National Curriculum of Pakistan
2022-23

TECHNICAL EDUCATION

IOT & Data Coding

Cloud Computing Fundamentals

Grades 11-12

NATIONAL CURRICULUM COUNCIL SECRETARIAT
MINISTRY OF FEDERAL EDUCATION AND
PROFESSIONAL TRAINING, ISLAMABAD
GOVERNMENT OF PAKISTAN

بسم الله الرحمن الرحيم

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It is with great pride that we, at the National Curriculum Council Secretariat, present the first core curriculum in Pakistan's 75-year history. Consistent with the right to education guaranteed by Article 25-A of our Constitution, the National Curriculum of Pakistan (2022-23) aspires to equip every child with the necessary tools required to thrive in and adapt to an ever-evolving globalized world.

The National Curriculum is in line with international benchmarks, yet sensitive to the economic, religious, and social needs of young scholars across Pakistan. As such, the National Curriculum aims to shift classroom instruction from rote learning to concept-based learning.

Concept-based learning permeates all aspects of the National Curriculum, aligning textbooks, teaching, classroom practice, and assessments to ensure compliance with contemplated student learning outcomes. Drawing on a rich tapestry of critical thinking exercises, students will acquire the confidence to embark on a journey of lifelong learning. They will further be able to acknowledge their weaknesses and develop an eagerness to build upon their strengths.

The National Curriculum was developed through a nationwide consultative process involving a wide range of stakeholders, including curriculum experts from the public, private, and non-governmental sectors. Representatives from provincial education departments, textbook boards, assessment departments, teacher training departments, *deeni madaris*, public and private publishers, private schools, and private school associations all contributed their expertise to ensure that the National Curriculum could meet the needs of all Pakistani students.

The experiences and collective wisdom of these diverse stakeholders enrich the National Curriculum, fostering the core, nation-building values of inclusion, harmony, and peace, making the National Curriculum truly representative of our nation's educational aspirations and diversity.

I take this opportunity to thank all stakeholders, including students, teachers, and parents who contributed to developing the National Curriculum of Pakistan (2022-23)

Dr. Mariam Chughtai
Director
National Curriculum Council Secretariat
Ministry of Federal Education and Professional Training

Cloud Computing Fundamentals

Grades 11-12

Domain A: Introduction to Cloud Computing

Standard: Gain a comprehensive understanding of cloud computing, the fundamental concepts, service models and deployment strategies to enable students to make informed decisions based on performance, security, and cost considerations.

Grade 11	**Grade 12**
Benchmark I: Describe the key concepts of cloud computing.	**Benchmark I**: Explain different delivery models of cloud.
Student Learning Outcomes	
[SLO:CC-11-A-01]: Define cloud computing. [SLO:CC-11-A-02]: Explain the fundamental concepts of cloud computing.	[SLO:CC-12-A-01]: Define IaaS, PaaS, and SaaS models [SLO:CC-12-A-02]: Differentiate between IaaS, PaaS, and SaaS models [SLO:CC-12-A-03]: Explain how IaaS provides virtualized infrastructure components, PaaS offers a platform for developing and

	deploying applications, and SaaS provides ready-to-use software applications over the internet. [SLO:CC-12-A-04]: Describe the scalability, flexibility, and cost-efficiency features of each service model. [SLO:CC-12-A-05]: Illustrate how IaaS can provide infrastructure cost savings, on-demand scalability, and disaster recovery capabilities. [SLO:CC-12-A-06]: Elaborate how PaaS simplifies application development, enables collaboration, and accelerates time-to-market, [SLO:CC-12-A-07]: Explain how SaaS offers easy access to software applications, reduces maintenance efforts, and allows for rapid deployment. [SLO:CC-12-A-08]: List some ways in which PaaS can be used for developing, testing, and deploying applications. [SLO:CC-12-A-09]: Explain how SaaS can meet business needs for email, customer relationship management (CRM), enterprise resource planning (ERP), and other software applications.

