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## 🟢 Beginner Node.js Topics

### ⚙️ Core Node.js Basics

- What is Node.js?
- What is an Event-Driven Architecture?
- What is Concurrency in Node.js?
- Single Thread vs Multi Thread in Node.js
- Concurrency vs Parallelism vs Multithreading
- Is Node.js Single-Threaded?
- Libuv and its Role in Node.js
- Thread Pool
- Process vs Thread
- Node.js Core Modules Overview
- os Module
- process Module
- Environment Variables
- Examples for JS Engine in Node.js Runtime

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### 🧱 Modules & Exports

- What is a Module?
- CommonJS Module System
- Importing & Exporting in Node.js
- Core Modules (fs, os, path, http, etc.)
- Creating Custom Modules
- Promisify (util.promisify)

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### 📦 File System (fs)

- Reading and Writing Files (fs.readFile, fs.writeFile)
- Creating Files (fs.mkdir, fs.link)
- Deleting Files (fs.unlink)
- Truncating Files

- Listing Files in a Directory
- fs.stat
- Difference Between readStream and createReadStream
- File System Streams (Read, Write, Transform, Duplex)

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🌐 **HTTP Basics**

- Parts of HTTP Request & Response
- HTTP Methods: GET, POST, PUT, DELETE, OPTIONS
- Difference Between GET and POST
- Sending Data via GET (Query Params)
- Path Params vs Query Params
- Query Params and Path Params Together
- HTTP Request Structure
- HTTP Headers
- HTTP Status Codes (200, 201, 400, 401, 403, 500)
- Content Negotiation
- Write Head (res.writeHead)
- Set Header (res.setHeader)
- Response Methods: res.send vs res.write
- Sending JSON Responses

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🔁 **Routing Basics**

- REST API Overview
- API Endpoint Example (Divide Two Numbers)
- Dynamic Routing
- Router Chaining
- Path Params & Query Params
- app.all()
- app.locals
- Application vs Router Middleware

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### 🧰 Middleware Basics

- What is Middleware?
- Types of Middleware
- express.json()
- express.urlencoded()
- express.static()
- Logging Middleware Example
- Invoking Error Handling Middleware

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## 🟡 Intermediate Node.js Topics

### 🧠 Process & Child Processes

- What is a Process?
- Child Process Module
- Creating Child Processes (spawn, fork, exec, execFile)
- Difference Between spawn and fork
- exec vs execFile
- Cluster Module (Clustering in Node.js)
- process.nextTick
- setImmediate
- Cron Jobs (node-cron)

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### 🧩 Streams

- What are Streams?
- Types of Streams
- Readable Streams
- Writable Streams
- Duplex Streams
- Transform Streams
- Stream Piping
- Piping and Concurrency in Node.js

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### 🌎 HTTP Advanced Concepts

- OPTIONS Method
- Preflight Request
- Idempotency in HTTP
- Content Negotiation (Detailed)
- REST API Best Practices
- API Versioning
- Reverse Proxy
- Subdomain and Reverse Proxying
- HTTPS Port (443)
- HTTP 201, 400, 403, 401 Codes Deep Dive

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### 🔐 Authentication & Security

- What is JWT (JSON Web Token)?
- JWT Structure (Header, Payload, Signature)
- JWT Signature & Verification
- Refresh Tokens
- HttpOnly Cookies
- Cookie vs Session
- Disadvantages of Cookies
- Handling Cookie Expiry
- CSRF (Cross-Site Request Forgery) & Prevention
- CORS (Cross-Origin Resource Sharing)
- Encryption vs Hashing

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### ⚙️ Configuration & Deployment

- PM2 (Process Manager)
- PM2 vs Nginx
- DNS Overview
- Reverse Proxy Setup
- Environment Variables

- Rate Limiting
- Throttling

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🔵 **Advanced Node.js Topics**

🧱 **Networking & Protocols**

- Socket Programming in Node.js
- WebSockets
- TCP vs UDP
- SSH Basics
- TLS / HTTPS
- User-Agent Header
- URL Structure & Fragments
- Reverse Proxying
- Subdomain Handling

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⚡ **Performance & Internals**

- How Node.js Handles Concurrency (Event Loop + Libuv)
- Thread Pool Optimization
- Non-Blocking I/O Model
- Event Loop Phases
- Process vs Threads Deep Dive
- Event Queue, Callback Queue, and Microtask Queue
- Node.js Internals (Libuv, Event Loop, C++ Bindings)

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🧱 **Express.js Deep Dive**

- Application Middleware vs Router Middleware
- Dynamic Routing
- Router Chaining
- Express Static Middleware
- app.locals Usage
- app.all() Route Handler

- Error-Handling Middleware
- Request Method Identification (req.method)
- URL Encoded Form Data (express.urlencoded)
- JSON Parsing Middleware (express.json)

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🧠 **Advanced Topics & Tools**

- API Logging (Morgan)
- API Rate Limiting
- Handling Expired Cookies
- Partials in Express (Template Engines)
- REST API Architecture Design
- Monitoring & Debugging Node.js
- Using Environment Variables for Config
- Security Headers in Node.js
- Dynamic Import and Module Caching

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🔴 **Expert / System-Level Node.js Topics**

🧩 **Advanced Concurrency & Scaling**

- Concurrency, Parallelism, and Multiprocessing
- Clustering in Node.js
- Child Process vs Worker Threads
- Multi-core Utilization
- Load Balancing with Cluster
- PM2 for Cluster Management
- Scaling Node.js Applications

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🔐 **Advanced Security**

- JWT Token Expiry Handling
- Refresh Token Rotation
- HttpOnly vs Secure Cookies
- CSRF Tokens in SPA

- Rate Limiting (Advanced Implementations)
- CORS Configurations in Production
- HTTPS Certificates & TLS Setup

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🧭 **Advanced Networking**

- Reverse Proxying with Nginx
- Subdomains & Virtual Hosts
- Socket.io for Realtime Apps
- TCP/UDP Socket Handling
- HTTP/2 in Node.js
- Connection Keep-Alive
- WebSocket Lifecycle

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🧱 **Advanced System Topics**

- Libuv Deep Dive
- Thread Pool Tuning
- Process.nextTick vs SetImmediate
- Event Loop Timing
- Asynchronous Hooks
- Memory Management in Node.js
- Garbage Collection in V8

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🟣 **Miscellaneous / Tools / Supporting Topics**

🧰 **System Utilities & Tools**

- fs Practical Examples
- os Module (System Info)
- path Module
- crypto Module
- events Module
- dns Module
- http / https Module

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### 🧪 Practical Implementations

- Middleware to Log All Parameter Names
- API Endpoint Examples
- Dynamic Routing with Parameters
- REST API with CRUD Operations
- JWT Authentication API
- Cron Job Scheduler Example
- File Upload/Download Example
- Express Error Handling Example

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### 📦 Miscellaneous Concepts

- LocalStorage vs SessionStorage (Front-end vs Server Context)
- API Endpoint to Divide Two Numbers (Example Exercise)
- Developers who know HTML/CSS but not Node.js (Bridging Topic)
- Query Param Construction
- Sending JSON Data from Server
- Dynamic Routing vs Static Routing

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