📘 Module 1 – Introduction (Detailed Notes)

🌐 Cloud Computing – Definition

Cloud computing is a model for **on-demand network access** to shared computing resources (servers, storage, apps, services) that can be rapidly provisioned and released with minimal management effort.

- **Key features:**
  - On-demand self-service
  - Broad network access
  - Resource pooling
  - Rapid elasticity
  - Measured service (pay for what you use)

🏛️ Evolution of Cloud Computing

Cloud computing evolved step by step:

1. **Mainframe Era:** Centralized computing, terminals for users
2. **Client-Server Computing:** Personal computers connected to servers
3. **Virtualization:** Multiple OS on one physical machine
4. **Grid Computing:** Distributed computing resources for big tasks
5. **Cloud Computing:** Internet-based, scalable, service-oriented model

Key trend: Ownership → Rental → Utility-like computing

☑️ Benefits of Cloud Computing

- **Scalability:** Easily scale resources up/down based on demand
- **Cost Savings:** Pay-as-you-go pricing, no upfront hardware cost
- **Flexibility:** Access from anywhere with internet
- **High Availability:** Providers ensure redundancy & failover
- **Automatic Updates:** Security patches & upgrades handled by provider
- **Business Focus:** Companies can focus on core operations instead of IT infrastructure

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⚠ Challenges of Cloud Computing

- **Data Security & Privacy:** Risk of breaches & data leaks
- **Vendor Lock-in:** Hard to migrate between providers
- **Downtime:** Provider outages can affect services
- **Compliance:** Must meet regulations like GDPR, HIPAA
- **Latency:** Network delays for real-time applications
- **Cost Overruns:** Poor management can lead to unexpected bills

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🛠 Cloud Service Models

1. IaaS (Infrastructure as a Service)

- Provides: Virtual machines, storage, network
- Users manage: OS, apps
- Example: AWS EC2, Azure VM

2. PaaS (Platform as a Service)

- Provides: Runtime environment, databases, dev tools
- Users manage: Code & data only
- Example: Google App Engine, Heroku

3. SaaS (Software as a Service)

- Provides: Ready-to-use applications
- Users only consume the service
- Example: Gmail, Microsoft 365, Dropbox

🏗 Cloud Deployment Models

1. Public Cloud

- Owned & managed by provider
- Shared infrastructure (multi-tenant)
- Low cost, scalable
- Example: AWS, Azure, GCP

2. Private Cloud

- Dedicated to single organization

- Higher security & control
- Can be on-premises or hosted
- Example: VMware vSphere private cloud

3. Hybrid Cloud

- Mix of public & private
- Sensitive workloads kept private
- Allows cloud bursting (scaling into public cloud when demand spikes)

4. Community Cloud

- Shared by organizations with similar needs
- Cost is distributed
- Example: Universities sharing research infrastructure

🏢 Cloud Architecture

- **Front-End:** Client devices, browsers, apps
- **Back-End:** Servers, storage, hypervisors, management software
- **Network:** Internet connectivity between front-end & back-end
- **Orchestration:** Manages provisioning, scaling, monitoring

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🏛️ NIST Cloud Reference Architecture

- **Five Key Characteristics:**
    1. On-demand self-service
    2. Broad network access
    3. Resource pooling
    4. Rapid elasticity
    5. Measured service
- **Service Models:** IaaS, PaaS, SaaS
- **Deployment Models:** Public, Private, Hybrid, Community

💼 Business Models

- **Pay-as-you-go:** Pay only for used resources
- **Subscription:** Fixed recurring payment
- **Freemium:** Basic version free, advanced paid
- **Spot Pricing:** Dynamic pricing for unused capacity (AWS Spot Instances)