#### Section 4. Ensuring successful operation of a cloud solution

4.1 Managing Compute Engine resources. Tasks include:

a. Managing a single VM instance (e.g., start, stop, edit configuration, or delete an instance)

* Start: <https://cloud.google.com/sdk/gcloud/reference/compute/instances/start>
* Stop: <https://cloud.google.com/sdk/gcloud/reference/compute/instances/stop>
* Edit configuration - This is a non-Google resource - shows which settings can be changed when the VM is running and which can not. <https://tech.aaronteoh.com/edit-gce/>
* Update: <https://cloud.google.com/sdk/gcloud/reference/compute/instances/update>
* Update instance properties: <https://cloud.google.com/compute/docs/instances/update-instance-properties>
* Delete: <https://cloud.google.com/sdk/gcloud/reference/compute/instances/delete>

b. Remotely connecting to the instance

* Securely connecting to VM instances: <https://cloud.google.com/solutions/connecting-securely>
* Using IAP for TCP forwarding: <https://cloud.google.com/iap/docs/using-tcp-forwarding>
* Bastion host: <https://cloud.google.com/solutions/connecting-securely#bastion>
* Connect to Linux VMs using Google tools: <https://cloud.google.com/compute/docs/instances/connecting-to-instance>
* Connect to Windows VMs: <https://cloud.google.com/compute/docs/instances/connecting-to-windows>
* Connecting to Linux VMs using advanced methods: <https://cloud.google.com/compute/docs/instances/connecting-advanced>
* Suggested lab - Bastion Host: <https://partner.cloudskillsboost.google/focuses/11370?catalog_rank=%7B%22rank%22%3A1%2C%22num_filters%22%3A0%2C%22has_search%22%3Atrue%7D&parent=catalog&search_id=17760515>

c. Attaching a GPU to a new instance and installing necessary dependencies

* About GPUs: <https://cloud.google.com/compute/docs/gpus/about-gpus>
* Create a VM with attached GPUs: <https://cloud.google.com/compute/docs/gpus/create-vm-with-gpus>
* Installing GPU drivers: <https://cloud.google.com/compute/docs/gpus/install-drivers-gpu>

d. Viewing current running VM inventory (instance IDs, details)

* VM Manager: <https://cloud.google.com/compute/docs/manage-os>
* Set up VM Manager: <https://cloud.google.com/compute/docs/manage-os#gcloud>
* OS inventory management: <https://cloud.google.com/compute/docs/instances/os-inventory-management>
* View operating system details: <https://cloud.google.com/compute/docs/instances/view-os-details>
* Create an OS policy assignment: <https://cloud.google.com/compute/docs/os-configuration-management/create-os-policy-assignment>

e. Working with snapshots (e.g., create a snapshot from a VM, view snapshots, delete a snapshot)

* Persistent disk snapshots: <https://cloud.google.com/compute/docs/disks/snapshots>
* Create and manage disk snapshots (includes Create, List, View, Delete): <https://cloud.google.com/compute/docs/disks/create-snapshots>
* Move a VM instance between zones or regions: <https://cloud.google.com/compute/docs/instances/moving-instance-across-zones>
* Introducing Google Cloud Backup and DR (new 2022): <https://cloud.google.com/blog/products/storage-data-transfer/introducing-google-cloud-backup-and-dr> auto
* Backup and DR Service (new 2022): <https://cloud.google.com/backup-disaster-recovery>

f. Working with images (e.g., create an image from a VM or a snapshot, view images, delete an image)

* Create an image from a VM disk, other image or a snapshot: <https://cloud.google.com/sdk/gcloud/reference/compute/images/create>
* View: <https://cloud.google.com/sdk/gcloud/reference/compute/images/list>
* Delete: <https://cloud.google.com/sdk/gcloud/reference/compute/images/delete>
* Enable guest operating system features on custom images: <https://cloud.google.com/compute/docs/images/create-delete-deprecate-private-images#guest-os-features>

g. Working with instance groups (e.g., set autoscaling parameters, assign instance template, create an instance template, remove instance group)

