# Course Outcomes, Assessment Plan & Lesson Plan

## B.E. (CE-A) (Semester VIII)

**Subject: Distributed Computing**

**Subject code:** CSC801

**Teacher-in-charge: Dr. Vijay Shelake**

**Academic Term: January – May 2023**

| Module | | Content | Hrs |
|---|---|---|---|
| **1** | | **Introduction to Distributed Systems** | **4** |
| | 1.1 | Characterization of Distributed Systems: Issues, Goals, Types of distributed systems, Grid and Cluster computing Models, Hardware and Software Concepts: NOS, DOS | |
| | 1.2 | Middleware: Models of middleware, Services offered by middleware | |
| **2** | | **Communication** | **4** |
| | 2.1 | Interprocess communication (IPC): Remote Procedure Call (RPC), Remote Method Invocation (RMI) | |
| | 2.2 | Message-Oriented Communication, Stream Oriented Communication, Group Communication | |
| **3** | | **Synchronization** | **10** |
| | 3.1 | Clock Synchronization: Physical clock, Logical Clocks, Election Algorithms | |
| | 3.2 | Distributed Mutual Exclusion, Requirements of Mutual Exclusion Algorithms and Performance measures. Non- token Based Algorithms: Lamport, Ricart–Agrawala's and Maekawa's Algorithms; Token-based Algorithms: Suzuki-Kasami's Broadcast Algorithms and Raymond's Tree-based Algorithm; and Comparative Performance Analysis | |
| | 3.3 | Deadlock: Introduction, Deadlock Detection: Centralized approach, Chandy -Misra_Hass Algorithm | |

| | | | |
|---|---|---|---|
| **4** | | **Resource and Process Management** | **7** |
| | 4.1 | Desirable Features of Global Scheduling algorithm, Task assignment approach, Load balancing approach and load sharing approach | |
| | 4.2 | Introduction to Process Management, Process Migration, Code Migration | |
| **5** | | **Replication, Consistency and Fault Tolerance** | **8** |
| | 5.1 | Distributed Shared Memory: Architecture, design issues | |
| | 5.2 | Introduction to replication and consistency, Data-Centric and Client-Centric Consistency Models, Replica Management | |
| | 5.3 | Fault Tolerance: Introduction, Process resilience, Recovery | |
| **6** | | **Distributed File Systems** | **6** |
| | 6.1 | Introduction and features of DFS, File models, File Accessing models, File Caching Schemes, File Replication, Case Study: Network File System (NFS) | |
| | 6.2 | Designing Distributed Systems: Google Case Study. | |

**Text books:**


1. Andrew S. Tanenbaum and Maarten Van Steen, Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education.
2. Mukesh Singhal, Niranjan G. Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems", MC Graw Hill education.
3. Pradeep K.Sinha, "Distributed Operating System-Concepts and design", PHI.


**Reference Books:**


4. M. L. Liu, ―Distributed Computing Principles and Applications‖, Pearson Addison Wesley, 2004
5. George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems: Concepts and Design", 4th Edition, Pearson Education, 2005.


**Useful Links**

6. https://nptel.ac.in/courses/106106107
7. https://nptel.ac.in/courses/106106168
8. http://csis.pace.edu/~marchese/CS865/Lectures/Chap7/Chapter7fin.htm
9. https://nptel.ac.in/courses/106104182

**<u>Course Objectives:</u>**

1 To provide students with contemporary knowledge in distributed systems.

2 To explore the various methods used for communication in distributed systems.

3 To provide skills to measure the performance of distributed synchronization algorithms.

4 To provide knowledge of resource management, and process management including process migration.

5 To learn issues involved in replication, consistency, and file management.

6 To equip students with skills to analyze and design distributed applications.

**Course Outcomes:**

*Upon completion of this course students will be able to:*

CSC801 .1: Demonstrate the knowledge of basic elements and concepts related to distributed system technologies
CSC801 .2: Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object-based middleware.
CSC801 .3: Analyze the various techniques used for clock synchronization, mutual exclusion and deadlock.
CSC801 .4: Demonstrate the concepts of Resource and Process management.
CSC801 .5: Demonstrate the concepts of Consistency, Replication Management and fault Tolerance.
CSC801 .6: Apply the knowledge of Distributed File systems in building large-scale distributed applications.

