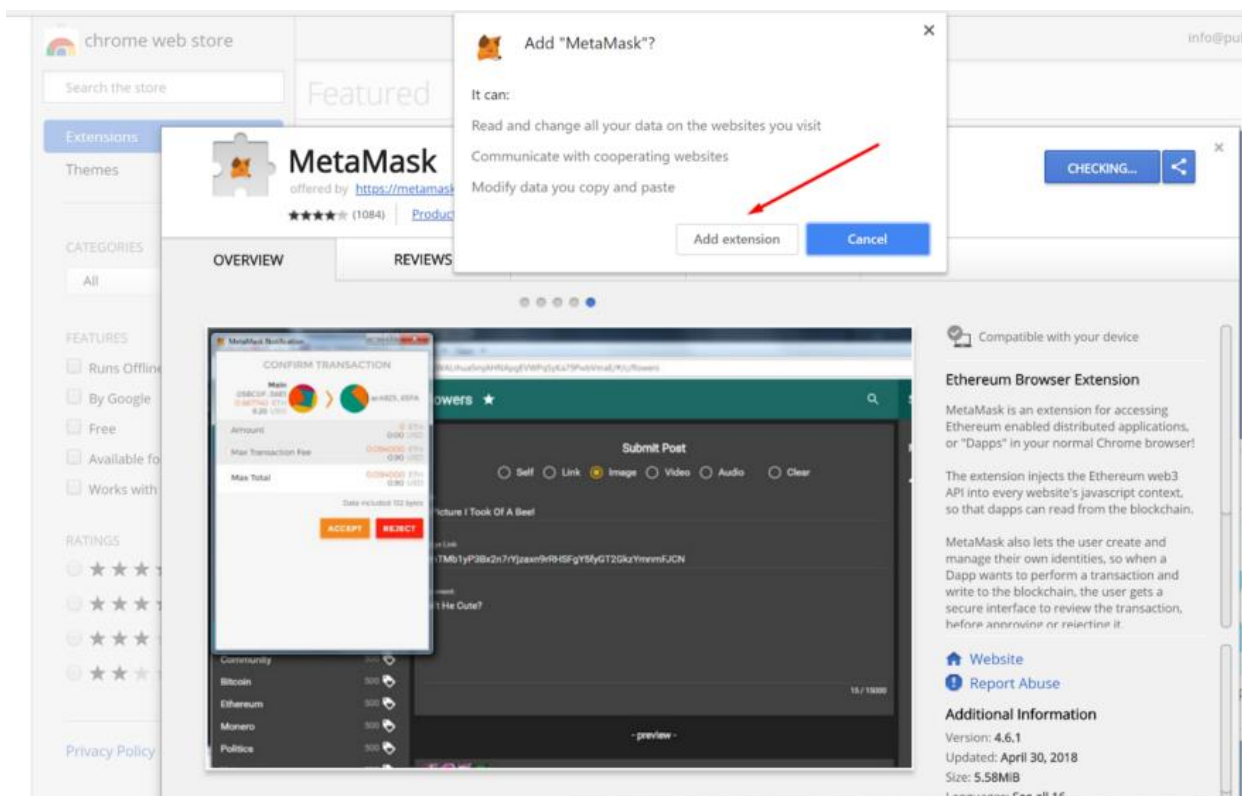
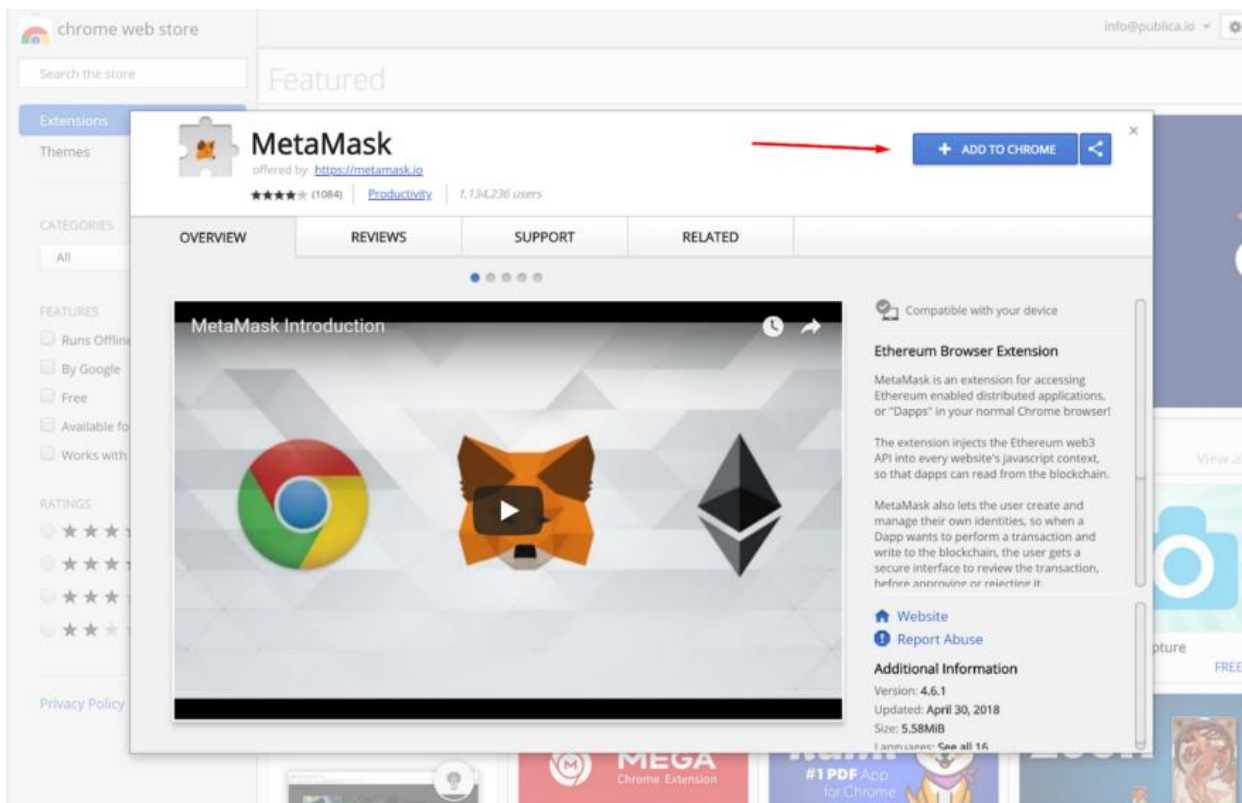
Step 1. Install MetaMask on your browser.

To create a new wallet, you have to install the extension first. Depending on your browser, there are different marketplaces to find it. Most browsers have MetaMask on their stores, so it's not that hard to see it, but either way, here they are [Chrome](#), [Firefox](#), and [Opera](#).

In this tutorial, I will be using Google Chrome as an example but the same steps apply to different browsers as well. If, for some reason, the links above don't work for you, just search MetaMask Extension on your favorite search engine, and you can find it there.



- Click on Install MetaMask as a Google Chrome extension.
- Click Add to Chrome.
- Click Add Extension.



And it's as easy as that to install the extension on your browser, continue reading the next step to figure out how to create an account.

Step 2. Create an account.

- Click on the extension icon in the upper right corner to open MetaMask.
- To install the latest version and be up to date, click Try it now.

- Click Continue.
- You will be prompted to create a new password. Click Create.

MetaMask | chrome-extension://nkbihfbeogaeaoehlefnkodbefgpgknn/home.html#initialize/create-password

## Create Password

New Password (min 8 chars)

Confirm Password

CREATE

Import with seed phrase



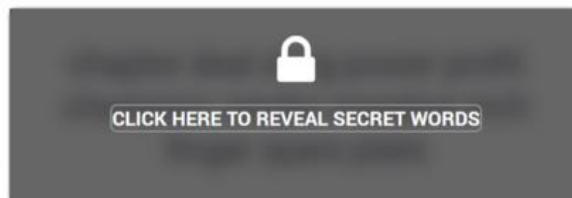
- Proceed by clicking Next and accept the Terms of Use.
- Click Reveal Secret Words. There you will see a 12 words seed phrase. This is really important and usually not a good idea to store digitally, so take your time and write it down.



