

ALLAMA IQBAL OPEN UNIVERSITY, ISLAMABAD

(Department of Computer Science)

Course Title:	Basics of Information and Communication Technology
Course Code:	1431/5403
Level:	BS
Semester:	Autumn 2026
Assignment No:	ASSIGNMENT-2
Total Marks:	100
Pass Marks:	50

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Question 1: Explain the architecture of the Internet using TCP/IP. Describe how the World Wide Web (WWW) works, including the roles of web browsers, HTML, URLs, and DNS in accessing web resources. (20)

Answer:

1. Architecture of the Internet: The TCP/IP Model

The global Internet is built upon the Transmission Control Protocol / Internet Protocol (TCP/IP) architecture. TCP/IP is an open-standard 4-layer network protocol suite that defines how digital data is formatted, addressed, packetized, routed, and transmitted securely across global computer networks.

Layer Number	Layer Name	Key Protocols	Primary Function
Layer 4	Application Layer	HTTP, HTTPS, FTP, SMTP, DNS, SSH	Provides end-user network services and interface.
Layer 3	Transport Layer	TCP, UDP	Ensures end-to-end communication, error checking, and flow control.
Layer 2	Internet Layer	IP (IPv4/IPv6), ICMP, ARP	Handles logical IP addressing, packet creation, and global routing.
Layer 1	Network Access / Link Layer	Ethernet, Wi-Fi (802.11), PPP	Manages physical hardware transmission across physical media.

2. How the World Wide Web (WWW) Works

While the Internet is the physical network infrastructure connecting computers globally, the World Wide Web (WWW) is an information service operating on top of the Internet. The Web allows users to view and share interlinked multimedia web documents using standardized technologies:

- **Web Browsers:** Client-side application software (e.g., Google Chrome, Mozilla Firefox, Microsoft Edge) that renders HTML/CSS code, executes JavaScript scripts, and handles HTTP network requests.
- **HTML (HyperText Markup Language):** Standard markup language used to structure web documents using tags (headings, paragraphs, images, tables, hyperlinks).
- **URL (Uniform Resource Locator):** Global web address format identifying web resource locations (e.g., `https://www.aiou.edu.pk/courses/1431.html`). Comprises Protocol (`https://`), Domain (`www.aiou.edu.pk`), and Path (`/courses/1431.html`).
- **DNS (Domain Name System):** The phonebook of the Internet. Converts human-readable domain names (`www.aiou.edu.pk`) into machine-readable numerical IP addresses (`192.0.2.1`).

Step-by-Step Sequence of Accessing a Web Resource:

- **1. User Request:** User types `https://www.example.com` into the web browser address bar.
- **2. DNS Resolution:** Browser sends a DNS query to a Resolver Server to resolve the domain to its numerical IP address.
- **3. TCP Handshake:** Browser establishes a secure TCP/IP connection (Port 443) with the target web server.
- **4. HTTP Request & Response:** Browser sends an `HTTP GET` request; web server locates requested files and returns HTML code.
- **5. Browser Rendering:** Browser layout engine parses HTML, renders visual elements, and displays the webpage.

Question 2: Discuss different categories of software, including commercial, freeware, public domain, and open-source software. Compare their advantages, limitations, and practical uses. (20)

Answer:

1. Categories of Software Licensing

Software is categorized based on legal copyright ownership, licensing terms, distribution rights, source code availability, and pricing models.

- **Commercial Software:** Proprietary software developed for commercial profit. Source code is closed, and users must purchase user licenses (e.g., Microsoft Windows, Adobe Photoshop).
- **Freeware:** Copyrighted software distributed free of cost. Users can download and use it without payment, but source code is closed and modification is forbidden (e.g., WhatsApp, Adobe Acrobat Reader).
- **Public Domain Software:** Software with no copyright restrictions (expired or explicitly donated to public domain). Absolute freedom to use, modify, distribute, or sell without permission.
- **Open-Source Software (OSS):** Software distributed with open access to source code under licenses like GPL, MIT, or Apache. Users can modify, audit, and distribute code (e.g., Linux OS, Python, VLC Media Player).

2. Comparative Analysis Matrix

Category	Source Code	Cost Structure	Key Advantages	Limitations / Drawbacks	Practical Example
Commercial	Closed Source	Paid License / Subscription	Professional support, high polish, regular updates.	High cost, vendor lock-in, zero code flexibility.	MS Office, Windows 11, AutoCAD
Freeware	Closed Source	100% Free of Cost	No financial cost, easy distribution.	No source code access, potential bundled ad-ware.	VLC, Skype, Adobe Reader
Public Domain	Open Access	100% Free of Cost	Complete freedom; no legal restrictions.	No guaranteed support or official security updates.	SQLite, CERN WWW code
Open-Source	Fully Open	Free or Donation-based	High security auditability, customization, no lock-in.	Requires technical skills for custom configuration.	Linux Kernel, LibreOffice, GIMP

Question 3: Explain the concept of programming and describe the steps involved in developing a computer program. Discuss algorithms, heuristics, and program control flow with suitable examples. (20)

Answer:

1. The Concept of Programming

Computer programming is the process of formulating, designing, writing, testing, debugging, and maintaining instruction sets (code) in programming languages (C++, Python, Java) that command computer hardware to solve algorithmic problems.

