

**Programme Name/s** : Computer Technology/ Computer Engineering/ Computer Science & Engineering/  
Computer Hardware & Maintenance/  
**Programme Code** : CM/ CO/ CW/ HA  
**Semester** : Third  
**Course Title** : COMPUTER GRAPHICS  
**Course Code** : 313001

**I. RATIONALE**

Computer Graphics is the discipline of generating images with the aid of computers. This course provides an introduction to the principles of Computer Graphics. In particular, the course will consider methods for Object Design, Transformation, Scan Conversion, Visualization and Modelling of real world and enables student to create impressive graphics easily and efficiently.

**II. INDUSTRY / EMPLOYER EXPECTED OUTCOME**

The aim of this course is to attain following Industry Identified Competency through various Teaching Learning Experiences:

Develop programs using Graphics concepts.

**III. COURSE LEVEL LEARNING OUTCOMES (COS)**

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Manipulate Visual and Geometric information of Images.
- CO2 - Develop programs in C applying standard graphics algorithms.
- CO3 - Perform and Demonstrate basic and composite graphical transformations on given object.
- CO4 - Implement various Clipping algorithms.
- CO5 - Develop programs to create Curves.

**IV. TEACHING-LEARNING & ASSESSMENT SCHEME**

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme										Total Marks	
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory			Based on LL & TL				Based on SL			
				CL	TL	LL					FA-TH	SA-TH	Total	Practical		SLA					
				Max	Max	Max	Min	Max						Min	Max		Min	Max	Min		
313001	COMPUTER GRAPHICS	CGR	DSC	1	-	2	1	4	2	-	-	-	-	-	25	10	-	-	25	10	50

**Total IKS Hrs for Sem. : 0 Hrs**

Abbreviations: CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, \*# On Line Examination , @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.\* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. \* Self learning hours shall not be reflected in the Time Table.
7. \* Self learning includes micro project / assignment / other activities.

## V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe coordinate system. TLO 1.2 Select and use various graphics file formats. TLO 1.3 Use different graphics functions and standards.	<b>Unit - I Basics of Computer Graphics</b> 1.1 Coordinate system 1.2 Graphics file formats: Basics, advantages, disadvantages – BMP – GIF – JPEG – TIFF – PCX 1.3 Graphics functions & standards: Text mode, Graphic mode, Shapes, Colors, Graphics standards.	Lecture Using Chalk-Board Demonstration Hands-on
2	TLO 2.1 Apply Line Drawing algorithms to generate Line. TLO 2.2 Apply Circle Drawing algorithms to generate Circle. TLO 2.3 Apply Polygon Filling algorithms to Fill Polygon.	<b>Unit - II Raster Scan Graphics</b> 2.1 Line Drawing Algorithms : Digital Differential Analyzer algorithm, Bresenham's algorithm. 2.2 Circle Generation- Symmetry of Circle, Bresenham's algorithm 2.3 Polygon Filling : Seed Fill algorithms- Flood Fill algorithm, Boundary Fill algorithm.	Lecture Using Chalk-Board Demonstration Hands-on
3	TLO 3.1 Perform various transformations on given graphics object. TLO 3.2 Use composite transformations. TLO 3.3 Write need of homogeneous coordinates.	<b>Unit - III Overview of 2D And 3D Transformations</b> 3.1 Basic Transformations: Translation, Scaling, Rotation. 3.2 Matrix representations & homogeneous coordinates. 3.3 Composite transformations. 3.4 Three-dimensional transformation. 3.5 Other transformations: Reflection, Shear.	Lecture Using Chalk-Board Demonstration Hands-on
4	TLO 4.1 Define: Windowing and Clipping. TLO 4.2 Apply Clipping algorithms for Line and Polygon.	<b>Unit - IV Windowing and Clipping Techniques</b> 4.1 Windowing concepts. 4.2 Line Clipping: Cohen Sutherland Line Clipping algorithm, Mid-Point Subdivision Line clipping algorithm. 4.3 Polygon Clipping: Sutherland Hodgeman Polygon clipping algorithm.	Lecture Using Chalk-Board Demonstration Hands-on
5	TLO 5.1 Draw various Curves using Curve generation algorithms. TLO 5.2 Identify different types of Projections.	<b>Unit - V Introduction to Curves and Projections</b> 5.1 Bezier and B-Spline Curves. 5.2 Projections: Perspective and Parallel Projection and its types.	Lecture Using Chalk-Board Demonstration Hands-on

## VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Implement a C program using different graphics functions.	1	*Write a C program to draw various graphics objects (Pixel, Circle, Line, Ellipse, Rectangle, Triangle, Polygon) using graphics functions.	2	CO1
LLO 2.1 Implement a C program to draw line using DDA algorithm.	2	*Write a C program to draw line using DDA algorithm.	2	CO2
LLO 3.1 Implement a C program to draw line using Bresenham's algorithm.	3	Write a C program to draw line using Bresenham's algorithm.	2	CO2
LLO 4.1 Implement a C program to draw circle using Bresenham's algorithm.	4	*Write a C program to draw circle using Bresenham's algorithm.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 5.1 Implement a C program for Flood fill algorithm.	5	*Write a C program for Flood fill algorithm of polygon filling.	2	CO2
LLO 6.1 Implement a C program for Boundary fill algorithm.	6	Write a C program for Boundary fill algorithm of polygon filling.	2	CO2
LLO 7.1 Implement a C program for 2D Translation and Scaling	7	*Write a C program for 2D Translation and Scaling.	4	CO3
LLO 8.1 Implement a C program for 2D Rotation.	8	Write a C program for 2D Rotation.	2	CO3
LLO 9.1 Implement a C program for 2D Reflection and Shear.	9	*Write a C program for 2D Reflection and Shear.	4	CO3
LLO 10.1 Implement a C program for 3D Translation and Scaling.	10	*Write a C program for 3D Translation and Scaling .	4	CO3
LLO 11.1 Implement a C program for 3D Rotation	11	Write a C program for 3D Rotation.	2	CO3
LLO 12.1 Implement a C program for Line Clipping using Cohen-Sutherland algorithm.	12	*Write a C program for Line Clipping using Cohen-Sutherland algorithm.	2	CO4
LLO 13.1 Implement a C program for Line Clipping using Midpoint Subdivision algorithm.	13	Write a C program for Line Clipping using Midpoint Subdivision algorithm.	2	CO4
LLO 14.1 Implement C program for Sutherland Hodgeman Polygon Clipping.	14	Write a C program for Sutherland Hodgeman Polygon Clipping.	2	CO4
LLO 15.1 Implement a C program for Bezier Curve.	15	Write a C program for Bezier Curve.	2	CO5
<b>Note : Out of above suggestive LLOs -</b> <ul style="list-style-type: none"> <li>*Marked Practicals (LLOs) Are mandatory.</li> <li>Minimum 80% of above list of lab experiment are to be performed.</li> <li>Judicial mix of LLOs are to be performed to achieve desired outcomes.</li> </ul>				

## VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

### Micro project

- Implement Snake Game
- Design Smile Face
- Design Digital Clock
- Any other micro projects suggested by subject teacher.
- Develop program for moving Car

### Self learning

- Develop C language code for relevant topics suggested by the teacher
- Any computer graphics course suggested by teacher (NPTEL, MOOCs courses etc.)

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicious mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

**VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computer System with basic configuration.	All
2	'C' Compiler	All

**IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Computer Graphics	CO1	2	0	0	0	0
2	II	Raster Scan Graphics	CO2	4	0	0	0	0
3	III	Overview of 2D And 3D Transformations	CO3	4	0	0	0	0
4	IV	Windowing and Clipping Techniques	CO4	3	0	0	0	0
5	V	Introduction to Curves and Projections	CO5	2	0	0	0	0
<b>Grand Total</b>				<b>15</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**X. ASSESSMENT METHODOLOGIES/TOOLS****Formative assessment (Assessment for Learning)**

- Continuous Assessment based on Process and Product related performance indicators. Each practical will be assessed considering  
60% weightage to Process  
40% weightage to Product

**Summative Assessment (Assessment of Learning)**

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**XI. SUGGESTED COS - POS MATRIX FORM**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	2	2	2	1	1	1			
CO2	2	2	2	2	-	1	1			
CO3	2	2	2	2	-	1	1			
CO4	2	2	2	2	-	1	1			
CO5	2	2	2	2	-	1	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -  
\*PSOs are to be formulated at institute level

## XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Donald Hearn , M Pauline Baker	Computer Graphics	Prentice-Hall • ISBN-10 : 0131615300 • ISBN-13 : 978-0131615304
2	William M. Newman Robert F. Sproull	Principles of Interactive Computer Graphics	McGraw-Hill • ISBN: 978-0-07-046338-7
3	Zhigang Xiang, Roy Plastock	Computer Graphics	Schaum O Series • ISBN: 9789389538847 • ISBN: 938953884X
4	Atul P. Godse, Dr. Deepali A. Godse	Computer Graphics	Technical Publications ISBN 933322338X, 9789333223386

## XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	<a href="https://www.javatpoint.com/computer-graphics-programs">https://www.javatpoint.com/computer-graphics-programs</a>	Basic graphics programs
2	<a href="https://www.tutorialspoint.com/computer_graphics/index.htm">https://www.tutorialspoint.com/computer_graphics/index.htm</a>	Basics of computer graphics
3	<a href="https://www.educba.com/line-drawing-algorithm/">https://www.educba.com/line-drawing-algorithm/</a>	Line drawing algorithm
4	<a href="https://www.javatpoint.com/computer-graphics-clipping">https://www.javatpoint.com/computer-graphics-clipping</a>	Clipping Algorithms
5	<a href="https://www.tutorialspoint.com/computer_graphics/computer_graphics_curves.htm">https://www.tutorialspoint.com/computer_graphics/computer_graphics_curves.htm</a>	Curves in computer graphics
6	<a href="https://www.tutorialspoint.com/computer_graphics/2d_transformation.htm">https://www.tutorialspoint.com/computer_graphics/2d_transformation.htm</a>	2D and 3D Transformation
7	<a href="https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01384200894190387210361_shared/overview">https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01384200894190387210361_shared/overview</a>	Project on Computer Graphics

### Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

<b>Programme Name/s</b>	: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Hotel Management & Catering Technology/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures
<b>Programme Code</b>	: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DD/ DE/ DS/ EE/ EJ/ EP/ ET/ EX/ FC/ HA/ HM/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ SC/ TC/ TE/ TR/ TX
<b>Semester</b>	: Third
<b>Course Title</b>	: ESSENCE OF INDIAN CONSTITUTION
<b>Course Code</b>	: 313002

### I. RATIONALE

This course will focus on the basic structure and operative dimensions of Indian Constitution. It will explore various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian Constitution. The Constitution of India is the supreme law of India. The document lays down the framework demarcating the fundamental political code, structure, procedures, powers, and sets out fundamental rights, directive principles, and the duties of citizens. The course on constitution of India highlights key features of Indian Constitution that makes the students a responsible citizen. In this online course, we shall make an effort to understand the history of our constitution, the Constituent Assembly, the drafting of the constitution, the preamble of the constitution that defines the destination that we want to reach through our constitution, the fundamental right constitution guarantees through the great rights revolution, the relationship between fundamental rights and fundamental duties, the futurist goals of the constitution as incorporated in directive principles and the relationship between fundamental rights and directive principles.

### II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry /employer expected outcome – Abide by the Constitution in their personal and professional life.