**CO-PO-PSO Mapping:**

## Course Learning Objectives:

The price/performance ratios offered by distribution in computing, and the concept of sharing resources globally, along with the steady improvements in networking technologies have made Distributed systems very attractive and highly popular. The fundamental concepts and design principles discussed in the course are applicable to a variety of systems especially WWW.

This course aims to:

| Course Objectives. |
|---|
| 1 To provide students with contemporary knowledge in distributed systems. |
| 2 To explore the various methods used for communication in distributed systems. |
| 3 To provide skills to measure the performance of distributed synchronization algorithms. |
| 4 To provide knowledge of resource management, and process management including process migration. |
| 5 To learn issues involved in replication, consistency, and file management |
| 6 To equip students with skills to analyze and design distributed applications. |

**Prerequisites:** **Operating Systems, Computer Networks**

**Course Outcomes:**

*Upon successful completion of this course students will be able to:*

| | |
|---|---|
| **CSC802.1** | Demonstrate knowledge of the basic elements and concepts related to distributed systems & technologies **(B2 – Comprehension)** |
| **CSC802.2** | Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object based middleware. **(B3 – Application)** |
| **CSC802.3** | Analyze the various techniques used for clock synchronization and mutual exclusion **(B4 – Analysis)** |
| **CSC802.4** | Demonstrate the concepts of Resource and Process management, and Fault Tolerance techniques **(B3 – Application)** |
| **CSC802.5** | Assess the significance of Consistency and Replication Management models **(B4 – Analysis)** |
| **CSC802.6** | Apply the knowledge of Distributed File System in building large-scale distributed applications. **(B4 – Analysis)** |

**Relationship of course outcomes with program outcomes:** Indicate 1 (low importance), 2 (Moderate Importance) or 3 (High Importance) in respective mapping cell.

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | 2 | | | | | | | | | 2 |
| **CO2** | 3 | | 2 | 2 | 2 | | | | | | | |
| **CO3** | 3 | 2 | 2 | 2 | | | | | | | | |
| **CO4** | 3 | | 2 | 2 | | | | | | | | |
| **CO5** | 3 | 3 | 2 | | | | | | | | | |
| **CO6** | 3 | 3 | | 2 | | | | | | | | |
| **Course** | 3 | 3 | 2 | 3 | 3 | | | | | | | 2 |

| Course Outcome | Competency | Performance Indicator |
|---|---|---|
| CSC801 .1 | 1.3 Demonstrate competence in engineering fundamentals | 1.3.1 Apply engineering fundamentals |
| CSC801 .2 | 1.3 Demonstrate competence in engineering fundamentals | 1.3.1 Apply engineering fundamentals |
| CSC801 .3 | 2.3 Demonstrate an ability to formulate and interpret a model | 2.3.1 Able to apply computer engineering principles to formulate modules of a system with required applicability and performance. |
| | 2.4 Demonstrate an ability to execute a solution process and analyze results | 2.4.1 Applies engineering mathematics to implement the solution |
| | 5.2 Demonstrate an ability to select and apply discipline-specific tools, techniques and resources | 5.2.2 Demonstrate proficiency in using discipline-specific tools |
| CSC801 .4 | 1.3 Demonstrate competence in engineering fundamentals | 1.3.1 Apply engineering fundamentals |
| CSC801 .5 | 1.3 Demonstrate competence in engineering fundamentals | 1.3.1 Apply engineering fundamentals |
| | 1.4 Demonstrate competence in specialized engineering knowledge to the program | 1.4.1 Apply theory and principles of Computer Science and engineering to solve an engineering problem |
| CSC801 .6 | 1.4 Demonstrate competence in specialized engineering knowledge to the program | 1.4.1 Apply theory and principles of Computer Science and engineering to solve an engineering problem |

