

<b>Software Engineering &amp; Project Management</b>		Semester	V
Course Code	<b>BCS501</b>	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	4:0:0:0	SEE Marks	50
Total Hours of Pedagogy	52 hours	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	<b>Theory</b>		
<p><b>Course objectives:</b> This course will enable students to,</p> <ul style="list-style-type: none"> <li>• Outline software engineering principles and activities involved in building large software programs. Identify ethical and professional issues and explain why they are of concern to Software Engineers.</li> <li>• Describe the process of requirement gathering, requirement classification, requirement specification and requirements validation.</li> <li>• Recognize the importance of Project Management with its methods and methodologies.</li> <li>• Identify software quality parameters and quantify software using measurements and metrics. List software quality standards and outline the practices involved.</li> </ul>			
<p><b>Teaching-Learning Process (General Instructions)</b> These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none"> <li>1. Lecturer method (L) need not be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.</li> <li>2. Use of Video/Animation to explain functioning of various concepts.</li> <li>3. Encourage collaborative (Group Learning) Learning in the class.</li> <li>4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.</li> <li>5. Adopt Problem Based-Learning (PBL), which fosters student's Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.</li> </ol>			
<b>MODULE-1</b>		<b>10 hours</b>	
<p><b>Software and Software Engineering:</b> The nature of Software, The unique nature of WebApps, Software Engineering, The software Process, Software Engineering Practice, Software Myths. <b>Process Models:</b> A generic process model, Process assessment and improvement, Prescriptive process models: Waterfall model, Incremental process models, Evolutionary process models, Concurrent models, Specialized process models. Unified Process , Personal and Team process models</p> <p><b>Textbook 1: Chapter 1: 1.1 to 1.6, Chapter 2: 2.1 to 2.5</b></p>			
<b>MODULE-2</b>		<b>12 hours</b>	
<p><b>Understanding Requirements:</b> Requirements Engineering, Establishing the ground work, Eliciting Requirements, Developing use cases, Building the requirements model, Negotiating Requirements, Validating Requirements. <b>Requirements Modeling Scenarios, Information and Analysis classes:</b> Requirement Analysis, Scenario based modeling, UML models that supplement the Use Case, Data modeling Concepts, Class-Based Modeling. <b>Requirement Modeling Strategies :</b> Flow oriented Modeling , Behavioral Modeling. <b>Textbook 1: Chapter 5: 5.1 to 5.7, Chapter 6: 6.1 to 6.5, Chapter 7: 7.1 to 7.3</b></p>			
<b>MODULE-3</b>		<b>10 hours</b>	

**Agile Development:** What is Agility?, Agility and the cost of change. What is an agile Process?, Extreme Programming (XP), Other Agile Process Models, A tool set for Agile process .

**Principles that guide practice:** Software Engineering Knowledge, Core principles, Principles that guide each framework activity.

**Textbook 1: Chapter 3: 3.1 to 3.6, Chapter 4: 4.1 to 4.3**

#### MODULE-4

10 hours

**Introduction to Project Management:** Introduction, Project and Importance of Project Management, Contract Management, Activities Covered by Software Project Management, Plans, Methods and Methodologies, Some ways of categorizing Software Projects, Stakeholders, Setting Objectives, Business Case, Project Success and Failure, Management and Management Control, Project Management life cycle, Traditional versus Modern Project Management Practices.

**Project Evaluation:** Evaluation of Individual projects, Cost-benefit Evaluation Techniques, Risk Evaluation

**Textbook 2: Chapter 1: 1.1 to 1.17 , Chapter 2: 2.4 to 2.6**

#### MODULE-5

10 hours

**Software Quality:** Introduction, The place of software quality in project planning, Importance of software quality, Defining software quality, Software quality models, product versus process quality management.

**Software Project Estimation:** Observations on Estimation, Decomposition Techniques, Empirical Estimation Models.

**Textbook 2: Chapter 13: 13.1 to 13.5, 13.7, 13.8, Text Book 1: Chapter 26: 26.5 to 26.7**

#### Course Outcomes

At the end of the course, the student will be able to:

- **Differentiate** process models to judge which process model has to be adopted for the given scenarios.
- **Derive** both functional and nonfunctional requirements from the case study.
- **Analyze** the importance of various software testing methods and agile methodology.
- **Illustrate** the role of project planning and quality management in software development.
- **Identify** appropriate techniques to enhance software quality.

#### Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

#### Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at

the end of the semester if two assignments are planned.

- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**The Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**).

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

Marks scored shall be proportionally reduced to 50 marks. .

**Suggested Learning Resources:**

**Textbooks**

1. Roger S. Pressman: Software Engineering-A Practitioners approach, 7th Edition, Tata McGraw Hill.
2. Bob Hughes, Mike Cotterell, Rajib Mall: Software Project Management, 6th Edition, McGraw Hill Education, 2018.

**Reference Book:**

3. Pankaj Jalote: An Integrated Approach to Software Engineering, Wiley India.
4. "Software Engineering: Principles and Practice", Hans van Vliet, Wiley India, 3rd Edition, 2010.

**Web links and Video Lectures (e-Resources):**

- [https://onlinecourses.nptel.ac.in/noc20\\_cs68/preview](https://onlinecourses.nptel.ac.in/noc20_cs68/preview)
- [https://onlinecourses.nptel.ac.in/noc24\\_mg01/preview](https://onlinecourses.nptel.ac.in/noc24_mg01/preview)

**Activity Based Learning (Suggested Activities in Class)/Practical-Based Learning**

- Demonstration of Agile tool: The students are expected to learn any of the popular agile tool. (10 marks)
- Field Survey (In Team): The students' team may of the size of 2 or 4. Students are expected to visit their library and understand the Library Automation Software. **OR** they have to understand the working of ERP or any inventory management, and then they have to prepare a report and then to be submitted to the concerned staff. Prepare a document/report which includes all the phases of SDLC and to be submitted accordingly (15 marks)