### III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - List salient features and characteristics of the constitution of India.
- CO2 - Follow fundamental rights and duties as responsible citizen of the country.
- CO3 - Analyze major constitutional amendments in the constitution.
- CO4 - Follow procedure to cast vote using voter-id.

### IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme										Total Marks	
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory			Based on LL & TL				Based on SL			
				CL	TL	LL					FA-TH	SA-TH	Total	Practical		SLA					
														FA-PR	SA-PR	Max	Min	Max	Min		
313002	ESSENCE OF INDIAN CONSTITUTION	EIC	VEC	1	-	-	1	2	1	-	-	-	-	-	-	-	-	-	50	20	50

**Total IKS Hrs for Sem. : 0 Hrs**

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, \*# On Line Examination , @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.\* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. \* Self learning hours shall not be reflected in the Time Table.
7. \* Self learning includes micro project / assignment / other activities.

**V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT**

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the meaning of preamble of the constitution. TLO 1.2 Explain the doctrine of basic structure of the constitution. TLO 1.3 List the salient features of constitution. TLO 1.4 List the characteristics of constitution.	<b>Unit - I Constitution and Preamble</b> 1.1 Meaning of the constitution of India. 1.2 Historical perspectives of the Constitution of India. 1.3 Salient features and characteristics of the Constitution of India. 1.4 Preamble of the Constitution of India.	Presentations Blogs Hand-outs Modules Flipped classrooms Case studies
2	TLO 2.1 Enlist the fundamental rights. TLO 2.2 . Identify fundamental duties in general and in particular with engineering field. TLO 2.3 Identify situations where directive principles prevail over fundamental rights.	<b>Unit - II Fundamental Rights and Directive Principles</b> 2.1 Fundamental Rights under Part-III. 2.2 Fundamental duties and their significance under part-IV-A. 2.3 Relevance of Directive Principles of State Policy under part-IV A.	Presentations Blogs Hand-outs Modules Case Study Flipped Classroom

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Enlist the constitutional amendments. TLO 3.2 Elaborate the elements of Centre-State Relationship TLO 3.3 Analyze the purposes of various amendments.	<b>Unit - III Governance and Amendments</b> 3.1 3.1 Amendment procedure of the Constitution and their types - simple and special procedures. 3.2 The Principle of Federalism and its contemporary significance along with special committees that were setup. 3.3 Major Constitutional Amendment procedure - 1st, 7th, 42nd, 44th, 73rd & 74th, 76th, 86th, 52nd & 91st, 102nd	Cases of Federal disputes with relevant Supreme court powers and Judgements Presentations Blogs Hand-outs Problem based learning
4	TLO 4.1 Explain the importance of electoral rights. TLO 4.2 Write the step by step procedure for process of registration TLO 4.3 Explain the significance of Ethical electoral participation TLO 4.4 Explain the steps to motivation and facilitation for electoral participation TLO 4.5 Enlist the features of the voter's guide TLO 4.6 Explain the role of empowered voter TLO 4.7 Write the steps of voting procedure TLO 4.8 Write steps to create voter awareness TLO 4.9 Fill the online voter registration form TLO TLO 4.10 Follow procedure to cast vote using voter-id.	<b>Unit - IV Electoral Literacy and Voter's Education</b> 4.1 Electoral rights , Electoral process of registration 4.2 Ethical electoral participation 4.3 Motivation and facilitation for electoral participation 4.4 Voter's guide 4.5 Prospective empowered voter 4.6 Voting procedure 4.7 Voter awareness 4.8 Voter online registration <a href="https://www.ceodelhi.gov.in/ELCdetails.aspx">https://www.ceodelhi.gov.in/ELCdetails.aspx</a>	Presentations Hand-outs Modules Blogs Problem based Learning

#### VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

#### VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

##### Assignment

- Outline the procedure to submit application for Voter-id
- Assignments are to be provided by the course teacher in line with the targeted COs.

A1. Prepare an essay on Constitution of India .

A2 Prepare a comparative chart of Unique features of Indian Constitution of India and Constitution of USA

- Assignments are to be provided by the course teacher in line with the targeted COs. A1. Prepare an essay on Constitution of India . A2 Prepare a comparative chart of Unique features of Indian Constitution of India and Constitution of USA A3. Self-learning topics: Parts of the constitution and a brief discussion of each part Right to education and girl enrollment in schools. GER of Girls and Boys. Right to equality. Social Democracy. Women Representation in Parliament and State Assemblies. LGBTQIA+

##### Micro project



- 1. Organize a workshop-cum discussions for spreading awareness regarding Fundamental Rights of the citizen of the country
- 2. Prepare elaborations where directive principle of State policy has prevailed over Fundamental rights with relevant Supreme Court Judgements.
- 3. Organize a debate on 42nd, 97th and 103rd Constitutional Amendment Acts of Constitution of India.

### Seminar

- 1 Differences in the ideals of Social democracy and Political democracy.
- 2 Democracy and Women's Political Participation in India.
- 3 Khap Panchayat - an unconstitutional institution infringing upon Constitutional ethos.
- 4 Situations where directive principles prevail over fundamental rights.

### Group discussions on current print articles.

- 
- Art 356 and its working in Post-Independent India.
- Women's Resrvation in Panchayat leading to Pati Panchayats - Problems and Solutions.
- Adoption of Article 365 in India.
- Need of Amendments in the constitution.
- Is India moving towards a Unitary State Model ?

### Activity

- Arrange Mock Parliament debates.
- Prepare collage/posters on current constitutional issues.
- i. National (Art 352) & State Emergencies (Art 356) declared in India.
  - ii. Seven fundamental rights.
  - iii. Land Reforms and its effectiveness - Case study of West-Bengal and Kerala.

### Cases: Suggestive cases for usage in teaching:

- A.K. Gopalan Case (1950) :SC contended that there was no violation of Fundamental Rights enshrined in Articles 13, 19, 21 and 22 under the provisions of the Preventive Detention Act, if the detention was as per the procedure established by law. Here, the SC took a narrow view of Article 21.
- Shankari Prasad Case (1951) : This case dealt with the amendability of Fundamental Rights (the First Amendment's validity was challenged). The SC contended that the Parliament's power to amend under Article 368 also includes the power to amend the Fundamental Rights guaranteed in Part III of the Constitution.
- Minerva Mills case (1980) :This case again strengthens the Basic Structure doctrine. The judgement struck down 2 changes made to the Constitution by the 42nd Amendment Act 1976, declaring them to violate the basic structure. The judgement makes it clear that the Constitution, and not the Parliament is supreme.
- Maneka Gandhi case (1978) :A main issue in this case was whether the right to go abroad is a part of the Right to Personal Liberty under Article 21. The SC held that it is included in the Right to Personal Liberty. The SC also ruled that the mere existence of an enabling law was not enough to restrain personal liberty. Such a law must also be "just, fair and reasonable."

#### Other cases:

1. Kesavananda Bharati Case (1973) : In this case the Hon. SC laid down a new doctrine of the 'basic structure' (or 'basic features') of the Constitution. It ruled that the constituent power of Parliament under Article 368 does not enable it to alter the 'basic structure' of the Constitution. This means that the Parliament cannot abridge or take away a Fundamental Right that forms a part of the 'basic structure' of the Constitution.
2. Mathura Rape Case(1979) : A tribal woman Mathura (aged 14 to 16 years) was raped in Police Custody. The case raised the questions on the idea of 'Modesty of Woman' and here it was was a tribal woman who succumbs to multiple patriarchies. Custodial rape was made an offence and was culpable with the detainment of 7 years or more under Section 376 of Indian Penal Code. The weight of proofing the allegations moved from the victim to the offender, once sexual intercourse is established. The publication of the victim's identity was banned and it was also held that rape trials should be conducted under the cameras.
3. Puttswamy vs Union of India (2017) : In this landmark case which was finally pronounced by a 9-judge bench of the Supreme Court on 24th August 2017, upholding the fundamental right to privacy emanating from Article 21. The court stated that Right to Privacy is an inherent and integral part of Part III of the Constitution that guarantees

fundamental rights. The conflict in this area mainly arises between an individual's right to privacy and the legitimate aim of the government to implement its policies and a balance needs to be maintained while doing the same.

4. Navtej Singh Johar & Ors. v. Union of India (2018) : Hon. SC Decriminalised all consensual sex among adults, including homosexual sex by scrapping down section 377 of the Indian penal code (IPC). The court ruled that LGBTQ community are equal citizens and underlined that there cannot be discrimination in law based on sexual orientation and gender.

5. Anuradha Bhasin Judgement (2020) : The Supreme Court of India ruled that an indefinite suspension of internet services would be illegal under Indian law and that orders for internet shutdown must satisfy the tests of necessity and proportionality. The Court reiterated that freedom of expression online enjoyed Constitutional protection, but could be restricted in the name of national security. The Court held that though the Government was empowered to impose a complete internet shutdown, any order(s) imposing such restrictions had to be made public and was subject to judicial review.

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicious mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

**VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED : NOT APPLICABLE**

**IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Constitution and Preamble	CO1	4	0	0	0	0
2	II	Fundamental Rights and Directive Principles	CO2	4	0	0	0	0
3	III	Governance and Amendments	CO3	4	0	0	0	0
4	IV	Electoral Literacy and Voter's Education	CO4	3	0	0	0	0
<b>Grand Total</b>				<b>15</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**X. ASSESSMENT METHODOLOGIES/TOOLS**

**Formative assessment (Assessment for Learning)**

- Assignment, Self-learning and Terms work Seminar/Presentation

**Summative Assessment (Assessment of Learning)**

**XI. SUGGESTED COS - POS MATRIX FORM**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	1	-	-	-	2	-	-			
CO2	1	-	-	-	2	-	-			
CO3	1	2	-	-	2	-	1			
CO4	-	-	-	1	-	-	-			

Legends :- High:03, Medium:02,Low:01, No Mapping: -  
\*PSOs are to be formulated at institute level

## XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	P.M.Bakshi	The Constitution of India	Universal Law Publishing, New Delhi 15th edition, 2018, ISBN: 9386515105 (Check the new edition)
2	D.D.Basu	Introduction to Indian Constitution	Lexis Nexis Publisher, New Delhi, 2015, ISBN:935143446X
3	B. K. Sharma	Introduction to Constitution of India	PHI, New Delhi, 6th edition, 2011, ISBN:8120344197
4	MORE READS :	Oxford Short Introductions - The Indian Constitution by Madhav Khosla. The Indian Constitution: Cornerstone of a Nation by Granville Austin. Working a Democratic Constitution: A History by Garnville Austin Founding Mothers of the Indian Republic: Gender Politics of the Framing of the Constitution by Achyut Chetan. Our Parliament by Subhash C. Kashyap. Our Political System by Subhash C. Kashyap. Our Constitution by Subhash C. Kashyap. Indian Constitutional Law by Rumi Pal.	Extra Read
5	B.L. Fadia	The Constitution of India	Sahitya Bhawan, Agra, 2017, ISBN:8193413768

## XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	<a href="http://www.legislative.gov.in/constitution-of-india">http://www.legislative.gov.in/constitution-of-india</a>	Constitution overview
2	<a href="https://en.wikipedia.org/wiki/Constitution_of_India">https://en.wikipedia.org/wiki/Constitution_of_India</a>	Parts of constitution
3	<a href="https://www.india.gov.in/my-government/constitution-india">https://www.india.gov.in/my-government/constitution-india</a>	Constitution overview
4	<a href="https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/">https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/</a>	Fundamental rights and duties
5	<a href="https://main.sci.gov.in/constitution">https://main.sci.gov.in/constitution</a>	Directive principles
6	<a href="https://legalaffairs.gov.in/sites/default/files/chapter%203.pdf">https://legalaffairs.gov.in/sites/default/files/chapter%203.pdf</a>	Parts of constitution

<b>Sr.No</b>	<b>Link / Portal</b>	<b>Description</b>
7	<a href="https://www.concourt.am/armenian/legal_resources/world_constitutions/constit/india/india-e.htm">https://www.concourt.am/armenian/legal_resources/world_constitutions/constit/india/india-e.htm</a>	Parts of constitution
8	<a href="https://constitutionnet.org/vl/item/basic-structure-indian-constitution">https://constitutionnet.org/vl/item/basic-structure-indian-constitution</a>	Parts of constitution

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

**Programme Name/s** : Cloud Computing and Big Data/ Computer Technology/ Computer Engineering/ Computer Science & Engineering/ Computer Hardware & Maintenance/ Information Technology/ Computer Science & Information Technology

**Programme Code** : BD/ CM/ CO/ CW/ HA/ IF/ IH

**Semester** : Third

**Course Title** : DATA STRUCTURE USING C

**Course Code** : 313301

**I. RATIONALE**

One of the most important courses in information and communication technology is data structures. Data organization or structuring is essential for developing effective algorithms and programs. Students will get the ability to develop logic to solve problem using principles of data structure with the aid of this course.