## Secret Backup Phrase

Your secret backup phrase makes it easy to back up and restore your account.

**WARNING:** Never disclose your backup phrase. Anyone with this phrase can take your Ether forever.





## Secret Backup Phrase

Your secret backup phrase makes it easy to back up and restore your account.

**WARNING:** Never disclose your backup phrase. Anyone with this phrase can take your Ether forever.

wool thought awful better jar  
music slush give mechanic ginger  
faculty portion

NEXT



- Verify your secret phrase by selecting the previously generated phrase in order. Click Confirm.

And that's it; now you have created your MetaMask account successfully. A new Ethereum wallet address has just been created for you. It's waiting for you to deposit funds, and if you want to learn how to do that, look at the next step below.

### Conclusion:

Thus we studied the different types of wallets and setup a wallet on our browser.

## Assignment No: 01 -b

**Title:** Operations in a crypto wallet.

**Objective:**

To learn operations in a wallet

**Problem Statement:**

Understand the basic operations in the wallet on bitcoin such as 1) buy 2) sell 3) send 4) receive 5) exchange 6) mining.

**Theory / Procedure / Diagrams / Circuits:**

Bitcoin (BTC) is a cryptocurrency, a virtual currency designed to act as money and a form of payment outside the control of any one person, group, or entity, thus removing the need for third-party involvement in financial transactions. It is rewarded to blockchain miners for the work done to verify transactions and can be purchased on several exchanges. Bitcoin uses blockchain technology to support peer-to-peer transactions between users on a decentralized network.

Transactions are authenticated through Bitcoin's proof-of-work consensus mechanism, which rewards cryptocurrency miners for validating transactions.

How does Bitcoin work?

Each Bitcoin is a digital asset that can be stored at a cryptocurrency exchange or in a digital wallet. Each individual coin represents the value of Bitcoin's current price, but you can also own partial shares of each coin. The smallest denomination of each Bitcoin is called a Satoshi, sharing its name with Bitcoin's creator. Each Satoshi is equivalent to a hundred millionth of one Bitcoin, so owning fractional shares of Bitcoin is quite common.

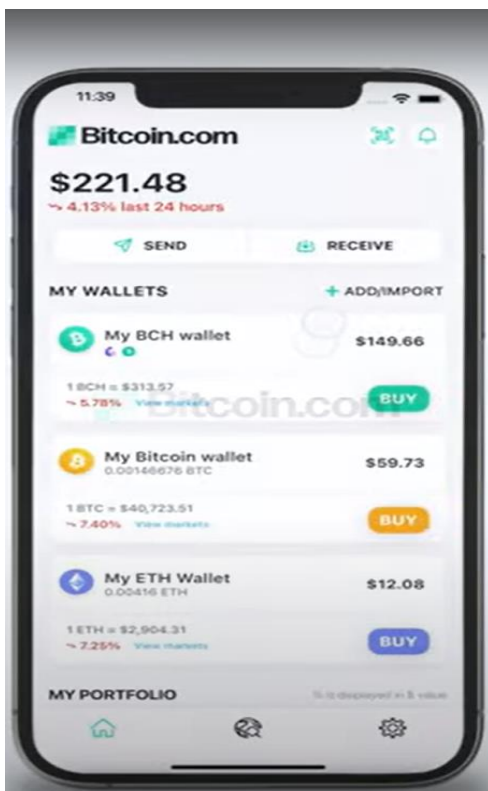
- **Blockchain:** Bitcoin is powered by open-source code known as blockchain, which creates a shared public history of transactions organized into "blocks" that are "chained" together to prevent tampering. This technology creates a permanent record of each transaction, and it provides a way for every Bitcoin user to operate with the same understanding of who owns what.
- **Private and public keys:** A Bitcoin wallet contains a public key and a private key, which work together to allow the owner to initiate and digitally sign transactions. This unlocks the central function of Bitcoin — securely transferring ownership from one user to another.
- **Bitcoin mining:** Users on the Bitcoin network verify transactions through a process known as mining, which is designed to confirm that new transactions are consistent with other

transactions that have been completed in the past. This ensures that you can't spend a Bitcoin you don't have, or that you have previously spent.

## Basic Operations in the wallet on bitcoin using bitcoin wallet:

### Receiving Bitcoin

1. Open your Bitcoin.com wallet app and tap the 'Receive' button at the top of the Home screen.
2. Choose which wallet you want to receive Bitcoin to. Make sure you select a (BCH) wallet if you are receiving Bitcoin Cash or a (BTC) wallet if you are receiving Bitcoin.
3. Your chosen wallet will generate an address that lets you receive coins. Copy this by tapping the QR code.
4. Provide this address to the sending party, or if you're in person, the sender can simply scan your wallet QR code with their device.



### Sending Bitcoin

1. Open your Bitcoin.com wallet app and tap the 'Send' button at the top of the Home screen.
2. Copy and paste the recipient's wallet address into your own wallet app. If you're in person, select "Scan QR code" and simply scan it with your app.

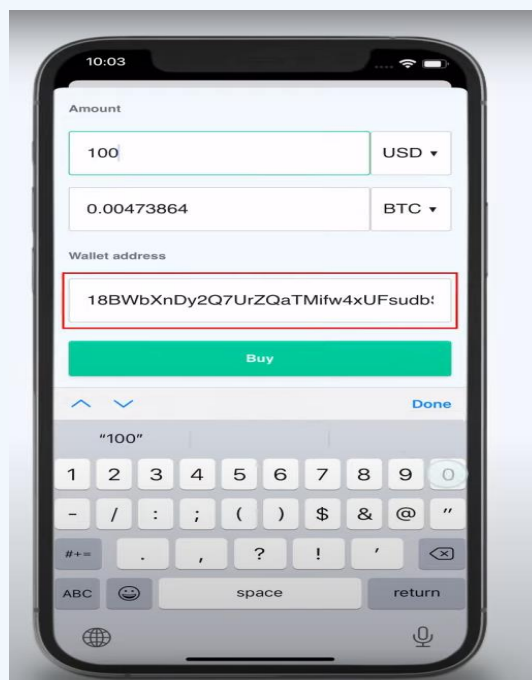


3. Choose which wallet you want to send Bitcoin from. Make sure you select a BCH wallet if you want to send Bitcoin Cash or a BTC wallet if you want to send Bitcoin.
4. Enter how much you want to send and tap on 'Continue'.

### iii. Buying a bitcoin

Crypto wallets allow you to buy bitcoin conveniently from within the wallet app, and the **Bitcoin.com Wallet** is no exception. Importantly, the **Bitcoin.com Wallet** is fully non-custodial. This means you're always in complete control of your bitcoin. Here's the process for buying bitcoin using our app:

1. Open the **Bitcoin.com Wallet** app on your device.
2. Select Bitcoin (BTC) and tap the "Buy" button. Note: you can also buy other digital assets.
3. Follow the on-screen instructions to choose your preferred wallet for depositing. The **Bitcoin.com Wallet** actually consists of separate wallets for each digital asset we support (eg. BTC, BCH, etc.). Additionally, you can make as many individual wallets as you want, a feature that can help you to organize your funds. For example, you can make one Bitcoin wallet called *My BTC Savings* and another Bitcoin wallet called *Everyday BTC Spending*.
4. If it's your first purchase, you may be asked to verify your identity. Future purchases are completed in seconds!.Once complete, your purchase will proceed.



### iv. selling a bitcoin

With this method, you can sell any amount of bitcoin (BTC) in your digital wallet directly to cash, which will then be deposited in your bank account. Here's how it works:

1. On the app's home screen, tap the "SELL" button.
2. If you haven't done so already, follow the instructions to connect your bank account.
3. Select the amount you'd like to sell. You can input the amount in either local currency terms or bitcoin terms.
4. Confirm the transaction.