<b>COMPUTER NETWORKS</b>		Semester	V
Course Code	<b>BCS502</b>	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory/practical		
<p><b>Course objectives:</b> This course will enable students to,</p> <ul style="list-style-type: none"> <li>• Study the TCP/IP protocol suite, switching criteria and Medium Access Control protocols for reliable and noisy channels.</li> <li>• Learn network layer services and IP versions.</li> <li>• Discuss transport layer services and understand UDP and TCP protocols.</li> <li>• Demonstrate the working of different concepts of networking layers and protocols.</li> </ul>			
<p><b>Teaching-Learning Process (General Instructions)</b> These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none"> <li>1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.</li> <li>2. Use of Video/Animation to explain functioning of various concepts.</li> <li>3. Encourage collaborative (Group Learning) Learning in the class.</li> <li>4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.</li> <li>5. Adopt Problem Based Learning (PBL), which fosters student's Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.</li> </ol>			
<b>MODULE-1</b>			
<p>Introduction: Data Communications, Networks, Network Types, Networks Models: Protocol Layering, TCP/IP Protocol suite, The OSI model, Introduction to Physical Layer: Transmission media, Guided Media, Unguided Media: Wireless. Switching: Packet Switching and its types. <b>Textbook:</b> Ch. 1.1 - 1.3, 2.1 - 2.3, 7.1 – 7.3, 8.3.</p>			
<b>MODULE-2</b>			
<p>Data Link Layer: Error Detection and Correction: Introduction, Block Coding, Cyclic Codes. Data link control: DLC Services: Framing, Flow Control, Error Control, Connectionless and Connection Oriented, Data link layer protocols, High Level Data Link Control. Media Access Control: Random Access, Controlled Access. Check Sum and Point to Point Protocol <b>Textbook:</b> Ch. 10.1-10.4, 11.1 -11.4, 12.1 - 12.2</p>			
<b>MODULE-3</b>			
<p>Network Layer: Network layer Services, Packet Switching, IPv4 Address, IPv4 Datagram, IPv6 Datagram, Introduction to Routing Algorithms, Unicast Routing Protocols: DVR, LSR, PVR, Unicast Routing protocols: RIP, OSPF, BGP, Multicasting Routing-MOSPF <b>Textbook:</b> Ch. 18.1, 18.2, 18.4, 22.2,20.1-20.3, 21.3.2</p>			
<b>MODULE-4</b>			
<p>Introduction to Transport Layer: Introduction, Transport-Layer Protocols: Introduction, User Datagram Protocol, Transmission Control Protocol: services, features, segments, TCP connections, flow control, Error control, Congestion control. <b>Textbook:</b> Ch. 23.1- 23.2, 24.1-24.3.4, 24.3.6-24.3.9</p>			
<b>MODULE-5</b>			

Introduction to Application Layer: Introduction, Client-Server Programming, Standard Client-Server Protocols: World Wide Web and HTTP, FTP, Electronic Mail, Domain Name System (DNS), TELNET, Secure Shell (SSH)  
**Textbook:** Ch. 25.1-25.2, 26.1-26.6

### PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Implement three nodes point – to – point network with duplex links between them. Set the queue size, vary the bandwidth, and find the number of packets dropped.
2	Implement transmission of ping messages/trace route over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion.
3	Implement an Ethernet LAN using n nodes and set multiple traffic nodes and plot congestion window for different source / destination.
4	Develop a program for error detecting code using CRC-CCITT (16- bits).
5	Develop a program to implement a sliding window protocol in the data link layer.
6	Develop a program to find the shortest path between vertices using the Bellman-Ford and path vector routing algorithm.
7	Using TCP/IP sockets, write a client – server program to make the client send the file name and to make the server send back the contents of the requested file if present.
8	Develop a program on a datagram socket for client/server to display the messages on client side, typed at the server side.
9	Develop a program for a simple RSA algorithm to encrypt and decrypt the data.
10	Develop a program for congestion control using a leaky bucket algorithm.

#### Course outcomes (Course Skill Set):

At the end of the course, the student will be able to:

- **Explain** the fundamentals of computer networks.
- **Apply** the concepts of computer networks to demonstrate the working of various layers and protocols in communication network.
- **Analyze** the principles of protocol layering in modern communication systems.
- **Demonstrate** various Routing protocols and their services using tools such as Cisco packet tracer.

**Note: For the Simulation experiments modify the topology and parameters set for the experiment and take multiple rounds of reading and analyze the results available in log files. Plot necessary graphs and conclude using NS2 or NS3. Installation procedure of the required software must be demonstrated, carried out in groups, and documented in the report. Non simulation programs can be implemented using Java.**

#### Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE

(Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

### **CIE for the theory component of the IPCC (maximum marks 50)**

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks**).
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

### **CIE for the practical component of the IPCC**

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test (**duration 02/03 hours**) after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks**.
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

### **SEE for IPCC**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks

**The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.**

### **Suggested Learning Resources:**

#### **Textbook:**

1. Behrouz A. Forouzan, Data Communications and Networking, 5th Edition, Tata McGraw-

Hill,2013.

**Reference Books:**

1. Larry L. Peterson and Bruce S. Davie: Computer Networks – A Systems Approach, 4th Edition, Elsevier, 2019.
2. Nader F. Mir: Computer and Communication Networks, 2nd Edition, Pearson Education, 2015.
3. William Stallings, Data and Computer Communication 10th Edition, Pearson Education, Inc., 2014.

**Web links and Video Lectures (e-Resources):**

1. <https://www.digimat.in/nptel/courses/video/106105183/L01.html>
2. <http://www.digimat.in/nptel/courses/video/106105081/L25.html>
3. <https://nptel.ac.in/courses/10610>

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Implementation of various protocols using open source simulation tools. (5 marks)
- Simulation of Personal area network, Home area network, achieve QoS etc. (5 marks)

<b>THEORY OF COMPUTATION</b>		Semester	V
Course Code	<b>BCS503</b>	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	(3:2:0:0)	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	3
Examination type (SEE)	Theory		
<p><b>Course objectives:</b></p> <ul style="list-style-type: none"> <li>● Introduce core concepts in Automata and Theory of Computation.</li> <li>● Identify different Formal Language Classes and their Relationships.</li> <li>● Learn concepts of Grammars and Recognizers for different formal languages.</li> <li>● Prove or disprove theorems in automata theory using their properties.</li> <li>● Determine the decidability and intractability of Computational problems.</li> </ul>			
<p><b>Teaching-Learning Process (General Instructions)</b>            These are sample Strategies which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none"> <li>1. Lecturer method (L) needs not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.</li> <li>2. Use of Video/Animation to explain functioning of various concepts.</li> <li>3. Encourage collaborative (Group Learning) Learning in the class.</li> <li>4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.</li> <li>5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it.</li> <li>6. Introduce Topics in manifold representations.</li> <li>7. Show the different ways to solve the same problem with different approaches and encourage the students to come up with their own creative ways to solve them.</li> <li>8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.</li> </ol>			
<b>Module-1</b>		<b>10 Hours</b>	
Introduction to Finite Automata, Structural Representations, Automata and Complexity. The Central Concepts of Automata Theory. Deterministic Finite Automata, Nondeterministic Finite Automata, An Application: Text Search, Finite Automata with Epsilon-Transitions. <b>TEXT BOOK: Sections 1.1, 1.5, 2.2,2.3,2.4,2.5</b>			
<b>Module-2</b>		<b>10 Hours</b>	
Regular Expressions, Finite Automata and Regular Expressions, Proving Languages not to be Regular. Closure Properties of Regular Languages, Equivalence and Minimization of Automata, Applications of Regular Expressions <b>TEXT BOOK: Sections 3.1, 3.2 (Except 3.2.1), 3.3, 4.1, 4.2, 4.4</b>			
<b>Module-3</b>		<b>10 Hours</b>	