Benchmark II: Explain the evolution of cloud computing and its benefits.	**Benchmark II**: Explain the strategies on cloud: public, private, hybrid, etc.
Student Learning Outcomes	
[SLO:CC-11-A-03]: Understand the key milestones and influential factors in the evolution of cloud computing, including virtualization, grid computing, and the emergence of cloud service providers. [SLO:CC-11-A-04]: Describe how cloud computing enables scalability, flexibility, cost-efficiency, and global accessibility for businesses and individuals.	[SLO:CC-12-A-10]: List considerations when adopting public cloud, including data security, privacy, and compliance. [SLO:CC-12-A-11]: Explain the concept of private cloud [SLO:CC-12-A-12]: Describe the benefits of using the private cloud for organizations. [SLO:CC-12-A-13]: Differentiate between on-premises private cloud and hosted private cloud models. [SLO:CC-12-A-14]: Explain the concept of hybrid cloud model [SLO:CC-12-A-15]: Describe the advantages in combining public and private cloud environments.

	[SLO:CC-12-A-16]: Plan workload placement strategies, including determining which workloads should be deployed in public or private cloud (based on performance, security, and cost considerations) [SLO:CC-12-A-17]: Explain how factors (such as data sensitivity, compliance regulations, performance requirements, and budget considerations) influence the choice of deployment model.

Domain B: Architecture

Standard: Develop a profound understanding of cloud architecture, encompassing the layers of internet connectivity and service model.

Grade 11	**Grade 12**
Benchmark I: Explain the various layers of connectivity and the role of the cloud.	**Benchmark I**: Understand the concepts and advantages of using virtualization.
Student Learning Outcomes	
[SLO:CC-11-B-01]: Identify different layers of internet connectivity in client and server communication.	[SLO:CC-12-B-01]: Define virtualization computing.

[SLO:CC-11-B-02]: Explain the role of servers in modern computing. [SLO:CC-11-B-03]: Distinguish different types of servers for example file servers, mail servers, web servers, database servers and dns servers. [SLO:CC-11-B-04]: Explain the difference between various types of databases for example relational, non relational, vector, key value and graph databases. [SLO:CC-11-B-05]: Define the OSI model for network communication. [SLO:CC-11-B-06]: Understand different transport protocols like TCP and UDP. [SLO:CC-11-B-07]: Understand different application layer protocols for example HTTP and SMTP	[SLO:CC-12-B-02]: List advantages of using virtual computing over traditional (physical) computing. [SLO:CC-12-B-03]: List the Types of virtualizations: (server, storage, and network virtualization). [SLO:CC-12-B-04]: Explore the GCP console and enlist various services for compute, storage and network virtualization. [SLO:CC-12-B-05]: Design a scalable web application with GCP services.
Benchmark II: Explain the cloud computing model.	
[SLO:CC-11-B-08]:	

Explore major cloud service providers, such as AWS, GCP or Azure.	

Domain C: Cloud Products

Standard: Attain proficiency in leveraging SaaS products running on backhone of the cloud for collaboration and productivity.

Grade 11	**Grade 12**
Benchmark I: Develop proficiency for using collaboration and productivity SaaS tools for example Notion, Pitch, and Canva.	
Student Learning Outcomes	
[SLO:CC-11-C-01]: Describe the role of productivity tools in work. [SLO:CC-11-C-02]: Gain a comprehensive understanding of Notion's interface, functionalities, and the concept of workspace organization.. [SLO:CC-11-C-03]: Demonstrate the ability to use Notion for project planning, task management, and tracking progress through the creation of boards, lists, and calendars.	

[SLO:CC-11-C-04]: Collaborate effectively on shared Notion documents, utilizing features such as comments, mentions, and version history. [SLO:CC-11-C-05]: Explore and use Canva templates and elements to create visually appealing and professional-looking graphics. [SLO:CC-11-C-06]: Dsicuss the purpose and benefits of creating and delivering presentations in a collaborative environment. [SLO:CC-11-C-07]: Navigate the features of Pitch.com, including slides, layouts, and interactive elements, to build engaging presentations	
Benchmark II: Discuss communication apps like Discord and Slack.	
Student Learning Outcomes	
[SLO:CC-11-C-08]: Describe the importance of effective online communication and collaboration in various contexts	

[SLO:CC-11-C-09]: Gain proficiency in navigating the interfaces of Slack and Discord, including channels, direct messages, and settings. [SLO:CC-11-C-10]: Comprehend the concept of servers, channels, and roles in Discord and workspaces, channels, and direct messages in Slack [SLO:CC-11-C-11]: Demonstrate effective teamwork through file sharing, brainstorming, and project coordination.	
Benchmark III: Discuss file storage and sharing apps like Dropbox and Wetransfer.	
Student Learning Outcomes	
[SLO:CC-11-C-12]: Define the concept of file sharing and its significance in modern digital collaboration. [SLO:CC-11-C-13]: Demonstrate proficiency in navigating the user interface of popular file sharing platforms like Dropbox and WeTransfer.	