2. Program Development Life Cycle (PDLC)

Developing robust computer applications follows six systematic engineering phases:

- **1. Problem Definition:** Identifying user requirements, inputs, desired outputs, and system constraints.
- **2. Program Design:** Formulating logical solution algorithms using flowcharts, pseudocode, and decision tables.
- **3. Coding & Implementation:** Translating algorithm logic into executable source code in a programming language.
- **4. Testing & Debugging:** Identifying and fixing Syntax Errors, Logic Errors, and Runtime Exceptions.
- **5. Documentation & Deployment:** Writing developer manuals, user guides, and deploying software to production environments.
- **6. Maintenance & Updates:** Refining code, patching security vulnerabilities, and adding new software features over time.

3. Algorithms vs. Heuristics

An Algorithm is a unambiguous, step-by-step mathematical procedure that guarantees an exact correct solution in a finite number of steps (e.g., Sorting algorithms, Binary Search).

A Heuristic is a practical, 'rule of thumb' strategy or approximation technique that finds a good-enough solution rapidly

when exact mathematical algorithms are computationally impossible (e.g., Anti-virus heuristic scanning, A* Pathfinding in games).

4. Program Control Flow

Program Control Flow refers to the order in which individual statements and code blocks are executed:

- **Sequential Control:** Default execution where statements execute line-by-line sequentially from top to bottom.
- **Selection / Conditional Control:** Branching statements (`if-else`, `switch-case`) executing specific paths based on boolean evaluations.
- **Iterative / Repetitive Control:** Looping structures (`for`, `while`, `do-while`) repeating code blocks until termination conditions are met.

Question 4: Explain the concept of databases and Database Management Systems (DBMS). Discuss the role of data warehouses and provide an introduction to data mining and its applications. (20)

Answer:

1. Databases and Database Management Systems (DBMS)

A Database is an organized collection of logically related data stored electronically. A Database Management System (DBMS) is enterprise software (MySQL, Oracle, PostgreSQL, MS SQL Server) that provides interfaces for defining, creating, querying, managing, and securing databases.

- **Key DBMS Features:** Data integrity, elimination of data redundancy, concurrent access control, multi-level security, transaction management (ACID properties), and automated backup/recovery.

2. Data Warehousing

A Data Warehouse is a large, centralized repository that aggregates historical, multi-source data from operational databases across an entire enterprise. It uses the ETL Process (Extract, Transform, Load) to structure data for analytical querying and Business Intelligence (BI).

- **Characteristics:** Subject-oriented, Integrated, Time-variant, and Non-volatile.

3. Data Mining and Applications

Data Mining is the computational process of discovering hidden patterns, anomalies, correlations, and predictive trends from massive datasets using machine learning, statistics, and pattern recognition algorithms.

- **Market Basket Analysis:** Retailers analyze purchasing habits to place complementary items together (e.g., bread and butter).
- **Fraud Detection:** Banks detect suspicious credit card transaction anomalies in real time.
- **Healthcare Pattern Mining:** Medical researchers uncover early disease diagnostic patterns from historical patient records.

Question 5: Discuss emerging technologies in ICT, including cloud computing, pervasive computing, wireless sensor networks, and RFID. Explain how these technologies are shaping the future of computing and society. (20)

Answer:

1. Emerging ICT Technologies

A. Cloud Computing

Cloud computing delivers on-demand computing services (servers, storage, databases, networking, software) over the Internet under a pay-as-you-go model. Service models include IaaS (Infrastructure as a Service), PaaS (Platform as a Service), and SaaS (Software as a Service).

B. Pervasive / Ubiquitous Computing

Pervasive computing envisions microprocessors embedded seamlessly into everyday physical objects (smart home appliances, wearables, vehicle sensors), making computing available everywhere silently and context-aware.

C. Wireless Sensor Networks (WSN)

WSNs consist of spatially distributed autonomous wireless sensor nodes that monitor environmental conditions (temperature, humidity, pressure, vibration) and cooperatively pass data to central processing sinks.

D. Radio Frequency Identification (RFID)

RFID uses electromagnetic fields to automatically identify and track electronic tags attached to objects. Used extensively in automated supply chain logistics, inventory management, and automated highway toll systems (M-Tag/E-PASS).

2. Shaping the Future of Computing and Society

These emerging technologies are driving Smart Cities, Industry 4.0 automation, Precision Agriculture, and Telemedicine. They enhance operational efficiency and quality of life while introducing critical challenges regarding data privacy, cybersecurity, and e-waste management.