Context-Free Grammars, Parse Trees, Ambiguity in Grammars and Languages, Ambiguity in Grammars and Languages, Definition of the Pushdown Automaton, The Languages of a PDA, Equivalence of PDA's and CFG's, Deterministic Pushdown Automata.  <b>TEXT BOOK: Sections 5.1, 5.2, 5.4, 6.1,6.2,6.3.1,6.4</b>
<b>Module-4</b> <span style="float: right;"><b>10 Hours</b></span>
Normal Forms for Context-Free Grammars, The Pumping Lemma for Context-Free Languages, Closure Properties of Context-Free Languages.  <b>TEXT BOOK: Sections 7.1, 7.2, 7.3</b>
<b>Module-5</b> <span style="float: right;"><b>10 Hours</b></span>
Introduction to Turing Machines: Problems That Computers Cannot Solve, The Turing Machine, Programming Techniques for Turing Machines, Extensions to the Basic Turing Machine, Undecidability: A Language That Is Not Recursively Enumerable. <b>TEXT BOOK: Sections 8.1,8.2, 8.3,8.4, 9.1, 9.2</b>
<b>Course outcome (Course Skill Set)</b> At the end of the course, the student will be able to: <ol style="list-style-type: none"> <li>1. Apply the fundamentals of automata theory to write DFA, NFA, Epsilon-NFA and conversion between them.</li> <li>2. Prove the properties of regular languages using regular expressions.</li> <li>3. Design context-free grammars (CFGs) and pushdown automata (PDAs) for formal languages.</li> <li>4. Design Turing machines to solve the computational problems.</li> <li>5. Explain the concepts of decidability and undecidability.</li> </ol>

### Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

#### Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 220B2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**The Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

#### Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**).

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

#### Suggested Learning Resources:

##### Books

1. John E Hopcroft, Rajeev Motwani, Jeffrey D. Ullman," Introduction to Automata Theory, Languages and Computation", Second Edition, Pearson.

##### Reference:

1. Elaine Rich, "Automata, Computability and complexity", 1st Edition, Pearson Education, 2018.
2. K.L.P Mishra, N Chandrashekar, 3rd Edition, "Theory of Computer Science", PHI, 2012.
3. Peter Linz, "An introduction to Formal Languages and Automata", 3rd Edition, Narosa Publishers, 1998.
4. Michael Sipser : Introduction to the Theory of Computation, 3rd edition, Cengage learning, 2013.
5. John C Martin, Introduction to Languages and The Theory of Computation, 3rd Edition, Tata McGraw –Hill Publishing Company Limited, 2013.

#### Web links and Video Lectures (e-Resources):

- <https://archive.nptel.ac.in/courses/106/105/106105196/>
- <https://archive.nptel.ac.in/courses/106/106/106106049/>
- <https://nptelvideos.com/course.php?id=717>

**Activity Based Learning (Suggested Activities in Class)/ Practical Based Learning**

- Open source tools (like JFLAP) to make teaching and learning more interactive [<https://www.jflap.org/>] (10 Marks)
- Assignments at RBTL-4 (15 marks)

DATA VISUALIZATION LAB		Semester	V
Course Code	<b>BAIL504</b>	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	100
Examination type (SEE)	Practical		
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>● Understand the Importance of data Visualization for business intelligence and decision making.</li> <li>● Learn different approaches to understand the importance of visual perception.</li> <li>● Learn different data visualization techniques and tools.</li> <li>● Gain knowledge of effective data visuals to solve workplace problems.</li> </ul>			
Sl.NO	Experiments		
1	<b>Getting Started</b> - Tableau Workspace, Tableau terminologies, basic functionalities.		
2	<b>Connecting to Data Source</b> – Connecting to Database, Different types of Tableau Joins.		
3	<b>Creating a View</b> - formatting charts, adding filters, creating calculated fields and defining parameters.		
4	<b>Dashboard Design and Storytelling</b> – Components of Dashboard, Understanding how to place worksheets in Containers, Action filters and its types.		
5	<b>Introducing Power BI</b> –Components and the flow of work. Power BI Desktop Interface-The Report has five main areas.		
6	<b>Querying Data from CSV</b> - Query Editor, Connecting the data from the Excel Source, Clean, Transform the data.		
7	<b>Creating Reports &amp; Visualizations</b> - Different types of charts, Formatting charts with Title, Colors.		
8	<b>Dashboards</b> - Filters in Power BI, Formatting dashboards.		
9	Analysis of revenue in sales dataset: i) Create a choropleth map (fill the map) to spot the special trends to show the state which has the highest revenue. ii) Create a line chart to show the revenue based on the month of the year. iii) Create a bin of size 10 for the age measure to create a new dimension to show the revenue. iv) Create a donut chart view to show the percentage of revenue per region by creating zero access in the calculated field. v) Create a butterfly chart by reversing the bar chart to compare female & male revenue based on product category. vi) Create a calculated field to show the average revenue per state & display profitable & non-profitable state. vii) Build a dashboard.		
10	Analysis of GDP dataset: i) Visualize the countries data given in the dataset with respect to latitude and longitude along with country name using symbol maps. ii) Create a bar graph to compare GDP of Belgium between 2006 – 2026. iii) Using pie chart, visualize the GDP of India, Nepal, Romania, South Asia, Singapore by the year 2010. iv) Visualize the countries Bhutan & Costa Rica competing in terms of GDP.		

	<p>v) Create a scatter plot or circle views of GDP of Mexico, Algeria, Fiji, Estonia from 2004 to 2006.</p> <p>vi) Build an interactive dashboard.</p>
11	<p>Analysis of HR Dataset:</p> <p>i) Create KPI to show employee count, attrition count, attrition rate, attrition count, active employees, and average age.</p> <p>ii) Create a Lollipop Chart to show the attrition rate based on gender category.</p> <p>iii) Create a pie chart to show the attrition percentage based on Department Category- Drag department into colours and change automatic to pie. Entire view, Drag attrition count to angle. Label attrition count, change to percent, add total also, edit label.</p> <p>iv) Create a bar chart to display the number of employees by Age group,</p> <p>v) Create a highlight table to show the Job Satisfaction Rating for each job role based on employee count.</p> <p>vi) Create a horizontal bar chart to show the attrition count for each Education field Education field wise attrition – drag education field to rows, sum attrition count to col,</p> <p>vii) Create multiple donut chart to show the Attrition Rate by Gender for different Age group.</p>
12	<p>Analysis of Amazon Prime Dataset:</p> <p>i) Create a Donut chart to show the percentage of movie and tv shows</p> <p>ii) Create a area chart to shows by release year and type</p> <p>iii) Create a horizontal bar chart to show Top 10 genre</p> <p>iv) Create a map to display total shows by country</p> <p>v) Create a text sheet to show the description of any movie/movies.</p> <p>vi) Build an interactive Dashboard.</p>
<p><b>Course outcomes (Course Skill Set):</b>                  At the end of the course the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Design the experiment to create basic charts and graphs using Tableau and Power BI.</li> <li>2. Develop the solution for the given real world problem.</li> <li>3. Analyze the results and produce substantial written documentation.</li> </ol>	