* Autoscaling groups of instances: <https://cloud.google.com/compute/docs/autoscaler/>
* Create instance templates: <https://cloud.google.com/compute/docs/instance-templates/create-instance-templates>
* Create a MIG in a single zone: <https://cloud.google.com/compute/docs/instance-groups/create-zonal-mig>
* Create a MIG with VMs in multiple zones in a region: <https://cloud.google.com/compute/docs/instance-groups/distributing-instances-with-regional-instance-groups>
* Create a MIG with autoscaling enabled: https://cloud.google.com/compute/docs/instance-groups/create-mig-with-basic-autoscaling
* Applying new configurations to VMs in a MIG: <https://cloud.google.com/compute/docs/instance-groups/updating-migs>
* Automatically apply VM configuration updates in a MIG: <https://cloud.google.com/compute/docs/instance-groups/rolling-out-updates-to-managed-instance-groups>
* Selectively apply VM configuration updates in a MIG: <https://cloud.google.com/compute/docs/instance-groups/updating-selected-instances-in-a-mig>
* Delete a MIG: <https://cloud.google.com/compute/docs/instance-groups/delete-mig>

h. Working with management interfaces (e.g., Cloud Console, Cloud Shell, Cloud SDK)

* How Cloud Shell works: <https://cloud.google.com/shell/docs/how-cloud-shell-works>
* Cloud SDK: <https://cloud.google.com/sdk/docs/>

4.2 Managing Google Kubernetes Engine resources. Tasks include:

4 low-effort, high-impact ways to cut your GKE costs (and your carbon footprint) (written Nov 2022): <https://cloud.google.com/blog/products/containers-kubernetes/4-ways-to-optimize-your-gke-costs>

a. Viewing current running cluster inventory (nodes, pods, services)

* kubectl Cheat Sheet: <https://kubernetes.io/docs/reference/kubectl/cheatsheet/>
  + kubectl get nodes
  + kubectl get pods
  + kubectl get services

b. Browsing Docker images and viewing their details in the Artifact Registry

* Artifact Registry: the new way to keep your App artifacts and Docker Images on GCP (dated 2020): <https://medium.com/google-cloud/artifact-registry-the-new-way-to-keep-your-app-artifacts-and-docker-images-on-gcp-d1a72da09ff9>
* Overview of Artifact Registry: <https://cloud.google.com/artifact-registry/docs/overview>
* Container concepts: <https://cloud.google.com/artifact-registry/docs/container-concepts>

c. Working with node pools (e.g., add, edit, or remove a node pool)

* Node pools : <https://cloud.google.com/kubernetes-engine/docs/concepts/node-pools>
* Add and manage node pools: <https://cloud.google.com/kubernetes-engine/docs/how-to/node-pools>
* Delete a node pool: <https://cloud.google.com/kubernetes-engine/docs/how-to/node-pools#deleting_a_node_pool>
* Running a GKE application on spot nodes with on-demand nodes as fallback: <https://cloud.google.com/blog/topics/developers-practitioners/running-gke-application-spot-nodes-demand-nodes-fallback>

d. Working with pods (e.g., add, edit, or remove pods)

* Pods: <https://cloud.google.com/kubernetes-engine/docs/concepts/pod>
* Creating pods (note: this says you should not create pods directly; instead you should use a deployment.) <https://cloud.google.com/kubernetes-engine/docs/concepts/pod#creating_pods>
  + Pods can be creating by a pod spec yaml file and using the “kubectl apply” command: <https://kubernetes.io/docs/concepts/workloads/pods/>
    - Spec: <https://kubernetes.io/docs/concepts/workloads/pods/>
* A pod template (which contains a pod spec) is included in a Deployment yaml file. This tells GKE how many pods to create and keep running at all times.
  + Pod template: <https://kubernetes.io/docs/concepts/workloads/pods/#pod-templates>
  + Deployments: <https://kubernetes.io/docs/concepts/workloads/controllers/deployment/>

e. Working with services (e.g., add, edit, or remove a service)