**II. INDUSTRY / EMPLOYER EXPECTED OUTCOME**

Implement algorithm using relevant Data Structures.

**III. COURSE LEVEL LEARNING OUTCOMES (COS)**

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Perform basic operations on Arrays.
- CO2 - Apply different Searching and Sorting methods.
- CO3 - Implement basic operations on Linked List.
- CO4 - Perform operations on Stack using Array and Linked List Implementations.
- CO5 - Perform operations on Queue using Array and Linked List Implementations.
- CO6 - Create and Traverse Tree to solve problems.

**IV. TEACHING-LEARNING & ASSESSMENT SCHEME**

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH			Theory	Based on LL & TL				Based on SL					
				CL	TL	LL						Practical				SLA					
							FA-TH	SA-TH				Total	FA-PR	SA-PR	Max	Min					
313301	DATA STRUCTURE USING C	DSU	DSC	3	1	4	-	8	4	3	30	70	100	40	50	20	25#	10	-	-	175

**Total IKS Hrs for Sem. : 0 Hrs**

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, \*# On Line Examination , @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.\* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. \* Self learning hours shall not be reflected in the Time Table.
7. \* Self learning includes micro project / assignment / other activities.

## V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Classify the given type of Data Structures based on their characteristics and space. TLO 1.2 Perform operations on the given type of Data Structure.	<b>Unit - I Introduction to Data Structures</b> 1.1 Introduction: Concept and Need of Data Structure, Definition, Abstract Data Type 1.2 Types of Data Structures: (i) Linear Data Structures (ii) Non-Linear Data Structures 1.3 Operations on Data Structures: (i) Traversing (ii) Insertion (iii) Deletion	Lecture Using Chalk-Board Presentations
2	TLO 2.1 Develop algorithm to search the given key using different Searching Techniques. TLO 2.2 Create algorithm to sort data using a given method.	<b>Unit - II Searching and Sorting</b> 2.1 Searching: Searching for an item in a data set using the following methods: (i) Linear Search (ii) Binary Search 2.2 Sorting: Sorting of data set in an order using the following methods: (i) Bubble Sort (ii) Selection Sort (iii) Insertion Sort (iv) Quick Sort (v) Merge Sort	Lecture Using Chalk-Board Demonstration Presentations Hands-on
3	TLO 3.1 Differentiate between Static and Dynamic Memory Allocation. TLO 3.2 Create a suitable structure using a Linked List to represent a Node. TLO 3.3 Create Algorithm to add or remove a specified item from a Linear Linked List.	<b>Unit - III Linked List</b> 3.1 Difference between Static and Dynamic Memory Allocation. 3.2 Introduction to Linked List, Terminologies: Node, Address, Pointer, Information field / Data field, Next pointer, Null Pointer, Empty List. 3.3 Type of Lists: Linear List, Circular List, Representation of Doubly Linked List. 3.4 Operations on a Singly Linked List: Creating a Linked List, Inserting a new node in a Linked List, Deleting a node from a Linked List, Searching a key in Linked List, Traversing a Singly Linked List. 3.5 Applications of Linked List.	Lecture Using Chalk-Board Demonstration Presentations Hands-on
4	TLO 4.1 Represent Stack using Array and Linked List. TLO 4.2 Create Algorithm to carry out the PUSH and POP operations in a Stack. TLO 4.3 Use Stack to transform the given expression from Infix to Postfix. TLO 4.4 Evaluate Postfix Expression.	<b>Unit - IV Stack</b> 4.1 Introduction to Stack: Definition, Stack as an ADT, Operations on Stack-(Push, Pop), Stack Operation Conditions – Stack Full / Stack Overflow, Stack Empty /Stack Underflow. 4.2 Stack Implementation using Array and representation using Linked List. 4.3 Applications of Stack: Reversing a List, Polish Notations, Conversion of Infix to Postfix Expression, Evaluation of Postfix Expression. 4.4 Recursion: Definition and Applications.	Lecture Using Chalk-Board Demonstration Presentations Hands-on
5	TLO 5.1 Represent Queue using Array and Linked List. TLO 5.2 Explain the characteristics of different types of Queue. TLO 5.3 Create Algorithm to carry out the INSERT and DELETE Operations on a Queue.	<b>Unit - V Queue</b> 5.1 Introduction to Queue: Queue as an ADT, Queue representation in memory using Array and representation using a Linked List. 5.2 Types of Queues: Linear Queue, Circular Queue, Concept of Priority Queue, Double-Ended Queue. 5.3 Queue Operations: INSERT, DELETE, Queue Operation Conditions: Queue Full, Queue Empty. 5.4 Applications of Queue.	Lecture Using Chalk-Board Demonstration Presentations Hands-on

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
6	TLO 6.1 Describe the given Tree Terminology. TLO 6.2 Create a Binary Search Tree based on the provided data. TLO 6.3 Create Algorithms to Traverse the Tree using the given method. TLO 6.4 Create an Expression Tree. TLO 6.5 Create Heap.	<b>Unit - VI Tree</b> 6.1 Introduction to Trees Terminologies: Tree, Degree of a Node, Degree of a Tree, Level of a node, Leaf Node, Depth / Height of a Tree, In-Degree and Out-Degree, Path, Ancestor and Descendant Nodes. 6.2 Tree Types and Traversal methods, Types of Trees: General Tree, Binary Tree, Binary Search Tree (BST). Binary Tree Traversal: In-Order Traversal, Preorder Traversal, Post-Order Traversal. 6.3 Expression Tree, Heap	Lecture Using Chalk-Board Demonstration Presentations Hands-on

#### VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Implement Array Operations.	1	* Write a 'C' program to perform following Operations on Array: Create, Insert, Delete, Display.	4	CO1
LLO 2.1 Implement Linear Search Method on Numbers.	2	Write a 'C' Program to Search a particular data from the given Array of numbers using: Linear Search Method.	2	CO2
LLO 3.1 Implement Linear Search Method on Strings.	3	* Write a 'C' Program to Search a particular data from the given Array of Strings using Linear Search Method.	2	CO2
LLO 4.1 Implement Binary Search Method on Numbers.	4	* Write a 'C' program to Search a particular data from the given Array of numbers using Binary Search Method.	2	CO2
LLO 5.1 Implement Binary Search Method on Strings.	5	Write a 'C' Program to Search a particular data from the given Array of Strings using Binary Search Method.	2	CO2
LLO 6.1 Apply Bubble Sort method for Sorting Numbers.	6	* Write a 'C' Program to Sort an Array of numbers using Bubble Sort Method.	2	CO2
LLO 7.1 Apply Bubble Sort method for Sorting Strings.	7	Write a 'C' Program to Sort an Array of Strings using Bubble Sort Method.	2	CO2
LLO 8.1 Apply Selection Sort for Sorting Numbers.	8	* Write a 'C' Program to Sort an Array of numbers using Selection Sort Method.	2	CO2
LLO 9.1 Apply Selection Sort for Sorting Strings.	9	Write a 'C' Program to Sort an Array of Strings using Selection Sort Method.	2	CO2
LLO 10.1 Apply Insertion Sort for Sorting Numbers.	10	* Write a 'C' Program to Sort an Array of numbers using Insertion Sort Method.	2	CO2
LLO 11.1 Apply Insertion Sort for Sorting Strings.	11	Write a 'C' Program to Sort an Array of Strings using Insertion Sort Method.	2	CO2
LLO 12.1 Create Singly Linked List.	12	* Write a 'C' Program to Implement Singly Linked List with Operations: (i) Insert at beginning, (ii) Search, (iii) Display	2	CO3
LLO 13.1 Perform given Operations on Singly Linked List.	13	* Write a C Program to Implement Singly Linked List with Operations: (i) Insert at end, (ii) Insert After, (iii) Delete (iv) Display	2	CO3
LLO 14.1 Create Polynomials using Linked List.	14	Write a C Program to Create Two Polynomials using a Linked List.	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 15.1 Perform the Addition of Two Polynomials using a Linked List.	15	* Write a 'C' Program to add Two Polynomials using a Linked List.	2	CO3
LLO 16.1 Perform Operations on the Stack using the Array.	16	* Write a 'C' Program to perform PUSH and POP Operations on Stack using an Array.	2	CO4
LLO 17.1 Perform Operations on the Stack using a Linked List.	17	* Write a 'C' Program to perform PUSH and POP Operations on a Stack using a Linked List.	2	CO4
LLO 18.1 Apply recursive procedure to multiply two numbers.	18	* Write a 'C' program to perform multiplication of two numbers using recursion.	2	CO4
LLO 19.1 Apply recursive procedure to reverse the string.	19	Write a 'C' program to print given string in reverse using recursion.	2	CO4
LLO 20.1 Apply recursive procedure to display linked list in reverse.	20	Write a 'C' program to create a Singly Linked List and traverse in reverse order using recursion.	4	CO3 CO4
LLO 21.1 Perform Operations on Linear Queue using Array.	21	* Write a 'C' Program to perform INSERT and DELETE Operations on Linear Queue using an Array.	2	CO5
LLO 22.1 Perform Operations on Linear Queue using Linked List.	22	* Write a 'C' Program to perform INSERT and DELETE operations on Linear Queue using a Linked List.	2	CO5
LLO 23.1 Perform Operations on Circular Queue using Array.	23	* Write a 'C' Program to perform INSERT and DELETE operations on Circular Queue using an Array.	2	CO5
LLO 24.1 Perform Operations on Circular Queue using a Linked List.	24	Write a 'C' Program to perform INSERT and DELETE operations on Circular Queue using a Linked List.	2	CO5
LLO 25.1 Implement Priority Queue using Linked List.	25	Write a 'C' Program to Create a Priority Queue using a Linked List.	4	CO5
LLO 26.1 Implement Binary Search Tree and perform In-Order Traversal.	26	* Write a 'C' Program to Implement BST (Binary Search Tree) and Traverse in In-Order.	2	CO6
LLO 27.1 Implement Tree Traversal Operations.	27	Write a 'C' Program to Traverse BST in Preorder, and Post-Order.	2	CO6