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

**Continuous Internal Evaluation (CIE):**

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

**Semester End Evaluation (SEE):**

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in - 60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

**Suggested Learning Resources:**

1. Microsoft Power BI Dashboards Step by Step by Errin O'Connor, 2019 by Pearson Education, Inc
2. Information Dashboard Design: Displaying Data for At-a-glance Monitoring” by Stephen Few
3. <https://help.tableau.com/current/guides/get-started-tutorial/en-us/get-started-tutorial-home.htm>
4. <https://www.tutorialspoint.com/tableau/index.htm>
5. <https://www.simplilearn.com/tutorials/power-bi-tutorial/power-bi-vs-tableau>

<b>COMPUTER VISION</b>		Semester	5
Course Code	<b>BAI151A</b>	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	<b>Theory</b>		
<p><b>Course objectives:</b>            CLO1: To understand the fundamentals of computer vision and digital image processing            CLO2: To introduce the processes involved image enhancement and restoration.            CLO3: To facilitate the students to gain understanding color image processing and morphology.            CLO5: To impart the knowledge of image segmentation and object recognition techniques.</p>			
<p><b>Teaching-Learning Process (General Instructions)</b>            These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none"> <li>1. Lecturer method (L) needs not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.</li> <li>2. Use of Video/Animation to explain functioning of various concepts.</li> <li>3. Encourage collaborative (Group Learning) Learning in the class.</li> <li>4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.</li> <li>5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.</li> <li>6. Use animations/videos to help the students to understand the concepts.</li> <li>7. Demonstrate the concepts using a suitable programming language.</li> </ol>			
<b>Module-1</b>			
<p><b>Introduction:</b> What is computer vision? A brief history. <b>Image Formation:</b> Photometric image formation, The digital camera. <b>Image processing:</b> Point operators, Linear filtering.</p> <p><b>Textbook-1:</b> Chap-1 (1.1, 1.2), Chap-2 (2.2, 2.3), Chap-3 (3.1, 3.2)</p>			
<b>Module-2</b>			
<p><b>Image processing:</b> More neighborhood operators, Fourier transforms, Pyramids and wavelets, and Geometric transformations.</p> <p><b>Textbook-1:</b> Chap- 3 (3.3 - 3.6)</p>			
<b>Module-3</b>			
<p><b>Image Restoration and Reconstruction:</b> A model of Image degradation/restoration process, restoration in the presence of noise only, periodic noise reduction by frequency domain filtering.</p> <p><b>Image Segmentation:</b> Fundamentals, Point, Line and edge detection, thresholding (Foundation &amp; Basic global thresholding only), Segmentation by region growing &amp; region splitting &amp; merging.</p> <p><b>Textbook-2:</b> Chap-5 (5.1 to 5.4), Chap-10 (10.1 to 10.3.2, 10.4)</p>			
<b>Module-4</b>			
<p><b>Color Image Processing:</b> Color fundamentals, color models, Pseudocolor image processing, full color image processing, color transformations, color image smoothing and sharpening, Using color in image segmentation, Noise in color images.</p>			



<p><b>Textbook-2:</b> Chap-6 (6.1-6.8)</p>	
<p><b>Module-5</b></p>	
<p><b>Morphological Image Processing:</b> Preliminaries, Erosion and Dilation, opening and closing, Hit-or-miss transform, some basic morphological algorithms.</p> <p><b>Feature Extraction:</b> Background, Boundary preprocessing (Boundary following &amp; Chain codes only).</p> <p><b>Image pattern Classification:</b> Background, Patterns and classes, Pattern classification by prototype matching (Minimum distance classifier only).</p> <p><b>Textbook-2:</b> Chap -9 (9.1-9.5), Chap-11(11.1-11.2.2), Chap-12 (12.1-12.3.1)</p>	
<p><b>Course outcome (Course Skill Set)</b></p> <p>At the end of the course, the student will be able to :</p> <ol style="list-style-type: none"> <li>1. Explain the fundamentals of computer vision and its applications.</li> <li>2. Apply the image enhancement techniques for smoothing and sharpening of images.</li> <li>3. Compare the different image restoration and segmentation techniques.</li> <li>4. Demonstrate the smoothing and sharpening techniques for color images.</li> <li>5. Explain morphological, feature extraction, and pattern classification techniques for object recognition.</li> </ol>	
<p><b>Assessment Details (both CIE and SEE)</b></p> <p>The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.</p> <p><b>Continuous Internal Evaluation:</b></p> <ul style="list-style-type: none"> <li>● For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.</li> <li>● The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered</li> <li>● Any two assessment methods mentioned in the 220B2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Implementation of Image processing and video processing techniques in Java/Python/Matlab is recommended.</li> <li>● For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.</li> </ul> <p><b>Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.</b></p> <p><b>Semester-End Examination:</b></p> <p>Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (<b>duration 03 hours</b>).</p> <ol style="list-style-type: none"> <li>1. The question paper will have ten questions. Each question is set for 20 marks.</li> <li>2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), <b>should have a mix of topics</b> under that module.</li> <li>3. The students have to answer 5 full questions, selecting one full question from each module.</li> </ol>	

4. Marks scored shall be proportionally reduced to 50 marks

**Suggested Learning Resources:**

**Textbooks**

1. Richard Szeliski, Computer Vision: Algorithms and Applications (Texts in Computer Science), 2nd Edition, 2022, Springer.
2. Rafael C G., Woods R E. and Eddins S L, Digital Image Processing, Pearson, 4th edition, 2019.

**Reference books**

1. David Forsyth and Jean Ponce, Computer Vision: A Modern Approach, 2nd Edition, Pearson, 2015.
2. Reinhard Klette, Concise Computer Vision - An Introduction into Theory and Algorithms, Springer, 2014.

