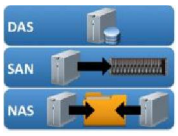
Government of Karnataka
Department of Technical Education
Bengaluru

	**Course Title: Information Storage and Management**		
	Scheme (L:T:P) : **4:0:0**	Total Contact Hours: **52**	Course Code: **15CS63A**
	Type of Course: **Lectures, Self Study & Student Activity.**	Credit **:04**	Core/ Elective: **Elective**
CIE- 25 Marks			SEE- 100 Marks

Prerequisites

Basic knowledge about Networking.

Course Objectives

To Understand the Concept of Information Storage, Data centre Environment, Data Protection, Fibre Channel SAN and Backup and Archive Techniques.

Course Outcome

On successful completion of the course, the students will be able to attain below Course Outcome (CO):

Course outcome		CL	Linked PO	Teaching Hours
CO1	To Understand the Concept of Information Storage and Data centre Environment.	***R,U,A***	**1,2,8,9,10**	**12**
CO2	To understand about Data Protection.	***U,A***	**1,2,4,8,9,10**	**08**
CO3	To Know and understand Intelligent Storage System.	***R,U,A***	**1,2,4,8,9,10**	**08**
CO4	To Understand Fibre Channel SAN	***U,A***	**1,2,4,8,9,10**	**10**
CO5	To Understand Network Attached Storage (NAS).	***U,A***	**1,2,4,8,9,10**	**06**
CO6	To Know the Backup and Archive Technologies.	***U,A***	**1,2,4,8,9,10**	**08**
			Total	**52**

Legends: R = Remember U= Understand; A= Apply and above levels (Bloom's revised taxonomy)

Course-PO Attainment Matrix

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Information Storage and Management	**3**	**3**		**3**				**3**	**3**	**3**

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.
Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.
If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3
If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2
If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1
If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not addressed.

Course Content and Blue Print of Marks for SEE

Unit No	Unit Name	Hour	Questions to be set for SEE			Marks Weightage	Marks Weightage (%)
			R	U	A	A	
I	Introduction to Information Storage and Data centre Environment.	12	10	15	05	30	22.75
II	Data Protection : RAID	08	-	10	10		15.17
III	Intelligent Storage System.	08	10	10	10		15.17
IV	Fibre Channel Storage Area Networks	10	-	20	20		19.32
V	Network Attached Storage	06	-	10	10		12.42
VI	Backup and Archive	08	-	10	10		15.17
	Total	**52**	**20**	**80**	**70**	**145**	**100**

UNIT I : Introduction to Information Storage and Data centre Environment. 12 Hrs

Introduction to Information Storage- Information Storage, Data, Types of Data, Big Data, Information, Storage, Evolution of Storage Architecture, Data Centre Infrastructure, Core Elements, Key characteristics for Data Centre Elements, Managing Data centre, Virtualization and Cloud Computing.

Data Centre Environment -Application, DBMS, Host, OS, Memory Virtualization, Device Driver, Volume Manager, File System, Compute Virtualization, Connectivity- Physical Components of Connectivity, Interface protocols- IDE/ATA and Serial ATA, SCSI and Serial SCSI, Fibre Channel, Internet Protocol, Storage, Disk Drive Components- Platter, Spindle, R/W Head, Actuator Arm Assembly, Drive Controller Board, Physical Disk Structure, Zoned Bit Recording, Logical Block Addressing, Disk Drive Performance- Disk Service Time, Seek Time, Rotational Latency, Data Transfer Rate; Host Access to Data, Direct-Attached Storage- Benefits and Limitations, Storage Design Based on Application,

Requirements and Disk Performance, Disk Native Command Queuing, Introduction to Flash Drives- Components and Architecture of Flash Drives, Features Of Enterprise Flash drives.

UNIT II: Data protection: RAID **08 Hrs**

Data Protection: RAID - Implementation of RAID, Software RAID, Hardware RAID, RAID Array Components, RAID Techniques- Striping, Mirroring, Parity; RAID Levels- RAID 0, RAID 1, Nested RAID, RAID 3, RAID 4, RAID 5, RAID 6, RAID Impact on Disk Performance, Application IOPS and RAID Configurations, RAID Comparison, Hot Spares.

