

Internal Assessment Test 2 – November 2024

Sub:	Cloud Computing	Sub Code:	21CS72	Branch:	CSE
Date:	20.11.2024	Duration:	90 mins	Max Marks:	50
Sem / Sec:	7 B,C			OBE	

Answer any FIVE FULL Questions

MARKS

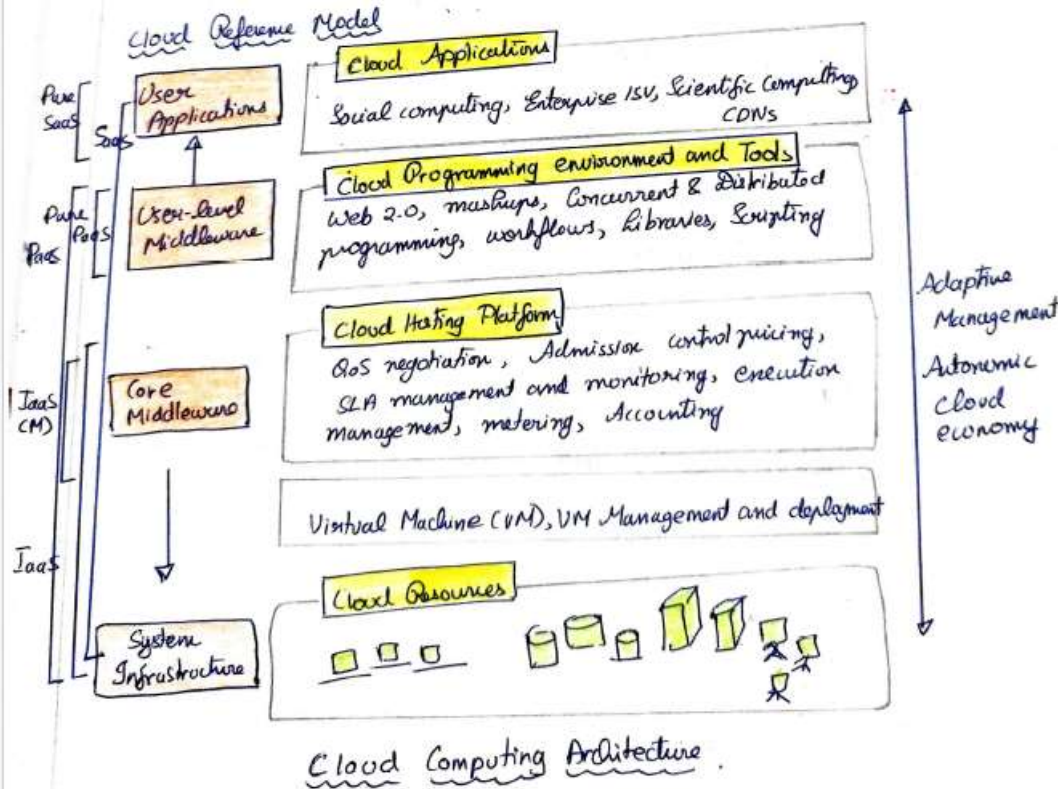
CO RBT

- 1 (a) Explain cloud computing architecture (IaaS, IaaS(M), PaaS, Pure PaaS, SaaS, Pure SaaS) with a neat diagram. State the vision, and summarize the major characteristics, product type and vendors (8M)

8M

CO3

L2



- Computing power - implemented in a datacenter.
- 100's, 1000's of nodes are stacked together
- Cloud infrastructure is heterogeneous in nature
 - ↳ built from clusters, networked PCs
- database systems and other storage services can also be part of the infrastructure.
- physical infrastructure is managed by some middleware to provide runtime environment for applications to best utilize resources
- Hardware virtualization is used at bottom of stack
 - Hypervisors manage pool of resources
 - Embrace distributed infrastructure as collection of VMs.
 - gives runtime environment customizations, application isolation, sandboxing, Quality of Service (QoS).
 - hardware resources such as CPU and memory are partitioned to virtualize devices.
 - commonly paired with storage and network virtualization

- programming-level virtualization allows a portable runtime environment to be created. - Java, .NET, Python.
- Negotiation of QoS, admission control, execution management and monitoring, accounting and billing can be done as part of infrastructure management.
- IaaS - combination of cloud hosting platforms and resources
 - ↳ IaaS(M): provide only the management layer
 - ↳ IaaS: provide both the management layer & physical infrastructure
 - suitable for designing the system infrastructure
 - provide limited services to build applications.
- PaaS - development platform for applications.
 - include web-based interfaces, command-line tools, frameworks for concurrent and distributed processing.
 - the applications are developed specifically for the cloud using the API exposed at user-level middleware.
 - usually includes infrastructure also.
- Pure PaaS - only user-level middleware is offered.