**Justification of CO to PO mapping**

| **CSC802.1** | Demonstrate knowledge of the basic elements and concepts related to distributed systems & technologies | |
|---|---|---|
| | **PO1** | As an Engineering solution to some complex computational problems which is efficient and cost effective |
| | **PO3** | Design of System components to meet the specific needs |

| | | |
|---|---|---|
| | **PO12** | Gain ability to be prepared for life-long learning in the broadest context of technological change |
| | **Tools** | Lectures, Presentations, Practical Sessions, Assignment I & IV |
| | **Target** | 2.5 |
| **CSC802.2** | Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object based middleware. | |
| | **PO1** | Specialized solutions to some complex computational problems |
| | **PO3** | Design of System components or mini models to meet the specific needs |
| | **PO4** | Implementation of RPC, RMI and MPI |
| | **PO5** | Apply appropriate techniques and tools |
| | **Tools** | Lectures, Presentations, Practical Sessions |
| | **Target** | 2.5 |
| **CSC802.3** | Analyze the various techniques used for clock synchronization and mutual exclusion | |
| | **PO1** | An Engineering solution to some complex computational problems |
| | **PO2** | Formulate solutions considering the several design issues |
| | **PO3** | Design solutions by developing components and processes |
| | **PO4** | Experimental approach to design solutions and valid conclusions |
| | **Tools** | Lectures, Presentations, Practical Sessions, Seminars |
| | **Target** | 2.5 |
| **CSC802.4** | Demonstrate the concepts of Resource and Process management and Fault tolerant solutions | |
| | **PO1** | Specialized solutions to some complex computational problems |
| | **PO3** | Design of System components or mini models to meet the specific needs |
| | **PO4** | Apply appropriate techniques and tools for solutions |
| | **Tools** | Lectures, Presentations, Practical Sessions, Seminars |

| | | |
|---|---|---|
| | **Target** | 2.5 |
| **CSC802.5** | Assess the significance of Consistency and Replication Management | |
| | **PO1** | An Engineering solution to some complex computational problems |
| | **PO2** | Formulate solutions considering the several design issues |
| | **PO3** | Design solutions by developing components and processes |
| | **Tools** | Lectures, Presentations, Practical Sessions, Seminars |
| | **Target** | 2.5 |
| **CSC802.6** | Apply the knowledge of Distributed File System to analyze various file systems like NFS, AFS and the experience in building large-scale distributed applications | |
| | **PO1** | An Engineering solution to some complex computational problems |
| | **PO2** | Formulate solutions considering the several design issues |
| | **PO3** | Design solutions by developing components and processes |
| | **Tools** | Lectures, Presentations, Practical Sessions, Seminars |
| | **Target** | 2.5 |

**Program Specific Outcomes (PSOs)**

Student will have an ability to

1. Apply fundamental computer science knowledge to address real world challenges/opportunities.
2. Design and implement computing systems of varying complexity in multidisciplinary scenarios that meet specified requirements with appropriate consideration to architectural, algorithmic and security aspects.

**Modes of delivery**

**Most of the time is spent on teaching the principles of Distributed Computations.**

| **Modes of Delivery** | **Brief description of content delivered** | **Attained COs** | **Attained POs** |
|---|---|---|---|
| Class room lectures and Presentations | All modules | ALL | PO1, PO2, PO3, PO4, PO5, PO12 |

| | | | |
|---|---|---|---|
| Lab Experiments | Modules 2-6 | CO2, CO3, CO6 | PO1, PO2, PO3, PO4, PO5 |
| Students presentations | Module 3,6 | CO5 | PO1, PO10 |
| Case Study | DCE, CORBA, HADOOP, NFS | CO6 | |

**CO Assessment Tools:**

| ***Course Outcome*** | ***Assessment Method*** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ***Direct Method (80 %)*** | | | | | | | | ***Indirect Method (20%)*** |
| | Unit Tests | | Assignments | | | | SEE | Laboratory Practical | Course exit survey |
| | 1 | 2 | 1 | 2 | 3 | 4 | | | |
| CO1 | 30% | | 30% | | | | 40% | | 100% |
| CO2 | 20% | 20% | | 20% | | | 40% | | 100% |
| CO3 | | | | | | | | 100% | 100% |
| CO4 | | 30% | | | 30% | | 40% | | 100% |
| CO5 | | 30% | | | | 30% | 40% | | 100% |

**Assignments:**

Five assignments will be given on completion the modules as follows:

| | |
|---|---|
| Assignment No.1 | On completion of the 1st module |
| Assignment No.2 | On completion of 2nd and 3rd module |
| Assignment No.3 | On completion of the 4th module |
| Assignment No.4 | On completion of 2nd and 3rd module |
| Assignment No.5 | On completion of the 1st module |