UNIT III: Intelligent Storage System **08 Hrs**

Intelligent Storage System - Components of an Intelligent Storage System, Front End, Cache- Structure of Cache, Read Operation with Cache, Write Operation with Cache, Cache Implementation, Cache management, Cache Data Protection, Back End, Physical Disk, Storage Provisioning- Traditional Storage Provisioning, LUN Expansion: Meta LUN, Virtual Storage Provisioning, Comparison between Virtual and Traditional Storage Provisioning, LUN Masking, Types of Intelligent Storage Systems- High end Storage Systems, Mid Range Storage Systems.

UNIT IV: Fibre Channel Storage Area Networks **10 Hrs**

Fibre Channel Storage Area Networks - Fibre Channel: Overview, The SAN and Its Evolution, Components of FC-SAN, Node Ports, Cables and Connectors, Interconnect Devices, SAN Management Software, FC Connectivity, Point-to-Point, Fibre Channel Arbitrated Loop, Fibre Channel Switched Fabric, FC-SW Transmission, Switched Fabric Ports, Fibre Channel Architecture, Fibre Channel Protocol Stack- FC-4 Layer, FC-2 Layer, FC-1 Layer, FC-0 Layer, Fibre Channel Addressing, World Wide Names, FC Frame, Structure and Organization of FC Data, Flow Control- BB_Credit, EE_Credit,, Classes of Service, Fabric Services, Switched Fabric Login Types, Zoning, FC SAN Topologies- Mesh Topology, Core-Edge Fabric, Benefits and Limitations of Core Edge Fabric.

UNIT V: Network Attached Storage **06 Hrs**

Network-Attached Storage - General-Purpose Servers vs. NAS Devices, Benefits of NAS, File Systems and Network File Sharing- Accessing a File System, Network File Sharing; Components of NAS, NAS I/O Operations ,NAS Implementations- Unified NAS, Unified NAS Connectivity, Gateway NAS, Gateway NAS Connectivity, Scale Out NAS, Scale Out NAS Connectivity, NAS File-Sharing Protocols- NFS, CIFS; Factors Affecting NAS Performance, File Level Virtualization.

UNIT VI: Backup and Archive **08 Hrs**

Backup Purpose- Disaster Recovery, Operational Backup, Archival, Backup Considerations, Backup Granularity, Recovery Considerations, Backup Methods, Backup Architecture, Backup and Restore Operations, Backup Topologies, Backup in NAS Environments- Server Based and Server less Backup, NDMP- Based Backup; Backup Targets- Backup to Tape, Physical Tape Library, Limitations of Tape; Backup to Disk, Backup to Virtual Tape, Data Deduplication for Backup- Data Deduplication Methods, Data Deduplication Implementation, Backup in Virtualized Environments, Data Archive, Archiving Solution Architecture- Use Case- Email and File Archiving.

Text books

1. Information Storage and Management, Second Edition, EMC Education Services, Wiley India Edition, ISBN: 9788126537501.

References

1. Storage Networks Explained, Ulf Tropan, Rainer Erkens, Wofgang Muller, Wiley, ISBN: 9788126518326

Suggested list of student activities

Note: the following activities or similar activities for assessing CIE (IA) for 5 marks (Any one)

Student activity like mini-project, surveys, quizzes, etc. should be done in group of 3-5 students.

1. Each student should do any one of the following type activity or any other similar activity related to the course and before conduction, get it approved from concerned course coordinator and programme coordinator.
2. Each student should conduct different activity and no repeating should occur

1	Prepare a presentation on different types of topologies
2	Survey on Network-Attached Storage
3	Survey on RAID Calculator

Course Delivery

The course will be delivered through lectures and Power point presentations/ Video

Course Assessment and Evaluation Scheme

Method	What		To whom	When/Where (Frequency in the course)	Max Marks	Evidence collected	Course outcomes
Direct Assessment	CIE	IA	Students	Three IA tests (Average of three tests will be computed)	20	Blue books	1,2,3,4
				Student activities	05	Report	1,2,3,4
				Total	**25**		
	SEE	End Exam		**End of the course**	**100**	Answer scripts at BTE	1,2,3,4
Indirect Assessment	Student Feedback on course		Students	Middle of the course		Feedback forms	1 & 2 Delivery of course
	End of Course Survey			End of the course		Questionnaires	1,2,3,4 Effectiveness of Delivery of instructions & Assessment Methods

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No	Bloom's Category	%
1	Remembrance	14
2	Understanding	55
3	Application	48

Note to IA verifier*: *The following documents to be verified by CIE verifier at the end of semester

1. Blue books (20 marks)
2. Student suggested activities report for 5 marks
3. Student feedback on course regarding Effectiveness of Delivery of instructions & Assessment Methods.