#### **v. exchanging a bitcoin:**

Bitcoin exchange platforms match buyers with sellers. Like a traditional stock exchange, traders can opt to buy and sell bitcoin by inputting either a market order or a limit order. When a market order is selected, the trader is authorizing the exchange to trade the coins for the best available price in the online marketplace. With a limit order set, the trader directs the exchange to trade coins for a price below the current ask or above the current bid, depending on whether they are buying or selling.

To transact in bitcoin on an exchange, a user has to register with the exchange and go through a series of verification processes to authenticate their identity. Once the authentication is successful, an account is opened for the user who then has to transfer funds into this account before they can buy coins.

#### **vi. mining a bitcoin:**

Bitcoin mining is the process by which new bitcoins are entered into circulation. It is also the way the network confirms new transactions and is a critical component of the blockchain ledger's maintenance and development. "Mining" is performed using sophisticated hardware that solves an extremely complex computational math problem. The first computer to find the solution to the problem receives the next block of bitcoins and the process begins again.

Cryptocurrency mining is painstaking, costly, and only sporadically rewarding. Nonetheless, mining has a magnetic appeal for many investors who are interested in cryptocurrency because of the fact that miners receive rewards for their work with crypto tokens. This may be because entrepreneurial types see mining as pennies from heaven, like California gold prospectors in 1849. And if you are technologically inclined, why not do it?

The bitcoin reward that miners receive is an incentive that motivates people to assist in the primary purpose of mining: to legitimize and monitor Bitcoin transactions, ensuring their validity. Because many users all over the world share these responsibilities, Bitcoin is a "decentralized" cryptocurrency, or one that does not rely on any central authority like a central bank or government to oversee its regulation.

**Input:** (Test Cases / Data sets / Database Links)

**Output:** (Results / Visualization)

Expected sample Output

**Conclusion:**

Thus, we studied the basic operations of bitcoin wallet.

## Assignment No: 02-a

**Title:** Build and deploy a smart contract using hardhat.

### Objective:

- Deploying a smart contract locally .
- To deploy a contract using test net and connect it to wallet

### Problem Statement:

1) Create a local Ethereum network using Hardhat or any other tool, build a smart contract that lets you send a 🌊 (wave) to your contract and keep track of the total # of waves. Compile it to run locally.

### Requirements:

VS code, Nodejs

### Theory / Procedure / Diagrams / Circuits:

**Hardhat:** Hardhat is an Ethereum development environment for professionals. It facilitates performing frequent tasks, such as running tests, automatically checking code for mistakes or interacting with a smart contract. Hardhat Runner is the main component you interact with when using Hardhat. It's a flexible and extensible task runner that helps you manage and automate the recurring tasks inherent to developing smart contracts and dApps.

Hardhat Runner is designed around the concepts of **tasks** and **plugins**. Every time you're running Hardhat from the command-line, you're running a task. For example, `npx hardhat compile` runs the built-in compile task. Tasks can call other tasks, allowing complex workflows to be defined. Users and plugins can override existing tasks, making those workflows customizable and extendable.

Check out the plugin list to use it with your existing tools. Built by the Nomic Foundation for the Ethereum community. Hardhat is a flexible and diverse JavaScript-based framework for Ethereum blockchain developers. hardhat comes built-in with Hardhat Network, a local Ethereum network node designed for development. It allows you to deploy your contracts, run your tests and debug your code, all within the confines of your local machine. It runs as either an in-process or stand-alone daemon, servicing JSON-RPC and WebSocket requests. By default, it mines a block with each transaction that it receives, in order and with no delay.

It's backed by the @ethereumjs/vm EVM implementation, the same one used by ganache, Remix and Ethereum Studio.

### Procedure:

Creating a local Ethereum network and compiling it locally :

1. Install Node.js and npm (if you haven't already).
2. Install Hardhat  
To install it, you need to create an npm project by going to an empty folder, running npm init, and following its instructions. By running this command  
npm install --save-dev hardhat.
3. Initialize a new Hardhat project by running npx hardhat init.
4. Install the necessary dependencies for our project by running npm install ethers hardhat-deploy
5. Open the hardhat.config.js file and add the following lines of code to the networks section:

```
yaml
module.exports = {
  networks: {
    hardhat: {
      chainId: 1337
    }
  }
};
```

7. Create a new file called WavePortal.sol in the contracts directory and add the following code:

```
csharp
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.0;

contract WavePortal {
    uint256 public totalWaves;

    function wave() public {
        totalWaves += 1;
    }
}
```

This smart contract has a totalWaves variable that keeps track of the number of waves sent to the contract, and a wave function that increments this variable by 1 every time it's called.

7. Compile the smart contract by running npx hardhat compile.

8. Create a new file called `deploy.js` in the `scripts` directory and add the following code:

```
javascript Copy code

const { ethers } = require("hardhat");

async function main() {
  const WavePortal = await ethers.getContractFactory("WavePortal");
  const wavePortal = await WavePortal.deploy();

  console.log("WavePortal deployed to:", wavePortal.address);
}

main()
  .then(() => process.exit(0))
  .catch(error => {
    console.error(error);
    process.exit(1);
  });
```

This script deploys the WavePortal smart contract to the local network.

9. Deploy the smart contract by running `npx hardhat run scripts/deploy.js --network hardhat`.
10. Now we can interact with the contract using the Hardhat console. Run `npx hardhat console` to start the console, and then run the following commands to send a wave to the contract and check the current number of waves:

```
javascript Copy code

const WavePortal = await ethers.getContractFactory("WavePortal");
const wavePortal = await WavePortal.attach("CONTRACT_ADDRESS_HERE");
await wavePortal.wave();
console.log(await wavePortal.totalWaves());
```

**Input:** (Test Cases / Data sets / Database Links)

**Output:** (Results / Visualization)

Expected sample Output

**Conclusion:** Thus we studied the use of hardhat tool and to run the contract locally.

## Assignment No: 02-b

**Title:** Build and deploy a smart contract using hardhat on a web app.

### Objective:

- Deploying a smart contract locally.
- To deploy a contract using test net and connect it to wallet.

### Problem Statement:

Create a local Ethereum network using Hardhat or any other tool, build a smart contract that lets you send a 🌊 (wave) to your contract and keep track of the total # of waves. connect to any Ethereum wallet. Metamask. Deploy the contract with testnet. Connect your wallet with your web app. Call the deployed contract through your web app. Then store the wave messages from users in arrays using structs.

### Requirements:

VS code, NodeJS

### Theory / Procedure / Diagrams / Circuits:

#### Steps to follow to create an app web app to call the smart contract:

1. Create the smart contract: Write the smart contract code in Solidity programming language. You can use tools like Remix or Visual Studio Code with Solidity plugins to write, compile and debug your contract code.
2. Deploy the smart contract to a testnet: Deploy the smart contract to a testnet like Rinkeby, Ropsten or Kovan to test and validate its functionality. You can use a tool like Truffle or Remix to deploy your contract to a testnet.
3. Connect your wallet to your web app: In order to connect your wallet to your web app, you will need to use a Web3 provider like Metamask. Metamask is a browser extension that allows you to interact with the Ethereum network and your wallet from your web app. You can integrate Metamask by adding its script to your web app and calling its functions to interact with the Ethereum network.
4. Call the deployed contract through your web app: Once your wallet is connected to your web app, you can call the functions of the deployed contract using the Web3 provider. You will need

to use the contract address and ABI (Application Binary Interface) to interact with the contract functions.

