Ref No:

SRI KRISHNA INSTITUTE OF TECHNOLOGY, BENGALURU

COURSE PLAN

Academic Year 2019-20

Program:	B E – Information Science & Engineering
Semester:	7
Course Code:	15CS754
Course Title:	Storage Area Networks
Credit / L-T-P:	3 / 3-0-0
Total Contact Hours:	40
Course Plan Author:	MANJULA K

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Note : Remove "Table of Content" before including in CP Book
     Each Course Plan shall be printed and made into a book with cover page
     Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

A. COURSE INFORMATION

1. Course Overview

Degree:	B E		Program:	IS
Semester:	7		Academic Year:	2019-2020

Course Title:	Storage Area Networks	Course Code:		15CS754
Credit / L-T-P:	3/3-0-0	SEE Duration:		180 Minutes
Total Contact Hours:	40	SEE Marks:		80
CIA Marks:	20	Assignment		3
Course Plan Author:	Manjula K	Sign ..		Dt:
Checked By:		Sign ..		Dt:
CO Targets	CIA Target:85%	SEE Target:		80%

Note: Define CIA and SEE % targets based on previous performance.

2. Course Content

Content / Syllabus of the course as prescribed by University or designed by institute. Identify 2 concepts per module as in G.

Module	Content	Teaching Hours	Identified Module Concepts	Blooms Learning Levels
1	Storage System: Introduction to evolution of storage architecture, key data center elements, virtualization, and cloud computing. Key data center elements –Host (or compute), connectivity, storage, and application in both classic and virtual environments.	4	Storage Architecture	L2 Understand
	RAID implementations, techniques, and levels along with the impact of RAID on application performance. Components of intelligent storage systems and virtual storage provisioning and intelligent storage system implementations.	4	Data protection	L3 Apply
2	Storage Networking Technologies and Virtualization : Fibre Channel SAN components, connectivity options, and topologies including access protection mechanism 'zoning", FC protocol stack, addressing and operations, SAN -based virtualization and VSAN technology, iSCSI and FCIP protocols for storage access over IP network, Converged protocol FCoE and its components.	4	Storage Network Technologies	L3 Apply
	Network Attached Storage (NAS) -components, protocol and operations, File level storage virtualization, Object based storage and unified storage platform.	4	File sharing	L2 Understand
3	Backup, Archive, and Replication: Business continuity terminologies, planning and solutions, Clustering and multipathing architecture to avoid single points of failure,	4	Business continuity solutions	L4 Analyze
	Backup and recovery -methods, targets and topologies, Data deduplication and backup in virtualized environment, Fixed content and data archive, Local replication in classic and virtual environments, Remote replication in classic and virtual environments, Three-site remote replication and continuous data protection	4	Backup and recovery methods	L2 Understand
4	Cloud Computing Characteristics and benefits: ,Business drivers for Cloud computing, Definition of Cloud computing, Characteristics of Cloud computing, Steps involved in transitioning from Classic data center to Cloud computing environment Services and deployment models, Cloud infrastructure components, Cloud migration considerations.	8	Cloud computing architecture	L2 Understand
5	Securing and Managing Storage Infrastructure: implementation at storage networking. Security threats, and countermeasures in various domains Security solutions for FC -SAN, IP-SAN and NAS environments, Security in virtualized and cloud environments.	4	Securing Storage Information	L4 Analyze
	Monitoring and managing various information infrastructure components in classic and virtual environments, Information life cycle management (ILM) and storage tiering, Cloud service management activities.	4	Managing the storage information	L3 Apply
-	**Total**	**40**	-	-

3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).

1. Understanding: Concept simulation / video; one per concept; to understand the concepts; 15 – 30 minutes
2. Design: Simulation and design tools used – software tools used; Free / open source
3. Research: Recent developments on the concepts – publications in journals; conferences etc.

Modules	Details	Chapters in book	Availability
A	**Text books (Title, Authors, Edition, Publisher, Year.)**	-	-
1-5	Information Storage and Management,Author : EMC Education Services, Publisher: Wiley ISBN: 9781118094839		In Library
	Storage Virtualization, Author: Clark Tom, Publisher: Addison Wesley Publishing Company ISBN : 9780321262516		In Library
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	-	-
	NIL		
C	**Concept Videos or Simulation for Understanding**	-	-
C1	*https://www.youtube.com/watch?v=teEsgqI49Dk*		
C2	*https://www.youtube.com/watch?v=w7Ns4jGn7Tc*		
C3	*https://www.youtube.com/watch?v=zb2kEtjMmPg*		
C4	https://searchstorage.techtarget.com/definition/network-attached-storage		
C5	https://www.youtube.com/watch?v=Fs0XtfLNI8I		
C6	https://www.youtube.com/watch?v=Fs0XtfLNI8I		
C7	https://data-flair.training/blogs/storage-virtualization-in-cloud-computing/		
C8	https://slideplayer.com/slide/6199374/		
C9	https://www.youtube.com/watch?v=zsv_sSFhhTE		
D	**Software Tools for Design**	-	-
E	**Recent Developments for Research**	-	-
F	**Others (Web, Video, Simulation, Notes etc.)**	-	-
1	https://www.youtube.com/watch?v=akEr8cUAd5g		

4. Course Prerequisites

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

Students must have learnt the following Courses / Topics with described Content …

Modules	Course Code	Course Name	Topic / Description	Sem	Remarks	Blooms Level
	15CS64	Operating System	Security at the Network Layer, Security at the Transport Layer, IEEE 802.11 Wireless LAN Security, Intrusion Prevention and Detection, Web Service Security	6		L4
	15CS52	Computer Networks	Connection-Oriented Transport TCP, IPv6,A Brief foray into IP Security, Network Support for Multimedia	5		L3

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.

Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Modules	Topic / Description	Area	Remarks	Blooms Level

B. OBE PARAMETERS

1. Course Outcomes

Expected learning outcomes of the course, which will be mapped to POs. Identify a max of 2 Concepts per Module. Write 1 CO per Concept.