Benchmark IV: Discuss workspace tools for organizations like Google slides, docs, sheets, and meet.	
Student Learning Outcomes	
[SLO:CC-11-C-14]: Explain the purpose and features of workspace platforms like Google Workspace and Microsoft 365 [SLO:CC-11-C-15]: Demonstrate the use of Google Meet for synchronous communication, virtual meetings, and collaborative discussions. [SLO:CC-11-C-16]: Illustrate how to use Google docs and sheets for creating, editing and sharing documents online. [SLO:CC-11-C-17]: Compare collaborative features of Google Workspace across different platforms, such as Microsoft Office 365, Notion, Pitch, Discord and Dropbox.	

Domain D: Serverless

Standard: Acquire in-depth understanding of PaaS/serverless models and learn practical skills to deploy a web application.

Grade 11	Grade 12
Benchmark I: Explain the PaaS / serverless model for cloud.	
Student Learning Outcomes	
[SLO:CC-11-D-01]: Define serverless architecture and its advantages in terms of cost, scalability, and maintenance. [SLO:CC-11-D-02]: Enlist the modern PaaS platforms for example Replit, Heroku, Railway, Firebase, Vercel and Supabase.	
Benchmark II: Using Supabase to build a full stack application.	
Student Learning Outcomes	
[SLO:CC-11-D-03]: Explore the Supabase platform and understand its features [SLO:CC-11-D-04]: Create a new project on Supabase and set up a PostgreSQL database.	

[SLO:CC-11-D-05]: Demonstrate proficiency in creating a simple web application with html, css and javascript. [SLO:CC-11-D-06]: Demonstrate integrating Supabase in web applications with javascript. [SLO:CC-11-D-07]: Explain various components of Supabase for example database, authentication, edge functions and storage. [SLO:CC-11-D-08]: Build a web-based task management application that allows users to create, update, delete, and mark tasks as complete. Key features are a. Authenticating users (sign up users). b. Connect the web application to the Supabase database for storing and retrieving user and task data. c. Design a dashboard that displays the user's tasks. d. Explore Supabase real-time features to ensure that changes made by one user are instantly reflected for others.	

Benchmark III: Use Replit to serve custom applications with Python.	
Student Learning Outcomes	
[SLO:CC-11-D-09]: Set up and configure a development environment using online collaborative coding platforms like Replit [SLO:CC-11-D-10]: Explain the concept of serverless functions, highlighting their advantages and use cases. [SLO:CC-11-D-11]: Utilize Flask for python to build and handle a basic http request with python. [SLO:CC-11-D-12]: Build proficiency with using Replit database to store data in key value pairs. [SLO:CC-11-D-13]: Utilize Flask to build a task management CRUD api	

Domain E: Virtual Machines

Standard: Develop practical expertise in virtualization of compute resources, focusing on Google Cloud Platform.

Grade 11	Grade 12
	Benchmark I: Run your own virtual machines on Google Cloud Platform.
Student Learning Outcomes	
	[SLO:CC-12-E-01]: Explore and compare different compute options on GCP, including Compute Engine, App Engine, and Cloud Functions. [SLO:CC-12-E-02]: Provision and configure virtual machines using Compute Engine, understanding key concepts such as instances, images, and snapshots. [SLO:CC-12-E-03]: Create and manage virtual machines in GCP according to the requirements (storage, cpu, network, memory, os etc.) [SLO:CC-12-E-04]: Explain connecting to a virtual machine with SSH.
	Benchmark II: Exposing virtual machine to internet

Student Learning Outcomes	
	[SLO:CC-11-E-05]: Understand configuring a virtual private cloud. [SLO:CC-11-E-06]: Implement and manage firewall rules and routing within a VPC (allow incoming traffic on port 80)

Domain F: Networks On the Cloud

Standard: Explain securely exposing virtual machines to the internet and managing the load.

Grade 11	Grade 12
	Benchmark I: Describe the key components of networking on GCP
Student Learning Outcomes	
	[SLO:CC-12-F-01]: Define the concept of VPCs and their role in cloud networking [SLO:CC-12-F-02]:

	Describe IP addressing, subnets, and firewall rules within a VPC. [SLO:CC-12-F-03]: Explore load balancing solutions in GCP [SLO:CC-12-F-04]: Understand using cloud DNS for domain management.
	Benchmark II: Securing a virtual machine and load balancing.
Student Learning Outcomes	
	[SLO:CC-12-F-05]: Explore the types of load balancing services offered by GCP (application / network load balancing) [SLO:CC-12-F-06]: Explore connecting an application load balancer to a virtual machine and routing traffic to the virtual machine port. [SLO:CC-12-F-07]: Create and manage SSL certificates with the certificate management service.