Here's a high-level example of how you can connect your web app to a deployed smart contract on the Rinkeby testnet using Metamask:

1. Write the smart contract code in Solidity and compile it using Remix.
2. Deploy the smart contract to the Rinkeby testnet using Truffle.
3. Create a new web app and integrate the Metamask script by adding the following code to your HTML file:
4. Connect your wallet to the web app by calling the `window.ethereum.request` function when the user clicks a "Connect Wallet" button:
5. Call the contract functions by creating a new instance of the contract object using the contract address and ABI, and calling the desired function:

### Smart Contract :

```
// SPDX-License-Identifier: MIT
```

```
pragma solidity ^0.8.0;
```

```
contract WavePortal {
```

```
    struct Wave {
```

```
        address sender;
```

```
        string message;
```

```
        uint256 timestamp;
```

```
    }
```

```
    uint256 totalWaves;
```

```
    Wave[] waves;
```

```
    event NewWave(address indexed sender, string message, uint256 timestamp);
```

```
    function wave(string memory _message) public {
```

```
        totalWaves += 1;
```

```
        waves.push(Wave(msg.sender, _message, block.timestamp));
```

```
        emit NewWave(msg.sender, _message, block.timestamp);
```

```
    }
```

```
    function getTotalWaves() public view returns (uint256) {
```



```

        return totalWaves;
    }

    function getWaves() public view returns (Wave[] memory) {
        return waves;
    }
}

```

This contract has a struct called **Wave** which contains the **sender** address, the **message** string, and the **timestamp** of the wave. When a user sends a wave, the **wave** function is called, which increments the **totalWaves** counter, creates a new **Wave** struct with the sender's address, message, and timestamp, and adds it to the **waves** array. The **NewWave** event is also emitted with the same information.

The **getTotalWaves** function returns the total number of waves that have been sent, while the **getWaves** function returns an array of all the **Wave** structs that have been sent so far.

To deploy this contract on a testnet, you can use tools like Remix or Truffle. Once deployed, you can connect to the deployed contract using your Ethereum wallet (e.g., Metamask) and call the **wave** function through your web app to send a wave to the contract. You can also call the **getTotalWaves** and **getWaves** functions to retrieve information about the waves that have been sent.

**Input:** (Test Cases / Data sets / Database Links)

**Output:** (Results / Visualization)

Expected sample Output

**Conclusion:** Thus we studied the use of hardhat tool and to run the contract and called the contract using web app.

## Assignment No: 03

**Title:** Solidity

**Objective:**

1. To learn solidity basics.
2. To create contracts using solidity

**Problem Statement:**

Prepare your build system and Building Bitcoin Core.

- a. Write Hello World smart contract in a higher programming language (Solidity).
- b. Solidity example using arrays and functions.

**Requirements:** Remix IDE

**Theory / Procedure / Diagrams / Circuits:**

Solidity is a contract-oriented, high-level programming language for implementing smart contracts. Solidity is highly influenced by C++, Python and JavaScript and has been designed to target the Ethereum Virtual Machine (EVM).

A Solidity source files can contain an any number of contract definitions, import directives and pragma directives.

Let's start with a simple source file of Solidity. Following is an example of a Solidity file –

```
pragma solidity >=0.4.0 <0.6.0;
contract SimpleStorage {
    uint storedData;
    function set(uint x) public {
        storedData = x;
    }
    function get() public view returns (uint) {
        return storedData;
    }
}
```

**Pragma:**

The first line is a pragma directive which tells that the source code is written for Solidity version 0.4.0 or anything newer that does not break functionality up to, but not including, version 0.6.0. A pragma directive is always local to a source file and if you import another file, the pragma from that file will not automatically apply to the importing file. So a pragma for a file which will not

compile earlier than version 0.4.0 and it will also not work on a compiler starting from version 0.5.0 will be written as follows –

```
pragma solidity ^0.4.0;
```

## Contract

A Solidity contract is a collection of code (its functions) and data (its state) that resides at a specific address on the Ethereum Blockchain.

The line `uint stored Data` declares a state variable called `stored Data` of type `uint` and the functions `set` and `get` can be used to modify or retrieve the value of the variable.

We're using Remix IDE to Compile and Run our Solidity Code base.

Step 1 – Copy the given code in Remix IDE Code Section.

### Example

```
pragma solidity ^0.5.0;
contract SolidityTest {
    constructor() public{
    }
    function getResult() public view returns(uint){
        uint a = 1;
        uint b = 2;
        uint result = a + b;
        return result;
    }
}
```

Step 2 – Under Compile Tab, click Start to Compile button.

Step 3 – Under Run Tab, click Deploy button.

Step 4 – Under Run Tab, Select SolidityTest at 0x... in drop-down.

Step 5 – Click getResult Button to display the result.

### Output

0: uint256: 3

### Value Types

Solidity offers the programmer a rich assortment of built-in as well as user defined data types.

Following table lists down seven basic C++ data types –

Type	Keyword	Values
Boolean	bool	true/false
Integer	int/uint	Signed and unsigned integers of varying sizes.
Integer	int8 to int256	Signed int from 8 bits to 256 bits. int256 is the same as int.
Integer	uint8 to uint256	Unsigned int from 8 bits to 256 bits. uint256 is the same as uint.
String	string	
address	address	address holds the 20 byte value representing the size of an Ethereum address.

### Strings:

Solidity supports String literal using both double quote (") and single quote ('). It provides string as a data type to declare a variable of type String.

```
pragma solidity ^0.5.0;
```

```
contract SolidityTest {
    string data = "test";
}
```

In above example, "test" is a string literal and data is a string variable. More preferred way is to use byte types instead of String as string operation requires more gas as compared to byte operation. Solidity provides inbuilt conversion between bytes to string and vice versa. In Solidity we can assign String literal to a byte32 type variable easily. Solidity considers it as a byte32 literal.

```
pragma solidity ^0.5.0;
```

```
contract SolidityTest {
    bytes32 data = "test";
}
```

## Bytes to String Conversion

Bytes can be converted to String using string() constructor.

```
bytes memory bstr = new bytes(10);
```

```
string message = string(bstr);
```

### Example

Try the following code to understand how the string works in Solidity.

```
pragma solidity ^0.5.0;
```

```
contract SolidityTest {  
    constructor() public {  
    }  
    function getResult() public view returns(string memory){  
        uint a = 1;  
        uint b = 2;  
        uint result = a + b;  
        return integerToString(result);  
    }  
    function integerToString(uint _i) internal pure  
        returns (string memory) {  
  
        if (_i == 0) {  
            return "0";  
        }  
        uint j = _i;  
        uint len;  
  
        while (j != 0) {  
            len++;  
            j /= 10;  
        }  
        bytes memory bstr = new bytes(len);  
        uint k = len - 1;  
  
        while (_i != 0) {  
            bstr[k--] = byte(uint8(48 + _i % 10));  
            _i /= 10;  
        }  
    }  
}
```

```

    }
    return string(bstr);
  }
}

```

Run the above program using steps provided in Solidity First Application chapter.

Output

```
0: string: 3
```

### Arrays:

Creating an Array

To declare an array in Solidity, the data type of the elements and the number of elements should be specified. The size of the array must be a positive integer and data type should be a valid Solidity type

### Syntax:

```
<data type> <array name>[size] = <initialization>
```

### Fixed-size Arrays

```
uint[6] data1;
```

### Dynamic Array:

The size of the array is not predefined when it is declared.

```
int[] data1=[10,20,30];
```

### Array Operations

**1. Accessing Array Elements:** The elements of the array are accessed by using the index. If you want to access *i*th element then you have to access (*i*-1)th index.

*Example:* In the below example, the contract Types first initializes an *array[data]* and then retrieves the value at specific index 2.

```

// Solidity program to demonstrate
// accessing elements of an array
pragma solidity ^0.5.0;

// Creating a contract
contract Types {

    // Declaring an array
    uint[6] data;

    // Defining function to
    // assign values to array
    function array_example(
    ) public payable returns (uint[6] memory){

        data
        = [uint(10), 20, 30, 40, 50, 60];
        return data;
    }

    // Defining function to access
    // values from the array
    // from a specific index
    function array_element(
    ) public payable returns (uint){
        uint x = data[2];
        return x;
    }
}

```

**Output :**

```

{
  "0": "uint256: 30"
}

```

**2. Length of Array:** Length of the array is used to check the number of elements present in an array. The size of the memory array is fixed when they are declared, while in case the dynamic array is defined at runtime so for manipulation length is required.

*Example:* In the below example, the contract Types first initializes an *array[data]* and then the length of the array is calculated.