Modules	Course Code.#	Course Outcome At the end of the course, student should be able to . . .	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
1	15CS754.1	Understand the need for Storage Area Architecture to manage and monitor the data centers.	4	Storage Architecture	- Lecture - -	- Q&A -Assignment	L2 Understand
1	15CS754.2	Identify the different RAID levels to increase the performance and reliability of data storage.	4	data protection	- Lecture - -	- Q&A -Assignment	L3 Apply
2	15CS754.3	Apply the SAN technologies to increase the storage utilization	4	Storage Network Technologies	- Lecture -	- Q&A -Assignment	L3 Apply
2	15CS754.4	Understand the file sharing operation on NAS and IP-SAN of the different network	4	File sharing	- Lecture -	- Q&A -Assignment	L2 Understand
3	15CS754.5	Analyze the SAN management strategies to fulfill the business continuity requirements	4	Business continuity solutions,	- Lecture -	- Q&A -Assignment	L4 Analyze
3	15CS754.6	Understand the different backup and recovery methods to enhance the storage devices	4	backup and recovery methods	- Lecture	- Q&A -Assignment	L2 Understand
4	15CS754.7	Understand the essential characteristics of cloud computing to handle the different kinds of data transfer	8	Cloud computing architecture	- Lecture -	- Q&A -Assignment	L2 Understand
5	15CS754.8	Analyze different storage security domains to facilitate storage for a system	4	Securing Storage Information	- Lecture -	- Q&A -Assignment	L4 Analyze
5	15CS754.9	Apply the different storage management techniques used to data maintenance.	4	Managing the storage information	- Lecture -	- Q&A -Assignment	L3 Apply
-	-	**Total**	**40**	-	-	-	**L2-L4**

2. Course Applications

Write 1 or 2 applications per CO.
Students should be able to employ / apply the course learnings to...

Modules	Application Area Compiled from Module Applications.	CO	Level
1	Used to Identify key challenges in managing information.	CO1	L2
2	Redundant Array of Independent Disks are used in large file servers, transaction of	CO2	L3

	application servers, where data accessibility is critical, and fault tolerance is required.			
3	Analyze different storage networking technologies and virtualization	CO3	L3	
4	Acquire the fundamental components and the implementation of NAS.	CO4	L2	
5	Analyzing the different continuity solutions in both virtualized and non-virtualized environments.	CO5	L4	
6	Describe Content addressable storage architecture and types of archives and forms of virtualization.	CO6	L2	
7	Understand essential characteristics a phases of journey to the cloud computing.	CO7	L2	
8	Analyze the different storage infrastructure for security in data centers.	CO8	L4	
9	Illustrate the management activities.	CO9	L3	

3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

Modules	Mapping		Mapping Level	Justification for each CO-PO pair	Level
-	CO	PO	-	**'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'**	-
1	CO1	PO1	L2	Knowledge of storage architecture is required to make all storage devices available to all servers.	L2
1	CO1	PO2	L2	To identify and eliminate the bottlenecks in traditional network SAN architecture is required.	L2
1	CO1	PO3	L2	Knowledge of storage architecture is required to build the storage system and to design the storage system	L2
1	CO1	PO4	-	No investigations and interpretation content no mapping	-
1	CO1	PO5	-	No content tool, no mapping	-
1	CO1	PO6	L2	Identify the need for performance evaluation and the metrics used for it	L2
1	CO1	PO7	-	No matching for environment and sustainability	-
1	CO1	PO8	-	No matching for ethical principles	-
1	CO1	PO9	L2	For storing and managing the data at the data centers individual should require the knowledge of storage area networks	L2
1	CO1	PO10	L2	Effective communication on engineering activities will be a part of every activities	L2
1	CO1	PO11	L2	Each and every projects has to maintain storage , to store the projects data understanding the basic concepts of storage is required	L2
1	CO1	PO12	L2	Learning in the context of technology changes .	L2
1	CO2	PO1	L3	Apply the RAID level in file sharing for improving the performance and reliability of data storage	L3
1	CO2	PO2	L3	Identifying different RAID techniques for data availability and performance characteristics of RAID set.	L3
1	CO2	PO3	L2	Designing a disk drives requires the RAID technologies	L2
1	CO2	PO4	-	No investigations and interpretation content no mapping	-
1	CO2	PO5	L2	Apply different RAID techniques for complex activities	L2
1	CO2	PO6	L2	Applying these RAID technique in almost all the engineering and society application	L2
1	CO2	PO7	-	No matching for environment and sustainability	-
1	CO2	PO8	-	No matching for ethical principles	-
1	CO2	PO9	L2	Applications and even various categories of data within a given application require different levels of protection and performance which requires a knowledge of RAID techniques	L2
1	CO2	PO10	-	No matching	-
1	CO2	PO11	L2	Every applications requires a data protection so RAIDS levels must be chosen for protection of data.	L2
1	CO2	PO12	L2	Learning in the context of technology changes	L2
2	CO3	PO1	L3	Apply the suitable SAN technologies to increase storage utilization	L3

2	CO3	PO2	L3	To minimize resource management complexity and cost knowledge of SAN technologies is necessary.	L3
2	CO3	PO3	L3	The underpinnings of SANs are maturing , providing the SAN technology is required for an designing an applications	L3
2	CO3	PO4	L2	Analyzing different SAN techniques used for data utlization requires a knowledge of SAN technologies	L2
2	CO3	PO5	-	No content tool, no mapping	-
2	CO3	PO6	L2	Applying this SAN technique in almost all the engineering and society application	L2
2	CO3	PO7	-	No matching for environment and sustainability	-
2	CO3	PO8	-	No matching for ethical principles	-
2	CO3	PO9	L2	Effective team work or individual hands on practice makes Confident about concept	L2
2	CO3	PO10	L2	Effective communication on engineering activities will be the part of every activities	L2
2	CO3	PO11	L2	Demonstrating knowledge and understanding of Engg principles	L2
2	CO3	PO12	L2	Learning in the context of technology changes	L2
2	CO4	PO1	L2	Apply NAS solutions to database applications and to convert file I/O to block I/O and vice versa	L2
2	CO4	PO2	L2	To analyze the disk space utilization the knowledge of NAS is required.	L2
2	CO4	PO3	L2	Design a NAS solutions for file sharing and object based systems solutions for storing unstructured data .	L2
2	CO4	PO4		No investigation & interpretation content.	
2	CO4	PO5	L4	Designing a IP based infrastructure for storage networking using different IP protocols	L4
2	CO4	PO6	-	No mapping for engineer and society	-
2	CO4	PO7	-	No matching for environment & sustainability.	-
2	CO4	PO8	-	No matching for ethical principles	-
2	CO4	PO9	L2	Effective team work or individual hands on practice makes Confident about concept	L2
2	CO4	PO10	L2	Effective communication on engineering activities will be the part of every activities	L2
2	CO4	PO11	L2	NAS is specialized for serving files either by its hardware, software, or configuration so life long learning is required.	L2
2	CO4	PO12	L2	lifelong learning & understanding the IP networking is essential	L2
3	CO5	PO1	L3	Applying a SAN strategies to reduce the risk of financial loss requires the knowledge business continuity	L3
3	CO5	PO2	L4	Identify risk management and risk mitigation procedures to protect against possible failures	L4
3	CO5	PO3	L4	Develop an BC plan for a business impact analysis.	L4
3	CO5	PO4	L4	Analyze different configuration to identify single point of failure and their impact on business operations.	L4
3	CO5	PO5	L3	Applying a BC technology plans and solutions to mitigate the impact of planned and unplanned downtime of the applications.	L3
3	CO5	PO6	-	No mapping for engineer and society	-
3	CO5	PO7	-	No matching for environment & sustainability.	-
3	CO5	PO8	-	No matching for ethical principles	-
3	CO5	PO9	L2	Effective team work or individual hands on practice makes Confident about concept	L2
3	CO5	PO10	L2	Effective communication on engineering activities will be the part of every activities	L2
3	CO5	PO11	L2	Demonstrating knowledge and understanding of Engg principles	L2
3	CO5	PO12	L2	Learning in the context of technology changes .	L2
3	CO6	PO1	L2	Apply the different backup and recovery methods to data protection	L2
3	CO6	PO2	L2	Analyze the different backup topologies in a virtualized environments	L2