**Rubrics for Assignment Grading:**

| **Indicator** | | | | |
|---|---|---|---|---|
| Timeline (2) | | More than one session late (0) | One sessions late (1) | On time (2) |
| Level of content (4) | Just Managed (1) | Major points are addressed minimally (2) | Only major topics are covered(3) | Most major and some minor criteria are included. Information is Adequate (4) |
| Reading and Understanding (4) | Just Managed (1) | Superficial at most (2) | Understood concepts but no related topics (3) | Understood concepts and related topics (4) |

## Laboratory Experiment

Total ten number of laboratory experiments will be performed in the practical session as per the time schedule in the time table.

**Rubrics for Laboratory Experiment Grading:**

| **Indicator** | | | | |
|---|---|---|---|---|
| Timeline (3) | More than two sessions late (0) | Two sessions late (1) | One sessions late (2) | On time (3) |
| Knowledge (4) | Not adequate (1) | Superficial at most (2) | Understood concepts but no related topics (3) | Understood concepts and working (4) |
| skill (3) | Just Managed (1) | Just Managed (1) | Few steps are not appropriate (2) | Structured and optimum performance (3) |

## Teaching schema

**Program Structure for Fourth Year Computer Engineering**

**UNIVERSITY OF MUMBAI (With Effect from 2022-2023)**

## Semester VIII

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract. Tut. | Theory | Pract. | Total |
| CSC801 | Distributed Computing | 3 | -- | 3 | -- | 3 |
| CSDC 801X | Department Level Optional Course -5 | 3 | -- | 3 | -- | 3 |
| CSDC 802X | Department Level Optional Course -6 | 3 | -- | 3 | -- | 3 |
| ILO 801X | Institute Level Optional Course -2 | 3 | -- | 3 | -- | 3 |
| CSL801 | Distributed Computing Lab | -- | 2 | -- | 1 | 1 |
| CSDL 801X | Department Level Optional Course -5 Lab | -- | 2 | -- | 1 | 1 |
| CSDL 802X | Department Level Optional Course -6 Lab | -- | 2 | -- | 1 | 1 |
| CSP801 | Major Project 2 | -- | 12# | -- | 6 | 6 |
| **Total** | | **12** | **18** | **12** | **9** | **21** |

## Examination schema

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Pract & oral | Total |
| | | Internal Assessment | | | End Sem Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| CSC801 | Distributed Computing | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| CSDC 801X | Department Level Optional Course -5 | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| CSDC 802X | Department Level Optional Course -6 | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| ILO 801X | Institute Level Optional Course -2 | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| CSL801 | Distributed Computing Lab | -- | -- | -- | -- | -- | 25 | 25 | 50 |
| CSDL 801X | Department Level Optional Course -5 Lab | -- | -- | -- | -- | -- | 25 | 25 | 50 |
| CSDL 802X | Department Level Optional Course -6 Lab | | | | | | 25 | 25 | 50 |
| CSP801 | Major Project- 2 | -- | -- | -- | -- | -- | 100 | 50 | 150 |
| **Total** | | **--** | **--** | **80** | **320** | -- | **175** | **125** | **700** |

## Textbooks and References

| | |
|---|---|
| **T1** | Andrew S. Tanenbaum and Maarten Van Steen, “Distributed Systems: Principles and Paradigms”, 2nd edition, Pearson Education. |
| **T2** | Mukesh Singhal, Niranjan G. Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems", MC Graw Hill education. |
| **T3** | Pradeep K. Sinha, "Distributed Operating System-Concepts and design", PHI. |
| **R1** | M. L. Liu, —Distributed Computing Principles and Applications, Pearson Addison Wesley, 2004 |
| **R2** | George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems: Concepts and Design", 4th Edition, Pearson Education, 2005 |
| **R3** | Andrew S. Tanunbaum “Distributed Operating system” Low price edition, Pearson Education. |
| | **Useful Links** |
| **L1** | https://nptel.ac.in/courses/106106107 |
| **L2** | https://nptel.ac.in/courses/106106168 |
| **L3** | http://csis.pace.edu/~marchese/CS865/Lectures/Chap7/Chapter7fin.htm |
| **L4** | https://nptel.ac.in/courses/106104182 |