### **Solidity**

```
// Solidity program to demonstrate
// how to find length of an array
pragma solidity ^0.5.0;

// Creating a contract
contract Types {

    // Declaring an array
    uint[6] data;

    // Defining a function to
    // assign values to an array
    function array_example(
    ) public payable returns (uint[6] memory){
        data = [uint(10), 20, 30, 40, 50, 60];
        return data;
    }

    // Defining a function to
    // find the length of the array
    function array_length(
    ) public returns(uint) {
        uint x = data.length;
        return x;
    }
}
```



## Output :

```
{
  "0": "uint256: 6"
}
```

**3. Push:** Push is used when a new element is to be added in a dynamic array. The new element is always added at the last position of the array.

*Example:* In the below example, the contract Types first initializes an *array[data]*, and then more values are pushed into the array.

## Solidity

```
// Solidity program to demonstrate
// Push operation
pragma solidity ^0.5.0;

// Creating a contract
contract Types {

    // Defining the array
    uint[] data = [10, 20, 30, 40, 50];

    // Defining the function to push
    // values to the array
    function array_push(
    ) public returns(uint[] memory){

        data.push(60);
        data.push(70);
        data.push(80);

        return data;
    }
}
```

**Output :**

```
{  
  "0": "uint256[]: 10,20,30,40,50,60,70,80"  
}
```

**Input:** (Test Cases / Data sets / Database Links)

**Output:** (Results / Visualization)

**Conclusion:**

Thus we studied the accessing and manipulation of arrays and string in solidity.

## Assignment No: 04

**Title:** Deploy Contract

**Objective:** To deploy a smart contract over a blockchain network.

**Problem Statement:** Deploy a simple contract to the Ethereum blockchain.

**Pre-requisites:**

- Metamask Account
- Basics understanding of solidity

**Requirements**

- Visual Studio Code
- Node.js

**Theory / Procedure / Diagrams / Circuits:**

How Ethereum Blockchain Platform executes Smart Contracts

Before discussing how to create a smart contract on the Ethereum platform, you need to understand the Ethereum blockchain and how it runs smart contracts.

**Ethereum Virtual Machine (EVM)**

The purpose of EVM is to serve as a runtime environment for smart contracts built on Ethereum. Consider it as a global supercomputer that executes all the smart contracts. As the name indicates, Ethereum Virtual Machine is not physical but a virtual machine. The functionality of EVM is restricted to virtual machines; for example, it cannot make delayed calls on the internet or produce random numbers. Therefore, it is considered a simple state machine. Writing programs in assembly language do not make any sense, so, Ethereum required a programming language for the EVM.

**Gas**

In the Ethereum Virtual Machine, gas is a measurement unit used for assigning fees to each transaction with a smart contract. Each computation happening in the EVM needs some amount of gas. The more complex the computation is, the more the gas is required to run the smart contracts.

Transaction fee = Total gas used\*gas price

## **Solidity**

Solidity is a smart contract programming language on Ethereum. Developed on the top of the EVM, it is similar to the object-oriented programming language that uses class and methods. It allows you to perform arbitrary computations, but it is used to send and receive tokens and store states. When it comes to syntax, Solidity is greatly influenced by C++, Python, and Javascript so that developers can understand its syntax quickly. It would be best to have a good understanding of Solidity programming language to efficiently write an Ethereum Smart Contract.

## **What is a Smart Contract?**

Smart Contracts are the business logic or a protocol according to which all the transactions on a Blockchain happen. The smart contract's general objective is to satisfy common contractual conditions like creating its own token on ethereum. We need to develop smart contracts according to which all the calculations on our token would happen.

It is a stand-alone script written in Solidity and compiled into JSON and deployed to a particular address on the blockchain. Just like we can call a URL endpoint of a RESTful API to run some logic through an HttpRequest, we can execute deployed smart contract similarly at a particular address by entering the accurate data along with Ethereum to call the compiled and deployed Solidity function.

Smart contracts are deployed to the decentralized database for a fee proportional to the containing code's storage size. It can also be defined as a collection of code stored in the blockchain network, defining conditions to which all parties within the contract should agree. We will be sharing the example of Ethereum smart contract creation using the Solidity programming language. So, it is first essential to understand what is Solidity.

## **What is Solidity?**

- Solidity is a Javascript-like language developed specifically for creating smart contracts. It is typed statically and supports libraries, inheritance and complex user-defined types.
- Solidity compiler converts code into EVM bytecode which is sent to the Ethereum network as a deployment transaction.

## **Steps Create and deploy a smart contract:**

1. Connect to Ethereum network: There are many ways to make requests to the Ethereum chain. For simplicity, we'll use a free account on Alchemy, a blockchain developer platform and API

that allows us to communicate with the Ethereum chain without running a node ourselves. Alchemy also has developer tools for monitoring and analytics.

2.Create your app and api key: Once you've created an Alchemy account, you can generate an API key by creating an app. This will allow you to make requests to the Goerli testnet. If you're not familiar with testnets you can. Click create App and create the new app. Give your app the name and write a short description. Select staging as your environment and Goerli as your network. Click Create App. Your app will appear in the table below.

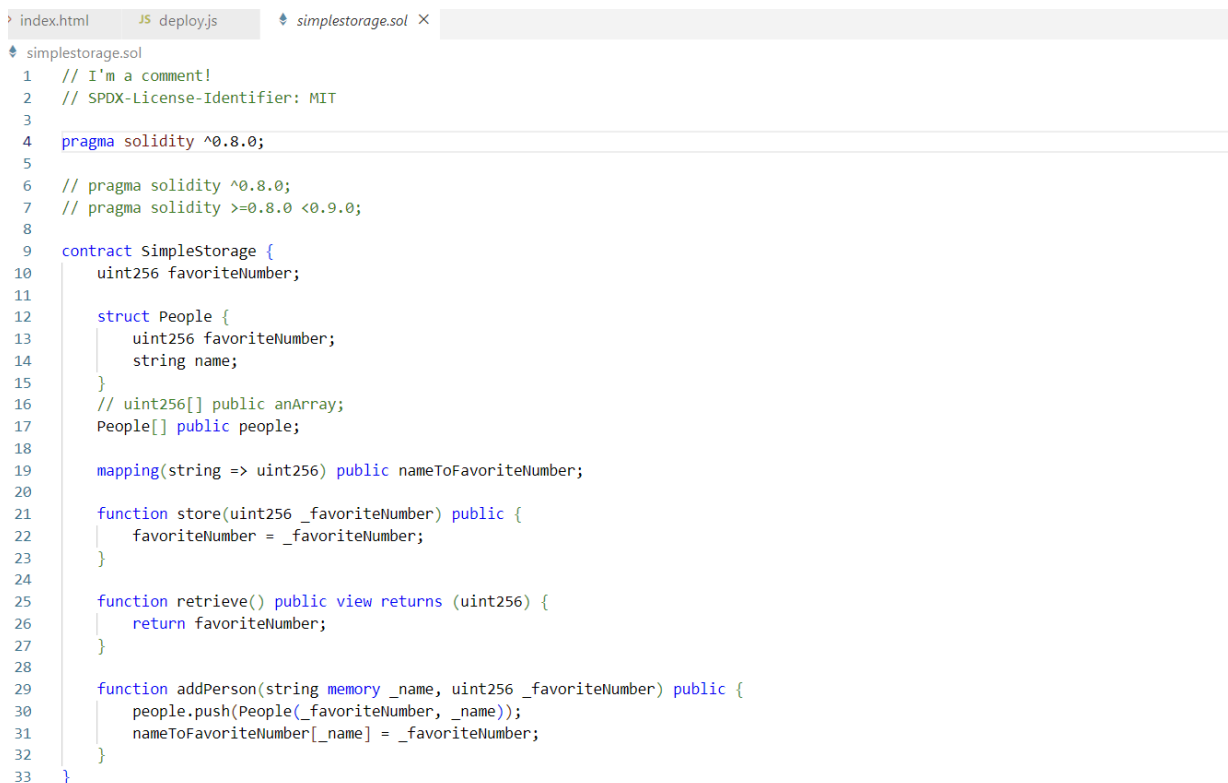
3.Add ether from a faucet: you already have an account, make sure to switch over to the “Goerli Test Network” in the upper right (so that we’re not dealing with real money). To deploy your smart contract to the test network, you'll need some fake ETH. To get ETH on the Goerli network, go to a Goerli faucet and enter your Goerli account address.