3	CO6	PO3	L2	To design a backup and recovery solutions of data requires a knowledge of back and recovery methods	L2
3	CO6	PO4	-	No investigation & interpretation content.	-
3	CO6	PO5	L2	Predict the different types of replication solutions for data corruption and natural or human disasters.	L2
3	CO6	PO6	-	No mapping for engineer and society	-
3	CO6	PO7	-	No matching for environment & sustainability.	-
3	CO6	PO8	-	No matching for ethical principles	-
3	CO6	PO9	L2	Effective team work or individual hands on practice makes Confident about concept	L2
3	CO6	PO10	-	NO mapping	-
3	CO6	PO11	L2	Applying a backup and recovery methods and solutions to the different applications or projects is essential and requires a learning of basics of backup concepts	L2
3	CO6	PO12	L2	Learning in the context of technology changes .	L2
4	CO7	PO1	L2	Knowledge of Cloud computing is required to select the cloud services to the users.	L2
4	CO7	PO2	L2	Analyze different cloud services for data storing	L2
4	CO7	PO3	L2	Designing a application requires a knowledge of cloud computing	L2
4	CO7	PO4	-	No investigation & interpretation content.	-
4	CO7	PO5	L2	Use different clouds available for developing and storing the applications requires the knowledge of cloud computing	L2
4	CO7	PO6	-	No mapping for engineer and society	-
4	CO7	PO7	-	No matching for environment & sustainability.	-
4	CO7	PO8	-	No matching for ethical principles	-
4	CO7	PO9	L2	To deploy the application on cloud computing requires the knowledge of cloud services	L2
4	CO7	PO10	L2	Effective communication on engineering activities will be the part of every activities	L2
4	CO7	PO11	L2	The applications can be developed using cloud computing models.	L2
4	CO7	PO12		Learning in the context of technology changes .	
5	CO8	PO1	L3	Apply different storage domains to reduce the threats in the network	L3
5	CO8	PO2	L4	To identify the threats that apply to a storage network, access paths to data storage requires the knowledge of security domains	L4
5	CO8	PO3	-	No design and development content. No mapping	-
5	CO8	PO4	L4	Analyzing different security domains for application access, management access to storage and interconnect devices, backup, replication, and archive access.	L4
5	CO8	PO5	-	No content tool, no mapping	-
5	CO8	PO6	-	No mapping for engineer and society	-
5	CO8	PO7	-	No matching for environment & sustainability.	-
5	CO8	PO8	L4	Apply the different securing methods against identified threats in storage networking	L4
5	CO8	PO9	L4	Develop a different securing measures and solution for securing storage infrastructure	L4
5	CO8	PO10	-	No mapping	-
5	CO8	PO11	L2	Demonstrating knowledge and understanding of Engg principles	L2
5	CO8	PO12	L4	Identifying security architecture and protection mechanism in SAN,NAS,IP-SAN environments.	L4
5	CO9	PO1	L2	Knowledge of storage management is necessary for applying the storage management techniques which is used to data maintenance.	L2
5	CO9	PO2	L2	Identifying different storage management techniques for data storing and maintenance	L2
5	CO9	PO3	L3	Develop techniques for evaluating policies for LUN masking, file systems	L3
5	CO9	PO4	-	No investigation & interpretation content.	-

5	CO9	PO5	L4	Using different storage techniques to develop a application is required a knowledge of Storage management	L4
5	CO9	PO6	-	No mapping for engineer and society	-
5	CO9	PO7	-	No matching for environment & sustainability.	-
5	CO9	PO8	-	No matching for ethical principles	-
5	CO9	PO9	L2	Individual should have a knowledge of storage management while developing a projects.	L2
5	CO9	PO10	-	No mapping	-
5	CO9	PO11	L2	Implementation of projects requires the knowledge of storage management	L2
5	CO9	PO12	L2	Learning in the context of technology changes .	L2

4. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

-	-	Course Outcomes	Program Outcomes															-
Mod ules	CO.#	At the end of the course student should be able to . . .	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	Level
1	15CS754.1	Understand the need for Storage Area Architecture to manage and monitor the data centers.	2.3	2.3	2.3	-	-	2.3	-	-	2.3	2.3	2.3	2.3				L2
1	15CS754.2	Identify the different RAID levels to increase the performance and reliability of data storage.	2.3	2.3	2.3	-	2.3	2.3	-	-	2.3	-	2.3	2.3				L3
2	15CS754.3	Apply the SAN technologies to increase the storage utilization	2.3	2.3	2.3	2.3	-	2.3	-	-	2.3	2.3	2.3	2.3				L3
2	15CS754.4	Understand the file sharing operation on NAS and IP-SAN of the different network	2.3	2.3	2.3	-	2.3	-	-	-	2.3	2.3	2.3	2.3				L2
3	15CS754.5	Analyze the SAN management strategies to fulfill the business continuity requirements	2.3	2.3	2.3	2.3	2.3	-	-	-	2.3	2.3	2.3	2.3				L4
3	15CS754.6	Understand the different backup and recovery methods to enhance the storage devices	2.3	2.3	2.3	-	2.3	-	-	-	2.3	-	2.3	2.3				L2
4	15CS754.7	Understand the essential characteristics of cloud computing to handle the different kinds of data transfer	2.3	2.3	2.3	-	2.3	-	-	-	2.3	2.3	2.3	2.3				L2
5	15CS754.8	Analyze different storage security domains to facilitate storage for a system	2.3	2.3	-	2.3	-	-	-	2.3	2.3	-	2.3	2.3				L4
5	15CS754.9	Apply the different storage management techniques used to data maintenance.	2.3	2.3	2.3	-	2.3	-	-	-	2.3	-	2.3	2.3				L3
-	**15CS754**	**Average attainment (1, 2, or 3)**	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**				**2.3**	**2.3**	**2.3**	**2.3**				
-	PO, PSO	1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design																

5. Curricular Gap and Content

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

Mod ules	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping

6. Content Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

Modules	Gap Topic	Area	Actions Planned	Schedule Planned	Resources Person	PO Mapping

C. COURSE ASSESSMENT

1. Course Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Modules	Title	Teach. Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Storage System	8	2	-	-	1	1	2	CO1, CO2	L2,L3
2	Storage Networking Technologies and Virtualization	8	2	-	-	1	1	2	CO3, CO4	L2,L3
3	Backup, Archive, and Replication	8	-	2	-	1	1	2	CO5, CO6	L2,L4
4	Cloud Computing Characteristics and benefits	8	-	2	2	1	1	2	CO7	L2
5	Securing and Managing Storage Infrastructure	8	-	-	2	1	1	2	C08,CO9	L2,L3
-	**Total**	**40**	**4**	**4**	**4**	**5**	**5**	**10**	**-**	**-**

2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Modules	Evaluation	Weightage in Marks	CO	Levels
1, 2	CIA Exam – 1	15	CO1, CO2, CO3, CO4	L2,L3
3, 4	CIA Exam – 2	15	CO5, CO6, CO7	L1, L2, L4
5	CIA Exam – 3	15	C08,CO9	L3, L4
1, 2	Assignment-1	05	CO1, CO2, CO3, CO4	L2,L3
3, 4	Assignment -2	05	CO5, CO6, CO7	L1,L2, L4
5	Assignment -3	05	C08,CO9	L3, L4
1, 2	Seminar-1	-	-	-
3, 4	Seminar- 2	-	-	-
5	Seminar -3	-	-	-
1, 2	Quiz- 1	-	-	-
3, 4	Quiz- 2	-	-	-
5	Quiz- 3	-	-	-
1-5	Other Activities – Mini Project	-	-	-
	Final CIA Marks	**20**	**-**	**-**

D1. TEACHING PLAN -1

Module – 1

Title:	Storage System		Appr Time:	8 Hrs
a	***Course Outcomes***		-	**Blooms**
-	The student should be able to:		-	**Level**

1	Understand the need for Storage Area Architecture to manage and monitor the data centers.		CO1	L2
2	Identify the different RAID levels to increase the performance and reliability of data storage.		CO2	L3
b	*Course Schedule*		-	-
Class No	Portion covered per hour		CO	Level
1	Introduction to evolution of storage architecture, key data center elements,		C01	L2
2	Virtualization, and cloud computing.		C01	L2
3	Key data center elements –Host (or compute)		C01	L2
4	storage, and application in both classic and virtual environments.		C01	L2
5	RAID implementations, techniques,		C02	L3
6	Levels along with the impact of RAID on application performance.		C02	L3
7	Components of intelligent storage systems		C02	L3
8	Virtual storage provisioning and intelligent storage system implementations.		C02	L3
c	**Application Areas**		CO	Level
1	Use to Identify key challenges in managing information		CO1	L2
2	Redundant Array of Independent Disks are used in large file servers, transaction of application servers, where data accessibility is critical, and fault tolerance is required.		CO2	L3
d	**Review Questions**		-	-
1	What is data center? Explain the key characteristics of center elements?		CO1	L2
2	What is structured and unstructured data ?		CO1	L2
3	List the challenges of storing and managing unstructured data?		CO2	L2
4	Identify the various techniques on the basis of which RAID levels are used?		CO2	L3
5	What are the advantages of a virtualized data center over a classic data center?		CO2	L2
6	How are the disk storage systems classified based on its complexity? Explain just a bunch of disks.		CO2	L2
7	With a neat diagram explain the FCIP topology		CO2	L2
8	List the core elements of a data center		CO1	L1
9	What is file? Give examples of common flie systems.		CO2	L1
10	Explain the key features of Enterprise Flash drivers		CO1	L2
e	**Experiences**		-	-

Module – 2

Title:	Storage networking technologies and virtualization		Appr Time:	8 Hrs
a	*Course Outcomes*		-	**Blooms**
-	The student should be able to:		-	**Level**
1	Apply the SAN technologies to increase the storage utilization		CO3	L3
2	Understand the file sharing operation on NAS and IP-SAN of the different network		CO4	L2
b	*Course Schedule*		-	-
Class No	Portion covered per hour		CO	Level
9	Fibre Channel SAN components, connectivity options,		CO3	L2, L3
10	topologies including access protection mechanism 'zoning",		CO3	L2, L3

11	FC protocol stack, addressing and operations,	CO3	L2, L3
12	SAN -based virtualization and VSAN technology,	CO3	L2, L3
13	SCSI and FCIP protocols for storage access over IP network,	CO3	L2, L3
14	Converged protocol FCoE and its components,	CO4	L2
15	Network Attached Storage (NAS) -components, protocol and operations,	CO4	L2
16	File level storage virtualization, Object based storage and unified storage platform.	CO4	L2
c	**Application Areas**	**CO**	**Level**
1	Acquire the fundamental components and the implementation of NAS	CO3	L3
2	Use different continuity solutions in both virtualized and non-virtualized environments.	CO4	L2
d	**Review Questions**	-	-
14	Explain the Fiber Channel SAN components.	CO3	L2
15	List common connectivity protocols used in computing environments?	CO4	L3
16	Define the purpose of zoning.	CO3	L2
17	Show how the communication of a public loop device with a device in the fibre can be accomplished.	CO4	L4
18	What are the different protocols available for transmitting storage data traffic over TCP/IP? Explain the use of these protocols	CO4	L2
19	Compare the difference between FC switch versus FC hub	CO3	L4
e	**Experiences**		