FORMAT OF IA TEST QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
Ex: I test/6 th week of sem 10-11 AM	VI SEM		20
	Year: 2017-18		

Name of Course coordinator :
Units:__ CO's:____

Question no	Question	MARKS	CL	CO	PO
1					
2					
3					
4					

Note: Internal choice may be given in each CO at the same cognitive level (CL).

MODEL QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
Ex: I test/6 th week of sem 10-11 AM	VI SEM	**Information Storage and Management**	20
	Year: 2017-18	Course code: **15CS63A**	

Name of Course coordinator :
Units:1,2 CO- 1,2

Note: Answer all questions

Question no	Question	CL	CO	PO
1	Define data. Explain the types of data with diagram.	R	CO1	1,2,8,9, 10
2	Differentiate between server-centric and information-centric storage architecture.	U	CO1	
3	Explain the different RAID techniques with diagrams. **OR** Briefly explain the different RAID levels with diagrams.	A	CO2	1,2,4,8, 9,10

Format for Student Activity Assessment

DIMENSION	Unsatisfactory 1	Developing 2	Satisfactory 3	Good 4	Exemplary 5	Score
Collection of data	Does not collect any information relating to the topic	Collects very limited information; some relate to the topic	Collects some basic information; refer to the topic	Collects relevant information; concerned to the topic	Collects a great deal of information; all refer to the topic	3
Fulfill team's roles & duties	Does not perform any duties assigned to the team role	Performs very little duties	Performs nearly all duties	Performs all duties	Performs all duties of assigned team roles with presentation	4
Shares work equally	Always relies on others to do the work	Rarely does the assigned work; often needs reminding	Usually does the assigned work; rarely needs reminding	Does the assigned job without having to be reminded.	Always does the assigned work without having to be reminded and on given time	3

					frame	
Listen to other Team mates	Is always talking; never allows anyone else to speak	Usually does most of the talking; rarely allows others to speak	Listens, but sometimes talk too much	Listens and contributes to the relevant topic	Listens and contributes precisely to the relevant topic and exhibit leadership qualities	3
					TOTAL	**13/4=3.25=4**

Note: This is only an example. Appropriate rubrics/criteria may be devised by the concerned Course Coordinator for assessing the given activity

MODEL QUESTION PAPER Code: **15CS63A**

Diploma in Computer Science & Engineering

VI- Semester

Course Title: Information Storage & Management

Time: **3 Hours** Max Marks**: 100**

PART-A

Answer any SIX questions. Each carries 5 marks. 5X6=30 Marks

1. Mention the key challenges in managing information.
2. Write a note on Virtualization
3. Explain the two different methods to implement RAID.
4. Write a note on hot spares.
5. Write a note on Storage provisioning
6. What are the two techniques to protect the data in a Cache
7. Explain SAN and its Evolution.
8. Write a note on NFS
9. Explain SAN-Based Backup Topology.

PART-B

Answer any SEVEN full questions each carries 10 marks. 10X7=70 Marks

1. Discuss various Interface Protocols.
2. Explain with Diagram RAID 5 and RAID Levels
3. What is Intelligent Storage Systems (ISS)? Explain the different components of an ISS with a neat diagram.
4. Explain the read and write operations with Cache.
5. What is Fibre Channel? Explain in brief the FC SAN implementation.
6. Discuss the types of Zoning.
7. How to implement NAS? Explain.
8. Explain File-Level Virtualization.
9. Discuss Backup and Restore Operations.
10. Discuss Backup in NAS Environments.