* Service overview: <https://cloud.google.com/kubernetes-engine/docs/concepts/service>
* Another overview: <https://kubernetes.io/docs/concepts/services-networking/service/>
* Exposing applications using services (includes add, edit and remove): <https://cloud.google.com/kubernetes-engine/docs/how-to/exposing-apps>
* Non-Google website with a walkthrough: <https://www.howtoforge.com/create-a-service-in-kubernetes/>

f. Working with stateful applications (e.g. persistent volumes, stateful sets)

* Deploying a stateful application: <https://cloud.google.com/kubernetes-engine/docs/how-to/stateful-apps>
* StatefulSet: <https://cloud.google.com/kubernetes-engine/docs/concepts/statefulset>
* Persistent volumes and dynamic provisioning: <https://cloud.google.com/kubernetes-engine/docs/concepts/persistent-volumes>
* GKE StatefulSets and PVs (persistent volumes). Nice summary here: <https://medium.com/devops-mojo/kubernetes-storage-options-overview-persistent-volumes-pv-claims-pvc-and-storageclass-sc-k8s-storage-df71ca0fccc3>
* Differences between Deployment and StatefulSet: <https://medium.com/devops-mojo/kubernetes-difference-between-deployment-and-statefulset-in-k8s-deployments-vs-statefulsets-855f9e897091>
* StatefulSet tutorial: <https://kubernetes.io/docs/tutorials/stateful-application/basic-stateful-set/>

g. Managing Horizontal and Vertical autoscaling configurations

* Autoscaling with GKE: Clusters and nodes: <https://www.youtube.com/watch?v=VNAWA6NkoBs&t=106s>
* Youtube video - Autoscaling with GKE: Overview and pods: <https://www.youtube.com/watch?v=7naCIxIaV1M>
* Horizontal Pod autoscaling: <https://cloud.google.com/kubernetes-engine/docs/concepts/horizontalpodautoscaler>
* Vertical Pod autoscaling: <https://cloud.google.com/kubernetes-engine/docs/concepts/verticalpodautoscaler>
* Cluster nodes scaling: <https://cloud.google.com/kubernetes-engine/docs/concepts/cluster-autoscaler>
* Enabling node auto-provisioning: <https://cloud.google.com/kubernetes-engine/docs/how-to/node-auto-provisioning#enable>
* Configuring multidimensional Pod autoscaling: <https://cloud.google.com/kubernetes-engine/docs/how-to/multidimensional-pod-autoscaling>
* Lab: Understanding and Combining GKE Autoscaling Strategies: <https://www.cloudskillsboost.google/focuses/15636?parent=catalog>

h. Working with management interfaces (e.g., Cloud Console, Cloud Shell, Cloud SDK)

* Console: <https://cloud.google.com/cloud-console>
* Cloud Shell: <https://cloud.google.com/shell>
* Cloud SDK: <https://cloud.google.com/sdk> ,

4.3 Managing Cloud Run resources. Tasks include:

a. Adjusting application traffic-splitting parameters

* This links also appear in Section 3 of the Exam Guide
  + Rollbacks, gradual rollouts, and traffic migration: <https://cloud.google.com/run/docs/rollouts-rollbacks-traffic-migration>
  + Traffic splitting: <https://cloud.google.com/run/docs/rollouts-rollbacks-traffic-migration>

b. Setting scaling parameters for autoscaling instances

* This links also appear in Section 3 of the Exam Guide
  + Using maximum instances: <https://cloud.google.com/functions/docs/configuring/max-instances#gcloud>
  + Using minimum instances: <https://cloud.google.com/functions/docs/configuring/min-instances>

c. Choosing between Cloud Run and Cloud Run for Anthos: <https://cloud.google.com/anthos/run/docs/choosing-a-platform>