**Note : Out of above suggestive LLOs -**

- '\*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

#### VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING) : NOT APPLICABLE

#### VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computer System with all necessary Peripherals and Internet Connectivity. 'C' Compiler / GCC Compiler/ Online 'C' Compiler	All

#### IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)



Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Data Structures	CO1	2	2	2	0	4
2	II	Searching and Sorting	CO2	8	2	2	8	12
3	III	Linked List	CO3	12	2	4	10	16
4	IV	Stack	CO4	8	2	4	6	12
5	V	Queue	CO5	6	2	2	6	10
6	VI	Tree	CO6	9	2	4	10	16
<b>Grand Total</b>				<b>45</b>	<b>12</b>	<b>18</b>	<b>40</b>	<b>70</b>

### X. ASSESSMENT METHODOLOGIES/TOOLS

#### Formative assessment (Assessment for Learning)

- Continuous Assessment based on Process and Product related Performance Indicators. Each practical will be assessed considering 60% weightage to Process and 40% weightage to Product

#### Summative Assessment (Assessment of Learning)

- End semester Examination, Lab performance, Viva-Voce

### XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	-	-	1	-	-	1			
CO2	2	2	2	1	-	-	1			
CO3	2	2	2	1	1	1	1			
CO4	2	2	2	1	-	1	1			
CO5	2	2	2	1	-	1	1			
CO6	2	2	2	1	-	1	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -

\*PSOs are to be formulated at institute level

### XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Lipschutz	Data Structures with 'C' (SIE) (Schaum's Outline Series)	McGraw Hill Education, New Delhi ISBN: 978-0070701984
2	Balgurusamy, E.	Data Structures using 'C'	McGraw Hill Education, New Delhi 2013, ISBN: 978-1259029547
3	ISRD Group	Data Structures using 'C'	McGraw Hill Education, New Delhi 2013, ISBN: 978-12590006401
4	Yashwant Kanetkar	Understanding Pointers in C	BPB ISBN 8170298911

### XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	<a href="https://www.javatpoint.com/data-structure-introduction">https://www.javatpoint.com/data-structure-introduction</a>	For All Content
2	<a href="https://www.geeksforgeeks.org/introduction-to-data-structures/">https://www.geeksforgeeks.org/introduction-to-data-structures/</a>	For All Content
3	<a href="https://studytonight.com/data-structures/">https://studytonight.com/data-structures/</a>	For All Content
4	<a href="https://www.tutorialspoint.com/data_structures_algorithms/">https://www.tutorialspoint.com/data_structures_algorithms/</a>	For All Content
5	<a href="https://www.w3schools.in/data-structures/">https://www.w3schools.in/data-structures/</a>	For All Content
6	<a href="https://www.mygreatlearning.com/blog/data-structure-tutorial-for-beginners/">https://www.mygreatlearning.com/blog/data-structure-tutorial-for-beginners/</a>	For All Content
7	<a href="https://byjus.com/gate/introduction-to-data-structure-notes/">https://byjus.com/gate/introduction-to-data-structure-notes/</a>	For All Content
<b>Note :</b> <ul style="list-style-type: none"><li>Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students</li></ul>		

**Programme Name/s** : Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Cloud Computing and Big Data/ Computer Technology/ Computer Engineering/ Computer Science & Engineering/ Data Sciences/ Computer Hardware & Maintenance/ Information Technology/ Computer Science & Information Technology/ Electronics & Computer Engg.

**Programme Code** : AI/ AN/ BD/ CM/ CO/ CW/ DS/ HA/ IF/ IH/ TE

**Semester** : Third

**Course Title** : DATABASE MANAGEMENT SYSTEM

**Course Code** : 313302

**I. RATIONALE**

This course focuses on fundamentals of relational database management system and enables students to design and manage database for various software applications. It also provides students with theoretical knowledge and practical skills in the use of databases and database management systems in Information Technology applications.

**II. INDUSTRY / EMPLOYER EXPECTED OUTCOME**

To design database and use any RDBMS package as a backend for developing database applications.

**III. COURSE LEVEL LEARNING OUTCOMES (COS)**

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Explain concept of database management system.
- CO2 - Design the database for given problem.
- CO3 - Manage database using SQL.
- CO4 - Implement PL/SQL codes for given application.
- CO5 - Apply security and backup methods on database.

**IV. TEACHING-LEARNING & ASSESSMENT SCHEME**

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Assessment Scheme										Total Marks			
				Actual Contact Hrs./Week			SL	H	NL		LH	Paper Duration	Theory				Based on LL & TL					Based on SL		
				CL	TL	LL							Practical			Total		FA-PR		SA-PR		SLA		
													Max	Min	Max	Min	Max	Min	Max	Min		Max	Min	
313302	DATABASE MANAGEMENT SYSTEM	DMS	DSC	3	1	4	2	10	5	3	30	70	100	40	50	20	25#	10	25	10	200			

**Total IKS Hrs for Sem. : 0 Hrs**

Abbreviations: CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, \*# On Line Examination , @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.\* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. \* Self learning hours shall not be reflected in the Time Table.
7. \* Self learning includes micro project / assignment / other activities.

**V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain given database concept. TLO 1.2 Explain Overall structure of DBMS TLO 1.3 Describe architecture of database.	<b>Unit - I Introduction To Database System</b> 1.1 Database concepts:-Data, Database, Database management system, File system Vs DBMS, Applications of DBMS, Data Abstraction, Data Independence, Database Schema, The Codd's rules, Overall structure of DBMS 1.2 Architecture:- Two tier and Three tier architecture of database. 1.3 Data Models:- Hierarchical, Networking, Relational Data Models.	Presentations, Hands-on, Chalk-Board.
2	TLO 2.1 Explain relational structure of database. TLO 2.2 State types of keys with example. TLO 2.3 Draw ER diagrams for given problem. TLO 2.4 Explain different normalization forms.	<b>Unit - II Relational Data Model</b> 2.1 Relational Structure :- Tables (Relations), Rows (Tuples), Domains, Attributes, Entities 2.2 Keys :- Super Keys, Candidate Key, Primary Key, Foreign Key. 2.3 Data Constraints :- Domain Constraints ,Referential Integrity Constraints 2.4 Entity Relationship Model : - Strong Entity set, Weak Entity set, Types of Attributes, Symbols for ER diagram, ER Diagrams 2.5 Normalization:- Functional dependencies, Normal forms: 1NF, 2NF, 3NF	Presentations, Hands-on, Chalk-Board.

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	<p>TLO 3.1 Write SQL queries using DDL, DML, DCL and TCL.</p> <p>TLO 3.2 Write SQL queries to join relations.</p> <p>TLO 3.3 Write SQL queries for ordering and grouping data.</p> <p>TLO 3.4 Use various class of operators in SQL. .</p> <p>TLO 3.5 Create schema objects for performance tuning.</p>	<p><b>Unit - III Interactive SQL and Performance Tuning</b></p> <p>3.1 SQL: -Data-types, Data Definition Language (DDL), Data Manipulation language (DML), Data Control Language (DCL), Transaction Control Language (TCL).</p> <p>3.2 Clauses &amp; Join:- Different types of clauses - Where, Group by ,Order by, Having. Joins: Types of Joins, Nested queries.</p> <p>3.3 Operators:- Relational, Arithmetic, Logical, Set operators.</p> <p>3.4 Functions:- Numeric , Date and time, String functions, Aggregate Functions.</p> <p>3.5 Views, Sequences, Indexes: -Views : Concept ,Create ,Update, Drop Views. Sequences :- Concept ,Create, Alter , Drop, Use of Sequence in table, Index: Concept ,Types of Index , Create ,Drop Indexes</p>	<p>Presentations, Hands-on, Chalk-Board.</p>
4	<p>TLO 4.1 Use control Structures in PL-SQL.</p> <p>TLO 4.2 Handle different types of exceptions.</p> <p>TLO 4.3 Explain various types of cursors.</p> <p>TLO 4.4 Create Procedure, Function on given problem.</p> <p>TLO 4.5 Explain types of triggers with examples</p>	<p><b>Unit - IV PL/SQL Programming</b></p> <p>4.1 Introduction of PL/SQL: -Advantages of PL/SQL, The PL/SQL Block Structure, PL/SQL Data Types, Variable , Constant</p> <p>4.2 Control Structure:- Conditional Control, Iterative Control, Sequential Control.</p> <p>4.3 Exception handling: -Predefined Exception, User defined Exception.</p> <p>4.4 Cursors:- Implicit and Explicit Cursors, Declaring, opening and closing cursor, fetching a record from cursor ,cursor for loops, parameterized cursors</p> <p>4.5 Procedures:- Advantages, Create, Execute and Delete a Stored Procedure</p> <p>4.6 Functions:- Advantages, Create, Execute and Delete a Function</p> <p>4.7 Database Triggers :- Use of Database Triggers, Types of Triggers, Create Trigger, Delete Trigger</p>	<p>Presentations, Hands-on, Chalk-Board.</p>
5	<p>TLO 5.1 Implement SQL queries for database administration.</p> <p>TLO 5.2 Explain concept of various types database backup processes.</p> <p>TLO 5.3 Describe various terms related to advanced database concepts.</p>	<p><b>Unit - V Database Administration</b></p> <p>5.1 Introduction to database administration:- Types of database users, Create and delete users, Assign privileges to users</p> <p>5.2 Transaction: Concept, Properties &amp; States of Transaction</p> <p>5.3 Database Backup: Types of Failures, Causes of Failure, Database backup introduction, types of database backups: Physical &amp; Logical</p> <p>5.4 Data Recovery – Recovery concepts , recovery techniques- roll forward ,Rollback</p> <p>5.5 Overview of Advanced database concepts:- Data Warehouse ,Data lakes , Data mining, Big data ,Mongo DB , DynamoDB,</p>	<p>Presentations, Hands-on, Chalk-Board.</p>

**VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Install database software	1	* Install the provided database software	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Create Database schema for given application	2	*Note :- Ensure to Carry out following activities before creating database: - Draw ER diagram for given problem - Normalize the relation up to 3NF 1) Create Database for given application 2) Create tables for the given application 3)Assign Primary key for created table 4) Modify the table as per the application needs	4	CO1
LLO 3.1 Execute DDL Commands to manage database using SQL	3	* Write queries using DDL Statements for following operations – 1) Create, alter, truncate, drop ,rename table 2) Apply Key Constraints for suitable relation.	2	CO3
LLO 4.1 Execute DML Commands to manipulate data using SQL	4	* Write queries using DML Statements for following operations – 1) Select, Insert, delete, update, table 2) Apply Key Constraints for suitable relation.	2	CO3
LLO 5.1 Execute DCL Commands to control the access to data using SQL .	5	* Write queries using DCL Statements for following operations – 1)Grant, Revoke	2	CO3
LLO 6.1 Execute TCL Commands to control transactions on data using SQL .	6	* Write queries using TCL Statements for following operations – 1) Commit, Rollback, Savepoint	2	CO3
LLO 7.1 Implement Queries using Arithmetic operators	7	Write Queries using built-in Arithmetic operators.	2	CO3
LLO 8.1 Implement Logical operators to apply various conditions in query.	8	Apply built-in Logical operators on given data	2	CO3
LLO 9.1 Implement Relational operators to apply various conditions in query.	9	Apply built-in relational operators on given data	2	CO3
LLO 10.1 Write Queries to implement SET operations using SQL .	10	* Use following Set operators to perform different operations.	2	CO3
LLO 11.1 Execute queries using String functions	11	Write SQL Queries using built-in String functions	2	CO3
LLO 12.1 Execute queries using Arithmetic functions	12	Write SQL Queries using built-in Arithmetic functions	2	CO3
LLO 13.1 Implement queries using Date and Time functions	13	Write Queries using built-in Date and Time functions	4	CO3
LLO 14.1 Implement queries using Aggregate functions	14	Write Queries using SQL built-in Aggregate functions	2	CO3
LLO 15.1 Execute Queries for ordering and grouping data.	15	* Implement Queries Using different Where, Having, Group by, & Order by clauses .	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 16.1 Execute the queries based on Inner & outer join	16	* Implement SQL queries for Inner and Outer Join	2	CO3
LLO 17.1 Create and manage Views for faster access on relations.	17	* Create and Execute Views ,Sequeunce and Index in SQL.	4	CO3
LLO 18.1 Implement PL/SQL program using Conditional Statements	18	* Write a PL/SQL program using Conditional Statements- if, if then else ,nested if, if elseif else	2	CO4
LLO 19.1 Implement PL/SQL program using Iterative Statements	19	* Write a PL/SQL program using Iterative Statements- loop,for, do-while, while	2	CO4
LLO 20.1 Implement PL/SQL program using Sequential Control	20	Write a PL/SQL program using Sequential Control-switch, continue,goto	2	CO4
LLO 21.1 Create implicit & explicit cursors	21	* Write a PL/SQL code to implement implicit & explicit cursors	2	CO4
LLO 22.1 Implement PL/SQL program based on Exception Handling (Pre-defined exceptions)	22	* Write a PL/SQL program based on Exception Handling (Pre-defined exceptions)	2	CO4
LLO 23.1 Implement PL/SQL program based on Exception Handling (user defined exceptions)	23	* Write a PL/SQL program based on Exception Handling (user defined exceptions)	2	CO4
LLO 24.1 Create Procedures and stored procedures for modularity.	24	* Write a PL/SQL code to create Procedures and stored procedures	2	CO4
LLO 25.1 Create function for given database	25	* Write a PL/SQL code to create functions.	2	CO4
LLO 26.1 Implement triggers for given database.	26	* Write a PL/SQL code to create triggers for given database.	2	CO4
LLO 27.1 Implement SQL queries for database administration.	27	Execute DCL commands using SQL 1) Create Users 2) Grant Privileges to users 3)Revoke Privileges to users	2	CO5

**Note : Out of above suggestive LLOs -**

- '\*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

**VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)**

**Self Learning**

- Implement PL/SQL code for relevant topics suggested by the teacher.
- Complete any one course related to Database Management System on Infosys Springboard platform.

**Assignment**

- Solve an assignment on any relevant topic given by the teacher.

**Micro project**

- Develop a database for restaurant management system. The restaurant maintain catalogue for the list of food items and generate bill for the ordered food.
- Prepare Invoice management system for electricity bill generation. Accept meter reading as inputs and generate respective bill amount for the same.
- Design a database for registration and admission of patient for Hospital management system, draw ER diagram and normalize the database up to 3NF.

- Any topic suggested by teacher.

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicious mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

**VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computer system - (Any computer system with basic configuration)	All
2	Any RDBMS software (MySQL/Oracle/SQL server/ or any other)	All

**IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction To Database System	CO1	6	4	6	2	12
2	II	Relational Data Model	CO2	8	2	4	6	12
3	III	Interactive SQL and Performance Tuning	CO3	12	2	6	10	18
4	IV	PL/SQL Programming	CO4	12	4	4	10	18
5	V	Database Administration	CO5	7	2	4	4	10
<b>Grand Total</b>				<b>45</b>	<b>14</b>	<b>24</b>	<b>32</b>	<b>70</b>

**X. ASSESSMENT METHODOLOGIES/TOOLS**

**Formative assessment (Assessment for Learning)**

- Continuous assessment based on process and product related performance indicators.
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product.
- A continuous assessment based term work.

**Summative Assessment (Assessment of Learning)**

- End semester examination, Lab performance, Viva voce

**XI. SUGGESTED COS - POS MATRIX FORM**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3



CO1	3	-	-	-	1	-	1			
CO2	2	2	3	2	1	2	1			
CO3	1	2	2	2	-	2	1			
CO4	1	3	3	2	1	3	2			
CO5	1	1	2	2	2	2	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -  
 \*PSOs are to be formulated at institute level

**XII. SUGGESTED LEARNING MATERIALS / BOOKS**

Sr.No	Author	Title	Publisher with ISBN Number
1	Henry F. Korth	Database System Concepts	McGraw Hill Education ISBN : 9780078022159
2	Ivan Bayross	SQL, PL/SQL – The Programming Language of Oracle	BPB Publication ISBN 10: 8170298997 BPB Publication ISBN 13: 9788170298991
3	ISR D Group	Introduction to Database Management Systems	McGraw Hill Education ISBN 10: 0070591199 McGraw Hill Education ISBN-13 : 978-0070591196

**XIII . LEARNING WEBSITES & PORTALS**

Sr.No	Link / Portal	Description
1	<a href="https://nptel.ac.in/courses/106105175">https://nptel.ac.in/courses/106105175</a>	Data Base Management System
2	<a href="https://www.w3schools.com/sql/">https://www.w3schools.com/sql/</a>	SQL Tutorial
3	<a href="https://www.tutorialspoint.com/sql/index.htm">https://www.tutorialspoint.com/sql/index.htm</a>	SQL Programming Language

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

<b>Programme Name/s</b>	: Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Computer Technology/ Computer Engineering/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electronics & Tele-communication Engg./ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Instrumentation/ Medical Electronics/ Electronics & Computer Engg.
<b>Programme Code</b>	: AI/ AN/ AO/ CM/ CO/ CW/ DE/ DS/ EJ/ ET/ EX/ HA/ IC/ IE/ IS/ MU/ TE
<b>Semester</b>	: Third
<b>Course Title</b>	: DIGITAL TECHNIQUES
<b>Course Code</b>	: 313303

**I. RATIONALE**

Digitization implies use of digital circuits in most of automation and industrial systems. The knowledge of logic gates, combinational and sequential circuits using discrete gates and digital ICs will enable students to interpret working of digital equipment and test their functionality.

**II. INDUSTRY / EMPLOYER EXPECTED OUTCOME**

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences:

Student will be able to test the functionality of the digital circuits/system.

**III. COURSE LEVEL LEARNING OUTCOMES (COS)**

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply number system and codes concept to interpret working of digital systems.
- CO2 - Apply Boolean laws to minimize complex Boolean function.
- CO3 - Develop combinational logic circuits for given applications.
- CO4 - Develop sequential logic circuits using Flip-flops.
- CO5 - Interpret the functions of data converters and memories in digital electronic systems.

**IV. TEACHING-LEARNING & ASSESSMENT SCHEME**

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SL	H	NL			H	Theory			Based on LL & TL				Based on SL		
				CL	TL	LL							FA-TH	SA-TH	Total	Practical		SLA				
				Max	Max	Max	Min	Max	Min			Max	Min	Max	Min	Max	Min					
313303	DIGITAL TECHNIQUES	DTE	DSC	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175	

**Total IKS Hrs for Sem. : 0 Hrs**

Abbreviations: CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, \*# On Line Examination , @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.\* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. \* Self learning hours shall not be reflected in the Time Table.
7. \* Self learning includes micro project / assignment / other activities.

#### V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Convert the given number from one number system to another number system. TLO 1.2 Perform arithmetic operations on binary numbers. TLO 1.3 Subtract given binary numbers using 1's and 2's compliment method. TLO 1.4 Convert the given coded number into the other specified code. TLO 1.5 Write the application of the given code. TLO 1.6 Perform BCD addition and subtraction for the given Decimal numbers .	<b>Unit - I Number Systems</b> 1.1 Number Systems: Types of Number Systems (Binary, Octal, Decimal, Hexadecimal), conversion of number systems 1.2 Binary Arithmetic: Addition, Subtraction, Multiplication and Division 1.3 Subtraction using 1's and 2's complement method 1.4 Codes: BCD, Gray code, Excess-3 and ASCII code,Code conversions, Applications of codes. 1.5 BCD Arithmetic: BCD Addition, Subtraction using 9's and 10's complement	Lecture Using Chalk-Board

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	<p>TLO 2.1 Define the given characteristics parameters of the digital logic families.</p> <p>TLO 2.2 Draw symbol and truth table of given logic gates.</p> <p>TLO 2.3 Explain the concept of Buffer and Tristate logic .</p> <p>TLO 2.4 Implement basic gates and other gates with the help of universal gate.</p> <p>TLO 2.5 Simplify the given expression using Boolean laws and develop logic circuits .</p>	<p><b>Unit - II Logic Gates and Boolean Algebra</b></p> <p>2.1 Logic Families: Characteristics Parameters of logic Families- Noise margin, Power dissipation, Figure of merit ,Fan in, Fan out, Speed of operation, maximum clock frequency supply voltage requirement ,power per gate , Comparison of TTL, CMOS and ECL logic family</p> <p>2.2 Introduction to positive and negative logic systems, Logic Gates: Symbol ,Truth table of Basic logic gates(AND,OR,NOT),Universal gates(NAND,NOR) and Special purpose gates(EX-OR,EX-NOR)</p> <p>2.3 Buffer: Tristate logic, Unidirectional and Bidirectional</p> <p>2.4 Boolean algebra : Laws of Boolean algebra, Duality Theorem ,De-Morgan's theorem</p>	<p>Flipped Classroom Lecture Using Chalk-Board</p>
3	<p>TLO 3.1 Develop logic circuits for standard SOP/POS form of the given logic expression.</p> <p>TLO 3.2 Minimize the given logic expression using K-map (up to 4 variables).</p> <p>TLO 3.3 Design Adder and subtractor using K-map.</p> <p>TLO 3.4 Describe working of specified Encoder and Decoder with help of block diagram and truth table.</p> <p>TLO 3.5 Describe the working of Multiplexer and Demultiplexer.</p>	<p><b>Unit - III Combinational Logic Circuits</b></p> <p>3.1 Standard Boolean expression: Sum of products [SOP] and Products of Sum [POS], Min-term and Max-term, SOP-POS form conversion, realisation using NAND/NOR gates</p> <p>3.2 Boolean Expression reduction using K-map: Minimization of Boolean expressions (upto 4 variables) using SOP and POS form</p> <p>3.3 Arithmetic circuits : design Half and Full Adder using K-maps, design Half and Full Subtractor using K-maps , n bit adder and n bit subtractor .</p> <p>3.4 Encoder and Decoder: Functions of Encoder and Decoder, Block Diagram and Truth table, Priority Encoder (4:2, 8:3), BCD to 7 segment Decoder/Driver, Keyboard Encoder / decoder</p> <p>3.5 Multiplexer and Demultiplexer: Working, Truth table and applications of MUX and DEMUX. MUX tree, DEMUX tree, DEMUX as Decoder</p>	<p>Flipped Classroom Presentations Lecture Using Chalk-Board</p>