**Web links and Video Lectures (e-Resources):**

- Virtual Labs: <https://cse19-iiith.vlabs.ac.in/>
- [https://onlinecourses.nptel.ac.in/noc21\\_ee78/preview](https://onlinecourses.nptel.ac.in/noc21_ee78/preview)
- Introduction to Machine Vision: <https://www.youtube.com/watch?v=tY2gczObpfU>
- [https://coral.ise.lehigh.edu/optml/files/2019/10/OptML\\_CV\\_tutorial\\_1\\_compressed.pdf](https://coral.ise.lehigh.edu/optml/files/2019/10/OptML_CV_tutorial_1_compressed.pdf)

**Activity Based Learning (Suggested Activities in Class)/ Practical Based Learning**

- Programming Assignment-1: Implementation of important concepts of Image enhancement (point & filters) and restoration techniques with C++/Java/Python - 10 Marks
- Programming Assignment-2: Implementation of segmentation, Morphological and color image processing techniques with C++/Java/Python - 15 Marks

<b>Data Warehousing</b>		Semester	V
Course Code	<b>BAD515B</b>	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	42	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		
<p><b>Course objectives:</b></p> <ul style="list-style-type: none"> <li>● To understand the need of data warehousing.</li> <li>● To understand the planning a data warehouse based on business requirements</li> <li>● To understand the architectural components of Data warehouse</li> <li>● To understand the data modeling approaches in Data Warehousing</li> <li>● To understand OLAP operations and use them effectively to improve data quality</li> </ul>			
<p><b>Teaching-Learning Process (General Instructions)</b>  These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none"> <li>1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.</li> <li>2. Use of Video/Animation to explain functioning of various concepts.</li> <li>3. Encourage collaborative (Group Learning) Learning in the class.</li> <li>4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.</li> <li>5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.</li> <li>6. Introduce Topics in manifold representations.</li> <li>7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.</li> <li>8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.</li> </ol>			
<b>Module-1</b>			
<p>Escalating Need for Strategic Information, Failures Of Past Decision-Support Systems, Operational Versus Decision-Support Systems, Data warehousing—The Only Viable Solution, Data Warehouse Defined.  The Data warehousing Movement, Evolution of Business Intelligence  Data Warehouse: The Building Blocks: Defining Features, Data Warehouses and Data Marts, Architectural Types, Components: Source Data Component, Data Staging Component, Data Storage Component, Information Delivery Component, Metadata Component, Management and Control Component, Metadata In The Data Warehouse.  <b>Text Book:Chapter 1 , 2</b></p>			
<b>Module-2</b>			
<p>Planning And Project Management: Planning Your Data Warehouse, The Data Warehouse Project, The Development Phases, The Project Team, Project Management Considerations  Defining The Business Requirements: Dimensional Analysis, Information Packages: Requirements Not Fully Determinate, Business Dimensions, Dimension Hierarchies and Categories, Key Business Metrics Or Facts, Requirements Gathering Methods, Data Sources, Data Transformation, Data Storage, Information Delivery, Information Package Diagrams.  Requirements As The Driving Force For Data warehousing : Data Design , The Architectural Plan , Data Storage Specifications , Information Delivery Strategy.</p>			

	<b>Text Book:Chapter 4, 5,6</b>
	<b>Module-3</b>
	<p>Architectural Components : Understanding Data Warehouse Architecture , Distinguishing Characteristics , Architectural Framework , Technical Architecture , Architectural Types .  Infrastructure As The Foundation For Data warehousing: Infrastructure Supporting Architecture , Hardware And Operating Systems , Database Software , Collection Of Tools , Data Warehouse Appliances .  The Significant Role Of Metadata : Why Metadata Is Important , Metadata Types By Functional Areas , Business Metadata , Technical Metadata , How To Provide Metadata .  <b>Text Book:Chapter 7,8,9</b></p>
	<b>Module-4</b>
	<p>Principles Of Dimensional Modelling : From Requirements To Data Design , The Star Schema , Star Schema Keys , Advantages Of The Star Schema , Star Schema: Examples , Dimensional Modelling: Advanced Topics : Updates To The Dimension Tables , Miscellaneous Dimensions ,The Snowflake Schema , Aggregate Fact Tables ,Families Of Stars .  Data Extraction, Transformation, And Loading: ETL Overview, ETL Requirements And Steps, Data Extraction, Data Transformation, Data Loading, ETL Tool Options Reemphasizing ETL Metadata, ETL Summary And Approach.  <b>Text Book:Chapter 10,11,12</b></p>
	<b>Module-5</b>
	<p>Data Quality: A Key To Success: Why Is Data Quality Critical? Data Quality Challenges, Data Quality Tools, Data Quality Initiative, Master Data Management (Mdm) . Matching Information To The Classes Of Users: Information From The Data Warehouse, Who Will Use The Information? Information Delivery.  Information Delivery: Business Activity Monitoring (Bam) , Dashboards And Scorecards  OLAP In the Data Warehouse: Demand for Online Analytical Processing, Major Features And Functions, OLAP Models, OLAP Implementation Considerations.  Data Warehousing And the Web: Web-Enabled Data Warehouse, Web-Based Information Delivery, OLAP And The Web, Building A Web-Enabled Data Warehouse.  <b>Text Book:Chapter 13,14,15,16</b></p>
	<p><b>Course outcome (Course Skill Set)</b></p> <p><b>At the end of the course, the student will be able to :</b></p> <ol style="list-style-type: none"> <li>1. Explain the need for strategic information and data warehousing.</li> <li>2. Describe necessary skills to plan, manage, and execute data warehouse projects effectively.</li> <li>3. Identify the role of metadata in data warehousing.</li> <li>4. Analyse multi-dimensional modelling techniques for effective data organization in data warehouses.</li> <li>5. Explain the importance of data quality and master data management in data warehousing.</li> </ol>

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**).

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

**Suggested Learning Resources:****Books**

1. Data Warehousing Fundamentals for IT Professionals, Second Edition, PAULRAJ PONNIAH, Wiley 2010.

**Web links and Video Lectures (e-Resources):**

<https://archive.nptel.ac.in/courses/106/105/106105191/>

- <https://www.youtube.com/watch?v=m-aKj5ovDfg>
- [https://onlinecourses.swayam2.ac.in/cec19\\_cs01/preview](https://onlinecourses.swayam2.ac.in/cec19_cs01/preview)
- <http://nptel.ac.in/video.php?subjectId=106106093>
- <http://textofvideo.nptel.iitm.ac.in/video.php?courseId=106106093&p=4>

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Course Project - Build a simple data warehouse using various schemas.

