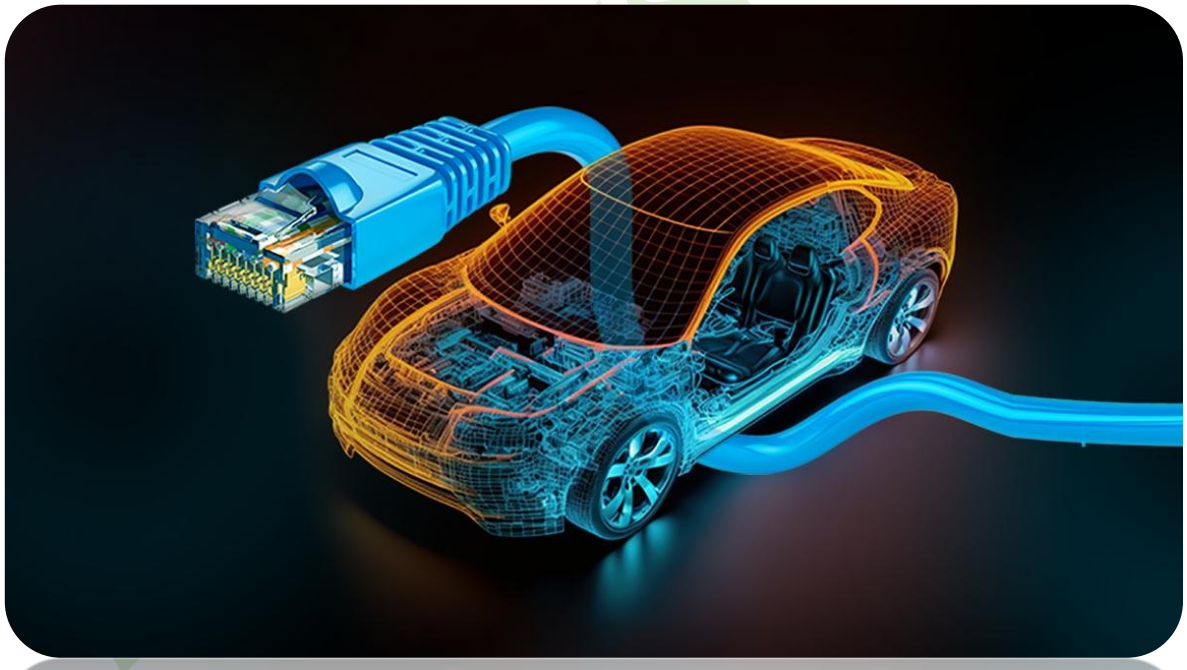
PiEST Systems
PIEST SYSTEMS (OPC) PRIVATE LIMITED

Ethernet Protocol Syllabus



Week 1 — Introduction, History, Features, Applications

Theory

- Introduction to Ethernet (scope, purpose, where it sits vs OSI)
- History timeline (DIX → IEEE 802.3; 10M → multi-hundreds of G)
- Features: full-duplex, auto-neg, PAUSE, VLAN/QoS, PoE, MACsec (mention), TSN (mention)
- Applications: enterprise, datacenter, industrial, automotive, home/IoT
- Standards map: IEEE 802.3 (L1/L2), 802.1 (bridging/VLAN)

Practicals/Labs

- "Where Ethernet lives" diagramming exercise (OSI layering)

Deliverables

- One-page overview (intro/history/features/applications)

Week 2 — Working Principle of Ethernet (Flow of Communication)

Theory

- End-to-end flow on a LAN: host → switch → host; half vs full duplex (concept), IFG/min frame
- Hubs vs switches; MAC learning tables; broadcast vs unicast vs multicast
- Where addressing fits in the flow (preview: L2 then L3)

Practicals/Labs

- Paper walk-through: flow of a unicast frame vs broadcast discovery

Deliverables

- Flow chart of a typical L2 conversation

Week 3 — Addressing I: Physical/MAC Addressing (L2)

Theory

- What is addressing? Entity, scope, interface identity
- Physical addressing: concept and purpose
- MAC addressing: 48-bit format, OUI/vendor, I/G (group), U/L (local), unicast/multicast/broadcast
- Multicast MAC mapping: IPv4 (01-00-5E), IPv6 (33-33)
- Switch CAM/aging; locally administered MACs; reserved ranges (LLDP, STP)

Practicals/Labs

- Identify and classify MACs from sample captures

Deliverables

- MAC addressing quick-reference (with examples)