- SaaS: web-based applications that rely on the cloud to provide service to the end user. (2)
 - sustain large number of users.
 - gaming portals/ social networking sites.
- Vision: any service should be able to adaptively change and expose autonomic behaviour. - for availability and performance.
 - should have an adaptive management layer for scaling on demand.
 - SaaS - should happen automatically.
 - PaaS & IaaS - provides the functionality as part of API exposed to users.
- XaaS (Anything as a Service)
 - cloud services from different providers can be combined to provide integrated solutions.

Category	Characteristics	Product Type	Vendor & Products
SaaS	- applications - accessible from anywhere, anytime	Web applications & Services (2.0)	Google Apps, Salesforce.com (CRM), Clarizen.com (Project Mgmt), 365 Management
PaaS	- platform for developing applications hosted in the cloud	Programming API & Frameworks	Google AppEngine, Microsoft Azure, Data Synapse, IBM Cloud, AWS Lambda
IaaS / HaaS	- virtualized hardware and storage on top of which they can build their infrastructure	VM management, Storage, network	Amazon EC2, S3, GIGamon, GICE, Microsoft Azure.

(b) Characterize as IaaS, PaaS or SaaS.

2M

CO3

L1

i) AWS Lambda(Serverless) -PaaS ii)Google Compute Engine(GCE)-IaaS iii) Microsoft 365-SaaS iv) Salesforce CRM-SaaS

2 (a) With a neat diagram, explain the 3 layer IaaS reference implementation

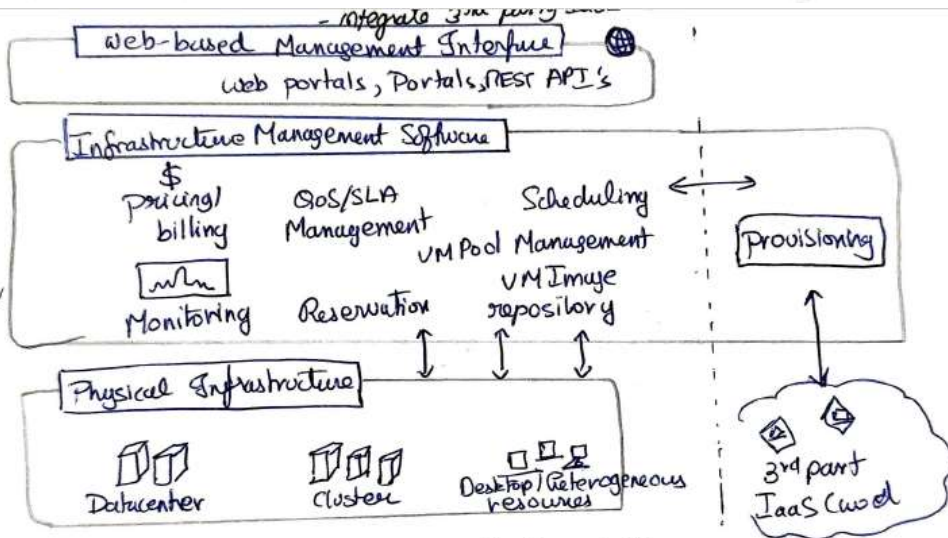
8M

CO3

L2

■ Infrastructure -and Hardware-as-a-Service

- deliver customizable infrastructure on demand.
- options - servers, load balancers, database, web servers.
- technology: Hardware Virtualization
- Virtual Machines: atomic components.
 - deployed and mixed according to features of hardware
 - ↳ memory ↳ # of processors ↳ disk storage.
- ↳ Benefits: workload partitioning, application isolation, sandboxing, hardware tuning.



