🟫 Cyber Physical System – Revision Notes

Cyber-Physical System (CPS) – Basics

- **Definition**: CPS is the integration of *computational (cyber)* and *physical processes*, using embedded computers and feedback loops.
- **Origin**: Term coined by *Helen Gill* at *NSF, USA* around *2006*.
- **Focus**: *Intersection*, not union, of cyber and physical systems.
- **Key Elements**: Cyber + Physical + Computation + Dynamics + Communication + Security + Safety.

CPS – Characteristics

- Deep interaction between physical and software components.
- Operates on multiple spatial and temporal scales.
- Context-aware behavior and multiple behavioral modalities.
- Uses *transdisciplinary approaches* (cybernetics, mechatronics, design science).

CPS – Applications

- **Automotive**, **Medical Devices**, **Military**, **Traffic Control**, **Power Systems**, **Manufacturing**, **Robotics**, **Assisted Living**, **Industrial Control**, **Avionics**, etc.
- Enables: *Collision avoidance*, *Robotic surgery*, *Deep-sea exploration*, *Air traffic control*, *Zero-net energy buildings*, *Healthcare monitoring*.

CPS – Components

- **Sensors + Actuators**: Bridge between real world and cyberspace.
- **Smart Networked Systems and Societies (SNSS)**: CPS forms their base.
- **Cloud Computing**: Enhances flexibility, scalability, and data processing in CPS.

Cyber-Physical Cloud Computing (CPCC)

- **Definition**: System that rapidly builds and provisions CPS using *cloud-based* sensor, processing, control, and data services.
- **Benefits**:
    - Efficient resource use
    - Modular and scalable
    - Smart environment adaptation
    - Reliable, resilient

Spatial Cloud Computing

- **Spatial Data**: Geospatial data includes *location* (coordinates), *attributes*, and *time*.
- **Purpose**: Integrates observation systems, visualization, analytics, and decision support on the cloud.
- **Advantages**:
    - Elastic, on-demand infrastructure
    - Supports multiple concurrent users
    - Geospatial science optimized by spatiotemporal principles

Spatial Cloud – Features

- Shared resource pooling (Network, Servers, Apps, Databases)
- Deployment flexibility (IaaS, PaaS, SaaS)
- High scalability and reliability
- Cost-efficient and risk-mitigated

Traj-Cloud for Urban Dynamics

- **Goal**: Analyze urban mobility and improve *location-based services (LBS)*.
- **Framework Services**:
    1. **TS1** – Trajectory Indexing (Uses Google BigQuery + Cloud SQL)
    2. **TS2** – Map-Matching Service (Uses Google Compute Engine)
    3. **TS3** – Trajectory Querying (Uses Google Compute Engine + SQL)

Cloud-Fog-Edge for Internet of Health Things (IoHT)

- **Objective**: Reduce *latency, cost, and cloud network usage*.
- **Key Tools/Goals**:
    - Fog-Edge health model (tested with iFogSim)
    - Custom wearable devices for health data
    - Implementation and testing on real hardware
    - Study and integrate *Dew Computing*

☑ High-Yield Keywords for MCQs

- CPS → Embedded Systems + Feedback Loops
- CPCC → Cloud + CPS + Modularity
- Spatial Data → Location + Attributes + Time
- SNSS → Smart Networked Systems
- iFogSim → Fog Simulation Tool
- Traj-Cloud → Mobility + GPS + MapReduce
- IoHT → Wearables + Fog-Edge Model
- Dew Computing → Lightweight local processing