| Module No | Unit No | Topics | Books | Portion (From Book) |
|---|---|---|---|---|
| | | | | |
| **1** | **Introduction to Distributed Systems** | **CO1** | **4 Hrs** | |
| | **1.1** | Characterization of Distributed Systems: Issues, Goals, Types of distributed systems, Grid and Cluster computing Models, Hardware and Software Concepts: NOS, DOS | **T1**<br><br>**R3** | **1.1, 1.2, 1.3.1**<br><br>**1.3,1.4** |

| | | | | |
|---|---|---|---|---|
| | **1.2** | Middleware: Models of middleware, Services offered by middleware | **R2** | **1.1-1.5** |
| **2** | **Communication CO2** | | **4 Hrs** | |
| | **2.1** | Interprocess communication (IPC): Remote Procedure Call (RPC),<br>Remote Method Invocation (RMI) | **T1**<br>**R2** | **4**<br>**(2.1-,2.3)** |
| | **2.2** | Message Oriented Communication, Stream Oriented Communication,<br>Group Communication. (ordering) | **T1**<br>**T3** | **4**<br>**3.10** |
| **3** | **Synchronization CO3** | | **10 Hrs** | |
| | **3.1** | Clock Synchronization: physical clock, Logical Clocks, Election Algorithms, Distributed Mutual Exclusion algorithms, Requirements of Mutual Exclusion Algorithms, Performance measure, Non- token Based (Lamport Algorithm, Ricart–Agrawala's Algorithm, Maekawa's Algorithm), Token based (Suzuki-Kasami's Broadcast Algorithms ,Raymond's Tree based Algorithm) and Comparative Performance Analysis. | **T1**<br><br>**T2** | **6.1, 6.2, 6.5**<br><br>**6.3 to 6.14** |
| | **3.2** | Deadlock: Introduction, Centralized, Chandy - Misra_Hass Algorithm. | **R3** | **3.5** |
| **4** | **Resource and Process Management CO4** | | **10 Hrs** | |
| | **4.1** | Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach | **T3** | **7** |
| | **4.2** | Introduction to process management, process migration, Code Migration | **T3**<br>**T1** | **8.2**<br>**3.5** |
| **5** | **Replication, Consistency and Fault Tolerance** | | **8 Hrs** | **CO5** |
| | **5.1** | Distributed Shared Memory: Architecture, design issues. | **T3** | **5.2,5.3** |
| | **5.2** | Introduction to replication and consistency, Data-Centric and Client-Centric Consistency Models, Replica Management. | **T1**<br>**/ L3** | **7** |
| | **5.3** | Fault Tolerance: Introduction, Process resilience, Recovery. | **T1** | **8.1, 8.2, 8.6** |
| **6** | **Distributed File Systems CO6** | | **8 Hrs** | |
| | **6.1** | Introduction and features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication,<br>Case Study: Network File System (NFS). | **T1**<br><br>**R2** | **9.1 to 9.7**<br><br>**8** |
| | **6.2** | Designing Distributed Systems: Google Case Study. | **R2** | **9** |

# Lesson Plan

| | |
|---|---|
| CLASS | BE Computer Engineering (A), Semester VIII |
| Academic Term | January- May 2023 |
| Subject | Distributed Computing |
| Subject Code | CSC 801<br><br>CSL 802 |

| | | | |
|---|---|---|---|
| ***Periods (Hours) per week*** | ***Lecture*** | ***3*** | |
| | ***Practical*** | ***2*** | |
| | ***Tutorial*** | -- | |
| ***Evaluation System*** | | ***Hours*** | ***Marks*** |
| | Theory examination | 3 | 80 |
| | Internal Assessment | -- | 20 |
| | Practical Examination | -- | 25 |
| | Oral Examination | -- | 25 |
| | Term work | -- | -- |
| | Total | -- | 150 |

***Time Table*** *(w.e.f 23/01/2023 to 21/04/2023)*

| | | |
|---|---|---|
| | ***Day*** | ***Time*** |
| ***Theory*** | Wednesday | 11:15AM-12:15 AM |
| | Thursday | 12:15AM-1:15 AM |
| | Friday | 10:00AM-11:00 AM |
| ***Practical's*** | Tuesday | 1.45-3.45 pm (A Batch) |
| | Wednesday | 1.45-3.45 pm (D Batch) |
| | Thursday | 1.45-3.45 pm (C Batch) |
| | Friday | 1.45-3.45 pm (B Batch) |