IaaS Reference Implementation.

- Top Layer - provides access to underlying services through web services, RESTful APIs and mash-ups.
- All featured services hosted on browsers.
 - Web services and RESTful APIs allow programs to interact with the service without human intervention.
 - core feature: management of virtual machines
 - care done by schedulers
 - Scheduler with other component takes care of
 - (i) pricing & billing: cost of executing VM & data used to charge the user

	<p>(2) monitoring - maintains data required for repositing and analyzing performance of the system.</p> <p>(3) reservation - stores info about time slots for VM execution</p> <p>(4) QoS/SLA management console - maintains repository of SLAs made with users, monitors if VM is executed with desired QoS.</p> <p>(5) VM repository: catalog of VM images users can use to create virtual instances. - allow users to upload specific VM images.</p> <p>(6) VM pool manager: responsible for keeping track of live instances.</p> <p>(7) Provisioning: if it is to be integrated with 3rd party services, interacts with scheduler to provide VM instance.</p> <p>Bottom layer: physical infrastructure:</p> <ul style="list-style-type: none"> - service provider - uses a massive datacenter - a medium sized enterprise - may use a cluster. - even PCs & workstations can be aggregated. <p>Public cloud vendors offer all 3 stacks: Amazon, Google, Rackspace, Terraform, Google, Microsoft.</p> <p>- Additional credentials may be required to access 3rd party IaaS providers or specify IaaS(M) solutions from VMware, IBM, Microsoft.</p>			
<p>(b)</p>	<p>Service availability is calculated as # of successful units / # of total units. Such as, uptime / (uptime + downtime). In a month (31 days 24 hours each) for a service availability of 99.9% what should be the uptime and acceptable downtime in hours.</p> $99.9/100 = \text{uptime}/(31*24)$ <p>Uptime = 743 hours Downtime = (31*24) - 743 1 hour</p>	<p>2M</p>	<p>CO3</p>	<p>L3</p>
<p>3 (a)</p>	<p>List the 4 essential characteristics of a PaaS solution with brief explanation.</p> <p>Essential characteristics of a PaaS solution</p> <ol style="list-style-type: none"> (1) Runtime Framework: executes end-user code according to policies set by the end user. (2) Abstraction: - higher level of abstraction than raw VM's. - offer mechanism to manage applications on the cloud. (3) Automation: scaling is performed automatically as per SLA. in IaaS, this can be done by provisioning more resources. (4) Cloud Services: API's and services to simplify creation and delivery of elastic and highly available cloud applications. 	<p>4M</p>	<p>CO3</p>	<p>L2</p>
<p>(b)</p>	<p>What are the 3 major PaaS classifications? Give a brief description, product type and vendors.</p>	<p>4M</p>	<p>CO3</p>	<p>L2</p>

PaaS Classifications

Category	Description	Product Type	Vendors & Products
PaaS-I	runtime with web-hosted application development platform. Rapid appln. prototyping	Middleware + Infra	Force.com LongJump
PaaS-II	runtime environment for scaling web applications runtime enhanced for scaling	middleware + Infra middleware	Google App Engine Heroku JoyentSmart EngineYard AppScale Gigaspaces xAP.
PaaS-III	middleware and programming model for developing distributed applications in the cloud	Middleware + Infra Middleware	Microsoft Azure DataSynapse Cloustra Apprenda DataGrid GigaSpaces