Domain G: Storage

Standard: Describe different models of storing data on the cloud and build expertise in connecting storage to compute on GCP.

Grade 11	Grade 12
	Benchmark I: Compare various storage options on GCP.
Student Learning Outcomes	
	[SLO:CC-12-G-01]: Explore a range of storage services, including Cloud Storage, Cloud SQL, Cloud Firestore, Persistent Disks and more. [SLO:CC-12-G-02]: Discuss the differences between object storage, databases, NoSQL databases, wide-column stores, and persistent disks. [SLO:CC-12-G-03]: Add persistent disks with virtual machines.
	Benchmark II: Configure and manage Cloud Storage for object storage.
Student Learning Outcomes	

	[SLO:CC-12-G-04]: Create buckets, upload objects, and set access controls. [SLO:CC-12-G-05]: Explore versioning, object lifecycle management, and access control features.
	Benchmark III: Explore application data management on GCP
Student Learning Outcomes	
	[SLO:CC-12-G-06]: Enlist different types of databases available on GCP for example relational and no sql databases. [SLO:CC-12-G-07]: Set up a Cloud SQL instance for a relational database. [SLO:CC-12-G-08]: Discuss different database engines supported by Cloud SQL, such as MySQL, PostgreSQL, and SQL Server. [SLO:CC-12-G-09]: Connect with database from virtual machines through IAM roles

Domain H: Cloud In Production

Standard: Learn about intricacies of scaling in cloud applications and developer practical expertise in horizontally scaling apps with containers.

Grade 11	**Grade 12**
Benchmark I: Understand the concept of scaling in cloud applications	**Benchmark I**: Describe the overview of containerization concepts
Student Learning Outcomes	
[SLO:CC-11-H-01]: Discuss the importance of scalability in modern web applications. [SLO:CC-11-H-02]: Differentiate between vertical scaling vs. horizontal scaling. [SLO:CC-11-H-03]: Discuss the advantages of transitioning to a full-fledged cloud platform for advanced features and scalability.	[SLO:CC-12-H-01]: Definition and role of containers in modern application development. [SLO:CC-12-H-02]: Comparison between containers and virtual machines.. [SLO:CC-12-H-03]: Create docker images. [SLO:CC-12-H-04]: Explore different components of a Docker image: layers, metadata, and filesystem.

	[SLO:CC-12-H-05]: Write a simple Dockerfile to define an application.
Benchmark II: Explore advanced cloud services for scalability	**Benchmark II**: Build and deploy images on GCP
Student Learning Outcomes	
[SLO:CC-11-H-04]: Enlist the key services of modern cloud platforms for example compute, load balancing (networking), storage and databases [SLO:CC-11-H-05]: Design a scalable architecture for a web application using GCP services.	[SLO:CC-12-H-06]: Define the core concepts and advantages of Google Cloud Build service. [SLO:CC-12-H-07]: Write a cloud build file to build a docker image. [SLO:CC-12-H-08]: Create triggers on cloud build and various strategies for triggering a build (manual or push to a branch). [SLO:CC-12-H-09]: Create a GCR repository for storing Docker images. [SLO:CC-12-H-10]: Connect the Github repository and build a docker image with GCP.
	Benchmark III: Deploying docker images with Cloud Run

Student Learning Outcomes	
	[SLO:CC-12-H-11]: Define the core concepts and advantages of using fully managed cloud run service by GCP. [SLO:CC-12-H-12]: Create a Cloud Run service using the GCR image. [SLO:CC-12-H-13]: Explore deployment options, including scaling and concurrency.
	Benchmark IV: Overview and use cases of Kubernetes
Student Learning Outcomes	
	[SLO:CC-12-H-14]: Define the purpose of container orchestration. How container orchestration simplifies deployment and scaling. [SLO:CC-12-H-15]: Explain kubernetes as an open-source container orchestration platform. [SLO:CC-12-H-16]:

	Explore core components of kubernetes like nodes, pods, deployments and services. [SLO:CC-12-H-17]: Explain the pros and cons of Kubernetes vs managed services like Cloud Run.

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