Week 4 — Addressing II: Logical/IP Addressing (L3) + Resolution

Theory

- Logical addressing: role of L3 addresses vs L2
- IPv4 addressing: classes A/B/C/D/E (for literacy), CIDR/VLSM, private ranges (RFC1918), APIPA, subnet/supernet, gateway
- IPv6 addressing: 128-bit format & notation, prefix length, GUA/ULA/link-local/multicast/anycast; SLAAC vs DHCPv6 (roles)
- Resolution protocols: ARP (IPv4), NDP (IPv6) — how L3 binds to L2

Practicals/Labs

- Subnetting drills (CIDR/VLSM); mapping L3→L2 from sample ARP/NDP traces

Deliverables

- IPv4/IPv6 addressing plan + solved subnetting set + labeled ARP/NDP trace

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Week 5 — The Ethernet Protocol (Frames, VLAN, Media, Interfaces)

Theory

- Frame formats: Ethernet II (DIX); 802.3 + LLC/SNAP; 802.1Q VLAN; QinQ; preamble/SFD, IFG, min/max, jumbo MTU
- VLAN/QoS basics: 802.1Q tag (TPID 0x8100, PCP/DEI/VID); trunk vs access (concept)
- Media & rates: 10/100/1G/10G/25/40/50/100/200/400/800; copper (-T), fiber (-SX/-LX/-LR/-ER/-ZR), DAC (-CR), backplane (-KR), NBASE-T (2.5/5G), single-pair (-T1/10BASE-T1S)
- MAC↔PHY interfaces: MII/RMII/RGMII/SGMII/USXGMII (timing idea), MDIO (Clause 22/45) overview

Practicals/Labs

- Frame identification set (Ethernet II, VLAN, QinQ) from pcaps

Deliverables

- Frame gallery (annotated) + VLAN tagging checklist

Week 6 — Transport Layer: TCP & UDP (+ supporting L3/L4 utilities)

Theory

- UDP: header, checksum role, typical uses (DNS, RTP, telemetry)
- TCP: handshake, reliability mechanisms (ACK/SACK, cwnd/rwnd), PMTUD/MSS, teardown
- Supporting utilities at L3/L4 to make it work end-to-end:

- ICMP/ICMPv6 (echo, errors, PMTUD)
- DHCP/DHCPv6 (addressing automation)
- DNS (name resolution; UDP/TCP use)
- NAT/PAT basics (awareness only)

Practicals/Labs

- Packet-reading drill: identify a full TCP handshake and a UDP exchange in sample traces

Deliverables

- Short worksheet: TCP vs UDP suitability matrix + annotated handshake trace

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Week 7 — Putting It Together (Linux Tools Orientation; No boards yet)

Theory

- Linux view of Ethernet: ip/ethtool/tcpdump/Wireshark/iperf3 roles (what each shows)
- Reading device/driver facts (names only): offloads, link state, MTU
- Test topologies for Week 8 (simple flat LAN; optional VLAN trunk)

Practicals/Labs

- Dry-run on a PC: capture a ping (ARP+ICMP), a DNS lookup, a TCP handshake to a website (no board)

Deliverables

- Tooling checklist + three clean captures with titles

Week 8 — Final Hands-On: Raspberry Pi (Linux) ↔ PC End-to-End

Theory (brief)

- Lab wiring & IP plan (IPv4 + optional IPv6), safety (ESD, cables), test steps

Practicals/Labs (boards used here)

- Bring-up: set static IPv4 (/24) and IPv6 link-local/GUA on Raspberry Pi and PC
- Verify resolution: ARP (IPv4) and NDP (IPv6) between Pi and PC (tcpdump/Wireshark)
- Show “how Ethernet really works” with tools:
  - Ping (ICMP/ICMPv6) Pi ↔ PC and capture frames
  - UDP demo: iperf3 UDP from PC↔Pi; record loss/jitter; show MAC/IP/UDP triplet
  - TCP demo: iperf3 TCP from PC↔Pi; observe handshake, throughput, window growth
  - Optional: VLAN tag demo between two switch ports; show tagged frames
- (Optional stretch) Check link details with ethtool (speed/duplex/auto-neg; stats)

Deliverables

- Lab report: IP plan, captures (ARP/NDP, ICMP, UDP, TCP), throughput charts, short conclusions on Ethernet operation

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Assessment & Materials

- Weekly checks (Weeks 1–7): 7 short quizzes + artifacts listed above
- Final (Week 8): demo + lab report
- Student reference set: IEEE 802.3/802.1Q tables (for literacy), RFCs for ARP/NDP, ICMP/ICMPv6, DHCP/DHCPv6, DNS, IPv4/IPv6, TCP/UDP