(c)	<p>Briefly explain in terms of PaaS i) vendor lock-in ii) Dynamic Scaling</p> <ul style="list-style-type: none"> - Concerns in PaaS <ul style="list-style-type: none"> • Vendor Lock-In : binds application to specific nature of runtime. <ul style="list-style-type: none"> - makes these applications completely dependent on the provider. eg. Force.com rely on proprietary runtime frameworks which makes retargeting very difficult. <p>Dynamic scaling - The ability to handle increased workloads, traffic and resources without compromising performance or reliability.</p>	2M	CO3	L2
4 (a)	<p>Fill in the blanks for the definition of SaaS according to SIIA</p> <p>In the software as a service model, the application, or service, is deployed from a central datacenter across a network—Internet, Intranet, LAN or VPN—providing access and use on a recurring basis. Users “rent,” “subscribe to,” “are assigned,” or “are granted access to” the applications from a central provider.</p>	2M	CO3	L2
(b)	<p>Discuss how SaaS provides access to application through the internet as a web based service.</p> <ul style="list-style-type: none"> - provides access to applications through <u>Internet</u> or <u>web-based</u> services - hardware and software management is done by <u>third-parties</u> - customers need <u>not install</u> anything <u>on-premise</u> - customers need not pay <u>upfront costs</u> or for <u>licensing</u>. - only <u>credentials</u> and <u>billing details</u> are required. - <u>customization</u> is usually allowed. - provider maintains details pertaining to the customer and provides infrastructure on demand. - SaaS model caters to applications for wide range of users - <u>one-to-many</u> model 	4M	CO3	L2
(c)	<p>Briefly explain the following terms in terms of SaaS i) CRM and ERP applications ii) one to many model iii) subscription based</p>	4M	CO3	L2

CRM: Customer Relationship management
 - identifies concerns relating to interaction with customers and sales strategies

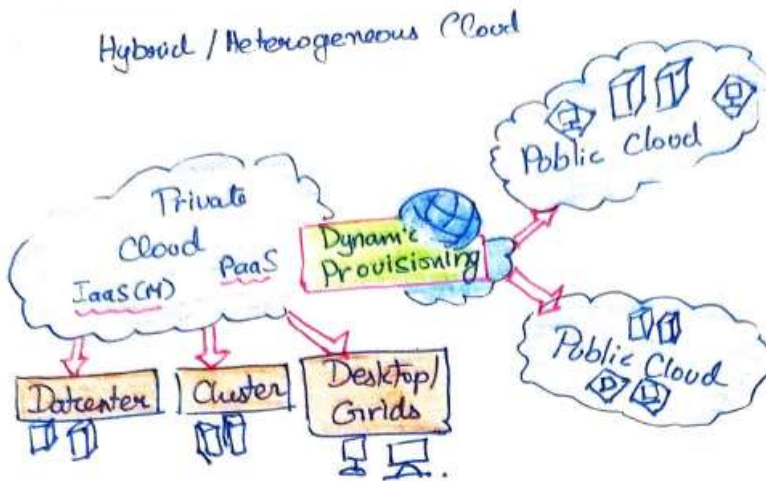
ERP: Enterprise Resource Planning
 - integrated computer system to manage internal and external resources, including tangible assets, materials, financial and human resources.

One to many model – same application caters many users
 Subscription based - periodic payment for use of software or a specific component.

5 (a) With a neat diagram explain hybrid clouds. Briefly explain i) dynamic provisioning ii) cloud bursting

4M CO3 L2

■ Hybrid Clouds.
 drawback of private cloud- cannot scale on demand.
 private cloud exists as companies have already invested on infrastructure
 Hybrid cloud solution -
 ~ allows companies to use existing ~~cloud solutions~~ IT infrastructure
 ~ maintain sensitive information on-premise.
 ~ grow and shrink external resources
 ~ Security concerns only stem from public cloud usage.



Dynamic provisioning : leverage external resources when there is a capacity demand.
cloud bursting : resources/services are temporarily leased during a workload spike.
 ~ more complex scheduling algorithm and policies. - optimize budget on public clouds.