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	<p>TLO 4.1 Differentiate between Latch and Flip Flop.</p> <p>TLO 4.2 Explain basic memory cell and use relevant triggering technique for the given digital circuit.</p> <p>TLO 4.3 Describe the truth tables for the given Flip flops, applications of Flip flops.</p> <p>TLO 4.4 Use the given type of flip flop and its excitation table to design specific type of counter.</p> <p>TLO 4.5 Describe the working of specified shift register with the help of timing diagram.</p> <p>TLO 4.6 Design specified modulo-N counter using Flip flops .</p> <p>TLO 4.7 Design Ring /Twisted ring counter using given Flip-Flop.</p>	<p><b>Unit - IV Sequential Logic Circuits</b></p> <p>4.1 Difference between Combinational and Sequential Logic circuits, Time independent (un-clocked )and Time dependent ( Clocked ) logic system , Flips- Flops and Latch, Basic memory cell ,RS-Latch using NAND and NOR, Triggering methods- Edge trigger and Level Trigger</p> <p>4.2 Flip-Flops: S-R, J-K, T and D, Truth table and logic circuits of each flip-flop, Excitation table, applications</p> <p>4.3 Race around condition in JK flip-flop, Master- Slave JK Flip Flop</p> <p>4.4 Shift registers- Serial In Serial Out, Serial In Parallel Out, Parallel In Serial Out ,Parallel In Parallel Out,Bi-directional Shift register, 4-bit Universal Shift register</p> <p>4.5 Counters- Synchronous and Asynchronous counters, Modulus of counter, Ripple counter, Ring Counter, Twisted Ring Counter, Up – down counter, Decade Counter, MOD-N counter, Timing Diagram</p>	<p>Video Demonstrations Lecture Using Chalk-Board Simulation</p>
5	<p>TLO 5.1 Describe the working of the given type of DAC.</p> <p>TLO 5.2 Calculate the output voltage for the given digital input for specified DAC.</p> <p>TLO 5.3 Describe the working of the given type of ADC.</p> <p>TLO 5.4 Compare working of ROM,EPRM, EEPROM and Flash Memory .</p>	<p><b>Unit - V Data Converters and Memories</b></p> <p>5.1 Digital to Analog Data Converter (DAC)- circuit diagram and working of Weighted resistor DAC and R-2R Ladder DAC, DAC Specification/Selection factors</p> <p>5.2 Analog to Digital Data Converter (ADC) : Block Diagram, Types and Working of Dual Slope ADC, Successive Approximation, Flash Type ADC, ADC selection factors/ specifications</p> <p>5.3 Memories: Types- Primary memory , Secondary Memory, Organization, Dimension, Memory Bank, Features , Applications: RAM (SRAM, DRAM), Volatile and Non-Volatile, ROM (PROM, EPROM, EEPROM), Flash Memory, Comparison of RAM and ROM,EPROM and Flash Memory, SIMM: Features, SSD memory: Features,</p>	<p>Video Demonstrations Lecture Using Chalk-Board</p>

#### VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Test the functionality of basic gates. LLO 1.2 Test the functionality of special purpose gates.	1	* Test the functionality of AND, OR, NOT, Ex-OR and EX-NOR logic Gates using equivalent 74 series or CMOS Devices [CD] series.	2	CO1 CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Test the functionality of NAND and NOR gate using breadboard.	2	* Test the functionality of the given Universal Gates using equivalent 74 series /CD series.	2	CO2
LLO 3.1 Test the functionality of the constructed Basic gates using universal gates.	3	* Construct Basic Gates using Universal Gates.	2	CO2
LLO 4.1 Construct Ex-OR, EX-NOR gates using universal gates.	4	Construct Exclusive Gates using Universal Gates.	2	CO2
LLO 5.1 Build the logic circuit on breadboard to verify the De - Morgan's theorems.	5	* Verify De-Morgan's Theorem (1 and 2).	2	CO2
LLO 6.1 Verify the truth table of Half and Full adder circuits for the given input.	6	* Implement 2 input, 3 input Adder Circuit.	2	CO3
LLO 7.1 Verify the truth table of Half and Full subtractor using Boolean expressions.	7	Implement 2 input, 3 input Subtractor Circuit.	2	CO3
LLO 8.1 Construct and test BCD to 7 segment decoder using Digital IC.	8	Test the output of BCD to 7 Segment Decoder using Digital IC for the given inputs.	2	CO3
LLO 9.1 Build/Test 2 or 4 bit Magnitude comparator using Digital IC.	9	Check the output of comparator circuit consisting of Digital IC.	2	CO3
LLO 10.1 Build / test function of MUX Digital IC.	10	* Build and test the functionality of 4:1/8:1 Multiplexer.	2	CO3
LLO 11.1 Build / test function of DEMUX Digital IC.	11	Build and test the functionality of 1:4/1:8 De-Multiplexer.	2	CO3
LLO 12.1 Test functionality of RS flip flop using NAND Gate .	12	Implement and verify the truth table of RS Flip flop.	2	CO4
LLO 13.1 Test functionality of Master Slave (MS) JK flip-flop using Digital IC.	13	Implement and test the functionality of master slave- JK Flip Flop using Digital IC.	2	CO4
LLO 14.1 Test functionality and truth table for D and T Flip flop.	14	Use Digital IC to construct and test the functionality of D and T flip flop.	2	CO4
LLO 15.1 Interpret timing diagram of 4 bit Universal Shift Register.	15	Build 4- bit Universal Shift register and observe the timing diagram.	2	CO4
LLO 16.1 Interpret timing diagram of 4-bit ripple counter using Digital IC.	16	Implement Ripple Counter using Digital IC.	2	CO4
LLO 17.1 Interpret timing diagram of Decade counter (Mod-10).	17	* Implement Decade Counter Using Digital IC.	2	CO4
LLO 18.1 Build R-2R resistive network on breadboard to convert given digital data into analog.	18	* Test the output of given R-2R type Digital to Analog Converter for the given input.	2	CO5
<b>Note : Out of above suggestive LLOs -</b>				
<ul style="list-style-type: none"> <li>• *Marked Practicals (LLOs) Are mandatory.</li> <li>• Minimum 80% of above list of lab experiment are to be performed.</li> <li>• Judicial mix of LLOs are to be performed to achieve desired outcomes.</li> </ul>				

## VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

### Micro project

- Implement 1:8 DEMUX using 1:4 /1:2 DE-MUX.
- Build a circuit to implement 4 Bit adder.
- Build a 4bit parity generator and parity tester.
- Implement 16:1 MUX using 8:1/4:1 MUX.
- Build a circuit to test 7 bit segment display.
- Build a LED display bar.
- Develop a project on Burglar alarm.
- Light Detector circuit using NAND gate.

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicious mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

**VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Digital Storage Oscilloscope 25MHz/60MHz/70MHz/100MHz Dual Channel, 4 Trace CRT / TFT based X10 magnification 20 nS max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out, USB interface. Any other Oscilloscope with additional features is also suitable with magnifying probe at least two probes, if possible isolated probe	15,16,17
2	Trainer kit for 4 bit Counter using Flip Flops 4 bit ripple counter synchronous counter IC 7476 based circuit, Input given by switches and output indicated on LED, Facility to select MOD 8 or MOD 16 mode, Built in DC power supply and manual pulser with indicator	16,17
3	Trainer kit IC DAC IC 0800 Trainer based on IC 0800, 8 bit digital input selected by switches and provision for measurement of analog output. Facility to study effect of change in reference voltage, Built in buffer amplifier, Built in DC power supply	18
4	Digital multimeter 3.5 digit with R, V, I measurements, diode and BJT testing	All
5	Digital IC Tester Tests a wide range of Analog and Digital ICs such as 74 series /CD series	All
6	Bread Board Development System Bread Board system with DC power output 5V,+/-12V and 0-5V variable , digital voltmeter ,ammeter , LED indicators 8 no , logic input switches 8 no, 7 segment display 2 no, clockgenerator	All
7	Trainer kits for digital ICs Trainer kit should consists of digital ICs for logic gates, flop flop, shift registers, counter alongwith toggle switches for inputs and bi-colourLED at outputs, built in power supply	All

**IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Number Systems	CO1	5	2	4	2	8

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
2	II	Logic Gates and Boolean Algebra	CO2	8	2	4	6	12
3	III	Combinational Logic Circuits	CO3	12	4	6	8	18
4	IV	Sequential Logic Circuits	CO4	12	4	6	8	18
5	V	Data Converters and Memories	CO5	8	4	6	4	14
<b>Grand Total</b>				<b>45</b>	<b>16</b>	<b>26</b>	<b>28</b>	<b>70</b>

## X. ASSESSMENT METHODOLOGIES/TOOLS

### Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be consider for out of 30 marks.
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product.
- For formative assessment of laboratory learning 25 marks

### Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks.
- End semester summative assessment of 25 marks for laboratory learning

## XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	-	1	-	-	-	3			
CO2	2	-	2	-	-	-	2			
CO3	3	2	3	2	-	1	2			
CO4	3	2	3	2	-	1	2			
CO5	2	-	2	2	1	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -  
\*PSOs are to be formulated at institute level

## XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Jain R.P	Modern Digital Electronics	McGraw-Hill Publishing, New Delhi,2009 ISBN:9780070669116
2	Anand Kumar	Fundamentals of Digital Circuits	PHI learning Private limited, ISBN:978-81-203-5268-1
3	Salivahanan S, Arivazhagan S.	Digital Circuits and Design	Vikas Publishing House, New Delhi,2013 ISBN: 9789325960411
4	Puri.V.K	Digital Electronics	McGraw-Hill Publishing, New Delhi,2016 ISBN:97800746331751
5	Malvino A.P Donald .P. Leach	Digital Principles	McGraw-Hill Education, New Delhi ISBN:9789339203405



Sr.No	Author	Title	Publisher with ISBN Number
6	Anil.K.Maini	Digital Electronics: Principles, Devices and Applications	Wiley India, Delhi, 2007, ISBN:9780470032145
7	Floyd, Thomas	Digital Fundamentals	Pearson Education India, Delhi 2014,ISBN:9780132737968
8	G.K.Kharate	Digital Electronics	Publisher: Oxford University Press, ISBN: 9780198061830

### XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	<a href="https://studytronics.weebly.com/digital-electronics.html">https://studytronics.weebly.com/digital-electronics.html</a>	Basics of Digital Electronics
2	<a href="https://www.udemy.com/course/basics-of-digital-techniques/">https://www.udemy.com/course/basics-of-digital-techniques/</a>	Introduction To Digital Number System & Logic Gates
3	<a href="https://www.geeksforgeeks.org/synchronous-sequential-circuits-in-digital-logic/">https://www.geeksforgeeks.org/synchronous-sequential-circuits-in-digital-logic/</a>	Boolean Algebra and Logic Gates, Combinational and Sequential Logic Circuits
4	<a href="https://onlinecourses.nptel.ac.in/noc19_ee51/preview">https://onlinecourses.nptel.ac.in/noc19_ee51/preview</a>	Digital Circuits
5	<a href="https://de-iitr.vlabs.ac.in/">https://de-iitr.vlabs.ac.in/</a>	Virtual Labs for Digital Systems
6	<a href="https://www.tutorialspoint.com/digital_circuits/digital_circuits_sequential_circuits.htm">https://www.tutorialspoint.com/digital_circuits/digital_circuits_sequential_circuits.htm</a>	Sequential Circuits

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

**Programme Name/s** : Cloud Computing and Big Data/ Computer Technology/ Computer Engineering/ Computer Science & Engineering/ Computer Hardware & Maintenance/ Information Technology/ Computer Science & Information Technology/ Electronics & Computer Engg./

**Programme Code** : BD/ CM/ CO/ CW/ HA/ IF/ IH/ TE

**Semester** : Third

**Course Title** : OBJECT ORIENTED PROGRAMMING USING C++

**Course Code** : 313304

**I. RATIONALE**

In the modern world of Information Technology, Object Oriented Programming provides the most preferred approach for software development. It offers a powerful way to cope up with real world problems. C++ helps to develop fundamental understanding of object oriented concepts. This course enables to implement object oriented approach to solve a given programming problem.