4. Initialise your project: a. Mkdir folder\_name

b.open the folder terminal

c.create the contract simplestorage.sol

d.put the solidity code in the file



```
simplestorage.sol
1 // I'm a comment!
2 // SPDX-License-Identifier: MIT
3
4 pragma solidity ^0.8.0;
5
6 // pragma solidity ^0.8.0;
7 // pragma solidity >=0.8.0 <0.9.0;
8
9 contract SimpleStorage {
10     uint256 favoriteNumber;
11
12     struct People {
13         uint256 favoriteNumber;
14         string name;
15     }
16     // uint256[] public anArray;
17     People[] public people;
18
19     mapping(string => uint256) public nameToFavoriteNumber;
20
21     function store(uint256 _favoriteNumber) public {
22         favoriteNumber = _favoriteNumber;
23     }
24
25     function retrieve() public view returns (uint256) {
26         return favoriteNumber;
27     }
28
29     function addPerson(string memory _name, uint256 _favoriteNumber) public {
30         people.push(People(_favoriteNumber, _name));
31         nameToFavoriteNumber[_name] = _favoriteNumber;
32     }
33 }
```

## 5.install packages:

First install yarn package manager

npm I -g install yarn

packages to :

Install solc

Yarn add solc@0.8.7-fixed

Yarn add ethers

Yarn add fs-extra

## 6.Compiling the contract:

To compile a contract that imports other contracts via relative paths:

```
solcjs --bin --abi --include-path node_modules/ --base-path .contractname.sol
```

Use the --base-path and --include-path options to describe the layout of your project. --base-path represents the root of your own source tree while --include-path allows you to specify extra locations containing external code.

## 7.Create a deploy.js javascript file :



```
1 const ethers = require("ethers")
2 // const solc = require("solc")
3 const fs = require("fs-extra")
4 require("dotenv").config()
5
6 async function main() {
7   // First, compile this!
8   // And make sure to have your ganache network up!
9   let provider = new ethers.providers.JsonRpcProvider("https://eth-goerli.g.alchemy.com/v2/hTwpm-pHx6og9Guk4lBz5_dV6vqyNzxz")
10  let wallet = new ethers.Wallet("a1d22fd52eabebfd8df82d3b7f3f6528a1edebfa6065683c898210f379614db5", provider)
11  const abi = fs.readFileSync("./SimpleStorage_sol_SimpleStorage.abi", "utf8")
12  const binary = fs.readFileSync(
13    "./SimpleStorage_sol_SimpleStorage.bin",
14    "utf8"
15  )
16  const contractFactory = new ethers.ContractFactory(abi, binary, wallet)
17  console.log("Deploying, please wait...")
18  const contract = await contractFactory.deploy()
19  // const contract = await contractFactory.deploy({ gasPrice: 10000000000 })
20  const deploymentReceipt = await contract.deployTransaction.wait(1)
21  console.log(`Contract deployed to ${contract.address}`)
22
23 }
24
25
26 main()
27   .then(() => process.exit(0))
28   .catch((error) => {
29     console.error(error)
30     process.exit(1)
31   })
```

8.For url in jsonrpcprovider to connect to a blockchain network provider go to alchemy ->go to app created->view key

From there copy http url .and paste it in jsonrpcprovider().

Connect to Alchemy

API KEY

hTwpm-pHx6og9GUk4lBz5\_dV6vqyNzxZ

Copy

HTTPS

https://eth-goerli.g.alchemy.com/v2/hTwpm-pHx6og9GUk4lBz5\_dV6vqyNzxZ

Copy

WEBSOCKETS

wss://eth-goerli.g.alchemy.com/v2/hTwpm-pHx6og9GUk4lBz5\_dV6vqyNzxZ

Copy

JAVASCRIPT

CLI

PYTHON

GO

INSTALLATION

Copy

npm install alchemy-sdk

CODE EXAMPLE

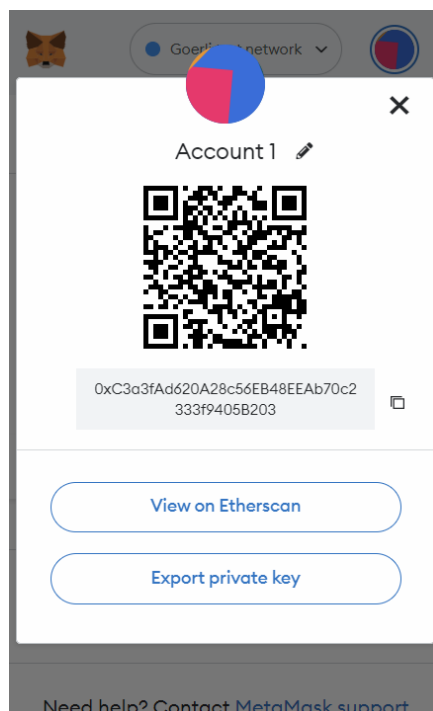
Copy

```
// Setup
import { Network, Alchemy } from 'alchemy-sdk';

const settings = {
  apiKey: "hTwpm-pHx6og9GUk4lBz5_dV6vqyNzxZ",
  network: Network.ETH_GOERLI,
};
```

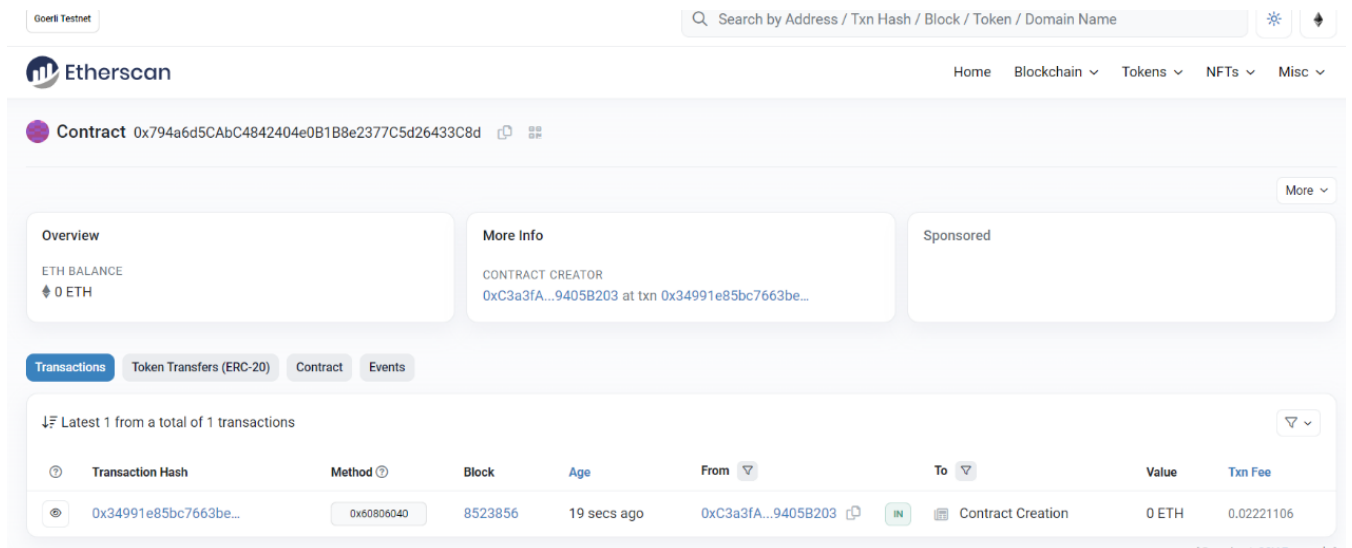
9. In ethers.wallet need to provide private key of your metamask account for this:

Go to metamask->click on 3 dots ->open account details->export private key by putting password for metamask



10.The Contract Factory function will create an instance of the smart contract which requires Abi ,bin which are autogenerated when we compile using solc.

11.now run using node deploy.js the contract will get deployed over test network and you can check the transaction details over ethers can using contract address.



**Input:** (Test Cases / Data sets / Database Links)

**Output:** (Results / Visualization)

Expected sample Output

**Conclusion:**

Thus, we deployed the smart contract over a blockchain network.