MODEL QUESTION BANK

Diploma in Computer Science & Engineering

VI Semester

Course Title: Information Storage & Management

CO	Question	CL	Marks
I	Define data. Explain the types of data with diagram.	R	05
	Differentiate between server-centric and information-centric storage architecture.	U	
	Discuss the five core elements of a data centre.	U	
	Mention the key challenges in managing information.	R	
	Write a note on Virtualization.	U	
	Explain key characteristics of a Data Centre.	R	
	Write a note on Volume manager	R	
	List and Explain the physical components of connectivity.	U	
	Define DAS. Explain different types of DAS with diagram.	U	
	List the benefits and limitation of DAS.	R	
	Write a note on zoned bit recording.	U	
	Write a note on Flash drives.	U	
	Write a note on physical disk structure.	R	
	List and Explain the features of Enterprise Flash Drives.	A	
	Explain the Logical Block Addressing	U	
	Discuss various disk drive interfaces.	A	
	Discuss various Interface Protocols.	A	10
	Discuss briefly various Disk Drive Components.	U	
	Explain the components of Disk drive Performance.	U	
II	Explain RAID Array Components.	U	05
	Discuss Mirroring RAID Technique	U	
	Explain the two different methods to implement RAID.	U	
	Explain Striping technique in RAID.	U	
	Write a note on hot spares.	U	
	Explain with Diagram RAID 5 and RAID Levels	A	10
	Discuss Impact on Disk performance.	U	
	Explain Nested RAID.	U	
	Explain the different RAID techniques with diagrams.	A	
	Briefly explain the different RAID levels with diagrams.	A	
III	What is meant by Read-hit and read-miss? Explain	U	05
	Write a note on Cache management.	U	
	Discuss the structure of Cache.	U	
	Write a note on Storage provisioning	A	
	Explain the types of flushing	A	
	Compare Virtual and traditional storage provisioning.	A	

	What are the two techniques to protect the data in a Cache.	**U**	
	Explain the types of Intelligent Storage Systems with a neat diagram.	**A**	
	What is Intelligent Storage Systems (ISS)? Explain the different components of an ISS with a neat diagram.	**A**	**10**
	Explain the read and write operations with Cache.	**U**	
	Discuss the types of MetaLUN.	**A**	
IV	Explain SAN and its Evolution.	**U**	**05**
	Explain different ports used in Switched Fabrics with a neat diagram.	**U**	
	Explain different Fabric Services.	**U**	
	Write a note on Zoning.	**A**	
	Explain Fibre Channel Protocol Stack.	**A**	
	Explain FC Frame with a neat diagram.	**U**	
	Explain Fibre Channel Switched Fabric.	**A**	
	Explain Mesh Topology.	**A**	
	List the benefits and limitations of Core-Edge fabric.	**U**	
	Discuss Core-Edge Fabric.	**A**	
	Write a note on VSAN	**A**	
	Write a note on Virtualization in SAN.	**U**	
	Discuss switched fabric login types.	**U**	
	What is Fibre Channel? Explain in brief the FC SAN implementation.	**U**	**10**
	Discuss the components of FC SAN	**U**	
	Discuss the types of Zoning.	**A**	
	Explain the three basic FC Connectivity.	**A**	
	Discuss FC SAN Topologies.	**A**	
	Explain the different components of FC SAN.	**U**	
V	What is Network-Attached Storage (NSS)? Explain different benefits of NAS.	**U**	**05**
	Explain the components of NAS with a neat diagram.	**U**	
	Explain the NAS I/O operation with a neat diagram.	**A**	
	Explain different file-sharing protocols in NAS.	**U**	
	Write a note on NFS.	**A**	
	Explain the benefits of NAS.	**U**	
	Write a note on Network File Sharing.	**U**	
	How to implement NAS? Explain.	**U**	**10**
	Explain File-Level Virtualization.	**A**	
	Explain different factors affecting NAS performance.	**A**	
VI	Discuss the purpose of backup.	**U**	**05**
	Explain Backup Architecture.	**U**	
	Explain Direct-attached Backup Topology.	**A**	
	Write a note on Virtual Tape Library.	**A**	
	Explain LAN-Based backup Topology.	**A**	
	Explain SAN-Based Backup Topology.	**A**	
	Discuss Archiving Solution Architecture.	**A**	

	Explain the backup methods.	**U**	
	Explain Data Archive Types.	**U**	
	Explain Data Deduplication methods.	**U**	
	Discuss Data Deduplication Implementations.	**A**	
	Discuss Backup and Restore Operations.	**A**	
	Explain Backup in Virtualized Environments	**A**	**10**
	Discuss Backup in NAS Environments.	**A**	
	Explain backup topologies.	**U**	