* Quickstart: <https://cloud.google.com/anthos/run/docs/deploy-application>
* Lab - Cloud Run for Anthos: <https://partner.cloudskillsboost.google/focuses/29772?catalog_rank=%7B%22rank%22%3A2%2C%22num_filters%22%3A0%2C%22has_search%22%3Atrue%7D&parent=catalog&search_id=17543058>

4.4 Managing storage and database solutions. Tasks include:

a. Managing and securing objects in and between Cloud Storage buckets

* Cloud Storage Overview: <https://cloud.google.com/blog/topics/developers-practitioners/all-you-need-know-about-cloud-storage>
* 4 best practices for ensuring privacy and security of your data in Cloud Storage: <https://cloud.google.com/blog/products/storage-data-transfer/google-cloud-storage-best-practices-to-help-ensure-data-privacy-and-security>
* Overview of access control: <https://cloud.google.com/storage/docs/access-control>
* Access control lists (ACLs): <https://cloud.google.com/storage/docs/access-control/lists>
* Lab - Getting Started with Cloud KMS: <https://partner.cloudskillsboost.google/focuses/11637?catalog_rank=%7B%22rank%22%3A1%2C%22num_filters%22%3A0%2C%22has_search%22%3Atrue%7D&parent=catalog&search_id=17584562>
* Quickstart - Use customer-supplied encryption keys: <https://cloud.google.com/storage/docs/encryption/using-customer-supplied-keys>

b. Setting object life cycle management policies for Cloud Storage buckets

* This link also appear in Section 2.3 of the Exam Guide
  + <https://cloud.google.com/storage/docs/gsutil/commands/lifecycle>
* Object Lifecycle Management: <https://cloud.google.com/storage/docs/lifecycle>
* Lifecycle conditions: <https://cloud.google.com/storage/docs/lifecycle#conditions>
* gsutil command: <https://cloud.google.com/storage/docs/gsutil/commands/lifecycle>
* Object versioning: <https://cloud.google.com/storage/docs/object-versioning>

c. Executing queries to retrieve data from data instances (e.g., Cloud SQL, BigQuery, Cloud Spanner, Datastore, Cloud Bigtable)

* Cloud SQL quickstarts: <https://cloud.google.com/sql/docs/mysql/connect-instance-cloud-shell>
* All Cloud SQL for MySQL code samples: <https://cloud.google.com/sql/docs/mysql/samples>
* BigQuery - All BigQuery code samples: <https://cloud.google.com/bigquery/docs/samples>
* BigQuery another example:: <https://cloud.google.com/bigquery/docs/samples/bigquery-query-script>
* bq command line tool: <https://cloud.google.com/bigquery/docs/bq-command-line-tool>
* BigQuery Running interactive and batch query jobs: <https://cloud.google.com/bigquery/docs/running-queries#bigquery-query-cl>i
* Spanner code examples: <https://cloud.google.com/spanner/docs/samples>
* Firestore: <https://cloud.google.com/firestore/docs/>
* Firestore code examples: <https://cloud.google.com/firestore/docs/samples>
* Firestore - Querying and filtering data: <https://cloud.google.com/firestore/docs/query-data/queries>
* Bigtable - python code example:: <https://googleapis.dev/python/bigtable/latest/index.html>

d. Estimating costs of data storage resources

* BigQuery - Estimate storage and query costs: <https://cloud.google.com/bigquery/docs/estimate-costs>
* Pricing calculator: <https://cloud.google.com/products/calculator>

e. Backing up and restoring database instances (e.g., Cloud SQL, Datastore)