E1. CIA EXAM – 1

a. Model Question Paper – 1

Crs Code:	15CS754	Sem:		7	Marks:		30	Time:		75 minutes	
Course:	C programming for problem solving										

-	-	Note: Answer all questions, each carry equal marks. Module : 1, 2	Marks	CO	Level
		MODULE-1			
1	a	Explain the five core technology elements of the Data Center Infrastructure?	5	CO1	L2
	b	An application has 1000 heavy users at a peak of 2 IOPS each and 2000 typical users at a peak of 1 IOPS each, with a read/write ratio of 2:1. it is estimated that the application also experiences an overhead of 20 percent for other workloads. Calculate the IOPS requirements for RAID 1, RAID 3.	5	CO2	L3
	c	Explain the service classes of Fiber Channel	5	CO3	L2
		OR			
2	a	With a neat diagram explain the different ways of connecting IO channels in internal hard disk in a disk subsystem.	5	CO1	L2
	b	Compare the principle of operation in RAID 0 + 1 and RAID 10 level?	5	CO2	L2
	c	Classify the different protocols available for transmitting storage data traffic over TCP/IP? Explain the use of these protocols ?	5	CO2	L2
3	a	Explain briefly layers of FC protocols.	5	CO3	L2
	b	Consider a isk I/O system in which an I/O request arrives at rate of 80 IOPS. The disk services time in 6 ms. Compute I) Utilization ii) response time iii) average queue size iv) time spent by request in a queue.	5	CO4	L3
	c	Summarize the issues that are important to known and understand to facilitate a long term productive NAS configuration.	5	C04	L2
		OR			
4	a	Write a note on SCSI architecture	5	CO4	L2

	b	Compare NAS , fiber channel SAN anD iSCSI SAN?	5	CO4	L2
	c	What is storage virtualization? Differentiate between block levels and file level virtualization.	5	CO3	L3

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions						
Crs Code:	15CS754	Sem:	7	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	Storage Area Networks					

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

SNo	USN	Assignment Description	Marks	CO	Level
1		Explain the various components of disk drive?	5	CO1	L2
2		Explain the various techniques on the basis of which RAID levels are defined.	5	CO2	L3
3		Differentiate storage centric IT architecture from server centric IT architecture.	5	CO1	L2
4		With neat diagram explain the architecture of intelligent disk storage	5	CO2	L2
5		Show the different RAID operation levels?	5	CO2	L3
6		Explain the RAID 0 level and RAID 1 level?	8	CO2	L2
7		The average I/O size of an application is 64 KB. The following specifications are available from the disk manufacture: average ssek time= 5ms, 7200 RPM, and transfer rate = 40 MB/s. determine the maximum IOPS that could perform with the disk for application.	8	CO2	L3
8		What are the advantages of a virtualized data center over classic data center.	5	CO1	L2
9		Which type of application benefits the most by bypassing write cache. Justify your answer.	5	CO1	L3
10		What is the stripe size of a five disk RAID 5 set with a strip size of 32 KB? Compare it with the stripe of a five disk RAID 0 array with the same strip size	5	CO2	L3
11		Explain the FC SAN architecture	5	CO3	L2
12		Describe NAS implementation and benefits.	10	CO3	L3
13		17 switches with 16 ports are connected in a full mesh topology. How many ports are available for host and storage connectivity.	08	CO4	L4
14		Discuss the object storage and retrieval process in a OSD system.	08	CO4	L2
15		List the CAS key features.	05	CO4	L2
16		Compare the difference between multimode and single mode fibre with diagram	08	CO3	L2

D2. TEACHING PLAN-2

Module – 3

Title:	Backup, Archive and replication	Appr Time:	8 Hrs
a	Course Outcomes	-	Blooms
-	The student should be able to:	-	Level
1	Analyze the SAN management strategies to fulfill the business continuity requirements	CO5	L4
2	Understand the different backup and recovery methods to enhance the storage devices	CO6	L2
b	Course Schedule		
Class No	Portion covered per hour	CO	Level
17	This unit focuses on information availability and business continuity solutions in both virtualized and non -virtualized environments.	CO5	L4

18	Business continuity terminologies, planning and solutions,	CO5	L4
19	Clustering and multipathing architecture to avoid single points of failure, Backup and recovery -methods,	CO5	L4
20	targets and topologies, Data deduplication	CO6	L2
21	backup in virtualized environment, Fixed content and data archive,	CO6	L2
22	Local replication in classic and virtual environments,	CO6	L2
23	Remote replication in classic and virtual environments,	CO6	L2
24	Three-site remote replication and continuous data protection	CO6	L2
c	**Application Areas**	**CO**	**Level**
1	Analyzing the different continuity solutions in both virtualized and non-virtualized environments.	CO6	L4
2	Describe Content addressable storage architecture and types of archives and forms of virtualization	CO7	L2
d	**Review Questions**	-	-
1	Analyze the difference between Disaster Recovery and Disaster Restart	CO6	L4
2	What are the primary purposes for backup	CO6	L3
3	What are the challenges of storage virtualization	CO7	L2
4	What are the three levels of granularity found in Backup	CO7	L2
5	What is the difference between synchronous and Asynchronous mode	CO7	L2
6	Discuss one host based remote replication technology?	CO7	L2
e	**Experiences**	-	-