<b>CLOUD COMPUTING</b>		Semester	V
Course Code	<b>BAD515C</b>	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		
<p><b>Course objectives:</b></p> <ul style="list-style-type: none"> <li>● Introduce the rationale behind the cloud computing revolution and the business drivers</li> <li>● Understand various models, types and challenges of cloud computing</li> <li>● Understand the design of cloud native applications, the necessary tools and the design tradeoffs.</li> <li>● Realize the importance of Cloud Virtualization, Abstraction`s, Enabling Technologies and cloud security</li> </ul>			
<p><b>Teaching-Learning Process (General Instructions)</b>            These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none"> <li>1. Lecturer method (L) needs not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.</li> <li>2. Use of Video/Animation to explain functioning of various concepts.</li> <li>3. Encourage collaborative (Group Learning) Learning in the class.</li> <li>4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.</li> <li>5. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.</li> <li>6. Use any of these methods: Chalk and board, Active Learning, Case Studies.</li> </ol>			
<b>Module-1</b>			
<p><b>Distributed System Models and Enabling Technologies:</b> Scalable Computing Over the Internet, Technologies for Network Based Systems, System Models for Distributed and Cloud Computing, Software Environments for Distributed Systems and Clouds, Performance, Security and Energy Efficiency.</p> <p><b>Textbook 1: Chapter 1: 1.1 to 1.5</b></p>			
<b>Module-2</b>			
<p><b>Virtual Machines and Virtualization of Clusters and Data Centers:</b> Implementation Levels of Virtualization, Virtualization Structure/Tools and Mechanisms, Virtualization of CPU/Memory and I/O devices, Virtual Clusters and Resource Management, Virtualization for Data Center Automation</p> <p><b>Textbook 1: Chapter 3: 3.1 to 3.5</b></p>			
<b>Module-3</b>			

<p><b>Cloud Platform Architecture over Virtualized Datacenters:</b> Cloud Computing and Service Models, Data Center Design and Interconnection Networks, Architectural Design of Compute and Storage Clouds, Public Cloud Platforms: GAE, AWS and Azure, Inter-Cloud Resource Management.</p> <p><b>Textbook 1: Chapter 4: 4.1 to 4.5</b></p>
<p><b>Module-4</b></p>
<p><b>Cloud Security:</b> Top concern for cloud users, Risks, Privacy Impact Assessment, Cloud Data Encryption, Security of Database Services, OS security, VM Security, Security Risks Posed by Shared Images and Management OS, XOAR, A Trusted Hypervisor, Mobile Devices and Cloud Security</p> <p><b>Cloud Security and Trust Management:</b> Cloud Security Defense Strategies, Distributed Intrusion/Anomaly Detection, Data and Software Protection Techniques, Reputation-Guided Protection of Data Centers.</p> <p><b>Textbook 2: Chapter 11: 11.1 to 11.3, 11.5 to 11.8, 11.10 to 11.14</b></p> <p><b>Textbook 1: Chapter 4: 4.6</b></p>
<p><b>Module-5</b></p>
<p><b>Cloud Programming and Software Environments:</b></p> <p>Features of Cloud and Grid Platforms, Parallel and Distributed Computing Paradigms, Programming Support for Google App Engine, Programming on Amazon AWS and Microsoft, Emerging Cloud Software Environments.</p> <p><b>Textbook 1: Chapter 6: 6.1 to 6.5</b></p>
<p><b>Course outcome (Course Skill Set)</b></p> <p>At the end of the course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. Describe various cloud computing platforms and service providers.</li> <li>2. Illustrate the significance of various types of virtualization.</li> <li>3. Identify the architecture, delivery models and industrial platforms for cloud computing based applications.</li> <li>4. Analyze the role of security aspects in cloud computing.</li> <li>5. Demonstrate cloud applications in various fields using suitable cloud platforms.</li> </ol>

### Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

#### Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

#### Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**).

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

#### Suggested Learning Resources:

##### Text Books:

1. Kai Hwang, Geoffrey C Fox, and Jack J Dongarra, Distributed and Cloud Computing, Morgan Kaufmann, Elsevier 2012
2. Dan C. Marinescu, Cloud Computing Theory and Practice, Morgan Kaufmann, 2nd Edition, Elsevier 2018

##### Reference Books:

1. Rajkumar Buyya, Christian Vecchiola, and Thamrai Selvi, Mastering Cloud Computing McGrawHill Education, 1<sup>st</sup> Edition, 2017
2. Toby Velte, Anthony Velte, Cloud Computing: A Practical Approach, McGraw-Hill Education, 2017.
3. George Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, O'Reilly Publication, 1<sup>st</sup> Edition, 2009
4. John Rhoton, Cloud Computing Explained: Implementation Handbook for Enterprises, Recursive Press, 2<sup>nd</sup> Edition, 2009.

#### Web links and Video Lectures (e-Resources):



- <https://freevideolectures.com/course/4639/nptel-cloud-computing/1>.
- <https://www.youtube.com/playlist?list=PLShJjCRzjWxhz7SfG4hpaBD5bK0loWx9J>
- [https://www.youtube.com/watch?v=EN4fEbcFZ\\_E](https://www.youtube.com/watch?v=EN4fEbcFZ_E)
- <https://www.youtube.com/watch?v=RWgW-CgdIk0>
- <https://www.geeksforgeeks.org/virtualization-cloud-computing-types/>
- <https://www.javatpoint.com/cloud-service-provider-companies>

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**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Installation of virtualization software (Virtual box, Xen etc..) and run applications with different OS.  
- 10 Marks
- Implement cloud applications using GAE, AWS, Azure/simulate cloud applications using Cloudsim/  
Greencloud/ Cloud Analyst etc... - 15 Marks

<b>DISTRIBUTED SYSTEMS</b>		Semester	5
Course Code	<b>BCS515D</b>	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	3Hrs	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		
<p><b>Course objectives:</b></p> <ul style="list-style-type: none"> <li>• Understand the goals and challenges of distributed systems</li> <li>• Describe the architecture of RPC/RMI, distributed file systems and name services</li> <li>• Learn clock synchronization algorithms to monitor and order the events, mutual exclusion, election and consensus algorithms.</li> <li>• Study the fundamental concepts and algorithms related to distributed transactions and replication.</li> </ul>			
<p><b>Teaching-Learning Process (General Instructions)</b>  These are sample strategies which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none"> <li>1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.</li> <li>2. Use of Video/Animation to explain functioning of various concepts.</li> <li>3. Encourage collaborative (Group Learning) Learning in the class.</li> <li>4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.</li> <li>5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyse information rather than simply recall it.</li> <li>6. Introduce Topics in manifold representations.</li> <li>7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.</li> <li>8. Demonstrate every concept by implementing an OpenGL program.</li> </ol>			
<b>Module-1</b>			
<p><b>CHARACTERIZATION OF DISTRIBUTED SYSTEMS:</b> Introduction, Focus on resource sharing, Challenges.</p> <p><b>REMOTE INVOCATION:</b> Introduction, Request-reply protocols, Remote procedure call, Introduction to Remote Method Invocation.</p> <p><b>Textbook: Chapter- 1.1,1.4,1.5, 5.1-5.5</b></p>			
<b>Module-2</b>			
<p><b>DISTRIBUTED FILE SYSTEMS:</b> Introduction, File service architecture.</p> <p><b>NAME SERVICES:</b> Introduction, Name services and the Domain Name System, Directory services.</p> <p><b>Textbook: Chapter- 12.1,12.2, 13.1-13.3</b></p>			
<b>Module-3</b>			
<p><b>TIME AND GLOBAL STATES:</b> Introduction, Clocks, events and process states, Synchronizing Physical clocks, Logical time and logical clocks, Global states</p>			