## Assignment No: 05

**Title:** Polling/voting system using Solidity, Ethereum and a data structure hashmap (optional).

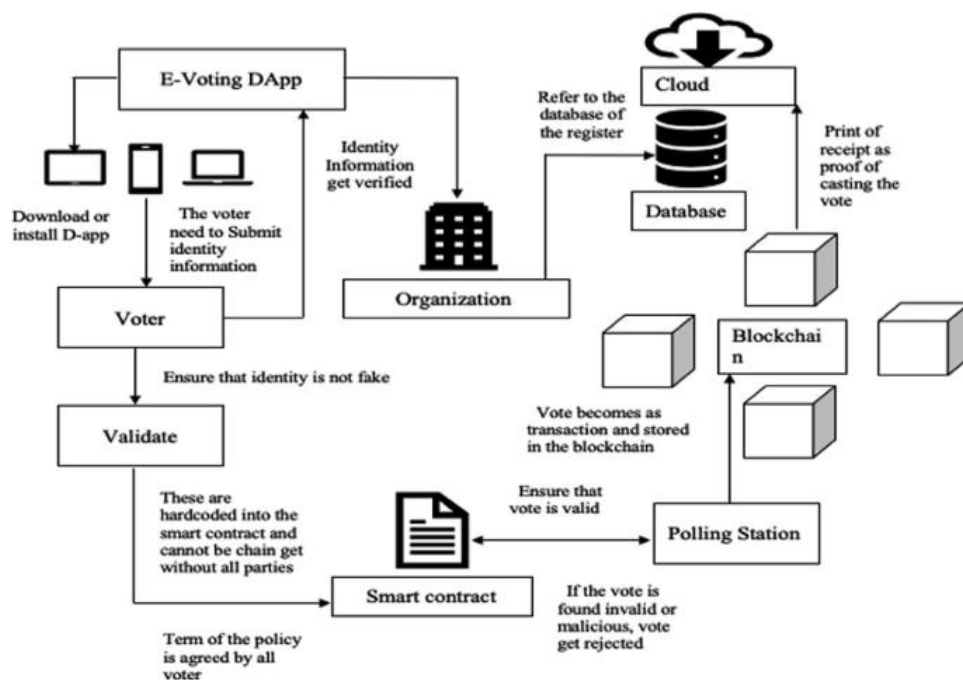
### Objective:

- 1) To study the concepts in Solidity.
- 2) To study different methods in Ethereum.
- 3) To understand the use of hashmap.

**Problem Statement:** Implement a polling/voting system with the help of Solidity, Ethereum and a data structure such as hashmap.

**Requirements:** (Components / Platform / Software / Hardware): Node Package Manager (NPM), Truffle Framework, Ganache, Metamask.

### Theory / Procedure / Diagrams:



*Voting System*

A voting system using Solidity and Ethereum is a decentralised and transparent system for conducting elections. The system uses a smart contract written in Solidity, a programming language for creating smart contracts on the Ethereum blockchain.

The voting system allows eligible voters to cast their votes securely and anonymously using their Ethereum addresses. The system uses the Ethereum blockchain to store the voting data, which makes the system transparent, secure, and tamper-proof. The results of the election are publicly accessible, and anyone can verify the authenticity and accuracy of the results.

The system can be designed to support various voting methods, including online voting, mail-in ballots, and in-person voting. The voting process can be automated and managed by the smart contract, which reduces the risk of human error and fraud.

Overall, a voting system using Solidity and Ethereum provides a transparent, secure, and efficient way to conduct elections. The system's decentralised nature and use of the Ethereum blockchain make it a powerful tool for promoting democracy and ensuring the integrity of the voting process.

### **What is a Smart Contract?**

Smart contracts are where all the business logic of our application lives. Smart contracts are in charge of reading and writing data to the blockchain, as well as executing business logic. Smart contracts are written in a programming language called Solidity.

The function of smart contracts on the blockchain is very similar to a microservice on the web. If the public ledger represents the database layer of the blockchain, then smart contracts are where all the business logic that transacts with that data lives.

Also, they're called smart contracts because they represent a covenant or agreement. In the case of this voting system, it is an agreement that your vote will count, that other votes are only counted once, and that the candidate with the most votes will actually win the election.

**The objectives of a voting system using Solidity, a programming language for creating smart contracts on the Ethereum blockchain, can include:**

**Transparency:** The voting system should be transparent to ensure that the results of the voting process are visible to all stakeholders. With Solidity, transparency can be achieved by using a public blockchain that allows anyone to access the voting data.

**Security:** The voting system should be secure to ensure that the votes are authentic and tamper-proof. With Solidity, security can be achieved through the use of cryptographic algorithms and by designing the smart contract in a way that prevents unauthorized access to the voting data.

**Immutability:** The voting system should be immutable to ensure that the results of the vote cannot be changed or altered after the voting process has concluded. With Solidity, immutability can be achieved by storing the voting data on a blockchain, which makes it nearly impossible to alter once it has been recorded.

**Efficiency:** The voting system should be efficient to ensure that the results are generated in a timely manner. With Solidity, efficiency can be achieved by designing the smart contract to minimise the computational resources required for vote counting and result tabulation.

**Accessibility:** The voting system should be accessible to ensure that all stakeholders can participate in the voting process. With Solidity, accessibility can be achieved by designing the smart contract to support multiple voting methods, such as online voting, mail-in ballots, and in-person voting.

#### **Algorithm / Methods / Steps:**

**Implementing a voting system using Solidity and Ethereum involves the following steps:**

**Design the smart contract:** The first step is to design the smart contract that will facilitate the voting process. The smart contract should include functions to create new elections, register voters, cast votes, and tally results. The contract should also include data structures to store information about the election and the votes cast.

**Define the rules:** The rules of the voting system should be defined in the smart contract. This includes the eligibility criteria for voters, the number of votes each voter can cast, and the duration of the voting period.

**Deploy the contract:** Once the smart contract is designed, it should be deployed to the Ethereum blockchain. This can be done using a development environment like Remix, which provides a Solidity compiler and an interface to interact with the smart contract.

**Register voters:** The next step is to register the eligible voters for the election. This can be done using a function in the smart contract that takes the voter's address as input and adds it to a list of eligible voters.

**Conduct the vote:** Once the voters are registered, they can cast their votes using another function in the smart contract. The function should take the voter's address and the candidate they want to vote for as input, and record the vote in the contract.

**Tally the results:** After the voting period ends, the smart contract should tally the votes and determine the winner of the election. This can be done using a function that iterates over the votes cast and updates a data structure to keep track of the number of votes each candidate received.

**Declare the winner:** Once the results are tallied, the smart contract should declare the winner of the election. This can be done by returning the candidate with the most votes to the calling function.

Overall, implementing a voting system using Solidity and Ethereum requires careful planning and attention to detail to ensure that the system is transparent, secure, and accessible to all stakeholders.