Module – 4

Title:	Cloud Computing Characteristics and Benefits	Appr Time:	8 Hrs
a	*Course Outcomes*	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Understand essential characteristics a phases of journey to the cloud computing	CO7	L2
b	*Course Schedule*		
Class No	**Portion covered per hour**	**CO**	**Level**
25	business drivers, definition, essential characteristics,	CO7	L2
26	phases o f journey to the Cloud.	CO7	L2
27	Business drivers for Cloud computing, Definition of Cloud computing,	CO7	L2
28	Characteristics of Cloud computing,	CO7	L2
29	Steps involved in transitioning from Classic data center to Cloud computing environment Services	CO7	L2
30	Services and deployment models,	CO7	L2
31	Cloud infrastructure components,	CO7	L2
32	Cloud migration considerations	CO7	L2
c	**Application Areas**	**CO**	**Level**
1	Understand essential characteristics a phases of journey to the cloud computing	CO7	L2
d	**Review Questions**	-	-
11	Define cloud computing	CO7	L1
12	List the characteristics of cloud computing.	CO7	L2
13	What are the cloud challenges	CO7	L2
14	Explain the cloud management and service creation tools.	CO7	L2
15	Explain the cloud service models.	CO7	L2

e	**Experiences**		-	-

E2. CIA EXAM – 2

a. Model Question Paper – 2

Crs Code:	15CS754	Sem:	7	Marks:	30	Time:	75 minutes		
Course:	C programming for problem solving								
-	-	**Note: Answer all questions, each carry equal marks. Module : 3, 4**					**Marks**	**CO**	**Level**
1	a	What is zoning ? discuss a scenario i) Where WWN zoning is preferred over port zoning. ii) Where port zoning is preferred over WWN zoning.					5	CO4	L4
	b	What is business continuity? Explain Bc planning life cycle with a neat diagram					5	CO5	L2
	c	What are the characteristics of cloud computing					5	CO7	L2
		OR							
2	a	What is Storage array based remote replication?					5	CO6	L2
	b	How does cloud computing bring in business agility?					5	CO7	L2
	c	Analyze the two three site replication.					5	CO6	L4
3	a	Analyze the two replication mode .					5	CO6	L4
	b	Describe the uses of a local replica in various business opeartions.					5	CO6	L2
	c	Explain various consideration for selecting a public cloud service provider.					5	CO7	L2
		OR							
4	a	Explain server clustering technology used in a data center.					5	CO5	L2
	b	Classify the various considerations using tape as the backup technology.					5	CO6	L3
	c	A system has three components and requires all three to be operational during 8 a.m. to 5 p.m. business hours, Monday through Friday. Failure of component 2 occurs as follows: i)Monday= 8 a.m. to 11 a.m. ii)Tuesday= no failure iii) Wednesday= 4.p.m. to 7.p.m iv) Thursday = 5 p.m. to 8 p.m. v) Friday= 1 p.m. to 2 p.m. calculate the availability of component 2					5	CO6	L3

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions								
Crs Code:	15CS754	Sem:	7	Marks:	5 / 10	Time:	90 – 120 minutes	
Course:	Storage Area Networks			Module:3,4				
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.								
SNo	**USN**	**Assignment Description**				**Marks**	**CO**	**Level**
1		List the various factors that determine storage capacity requirements for a save location in a pointer based replication technologies				8	CO6	L3
2		A system has three components and requires all three to be operational during 8 a.m. to 5 p.m. business hours, Monday through Friday. Failure of component 2 occurs as follows: i)Monday= 8 a.m. to 11 a.m. ii)Tuesday= no failure iii) Wednesday= 4.p.m. to 7.p.m iv) Thursday = 5 p.m. to 8 p.m. v) Friday= 1 p.m. to 2 p.m. calculate the availability of component 2				5	CO6	L3
3		Analyze the two three site replication.				5	CO6	L4
4		What are the costs that should be evaluated to determine the financial advantage of cloud.				5	CO7	L2

5		List and explain the different data deduplication implementation.	10	CO6	L4
6		List the set of tasks in Business impact analysis.	5	CO5	L4
7		Compare the two storage array based remote replication	5	CO6	
8		Explain the difeerent cloud deployment models.	10	CO7	L2
9		Explain the cloud challenges.	5	CO7	L2
10		Explain the service oriented Architecture and its application in cloud computing	5	CO7	L2
11		Define information availability in terms of information	5	CO5	L1
12		With neat diagram explain resolving single points of failure	8	CO5	L2
13		List and explain the uses of local replicas	8	CO6	L2
14		With diagram explain creating multiple replicas at different PIT	7	CO6	L3
15		List the characteristics of cloud optimized storage solution.	5	CO7	L2
16		Explain the key considerations for cloud adoption	7	CO7	L2

D3. TEACHING PLAN-3
Module – 5

Title:	Securing and Managing Infrastructure		Appr Time:	8 Hrs
a	*Course Outcomes*	-		**Blooms**
-	The student should be able to:	-		**Level**
1	Analyze different storage security domains to facilitate storage for a system	CO8		L4
2	Apply the different storage management techniques used to data maintenance.	CO9		L3
b	*Course Schedule*			
Class No	**Portion covered per hour**	**CO**		**Level**
33	Framework and domains of storage security along with covering security.	CO8		L2,L4
34	Implementation at storage networking. Security threats,	CO8		L2,L4
35	countermeasures in various domains Security solutions for FC -SAN,	CO8		L2,L4
36	IP-SAN and NAS environments,	CO8		L2,L4
37	Security in virtualized and cloud environments,	CO8		L2,L4
38	Monitoring and managing various information infrastructure components in classic and virtual environments,	CO9		L2,L3
39	Information life cycle management (ILM)	CO9		L2,L3
40	storage tiering Cloud service management activities	CO9		L2,L3
c	**Application Areas**	**CO**		**Level**
1	Analyze the different storage infrastructure for security in data centers	CO8		L4
2	Used to Illustrate the management activities	CO9		L2
d	**Review Questions**	-		-
1	Explain the basic SAN security mechanism	CO8		L2
2	How is security implemented in NAS	CO8		L2
3	Describe the physical configuration management for NAS	CO8		L2
4	Analyze the two authentication mechanism in IP SAN?	CO9		L4
5	Describe different security elements	CO9		L2
6	Analyze the switch failure in a storage infrastructure	CO8		L4
e	**Experiences**	-		-

E3. CIA EXAM – 3
a. Model Question Paper – 3

Crs Code:	15CS754	Sem:		7	Marks:		30	Time:		75 minutes		
Course:	Storage Area Networks											
-	-	**Note: Answer all questions, each carry equal marks. Module: 5**							**Marks**		**CO**	**Level**
1	a	Analyze the categories on the basis of which storage management is classified							5		CO8	L4
	b	Explain the implementation of intra array storage tiering.							5		CO9	L2
	c	Explain risk traid.							5		CO8	L2
		OR										
2	a	Explain the four security attributes which are under threat.							5		CO8	L2
	b	List and explain various security concerns and measures in a virtualized and cloud environment.							5		CO8	L3
	c	List the ProSphere capabilities							5		CO9	L2
3	a	Write a short note on accessibility monitoring							5		CO9	L2
	b	Explain the SAN security architecture with diagram.							5		Co8	L2
	c	With a neat diagram explain the FC SAN security architecture							5		CO9	L3
		OR										
4	a	Explain storage management activities in detail with example.							5		CO9	L4
	b	Write a short note on Kerberos							5		CO9	L2
	c	Explain the protection strategies implemented in various security zones.							5		CO9	L2