**II. INDUSTRY / EMPLOYER EXPECTED OUTCOME**

Develop applications using concepts of OOP in C++.

**III. COURSE LEVEL LEARNING OUTCOMES (COS)**

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Write C++ programs using classes and objects.
- CO2 - Develop C++ programs using constructors.
- CO3 - Implement Inheritance in C++.
- CO4 - Implement Polymorphism in C++.
- CO5 - Develop C++ programs to perform file operations.

**IV. TEACHING-LEARNING & ASSESSMENT SCHEME**

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SL	LH	NLH			Theory			Based on LL & TL				Based on SL			
				CL	TL	LL						FA-TH	SA-TH	Total	Practical		SLA					
				Max	Max	Max	Min	Max	Min						Max	Min	Max	Min				
313304	OBJECT ORIENTED PROGRAMMING USING C++	OOP	SEC	3	2	4	1	10	5	3	30	70	100	40	50	20	25@	10	25	10	200	

**Total IKS Hrs for Sem. : 0 Hrs**

Abbreviations: CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, \*# On Line Examination , @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.\* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. \* Self learning hours shall not be reflected in the Time Table.
7. \* Self learning includes micro project / assignment / other activities.

#### V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	<p>TLO 1.1 Compare POP vs OOP approach of programming.</p> <p>TLO 1.2 Describe the different features of Object Oriented Programming.</p> <p>TLO 1.3 Write programs to solve arithmetic expressions.</p> <p>TLO 1.4 Write programs to demonstrate use of special operators in C++.</p> <p>TLO 1.5 Develop C++ program to show the use of Classes and Objects.</p>	<p><b>Unit - I Principles of Object Oriented Programming</b></p> <p>1.1 Procedure Oriented Programming (POP) verses Object Oriented Programming (OOP)</p> <p>1.2 Features of Object Oriented Programming, Examples of Object Oriented languages, Applications of OOP</p> <p>1.3 Data types, Type compatibility, Declaration of variable, Dynamic initialization of variable, Reference variable, Type casting</p> <p>1.4 Special Operators in C++: Scope resolution operator, Memory management operators, Manipulators</p> <p>1.5 Structure of C++ program, Basic Input /Output operators and functions in C++, Simple C++ Program</p> <p>1.6 Class &amp; Object: Introduction, Specifying a class, Access specifiers, Defining member functions: Inside class and Outside class, Creating objects, Memory allocations for objects</p>	<p>Lecture Using Chalk-Board, Demonstration, Presentations, Hands-on, Flipped Classroom.</p>
2	<p>TLO 2.1 Develop a program using inline function.</p> <p>TLO 2.2 Develop friend function to solve given problem.</p> <p>TLO 2.3 Write C++ programs using array of objects.</p> <p>TLO 2.4 Write C++ program to initialize the object using constructor.</p> <p>TLO 2.5 Write C++ program to delete object using destructor.</p>	<p><b>Unit - II Functions and Constructors</b></p> <p>2.1 Inline function, Static data members, Static member function, Friend function: Using two different classes , Using non-member function</p> <p>2.2 Array of Objects, Object as function arguments</p> <p>2.3 Concepts of Constructors, Types of constructors</p> <p>2.4 Constructor overloading and Constructors with default arguments</p> <p>2.5 Destructors</p>	<p>Lecture Using Chalk-Board, Demonstration, Presentations, Hands-on, Flipped Classroom.</p>

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Explain the given type of inheritance based on its characteristics. TLO 3.2 Implement given type of inheritance in C++ program. TLO 3.3 Write C++ program using virtual base class. TLO 3.4 Use constructor in given derived class.	<b>Unit - III Extending classes using Inheritance</b> 3.1 Introduction to Inheritance, Defining a derived class, Visibility modes and effects 3.2 Types of Inheritance : Single, Multilevel, Multiple, Hierarchical, Hybrid 3.3 Virtual base class, Abstract class, Constructor in derived class	Lecture Using Chalk-Board, Demonstration, Presentations, Hands-on, Flipped Classroom.
4	TLO 4.1 Create C++ program to perform given arithmetic operations using pointers. TLO 4.2 Use 'pointer to object' to solve the given problem. TLO 4.3 Use compile time polymorphism to solve the given problem. TLO 4.4 Use run time polymorphism to solve the given problem.	<b>Unit - IV Pointers and Polymorphism in C++</b> 4.1 Concept of Pointer: Pointer declaration, Pointer operator, Address operator, Pointer arithmetic 4.2 Pointer to Object: Pointer to object, 'this' pointer, Pointer to derived class 4.3 Introduction of Polymorphism, Types of polymorphism 4.4 Compile time Polymorphism: Function overloading, Revision of constructor overloading, Operator overloading: Rules for operator overloading, Overloading of unary and binary operators 4.5 Run time polymorphism: Virtual function, Rules for virtual function, Pure virtual function	Lecture Using Chalk-Board, Presentations, Demonstration, Hands-on, Flipped Classroom.
5	TLO 5.1 Identify relevant class to perform the given file operations. TLO 5.2 Describe different file modes. TLO 5.3 Develop C++ program to perform read/write operations from/to the given file.	<b>Unit - V File operations</b> 5.1 C++ stream classes, Classes for file stream operations 5.2 Detection of end of file, File modes 5.3 Opening files: Using constructors and open(), Closing files, Reading from and writing to files, Formatted Input/output functions in file 5.4 Types of file: Random access, Sequential access	Lecture Using Chalk-Board, Presentations, Demonstration, Hands-on, Flipped Classroom.

#### VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Develop program to evaluate expressions using various operators and Input/output functions.	1	*Write programs to evaluate any expression using Input / Output functions	2	CO1
LLO 2.1 Develop C++ program using special type of operators.	2	*Write programs using- <ul style="list-style-type: none"> <li>• Scope resolution operator</li> <li>• Memory management operator</li> <li>• Manipulators</li> </ul>	4	CO1
LLO 3.1 Develop programs to implement type casting.	3	Write programs to demonstrate use of- <ul style="list-style-type: none"> <li>• Implicit type casting</li> <li>• Explicit type casting</li> </ul>	2	CO1
LLO 4.1 Implement classes and objects to define the function inside class.	4	Write programs to show use of classes and objects to define the function inside the class	2	CO1
LLO 5.1 Implement classes and objects to define the function outside class.	5	*Write programs to define the function outside the class	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Implement programs using inline function.	6	*Write programs to implement inline function	2	CO2
LLO 7.1 Implement friend function using different classes. LLO 7.2 Implement friend function using external function.	7	*Write programs to implement friend function using- <ul style="list-style-type: none"> <li>• Two different classes</li> <li>• External function</li> </ul>	2	CO2
LLO 8.1 Develop program using static data member. LLO 8.2 Develop program using static member function.	8	*Write programs to implement- <ul style="list-style-type: none"> <li>• Static data member</li> <li>• Static member function</li> </ul>	2	CO2
LLO 9.1 Implement programs to show the use of array of objects.	9	*Write programs to create array of objects	2	CO2
LLO 10.1 Implement the concept of constructor and destructor.	10	*Write programs for- <ul style="list-style-type: none"> <li>• Default constructor</li> <li>• Parameterized constructor</li> <li>• Copy constructor</li> <li>• Multiple constructor in one class</li> </ul>	4	CO2
LLO 11.1 Implement Single level inheritance. LLO 11.2 Implement multilevel inheritance.	11	Write programs using- <ul style="list-style-type: none"> <li>• Single level inheritance</li> <li>• Multilevel inheritance</li> </ul>	2	CO3
LLO 12.1 Develop program using multiple inheritance.	12	*Write programs to implement multiple inheritance	2	CO3
LLO 13.1 Develop program using hierarchical inheritance.	13	Write programs to implement hierarchical inheritance	2	CO3
LLO 14.1 Implement virtual base class in a program.	14	*Write programs to implement virtual base class.	2	CO3
LLO 15.1 Implement constructors in derived class in a program.	15	Write programs which show the use of constructors in derived class	2	CO3
LLO 16.1 Implement pointer arithmetic in a program. LLO 16.2 Implement pointer to object in a program. LLO 16.3 Implement 'this' pointer in a program.	16	*Write programs to implement- <ul style="list-style-type: none"> <li>• Pointer to object</li> <li>• 'this' pointer</li> </ul>	2	CO4
LLO 17.1 Implement program to use pointer to derived class.	17	*Write programs for- <ul style="list-style-type: none"> <li>• Pointer to derived class in single inheritance</li> <li>• Pointer to derived class in multilevel inheritance</li> </ul>	4	CO4
LLO 18.1 Implement function overloading in a program.	18	Write programs which show the use of function overloading	2	CO4
LLO 19.1 Implement unary operator overloading using member function. LLO 19.2 Implement unary operator overloading using friend function.	19	*Write programs to overload unary operator using- <ul style="list-style-type: none"> <li>• Member function</li> <li>• Friend function</li> </ul>	4	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 20.1 Implement binary operator overloading using member function. LLO 20.2 Implement binary operator overloading using friend function.	20	Write programs to overload binary operator using- <ul style="list-style-type: none"> <li>• Member function</li> <li>• Friend function</li> </ul>	2	CO4
LLO 21.1 Develop program using virtual function.	21	*Write programs to implement virtual function	2	CO4
LLO 22.1 Develop program using pure virtual function.	22	Write programs to implement pure virtual function	2	CO4
LLO 23.1 Implement read and write operations from/to file using constructor. LLO 23.2 Implement read and write operations from/to file using open().	23	*Write programs to read and write from/to file using- <ul style="list-style-type: none"> <li>• Constructor</li> <li>• open()</li> </ul>	2	CO5
LLO 24.1 Use formatted Input / Output functions to format the contents.	24	*Write programs to copy the content of one file into another file using formatted input/output functions	2	CO5
LLO 25.1 Implement get() and put() functions on file.	25	Write file programs to implement sequential input and output operations on file	2	CO5
LLO 26.1 Implement input/ output operations on binary file.	26	Write programs to perform input / output operations on binary files	2	CO5
<b>Note : Out of above suggestive LLOs -</b> <ul style="list-style-type: none"> <li>• '* Marked Practicals (LLOs) Are mandatory.</li> <li>• Minimum 80% of above list of lab experiment are to be performed.</li> <li>• Judicial mix of LLOs are to be performed to achieve desired outcomes.</li> </ul>				

## VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

### Micro project

- Develop Student Grading System. Accept student data and marks for 5 subjects for 5 students. Calculate the percentage and finalize grade awarded to the student. Write the records in to file.
- Develop Quiz Management System. Quiz should accept student credentials and contain 10 MCQ type questions. Determine the final result. Save the result in file along with student credentials.
- Develop advanced calculator for the following function: Binary to Decimal, Decimal to Binary etc..
- Develop Hotel Management Application. It should accept room reservation for 10 rooms. Find number of empty rooms. Display relevant information and write maximum 5 records into file.
- Develop Employee Management System using Inheritance. Collect following information from user: Employee\_ID ,Employee\_Name, Basic\_Salary, Leave taken in the month Calculate Net Salary assuming applicable deductions and display. Write maximum 5 records into file.
- Any other micro project as suggested by subject faculty.