* About Cloud SQL backups: <https://cloud.google.com/sql/docs/mysql/backup-recovery/backups>
* Cloud SQL - Create and manage on-demand and automatic backups: <https://cloud.google.com/sql/docs/mysql/backup-recovery/backing-up>
* Cloud SQL - Schedule Cloud SQL database backups: <https://cloud.google.com/sql/docs/mysql/backup-recovery/scheduling-backups>
* Firestore (Datastore) - Exporting and Importing Entities: <https://cloud.google.com/datastore/docs/export-import-entities>
* Firestore (Datastore) - Move data between projects: <https://firebase.google.com/docs/firestore/manage-data/move-data>
* Spanner - Backup and Restore with the Google Cloud console: <https://cloud.google.com/spanner/docs/backup/gcp>
* Spanner - Backup and Restore with the CLI: <https://cloud.google.com/spanner/docs/backup/gcloud>
* Bigtable - Manage backups: <https://cloud.google.com/bigtable/docs/managing-backups>

f. Reviewing job status in Dataproc, Dataflow, or BigQuery

* BigQuery
  + BigQuery - Introduction to BigQuery jobs: <https://cloud.google.com/bigquery/docs/jobs-overview>
  + BigQuery - Managing jobs: <https://cloud.google.com/bigquery/docs/managing-jobs>
  + View job details with bg cli: <https://cloud.google.com/bigquery/docs/managing-jobs#bq>
* Dataproc
  + What is Dataproc?: <https://cloud.google.com/dataproc/docs/concepts/overview>
  + Life of a Dataproc Job: <https://cloud.google.com/dataproc/docs/concepts/jobs/life-of-a-job>
  + gcloud command: <https://cloud.google.com/sdk/gcloud/reference/dataproc/jobs/list>
* Dataflow:
  + Using the Dataflow monitoring interface: <https://cloud.google.com/dataflow/docs/guides/using-monitoring-intf>
  + gcloud command: <https://cloud.google.com/sdk/gcloud/reference/dataflow/jobs/describe>

4.5 Managing networking resources. Tasks include:

a. Adding a subnet to an existing VPC

* Create and modify Virtual Private Cloud (VPC) networks: <https://cloud.google.com/vpc/docs/create-modify-vpc-networks>
* Subnets overview: <https://cloud.google.com/vpc/docs/subnets>
* Alias IP ranges overview: <https://cloud.google.com/vpc/docs/alias-ip>
* Create and modify Virtual Private Cloud (VPC) networks: <https://cloud.google.com/vpc/docs/using-vpc#add-subnets>
* Support for IPv6 addresses: <https://cloud.google.com/vpc/docs/subnets?hl=en_US#ipv6-ranges>

b. Expanding a subnet to have more IP addresses

* Expand a primary IPv4 range: <https://cloud.google.com/vpc/docs/create-modify-vpc-networks#expand-subnet>
* Edit secondary IPv4 ranges: <https://cloud.google.com/vpc/docs/create-modify-vpc-networks#edit-secondary>

c. Reserving static external or internal IP addresses

* Overview: <https://cloud.google.com/vpc/docs/ip-addresses>
* Reserving a static external IP address: <https://cloud.google.com/compute/docs/ip-addresses/reserve-static-external-ip-address>
* Reserving a static internal IP address: <https://cloud.google.com/compute/docs/ip-addresses/reserve-static-internal-ip-address>
* Internal DNS; <https://cloud.google.com/compute/docs/internal-dns>

d. Working with CloudDNS, CloudNAT, Load Balancers and firewall rules

* Firewall rules
  + VPC firewall rules overview: <https://cloud.google.com/vpc/docs/firewalls>
  + Using firewall rules: <https://cloud.google.com/vpc/docs/using-firewalls>
  + 3 ways to configure robust firewall rules: <https://cloud.google.com/blog/products/gcp/three-ways-to-configure-robust-firewall-rules>
* DNS
  + Internal DNS: <https://cloud.google.com/compute/docs/internal-dns>
  + How to Set Up a Custom Domain for Different GCP Applications Using a Load Balancer: <https://towardsdatascience.com/how-to-set-up-a-custom-domain-for-different-gcp-applications-using-a-load-balancer-bbcad40fed>
* Coud NAT:
  + Cloud NAT overview: <https://cloud.google.com/nat/docs/overview>
  + Use with Compute Engine: <https://cloud.google.com/nat/docs/gce-example>
  + Use with GKE: <https://cloud.google.com/nat/docs/gke-example>
  + Suggested Lab: Implement Private Google Access and Cloud NAT: <https://partner.cloudskillsboost.google/course_sessions/1138516/labs/209945>