(b) State the 3 key benefits of private cloud

3M CO3 L3

	<p><u>key benefits of private cloud</u></p> <ul style="list-style-type: none"> • Customer Information Protection • Infrastructure ensuring SLA's - clustering, failover, data replication, system monitoring and maintenance, disaster recovery, other uptime services • Compliance with standard procedures and operations 			
(c)	<p>Briefly discuss any 3 sectors that could benefit from community cloud.</p> <p><u>Candidate sectors</u></p> <ul style="list-style-type: none"> • <u>Media Industry</u>: aim: to improve content production <ul style="list-style-type: none"> - community clouds offer business-to-business collaboration - offer horsepower in terms of aggregate bandwidth, CPU, storage • <u>Healthcare Industry</u>: can provide a global platform to share knowledge without revealing sensitive information. <ul style="list-style-type: none"> - Hybrid model allows for keeping patient records in private cloud - offer non-critical services in public cloud • <u>Energy and other core industries</u>: they involve different vendors and providers <ul style="list-style-type: none"> - community cloud can provide right type of infrastructure to create an open and fair market. • <u>Public Sector</u>: <ul style="list-style-type: none"> - legal and political restrictions in public sector sector limits adoption of public cloud offerings - most governmental processes involve several institutions & agencies that provide business-to-business, citizen-to-administration and business-to-administration processes eg. invoice approval, infrastructure planning, public housing. • <u>Scientific Research</u>: <ul style="list-style-type: none"> - different organizations share large distributed infrastructure for scientific computing 	3M	CO3	L2
6 (a)	<p>Company X is a startup that that enables access to affordable institutional credit to financially excluded citizens, i.e. citizens who lack collateral and credit history. They use AI and ML models for credit risk assessment. They have been using AWS for the startup from the beginning.</p> <p>Describe how the pay-as-you-go business model in cloud works in favor or small enterprises / startups such as these.</p>	5M	CO3	L3

- pay-as-you-go model is offered by the cloud.

- It allows

- reducing capital costs associated to the IT infrastructure
- eliminating depreciation or lifetime costs associated with IT capital ~~costs~~ assets
- replace software licensing with subscriptions
- cutting maintenance and administrative costs of IT resources

capital cost: cost of purchasing an asset

~ a one-time expense.

~ IT infrastructure & software are capitalized for a business.

- payroll, ERP, CRM, generally are automated
tracking of inventory

~ capital costs should be kept low

→ as they are associated with material things
they depreciate over time

Advantage of
Cloud model : shifts the capital costs into operational costs from
renting IT infrastructure, pay subscriptions for software

- reduced administrative and maintenance costs
- IT support staff cost is reduced

Small Enterprise/Startup

- eliminate capital costs in IT infrastructure, CRM, ERP
- software development costs

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(b) Describe any 2 open challenges in the cloud in detail.

5M

CO3

L2

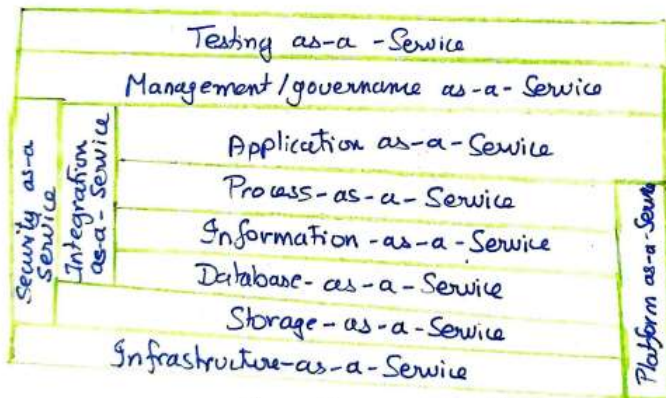
① Cloud Definition

- ~ most common - NIST definition
- ~ characterizes cloud computing as on-demand self-service broad network access, resource pooling, rapid elasticity, measured service
- ~ classifies services as SaaS, PaaS, IaaS.
- ~ categorizes deployment models as public, private, community, hybrid.

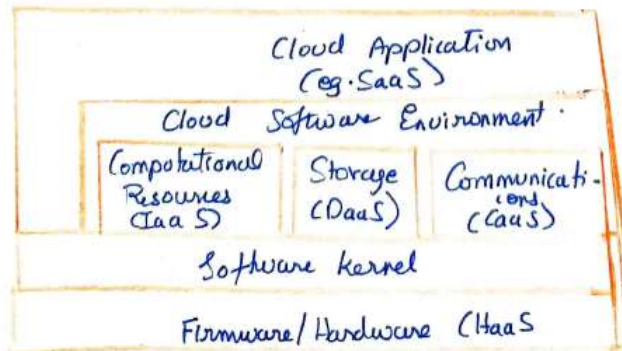
Other definitions

David Ritticism - defining clouds for enterprise

- ① Storage-as-a-Service
- ② Database-as-a-Service
- ③ Information-as-a-Service
- ④ Process-as-a-Service
- ⑤ Application-as-a-Service
- ⑥ Platform-as-a-Service
- ⑦ Integration-as-a-Service
- ⑧ Security-as-a-Service
- ⑨ Management/governance-as-a-Service
- ⑩ Testing-as-a-Service
- ⑪ Infrastructure-as-a-Service



According to researchers in University of California, 5 layers



nature of cloud
is constantly
changing.