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions											
Crs Code:	15CS754	Sem:	7	Marks:	5 / 10	Time:	90 – 120 minutes				
Course:	Storage Area Networks										
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.											
SNo	**USN**	**Assignment Description**							**Marks**	**CO**	**Level**
1		Explain the security attributes of storage security frame works.							5	CO8	L2
2		What are the components monitored for storage infrastructures.							5	CO9	L2
3		Explain the storage infrastructure management activities in detail.							5	CO9	L3
4		Describe SAN security architecture with diagram.							8	CO8	L3
5		Explain the concept of Kereros with a neat diagram.							8	CO9	L2
6		Write a note on accessibility monitoring							5	CO9	L2
7		Describe the categories on the basis of which storage management is classified.							5	CO9	L4
8		Explain the protection strategies implemented in various security zones.							5	CO9	L2
9		Classify the different SAN security mechanism. Explain them in brief							10	CO8	L3
10		Explain storage multitenancy and its advantages and disadvantages.							10	CO9	L2

F. EXAM PREPARATION
1. University Model Question Paper

Course:	Storage Area Networks						Month / Year	December/2019
Crs Code:	15CS754		Sem:		7	Marks:	80	Time:		180 minutes
-	**Note**	Answer all FIVE full questions. All questions carry equal marks.					**Marks**	**CO**	**Level**
1	a	Briefly explain the key data elements of Storage system.					08	CO1	L2
	b	An application generates 7650 IOPS with 50% being READ operation with disk handling capacity of 180 IOPS. Determine the disk load and number					05	CO2	L3

		of disks required in RAID 5 configuration. (given write penalty of RAID 5 is 4			
	c	With a neat diagram , explain the architecture of intelligent disk storage system.	07	CO1	L3
		OR			
-	a	What are the two major goals of RAID system? Explain the three major techniques used in RAID configurations.	08	CO2	L2
	b	How RAID 1 + 0 and RAID 0+1 are different. Explain , Why RAID 0 not an option for data protection and high availability? Justify	08	CO2	L3
	c	Explain cache on hard disk and read cache in raid controller	04	CO2	L2
2	a	Explain the Services classes in fiber channel	08	C03	L2
	b	Compare NAS and fibre channel San.	06	CO4	L3
	c	Briefly explain symmetric storage virtualization	06	CO3	L2
		OR			

	a	Explain
		    i) Addressing in fiber channel.
		    ii) Fibre channel frame format.
			06	CO3	L2

	b	Consider a isk I/O system in which an I/O request arrives at rate of 80 IOPS. The disk services time in 6 ms. Compute I) Utilization ii) response time iii) average queue size iv) time spent by request in a queue.	08	CO4	L3
	c	What is SCSI ? how SCSi addresses its device?	06	CO3	L2
3	a	What is business continuity? Discuss the role of storage network in business continuity.	08	CO5	L3
	b	Explain the server clustering technology used in a data center.	07	CO5	L2
	c	Describe the benefits of using a virtual tape library over a physical tape library.	05	CO6	L2
		OR			
	a	With a neat diagram explain BC planning life cycle.	08	CO5	L2
	b	A system has three components and requires all three to be operational during 8 a.m. to 5 p.m. business hours, Monday through Friday. Failure of component 2 occurs as follows: i)Monday= 8 a.m. to 11 a.m. ii)Tuesday= no failure iii) Wednesday= 4.p.m. to 7.p.m iv) Thursday = 5 p.m. to 8 p.m. v) Friday= 1 p.m. to 2 p.m. calculate the availability of component 2	06	CO6	L3
	c	With a neat diagram explain the backup architecture.	06	CO6	L2
4	a	Explain the characteristics of cloud computing.	08	CO7	L2
	b	Explain the benefits of Cloud computing	05	CO7	L2
	c	With a neat diagram explain the community cloud.	07	CO7	L2
		OR			
	a	Explain the cloud enabling Technologies.	05	CO7	L2
	b	Explain three cloud service models .	07	CO7	L2
	c	Explain the cloud infrastructure model with a neat diagram	08	CO7	L2
5	a	Explain various security concerns and measures in the virtualized and cloud environment.	08	CO8	L2
	b	Describe the categories on the basis of which storage management is classified.	07	CO9	L4
	c	Explain storage management activities in detail with example.	05	CO9	L4
		OR			
	a	Explain the protection strategies implemented in various security zones.	07	CO9	L3
	b	Write a short note on Kerberos	05	CO9	L2
	c	Explain the storage tiering with neat diagram in intra array storage tiering.	08	CO9	L2

2. SEE Important Questions

Course:	Storage Area Networks	Month / Year	December/2019

Crs Code:	15CS754		Sem:		7		Marks:		80		Time:			180 minutes	
	Note	Answer all FIVE full questions. All questions carry equal marks.										-		-	
Module	Qno.	Important Question										**Marks**	**CO**		**Year**
1	1	What is data center? Explain the key characteristics of data elements.										10	CO1		2016
	2	Explain the various components of disk drives.										06	CO1		2016
	3	Consider a disk I/O system in which an I/O request arrives at the rate of 80 IOPS. The disk services time is 6ms. Computer the following I) utilization ii) response time iii) average quque size iv) time spent by request in a queue										04	CO2		2016
	4	Explain the various techniques on the basis of which RAID levels defined.										09	CO2		2016
	5	What is information life cycle management . Describe ILM implementation with benefits.										10	CO2		2017
2	1	Explain FC frame										4	CO3		2017
	2	Describe the NAS implementation with its benefits.										10	CO3		2017
	3	What is Iscsi? Explain the protocol stack with neat diagram										10	CO3		2017
	4	Compare NAS and fibre channel San.										05	CO4		2016
	5	Briefly explain symmetric storage virtualization										06	CO4		2015
3	1	Describe the benefits of using a virtual tape library over a physical tape library.										08	CO7		
	2	Explain the server clustering technology used in a data center. What is business continuity?										05	CO7		
	3	Discuss the role of storage network in business continuity.										07	CO7		2016
	4	List the set of tasks in Business impact analysis.										5	CO5		
	5	Compare the two storage array based remote replication										5	CO6		
4	1	Explain the characteristics of cloud computing.										08	CO7		
	2	Explain the benefits of Cloud computing										05	CO7		
	3	With a neat diagram explain the community cloud.										07	CO7		
	4	Explain the different cloud deployment models.										07	CO7		
	5	Explain the cloud challenges.										05	CO7		
	6	Explain the service oriented Architecture and its application in cloud computing										08	CO7		
5	1	Explain various security concerns and measures in the virtualized and cloud environment.										08	CO8		2016
	2	Describe the categories on the basis of which storage management is classified.										07	CO9		2010
	3	Explain storage management activities in detail with example.										05	CO9		
	4	Explain the protection strategies implemented in various security zones.										07	CO9		2017
	5	Write a short note on Kerberos										05	CO9		2015
	6	Explain the storage tiering with neat diagram in intra array storage tiering.										08	CO9		