	<b>Textbook: Chapter- 14.1-14.5</b>
	<b>Module-4</b>
	<p><b>COORDINATION AND AGREEMENT:</b> Introduction, Distributed mutual exclusion, Elections, Coordination and agreement in group communication, Consensus and related problems.</p> <p><b>Textbook: Chapter -15.1-15.5</b></p>
	<b>Module-5</b>
	<p><b>DISTRIBUTED TRANSACTIONS:</b> Introduction, Flat and nested distributed transactions, Atomic commit protocols, Concurrency control in distributed transactions, Distributed deadlocks, Transaction recovery.</p> <p><b>REPLICATION:</b> Introduction.</p> <p><b>Textbook: Chapter -17.1-17.6, 18.1</b></p>
<p><b>Course outcome (Course Skill Set)</b></p> <p>At the end of the course, the student will be able to :</p> <ol style="list-style-type: none"> <li>1. Identify the goals and challenges of distributed systems</li> <li>2. Demonstrate the remote invocation techniques for communication</li> <li>3. Describe the architecture of distributed file systems and name services</li> <li>4. Apply clock synchronization algorithms to monitor and order the events.</li> <li>5. Analyze the performance of mutual exclusion, election and consensus algorithms.</li> <li>6. Illustrate the fundamental concepts and algorithms related to distributed transactions and replication</li> </ol>	

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester-End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**).

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

**Suggested Learning Resources:****Textbook's:**

1. George Coulouris, Jean Dollimore and Tim Kindberg, "Distributed Systems Concepts and Design", Fifth Edition, Pearson Education, 2012.

**Web links and Video Lectures (e-Resources):**

- [https://www.youtube.com/watch?v=Azyizl9w2xo&list=PLrjkTq13jnm9FEOXHA\\_qjRTMO-DlaIk-W](https://www.youtube.com/watch?v=Azyizl9w2xo&list=PLrjkTq13jnm9FEOXHA_qjRTMO-DlaIk-W)

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Programming Assignment (15 marks)
- Literature Review/ Case Studies (10 marks)

<b>EXPLORATORY DATA ANALYSIS</b>		Semester	5
Course Code	<b>BAI515E</b>	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	<b>Theory</b>		
<p><b>Course objectives:</b>            CLO1: To equip students with Python, IPython, and Jupyter for data analysis tasks.            CLO2: To provide a comprehensive understanding of NumPy for scientific computations.            CLO3: To introduce foundational and advanced data manipulation techniques using Pandas            CLO4: To enhance data visualization skills using Matplotlib and Seaborn            CLO5: To introduce Machine Learning concept with practical applications using Scikit-Learn.            CLO6: To promote the practical application of data analysis tools and techniques on real-world datasets</p>			
<p><b>Teaching-Learning Process (General Instructions)</b>            These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none"> <li>1. Lecturer method (L) needs not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.</li> <li>2. Use of Video/Animation/Demonstration to explain functioning of various concepts.</li> <li>3. Encourage collaborative (Group Learning) Learning in the class.</li> <li>4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.</li> <li>5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.</li> <li>6. Use animations/videos to help the students to understand the concepts.</li> <li>7. Demonstrate the concepts using PYTHON and its libraries</li> </ol>			
<b>Module-1</b>			
<p><b>Introduction to Python and NumPy:</b> Getting Started in IPython and Jupyter, Enhanced Interactive Features, The Basics of NumPy Arrays, Sorted Arrays, Structured Data: NumPy's Structured Arrays</p> <p><b>Textbook: Chapter 2, Chapter 5, Chapter 11, Chapter 12, Chapter 1 (Not for CIE/SEE),</b></p>			
<b>Module-2</b>			
<p><b>Data Manipulation with Pandas - I:</b> Introducing Pandas Objects, Handling Missing Data, Hierarchical Indexing, Pivot Tables.</p> <p><b>Textbook: Chapter 13, Chapter 16, Chapter 17, Chapter 21</b></p>			
<b>Module-3</b>			
<p><b>Data Manipulation with Pandas - II:</b> Vectorized String Operations, Working with Time Series, High-Performance Pandas: eval and query</p> <p><b>Textbook: Chapter 22, Chapter 23, Chapter 24</b></p>			
<b>Module-4</b>			

<p><b>Data Visualization with Matplotlib:</b> General Matplotlib Tips, Simple Line Plots, Simple Scatter Plots, Visualization with Seaborn</p> <p><b>Textbook: Chapter 25, Chapter 26, Chapter 27, Chapter 36</b></p>
<p><b>Module-5</b></p>
<p><b>Introduction to Machine Learning:</b> What Is Machine Learning?, Introducing Scikit-Learn, Hyperparameters and Model Validation</p> <p><b>Textbook: Chapter 37, Chapter 38, Chapter 39</b></p>
<p><b>Course outcome (Course Skill Set)</b></p> <p>At the end of the course, the student will be able to :</p> <ol style="list-style-type: none"> <li>1. Demonstrate the application of the NumPy for performing data analysis tasks.</li> <li>2. Make use of Pandas for various data manipulation tasks.</li> <li>3. Apply advanced data manipulation techniques to real-world datasets.</li> <li>4. Develop data visualizations using Matplotlib and Seaborn to effectively communicate data insights.</li> <li>5. Explain the fundamental concepts of machine learning and validation models using Scikit-Learn.</li> </ol>
<p><b>Assessment Details (both CIE and SEE)</b></p> <p>The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.</p> <p><b>Continuous Internal Evaluation:</b></p> <ul style="list-style-type: none"> <li>• For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.</li> <li>• The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered</li> <li>• Any two assessment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Implementation of Image processing and video processing techniques in Java/Python/Matlab is recommended.</li> <li>• For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.</li> </ul> <p><b>Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.</b></p> <p><b>Semester-End Examination:</b></p> <p>Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (<b>duration 03 hours</b>).</p> <ol style="list-style-type: none"> <li>1. The question paper will have ten questions. Each question is set for 20 marks.</li> <li>2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), <b>should have a mix of topics</b> under that module.</li> <li>3. The students have to answer 5 full questions, selecting one full question from each module.</li> <li>4. Marks scored shall be proportionally reduced to 50 marks</li> </ol>

**Suggested Learning Resources:****Text Books:**

1. Jake VanderPlas - Python Data Science Handbook: Essential Tools for Working with Data, Oreilly 2<sup>nd</sup> Edition, 2022.