## *Course Content and Lesson plan*

| **Week** | **Lecture No.** | **Date** | | **Topic** | |
|---|---|---|---|---|---|
| | | **Planned** | **Actual** | | **Remarks** |
| ***Module 1:*** Introduction to Distributed Systems | | | | | |
| 1 | 1 | 10-01-23 | | Characterization of Distributed Systems: Issues, Goals | |
| | 2 | 12-01-23 | | Types of distributed systems, Grid and Cluster computing Models | |
| | 3 | 13-01-23 | | Hardware and Software Concepts: NOS, DOS. | |
| | 4 | 17-01-23 | | Middleware: Models of middleware, Services offered by middleware | |

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|---|---|---|---|---|---|
| | ***Module 2:*** Communication | | | | |
| 2 | 5 | 19-01-23 | | Interprocess communication (IPC): Remote Procedure Call (RPC) | |
| | 6 | 20-01-23 | | Remote Method Invocation (RMI), Message-Oriented Communication | |
| | 7 | 25-01-23 | | Stream Oriented Communication | |
| | 8 | 27-01-23 | | Group Communication. | |
| **Module 3:** Synchronization | | | | | |
| 3 | 9 | 1-02-23 | | Clock Synchronization: Physical clock, | |
| | 10 | 1-02-23 | | Logical clocks, Election Algorithms | |
| | 11 | 2-02-23 | | Distributed Mutual Exclusion, Requirements of Mutual Exclusion | |
| | 12 | 3-02-23 | | Algorithms and Performance measures | |
| | 13 | 8-02-23 | | Non- token Based Algorithms: Lamport, Ricart–Agrawala's and Maekawa's Algorithm | |
| | 14 | 15-02-23 | | Token-based Algorithms: Suzuki-Kasami's Broadcast Algorithms | |
| | 15 | 15-02-23 | | Raymond_s Tree-based Algorithm Comparative Performance Analysis | |
| | 16 | 16-02-23 | | Deadlock: Introduction | |
| | 17 | 17-02-23 | | Deadlock Detection: Centralized approach | |
| | 18 | 22-02-23 | | Chandy Misra_Hass Algorithm | |
| **Module 4:** Resource and Process Management | | | | | |
| 4 | 19 | 23-02-23 | | Desirable Features of Global Scheduling algorithm | |
| | 20 | 24-02-23 | | Task assignment approach | |
| | 21 | 24-02-23 | | Load balancing approach | |
| | 22 | 2-03-23 | | and load sharing approach | |
| | 23 | 3-03-23 | | Introduction to Process Management | |
| | 24 | 8-03-23 | | Process Migration | |
| | 25 | 9-03-23 | | Code Migration | |
| 5 | ***Module 5:*** **Replication, Consistency and Fault Tolerance** | | | | |
| | 26 | 10-03-23 | | Distributed Shared Memory: Architecture | |

| | | | | | |
|---|---|---|---|---|---|
| | 27 | 14-03-23 | | Design issues | |
| | 28 | 15-03-23 | | Introduction to replication and consistency | |
| | 29 | 16-03-23 | | Data-Centric | |
| | 30 | 17-03-23 | | Client-Centric Consistency Models, | |
| | 31 | 21-03-23 | | Replica Management. | |
| | 32 | 23-03-23 | | Fault Tolerance: Introduction | |
| | 33 | 24-03-23 | | Process resilience, Recovery | |
| 6 | **Module 6: Distributed File Systems** | | | | |
| | 34 | 05-04-23 | | Introduction and features of DFS | |
| | 35 | 06-04-23 | | File models | |
| | 36 | 11-04-23 | | File Accessing models | |
| | 37 | 5-04-23 | | File Caching Schemes, File Replication | |
| | 38 | 6-04-23 | | Case Study: Network File System (NFS) | |
| | 39 | 11-04-23 | | Designing Distributed Systems: Google Case Study. | |
| ***Total*** | 39 | | | | |