#### **Input:**

- *Solidity Functions*

1. **Modifiers**

```
/**
 * @notice To check if the voter's age is greater than or equal to 18
 * @param currentTime_ Current epoch time of the voter
 */
modifier votingLinesAreOpen(uint256 currentTime_) {
    require(currentTime_ >= votingStartTime);
    require(currentTime_ <= votingEndTime);
    _;
}

/**
```

```

* @notice To check if the voter's age is greater than or equal to 18
* @param voterAadhar_ Aadhar number of the current voter
* @param nominationNumber_ Aadhar number of the candidate
*/
modifier isEligibleVote(uint256 voterAadhar_, uint256 nominationNumber_) {
    Types.Voter memory voter_ = voter[voterAadhar_];
    Types.Candidate memory politician_ = candidate[nominationNumber_];
    require(voter_.age >= 18);
    require(voter_.isAlive);
    require(voter_.votedTo != 0);
    require(
        (politician_.stateCode == voter_.stateCode &&
        politician_.constituencyCode == voter_.constituencyCode)
    );
    _;
}

/**
* @notice To check if the user is Election Chief or not
*/
modifier isElectionChief() {
    require(msg.sender == electionChief);
    _;
}

```

## 2. Voting timelines

- Voting will only be opened between a particular date(s) & election chief has the right to update the start & end dates of the voting process.
- start date can only be updated only if the voting process is not started yet
- Can extend the voting end date after the voting is started & before the voting is ended

```

/**
* @dev used to update the voting start & end times
* @param startTime_ Start time that needs to be updated
* @param currentTime_ Current time that needs to be updated
*/
function updateVotingStartTime(uint256 startTime_, uint256 currentTime_)
    public

```

```

    isElectionChief
{
    require(votingStartTime > currentTime_);
    votingStartTime = startTime_;
}

/**
 * @dev To extend the end of the voting
 * @param endTime_ End time that needs to be updated
 * @param currentTime_ Current time that needs to be updated
 */
function extendVotingTime(uint256 endTime_, uint256 currentTime_)
    public
    isElectionChief
{
    require(votingStartTime < currentTime_);
    require(votingEndTime > currentTime_);
    votingEndTime = endTime_;
}

```

### 3. Results

Everyone can check the voting results once the voting lines are closed

```

function getResults(uint256 currentTime_)
    public
    view
    returns (Types.Results[] memory)
{
    require(votingEndTime < currentTime_);
    Types.Results[] memory resultsList_ = new Types.Results[](
        candidates.length
    );
    // Since the candidates will be lesser in count than voter.
    // So looping is acceptable.
    for (uint256 i = 0; i < candidates.length; i++) {
        resultsList_[i] = Types.Results({
            name: candidates[i].name,
            partyShortcut: candidates[i].partyShortcut,

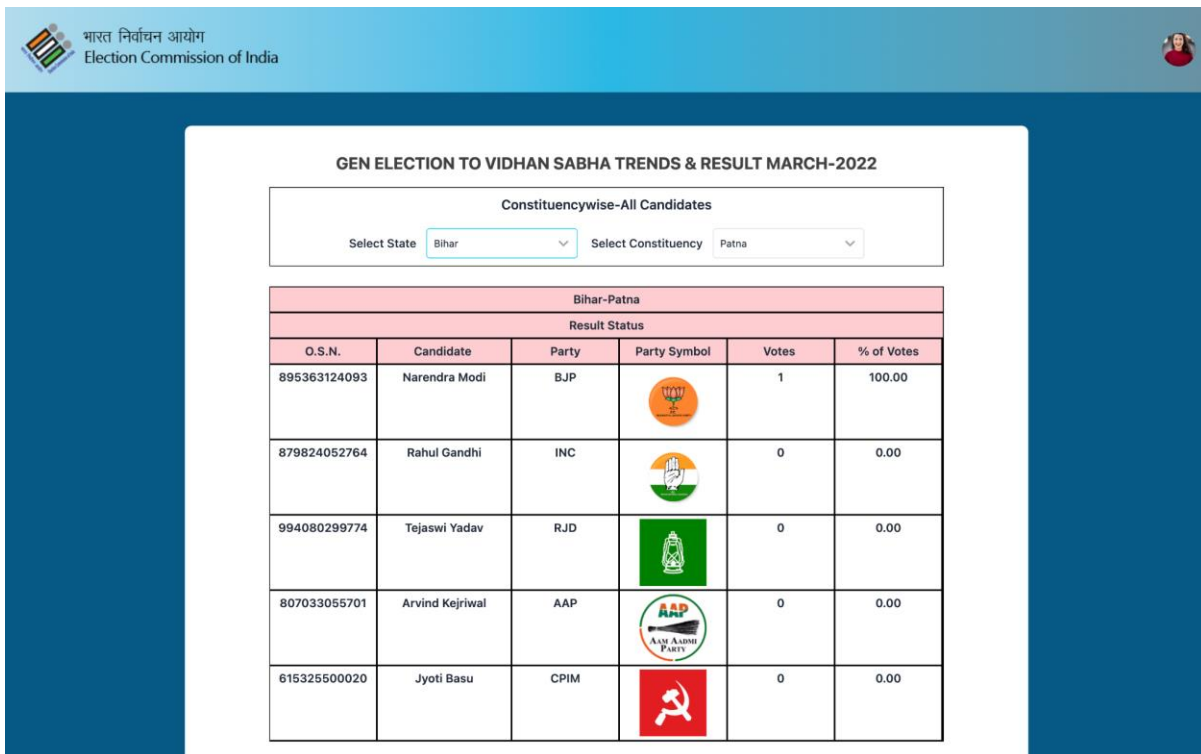
```






```

partyFlag: candidates[i].partyFlag,
nominationNumber: candidates[i].nominationNumber,
stateCode: candidates[i].stateCode,
constituencyCode: candidates[i].constituencyCode,
voteCount: votesCount[candidates[i].nominationNumber]
});
}
return resultsList_;
}

```

### Output:



GEN ELECTION TO VIDHAN SABHA TRENDS & RESULT MARCH-2022					
Constituencywise-All Candidates					
Select State		Select Constituency			
Bihar		Patna			
Bihar-Patna					
Result Status					
O.S.N.	Candidate	Party	Party Symbol	Votes	% of Votes
895363124093	Narendra Modi	BJP		1	100.00
879824052764	Rahul Gandhi	INC		0	0.00
994080299774	Tejaswi Yadav	RJD		0	0.00
807033055701	Arvind Kejriwal	AAP		0	0.00
615325500020	Jyoti Basu	CPIM		0	0.00

### Conclusion:

Studied and implemented a Polling/voting system using Solidity, Ethereum.

### Oral Question and Answers:

1. What are smart contracts in a voting system?

Smart contracts in voting systems are self-executing computer programs that ensure the integrity and transparency of the voting process. They specify the rules and requirements for an

election and automate certain aspects of the voting process, such as voter registration and identity verification. Once deployed on a blockchain network, the smart contract cannot be altered or tampered with, making the voting process secure and transparent.

## 2. What is Solidity, and how is it used in the context of voting systems?

Solidity is a programming language used to write smart contracts that run on Ethereum blockchain. In the context of voting systems, Solidity can be used to create smart contracts that automate the voting process, such as vote casting, vote counting, and result declaration. Solidity is specifically designed to work with blockchain technology, which provides a secure, transparent, and decentralized platform for running the voting system. By using Solidity, the voting system can be coded with specific rules and requirements, such as eligibility criteria for voters, the number of votes required to win, and the deadline for casting votes.

## 3. What are the benefits of using a blockchain-based voting system over traditional voting systems?

There are several potential benefits of using a blockchain-based voting system over traditional voting systems:

- 1) **Security:** Blockchain technology provides a high level of security, as the data stored on the blockchain is cryptographically secured and cannot be altered or deleted without the consensus of the network participants. This makes it less vulnerable to fraud and manipulation, which is a major concern in traditional voting systems.
- 2) **Transparency:** A blockchain-based voting system provides transparency by allowing every participant to view the entire voting process in real-time. The transactions on the blockchain can be tracked and verified, making it more difficult to cheat the system.
- 3) **Decentralization:** Blockchain-based voting systems are decentralized, which means that there is no central authority or single point of failure. This makes the system more resilient and less vulnerable to attacks.
- 4) **Efficiency:** A blockchain-based voting system can automate several aspects of the voting process, such as voter registration, identity verification, and vote counting, making it more efficient and less prone to errors.
- 5) **Accessibility:** Blockchain-based voting systems can be designed to be accessible to a wider range of voters, including those who are physically unable to vote in person or those who are in remote areas.



**This is for Student's Journal First Page for every assignment would be**

**Assignment No.:**

**Title:**

**Course Outcome:**

**Date of Completion:**

**Assessment Grade / Marks:**

**Assessor's Sign with Date:**

**Assignment write-up should be in this format**

**Assignment No: 1**

**Title**

**Objective:**

**Problem Statement:**

**Requirements:** (Components / Platform / Software / Hardware)

**Theory / Procedure / Diagrams:**

**Algorithm / Methods / Steps:** (if applicable)

**Input:** (Test Cases / Data sets / Database Links / Program)

**Output:** (Results / Visualization / Screenshot) (in pdf format)

**Conclusion:**