② Cloud Interoperability and Standards.

- ~ Standards allows interoperability between solutions offered by different vendors.
- ~ Vendor lock-in - ~~major~~ major issue that deters cloud adoption.
- ~ Standards lessen risks of vendor lock-in.
- ~ efforts are made by Cloud Computing Interoperability Forum (CCIF) (currently inactive)
- ~ Open Clouds Consortium
- ~ DMTF Cloud Standards Subcommittees DMTF (Distributed Management Task Force)
- ~ Open Cloud Manifesto
 - ↳ choice, flexibility, speed and agility, core goals to an open cloud skills

IaaS - Open Virtualization Format (OVF)

- ↳ attempt to provide a common format for storing information about virtual images.
- lack of common set of APIs make interaction with cloud-based solutions vendor specific.

④ Security, Trust, and privacy

- data is encrypted.
- but in virtualization, VMM has access to memory and it is shared in a multi-tenant architecture.
- when decryption takes place in memory, it becomes accessible to the VMM in a managed environment.
- lack of control over own data → leads to lack of trust
- regulations are set by service providers.
- but, cloud services are delivered as a conglomeration of various 3rd party services
- so the chain of responsibilities for service delivery introduces
 - more vulnerabilities in secure management of data
 - enforcement of privacy rules.
 - makes it difficult to detect and identify who is liable for privacy violations.

Challenge

designing secure and trustable systems → technical
→ social
→ legal

⑤ Organizational Aspects

- In cloud, compute, storage, networking and applications are delivered as metered services over the Internet.
- The billing model requires knowledge of how resources are billed
- some change is required in organizational processes & boundaries.
- Questions to be considered.
 - ① What is the new role of IT department that scales completely on cloud?
 - ② How will compliance department perform its activity when there is lack of control over application workflows?
 - ③ What are the implications (political, legal) for organizations that lose control over some aspects of their services?
 - ④ What will be the perception of end users of such services?

⑤ Organizational Aspects

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CO-PO and CO-PSO Mapping

Course Outcomes		Blooms Level	Modules covered	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	
				O 1	O 2	O 3	O 4	O 5	O 6	O 7	O 8	O 9	O 10	O 11	O 12	S 1	S 2	S 3	S 4
CO 1	Understand and analyze various cloud computing platforms and service provider.	L2	1	3	2	-	-	-	3	-	-	-	-	-	-	-	2	-	2

CO 2	Illustrate various virtualization concepts.	L2	2	3	2	-	-	2	-	-	-	-	-	-	-	-	2	-	2
CO 3	Identify the architecture, infrastructure and delivery models of cloud computing.	L2	3	3	2	-	-	2	-	3	-	-	-	-	-	-	2	-	2
CO 4	Understand the Security aspects of cloud	L2	4	3	2	-	-	-	3	-	-	-	-	-	-	-	2	-	2
CO 5	Define platforms for development of cloud applications.	L2	5	3	2	-	-	3	3	-	-	-	-	-	-	-	2	-	2

CO PO Mapping

COGNITIVE LEVEL	REVISED BLOOMS TAXONOMY KEYWORDS
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

PROGRAM OUTCOMES (PO), PROGRAM SPECIFIC OUTCOMES (PSO)				CORRELATION LEVELS	
PO1	Engineering knowledge	PO7	Environment and sustainability	0	No Correlation
PO2	Problem analysis	PO8	Ethics	1	Slight/Low
PO3	Design/development of solutions	PO9	Individual and team work	2	Moderate/ Medium
PO4	Conduct investigations of complex problems	PO10	Communication	3	Substantial/ High
PO5	Modern tool usage	PO11	Project management and finance		
PO6	The Engineer and society	PO12	Life-long learning		
PSO1	Develop applications using different stacks of web and programming technologies				
PSO2	Design and develop secure, parallel, distributed, networked, and digital systems				
PSO3	Apply software engineering methods to design, develop, test and manage software systems.				
PSO4	Develop intelligent applications for business and industry				