G. Content to Course Outcomes

1. TLPA Parameters

Table 1: TLPA – Example Course

Module-#	Course Content or Syllabus (Split module content into 2 parts which have similar concepts)	Content Teaching Hours	Blooms' Learning Levels for Content	Final Blooms' Level	Identified Action Verbs for Learning	Instruction Methods for Learning	Assessment Methods to Measure Learning
A	B	C	D	E	F	G	H
1	Storage System: Introduction to evolution of storage architecture, key data center elements, virtualization, and cloud	4	- L1 - L2	L2	- Understand	- Lecture - -	- Q&A -Assignment

	computing. Key data center elements –Host (or compute), connectivity, storage, and application in both classic and virtual environments.						
1	RAID implementations, techniques, and levels along with the impact of RAID on application performance. Components of intelligent storage systems and virtual storage provisioning and intelligent storage system implementations.	4	-L2 - L3	L3	-Develop - -	- Lecture -	- Q&A -Assignment
2	Storage Networking Technologies and Virtualization : Fibre Channel SAN components, connectivity options, and topologies including access protection mechanism 'zoning", FC protocol stack, addressing and operations, SAN -based virtualization and VSAN technology, iSCSI and FCIP protocols for storage access over IP network, Converged protocol FCoE and its components.	4	- L2 - L3	L3	-Develop -	- Lecture -	- Q&A -Assignment
2	Network Attached Storage (NAS) -components, protocol and operations, File level storage virtualization, Object based storage and unified storage platform.	4	- L1 - L2	L2	- Understand -	- Lecture -	- Q&A -Assignment
3	Backup, Archive, and Replication: Business continuity terminologies, planning and solutions, Clustering and multipathing architecture to avoid single points of failure,	4	- L2 - L3 - L4	L4	- Implement -	- Lecture -	- Q&A -Assignment
3	Backup and recovery -methods, targets and topologies, Data deduplication and backup in virtualized environment, Fixed content and data archive, Local replication in classic and virtual environments, Remote replication in classic and virtual environments, Three-site remote replication and continuous data protection	4	- L1 - L2	L2	- Understand -	- Lecture -	- Q&A -Assignment
4	Cloud Computing Characteristics and benefits: ,Business drivers for Cloud computing, Definition of Cloud computing, Characteristics of Cloud computing, Steps involved in transitioning from Classic data center to Cloud computing environment Services and deployment models, Cloud infrastructure components, Cloud migration considerations.	8	- L1 - L2	L2	- Understand -	- Lecture -	- Q&A -Assignment
5	Securing and Managing Storage Infrastructure: implementation at storage networking. Security threats, and countermeasures in various domains Security solutions for FC -SAN, IP-SAN and NAS environments, Security in virtualized and cloud environments.	4	- L2 - L3 - L4	L4	- Implement -	- Lecture -	- Q&A -Assignment
5	Monitoring and managing various information infrastructure components in classic and virtual environments, Information life cycle management (ILM) and storage tiering, Cloud service management activities.	4	- L2 - L3	L3	-Develop -	- Lecture -	- Q&A -Assignment

2. Concepts and Outcomes:

Table 1: Concept to Outcome – Example Course

Module-#	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or outcome)	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome **Student Should be able to …**
A	I	J	K	L	M	N
1	- Study of Storage Systems	- Data centers	Storage Architecture	Understand Storage Area Architecture	- Understand - Storage Area Architecture -Data centers	Understand the need for Storage Area Architecture to manage and monitor the data centers.
1	-Study of Data Protection	- Intelligent Storage Systems	data protection	Identifying the different RAID levels	-Identify - RAID levels - Data storage.	Identify the different RAID levels to increase the performance and reliability of data storage.
2	-Study of Storage Network Technologies	-Storage utilization	Storage Network Technologies	Applying the SAN technologies.	- Apply - SAN technologies - Storage utilization	Apply the SAN technologies to increase the storage utilization
2	-Study of File sharing	-NAS and IP-SAN	File sharing	Understand the File sharing in different network.	- Understand - File sharing - NAS and IP-SAN	Understand the file sharing operation on NAS and IP-SAN of the different network
3	-Study of Business continuity solutions,	- SAN management	Business continuity solutions	Analyzing the business continuity requirements.	- Analyze - SAN management - Business continuity	Analyze the SAN management strategies to fulfill the business continuity requirements
3	-Study of backup and recovery methods	-Storage devices	backup and recovery methods	Understand the backup and recover methods.	- Understand -Backup and recover - Storage devices	Understand the different backup and recovery methods to enhance the storage devices
4	-Study of Cloud computing architecture	-data transfer	Cloud computing architecture	Understand the characteristics of cloud computing.	- Understand - Cloud computing - Data transfer	Understand the essential characteristics of cloud computing to handle the different kinds of data transfer
5	-Study of Securing Storage Information	-Storage security	Securing Storage Information	Analyzing the storage security.	- Analyze - Storage security - Storage devices	Analyze different storage security domains to facilitate storage for a system
5	-Study of Managing the storage information	- Data maintenance	Managing the storage information	Applying the storage management techniques.	- Apply - Storage management techniques - Data maintenance.	Apply the different storage management techniques used to data maintenance.