4.6 Monitoring and logging. Tasks include:

a. Creating Cloud Monitoring alerts based on resource metrics

* Introduction to alerting: <https://cloud.google.com/monitoring/alerts>
* How to add an alerting policy: <https://cloud.google.com/monitoring/alerts#types-of-policies>

b. Creating and ingesting Cloud Monitoring custom metrics (e.g., from applications or logs)

* Custom metrics: <https://cloud.google.com/monitoring/custom-metrics>
* Create custom metrics with OpenCensus: <https://cloud.google.com/monitoring/custom-metrics/open-census>
* OpenCensus: <https://opencensus.io/>
* Create custom metrics with the API: <https://cloud.google.com/monitoring/custom-metrics/creating-metrics>
* Log-based metrics (Youtube): <https://www.youtube.com/watch?v=YiwT1cxpRDQ>
* Log based metrics: <https://cloud.google.com/logging/docs/logs-based-metrics>
* Suggested lab: <https://partner.cloudskillsboost.google/focuses/11619?parent=catalog>

c. Configuring log sinks to export logs to external systems (e.g., on-premises or BigQuery)

* Routing and storage overview: <https://cloud.google.com/logging/docs/routing/overview>
* Scenarios for exporting Cloud Logging data: Splunk : <https://cloud.google.com/architecture/exporting-stackdriver-logging-for-splunk>
* View logs in sink destinations: <https://cloud.google.com/logging/docs/export/using_exported_logs>
* BigQuery schema for logs: <https://cloud.google.com/logging/docs/export/bigquery>

d. Configuring log routers

* Cloud Logging pricing for Cloud Admins: How to approach it & save cost: <https://cloud.google.com/blog/topics/cost-management/how-to-approach-cloud-logging-pricing-for-cloud-admins>
* Routing and storage overview: <https://cloud.google.com/logging/docs/routing/overview>
* Configure and manage sinks: <https://cloud.google.com/logging/docs/export/configure_export_v2>
* Configure aggregated sinks: <https://cloud.google.com/logging/docs/export/aggregated_sinks>
* View logs in sink destinations: <https://cloud.google.com/logging/docs/export/using_exported_logs>
* Suggested lab: <https://docs.google.com/presentation/d/1YAjFQ4Nnij1q7Gv2LhaEfjhSmo7qdEXvI-6CYMBpJKg/edit#slide=id.g13260971041_0_2076>

e. Viewing and filtering logs in Cloud Logging

* Logs Explorer features summary: <https://cloud.google.com/logging/docs/view/logs-explorer-summary>
* Using the API to view logs: <https://cloud.google.com/logging/docs/reference/v2/rest/v2/entries/list>
* Using the CLI to view logs: <https://cloud.google.com/logging/docs/reference/tools/gcloud-logging>

f. Viewing specific log message details in Cloud Logging

g. Using cloud diagnostics to research an application issue (e.g., viewing Cloud Trace data, using Cloud Debug to view an application point-in-time)

* Cloud Trace
  + Product overview: <https://cloud.google.com/trace>
  + Viewing trace details: <https://cloud.google.com/trace/docs/viewing-details>
* Cloud Debug
  + Product overview: <https://cloud.google.com/debugger/docs>
  + Snapshots: <https://cloud.google.com/debugger/docs/using/snapshots#snapshot>
  + Logpoints: <https://cloud.google.com/debugger/docs/using/logpoints>

h. Viewing Google Cloud status

* Service Health: <https://status.cloud.google.com/>
* Incidents and the Google Cloud Service Health Dashboard: <https://cloud.google.com/support/docs/dashboard>