## Reference Book:

2. <https://python4csip.com/files/download/Data%20Visualization.pdf>

**Web links and Video Lectures (e-Resources):**

- Numpy Tutorial - <https://www.w3schools.com/python/numpy/default.asp>
- Pandas Tutorial - <https://www.w3schools.com/python/pandas/default.asp>
- Matplotlib Tutorial - [https://www.w3schools.com/python/matplotlib\\_intro.asp](https://www.w3schools.com/python/matplotlib_intro.asp)
- Introduction to ML with Scikit Learn - <https://scikit-learn.org/1.4/tutorial/basic/tutorial.html>

**Activity Based Learning (Suggested Activities in Class)/ Practical Based Learning**

- Programming Assignment-1: Implementation of important concepts of data manipulation using NumPy and Pandas (Python) - 10 Marks
- Programming Assignment-2: Implementation of simple Machine Learning models with Visualization using Python (Matplotlib, Scikitlearn) - 15 Marks

<b>Environmental Studies and E-Waste Management</b>		Semester	V
Course Code	<b>BCS508</b>	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	14	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		
<p><b>Course objectives:</b></p> <ul style="list-style-type: none"> <li>• Identify the major challenges of environmental issues</li> <li>• Develop skills, critical thinking and demonstrate socio-economic skills for Environmental protection</li> <li>• Analyze the impact of issues w. r. t. waste management</li> </ul>			
<p><b>Teaching-Learning Process (General Instructions)</b>                      These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none"> <li>1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.</li> <li>2. Use of Video/Animation to explain functioning of various concepts.</li> <li>3. Encourage collaborative (Group Learning) Learning in the class.</li> <li>4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes Critical thinking.</li> <li>5. Adopt Case study Based Learning (CBL), which fosters students' analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.</li> <li>6. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.</li> </ol>			
<b>Module-1</b>			
<p>Ecosystem and Sustainability:                      Ecosystem: Structure of Ecosystem, Types: Forest, Desert, Wetlands, Riverine, Oceanic ecosystems.                      Sustainability: 17SDG targets and possible actions.                      Self-Study Component (SSC): Components of the environment.                      Textbook 1: CH- 3, e-resource: 1</p>			
<b>Module-2</b>			
<p>Natural resources and Energy:                      Natural Resources: Water resources – Availability &amp; Quality aspects, Water borne diseases &amp; water induced diseases, Fluoride problem in drinking water.                      Energy: Different types of energy, Conventional sources &amp; Non -Conventional sources of Energy, Solar energy, Wind Energy, Hydrogen as an alternative energy                      Self-Study Component (SSC): Alternative Energy sources                      Textbook 1: CH- 2</p>			
<b>Module-3</b>			
<p>Environmental Pollution:                      Environmental Pollution: Water Pollution, Noise pollution, Air pollution (Sources, Impacts, Preventive measures and Public Health Aspects.                      Self-Study Component (SSC): Case studies of air pollution episodes                      Textbook 1: CH- 5</p>			
<b>Module-4</b>			
<p>Waste management:                      Waste management: Solid Waste Management , types and sources, functional elements of SWM, Biomedical Waste Management - Sources, Characteristics                      Environmental Legislation: Solid Waste Management Rules, 2016, Biomedical Waste Management Rules, 2016.</p>			



Self-Study Component (SSC): Case studies on waste management options

Textbook 1: CH- 6, e-resource:2

**Module-5**

E - Waste Management

E- waste; composition and generation. Global context in e- waste; E-waste pollutants, E waste hazardous properties, Effects of pollutant (E- waste) on human health and surrounding environment, domestic e-waste disposal, Basic principles of E waste management, Component of E waste management.

E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2022 - Salient Features and its implications.

Self-Study Component (SSC): E-Waste (Management) Amendment Rules, 2023, 2024

Textbook 1: CH- 6, Textbook 2: CH-2, e-resource:3

**Course outcome (Course Skill Set)**

At the end of the course the student will be able to:

1. Comprehend the principles of ecology and environmental issues pertaining to air, land, and water on a global scale.
2. Acquire observation skills for solving problems related to the environment.
3. Conduct survey to describe the realities of waste management system.

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous internal Examination (CIE)**

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

**Internal Assessment Test question paper is designed to attain the different levels of Bloom’s taxonomy as per the outcome defined for the course.**

**Semester End Examinations (SEE)**

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour**. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Textbooks**

1. S M Prakash , “Environmental Studies” 3rd Edition, Elite Publishing House, Mangalore, 2018.
2. Hester R.E., and Harrison R.M, Electronic Waste Management. Science, 2009.

**Reference Books:**

1. Earch Barucha, “Environmental Studies for UG students”, 2004.
2. Benny Joseph (2005), “Environmental Studies” , Tata McGraw – Hill Publishing Company Limited.
3. R. Rajagopalan, “Environmental Studies- From Crisis to Cure” , 2nd Edition, Oxford university press, New Delhi, 2013.
4. Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi.
5. Raman Sivakumar, “Principles of Environmental Science and Engineering”, 2nd edition, Cengage learning Singapur, 2005.
6. G. Tyler Miller Jr., “Environmental Science – working with the Earth”, Eleventh Edition, Thomson Brooks /Cole, 2006
7. Dr. Pratiba Singh, Dr.Anoop Singh and Dr. Piyush Malaviya, “Text Book of Environmental and Ecology”, Acme Learning Pvt. Ltd. New Delhi.

8. P. Meenakshi, "Elements of Environmental Science and Engineering", Prentice Hall of India Private Limited, New Delhi, 2006
<b>Web links and Video Lectures (e-Resources):</b>
<ol style="list-style-type: none"> <li>1. <a href="https://sdgs.un.org/goals">https://sdgs.un.org/goals</a></li> <li>2. <a href="https://kspcb.karnataka.gov.in/waste-management/biomedical-waste">https://kspcb.karnataka.gov.in/waste-management/biomedical-waste</a></li> <li>3. E Waste (Management) Rules, 2022: <a href="https://kspcb.karnataka.gov.in/sites/default/files/inline-files/E%20Waste%20%28Management%29%20Rules%2C%202022.pdf">https://kspcb.karnataka.gov.in/sites/default/files/inline-files/E%20Waste%20%28Management%29%20Rules%2C%202022.pdf</a></li> </ol>
<p><b>Activity Based Learning (Suggested Activities in Class)/ Practical Based learning</b></p> <ul style="list-style-type: none"> <li>• Analysis report of case study specified in the Textbooks and reference books (one per student). (10 marks)</li> <li>• Field Survey (In Team): The students' team of the size of 2 to 4 are expected to visit the organization or Industry understand the waste management, utilization of energy, pollution concerns, e-waste handling and other related suggested best practices specified in the syllabus and then submit a detailed visit report to the concerned staff. (15 marks)</li> </ul>