### Assignment

- Solve assignment covering all COs given by teacher

### Other

- Complete the course object oriented concepts using C++ on Infosys Springboard

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicious mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

**VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computer System (Any computer system with basic configuration)	All
2	“C++” Compiler (Any)	All

**IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Principles of Object Oriented Programming	CO1	8	2	4	6	12
2	II	Functions and Constructors	CO2	12	2	4	10	16
3	III	Extending classes using Inheritance	CO3	9	2	4	10	16
4	IV	Pointers and Polymorphism in C++	CO4	10	2	4	10	16
5	V	File operations	CO5	6	0	4	6	10
<b>Grand Total</b>				<b>45</b>	<b>8</b>	<b>20</b>	<b>42</b>	<b>70</b>

**X. ASSESSMENT METHODOLOGIES/TOOLS****Formative assessment (Assessment for Learning)**

- Continuous assessment based on process and product related performance indicators
- Each practical will be assessed considering 60% weightage to process and 40% weightage to product
- A continuous assessment-based term work

**Summative Assessment (Assessment of Learning)**

- End semester examination, Lab performance, Viva voce

**XI. SUGGESTED COS - POS MATRIX FORM**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	1	1	2	1	1	1			
CO2	2	1	1	2	1	1	1			

CO3	2	2	2	2	2	2	1			
CO4	2	2	2	2	2	2	1			
CO5	2	2	2	2	2	2	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -  
\*PSOs are to be formulated at institute level

## XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	E Balaguruswamy	Object Oriented Programming with C++	McGraw-Hill Education ISBN-10:0070669074, ISBN-13:9780070669079
2	D Ravichandran	Programming with C++	McGraw-Hill Education ISBN-10: 0070681899, ISBN-13: 978-0070681897
3	Stroustrup B.	The C++ Programming Language	Pearson Education New Delhi ISBN-10: 0275967301, ISBN-13: 978-0275967307
4	Robert Lafore	Object Oriented Programming in C++	Pearson Education India ISBN-10: 8131722821, ISBN-13: 978-8131722824

## XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	<a href="https://www.w3schools.com/cpp/">https://www.w3schools.com/cpp/</a>	C++ Tutorial for all topics
2	<a href="https://www.javatpoint.com/cpp-tutorial">https://www.javatpoint.com/cpp-tutorial</a>	C++ Tutorial for all topics
3	<a href="https://www.javatpoint.com/cpp-files-and-streams">https://www.javatpoint.com/cpp-files-and-streams</a>	C++ File Streams
4	<a href="https://www.programiz.com/cpp-programming">https://www.programiz.com/cpp-programming</a>	Inheritance in C++
5	<a href="https://www.programiz.com/cpp-programming/online-compiler/">https://www.programiz.com/cpp-programming/online-compiler/</a>	Online Compiler for C++
6	<a href="https://www.onlinegdb.com/online_cplusplus_compiler">https://www.onlinegdb.com/online_cplusplus_compiler</a>	Online compiler for C++

### Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students



Programme Name/s	: Cloud Computing and Big Data/ Information Technology/ Computer Science & Information Technology
Programme Code	: BD/ IF/ IH
Semester	: Third
Course Title	: DIGITAL TECHNIQUES AND MICROPROCESSORS
Course Code	: 313305

**I. RATIONALE**

It is essential to know the basics of digital techniques for understanding the applications of digital systems as well as microprocessors. Microprocessors serve as the heart of computer systems, and understanding their architecture is crucial for appreciating how computers process information. Microprocessors play a key role in embedded systems and Internet of Things (IoT) devices, making this course highly relevant for contemporary applications in IT. This course will help the student to comprehend logic and circuit design and enable them to perform assembly language programming for microprocessors, cultivating the skills essential for logic and software development in the IT sector.

**II. INDUSTRY / EMPLOYER EXPECTED OUTCOME**

This course aims to help the student to attain the following industry identified outcomes through various teaching-learning experiences:

Test digital systems by applying principles of digital techniques and microprocessors.

**III. COURSE LEVEL LEARNING OUTCOMES (COS)**

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Test logic gates and digital systems.
- CO2 - Use basic combinational and sequential logic circuits employing digital ICs.
- CO3 - Perform operations on registers using 8086 instructions.
- CO4 - Use 8086 microprocessor environment to build and execute assembly language programs.
- CO5 - Develop assembly language programming in 8086 to implement loops and branching instructions.

**IV. TEACHING-LEARNING & ASSESSMENT SCHEME**

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH	Theory			Based on LL & TL		Based on SL	Total Marks							
				CL	TL	LL						Practical										
							FA-TH	SA-TH				Total	FA-PR	SA-PR		SLA						
Max	Max	Max	Min	Max	Min	Max	Min	Max	Min													
313305	DIGITAL TECHNIQUES AND MICROPROCESSORS	DTM	AEC	3	-	2	1	6	3	3	30	70	100	40	25	10	25@	10	25	10	175	

**Total IKS Hrs for Sem. : 0 Hrs**

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, \*# On Line Examination , @\$ Internal Online Examination  
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.\* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. \* Self learning hours shall not be reflected in the Time Table.
7. \* Self learning includes micro project / assignment / other activities.

## V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	<p>TLO 1.1 Convert the given number system to the specified number system.</p> <p>TLO 1.2 Convert given form of code to another code.</p> <p>TLO 1.3 Apply arithmetic operations on the number belongs to given number system.</p> <p>TLO 1.4 Derive the truth table of the given basic logic gates / derived logic gates.</p> <p>TLO 1.5 Design the logical circuit for the given application.</p>	<p><b>Unit - I Number Systems and Digital Logic Gates</b></p> <p>1.1 Terms - Bit, Byte, Nibble, Word</p> <p>1.2 Number systems- Decimal, Binary, Octal, Hexadecimal and their conversions from one number system to another</p> <p>1.3 Codes and code conversion: BCD, GRAY, ASCII, EBCDIC</p> <p>1.4 Binary, Hexadecimal, BCD arithmetic and 1's and 2's complement (up to 8 bit)</p> <p>1.5 Basic logic gates(AND,OR,NOT), universal gates (NAND,NOR), special gates (EX-OR, EX-NOR), and their truth table, basic gates using universal gates</p> <p>1.6 Basic logic operations using laws of Boolean algebra, De-Morgan's theorems</p>	<p>Classroom Learning</p> <p>Flipped Classroom</p> <p>Collaborative Learning</p> <p>Use of logic simulator like</p> <p>Virtual Labs, online converters etc</p>
2	<p>TLO 2.1 Explain concept of Sum-of- Product (SOP) and Product-of-Sum(POS).</p> <p>TLO 2.2 Explain concept of half-full adder / half-full subtractor using K-MAP.</p> <p>TLO 2.3 Construct the logical diagrams using multiplexer / demultiplexer ICs to solve the given expression.</p> <p>TLO 2.4 State the use of latch, flipflop, counter, buffer.</p>	<p><b>Unit - II Combinational and Sequential Logic Circuits</b></p> <p>2.1 Standard/canonical forms for Boolean functions, Min-terms and Max-terms, Minimization of expression using SOP-POS and K-MAP, simplification of expression of half adder/full adder and half/full subtractor using K-MAPs</p> <p>2.2 Concept of multiplexer and demultiplexer, logical diagram development using multiplexer/ demultiplexer ICs</p> <p>2.3 Multiplexer tree and demultiplexer tree, applications of multiplexers and demultiplexers</p> <p>2.4 Clock signal, flipflop, latches, counter, buffer and tri-state buffer (only concept)</p>	<p>Lecture Using Chalk-Board</p> <p>Flipped Classroom</p> <p>Collaborative Learning</p> <p>Virtual Lab</p>
3	<p>TLO 3.1 Enlist features of 8086 microprocessor.</p> <p>TLO 3.2 Calculate physical address to locate the given data from memory segmentation.</p> <p>TLO 3.3 Explain given blocks of architecture of 8086 microprocessor.</p> <p>TLO 3.4 Compare minimum mode and maximum mode of 8086 features.</p>	<p><b>Unit - III 16-Bit Microprocessor 8086</b></p> <p>3.1 Microprocessor 8086 features, pin diagram description and architecture of 8086</p> <p>3.2 Units of 8086: Bus interface unit and execution unit, concept of memory segmentation and pipelining, physical address generation</p> <p>3.3 Flag register of 8086, segment registers, index register, ALU-arithmetic logic unit</p> <p>3.4 Minimum mode and maximum mode configuration of 8086, timing diagrams concept</p>	<p>Classroom Learning</p> <p>Flipped Classroom</p> <p>Cooperative Learning</p>

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	<p>TLO 4.1 Identify relevant addressing mode of instruction.</p> <p>TLO 4.2 Choose relevant instruction to perform the given operation from the instruction set of 8086.</p> <p>TLO 4.3 Use data transfer and arithmetic instruction for given situation employing specific addressing mode.</p> <p>TLO 4.4 Use logical and flag manipulation instruction for given situation employing specific addressing mode.</p>	<p><b>Unit - IV Basic assembly Language Programming using 8086</b></p> <p>4.1 Programming model of 8086 assembly language program assembler directives</p> <p>4.2 Addressing modes of 8086, register, direct, based, indexed, based-indexed addressing, assembler directives</p> <p>4.3 Format of instruction, instruction set: data transfer, arithmetic, logical, branch and loop, flag manipulation</p> <p>4.4 Shift and rotate instructions, string instructions</p>	<p>Classroom Learning</p> <p>Collaborative Learning</p> <p>Flipped Classroom Program</p> <p>development tools and simulators</p>
5	<p>TLO 5.1 Develop the assembly language program to solve the given problem using looping.</p> <p>TLO 5.2 Develop the assembly language program to solve the given problem using branching structure.</p>	<p><b>Unit - V Assembly Language Programming using Loops and Branching instructions</b></p> <p>5.1 Assembly language programs for addition, subtraction, multiplication, division on hexadecimal, BCD numbers (8/16 bit)</p> <p>5.2 Assembly language programs using decision making</p> <p>5.3 Assembly language programs using looping and branching structure. assembly language programs for sorting, searching and block transfer (with string and without string instructions) of given numbers</p> <p>5.4 Assembly language programs for uppercase to lowercase, lowercase to uppercase, conversion of hexadecimal to BCD and BCD to hexadecimal</p>	<p>Classroom Learning</p> <p>Flipped Classroom</p> <p>Collaborative Learning</p> <p>Program development tools and simulators</p>

#### VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
<p>LLO 1.1 Identify various logic gate ICs.</p> <p>LLO 1.2 Verify truth tables of basic logic gates (AND-7408, OR- 7432, NOT-7404) using breadboard</p> <p>LLO 1.3 Verify truth tables of universal gates (NAND-7400, NOR-7402).</p> <p>LLO 1.4 Verify truth tables of special logic gates EX-OR-7486, EX-NOR-74266</p>	1	* Verification of truth table of basic logic gates, special logic gates and Identify various Logic gate ICs.	2	CO1
<p>LLO 2.1 Design a circuit for a given logical expression using the universal gates (NAND)</p> <p>LLO 2.2 Design a circuit for a given logical expression using the universal gates (NOR).</p>	2	Implementation and verification of expression using universal logic gate ICs	2	CO1
<p>LLO 3.1 Verify the truth table of De-Morgan's first theorem using basic logic gates.</p> <p>LLO 3.2 Verify the truth table of De-Morgan's second theorem using basic logic gates..</p>	3	Verification of De-Morgan's theorems using basic logic gates	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Design and test the circuit for converting expression into Sum-of-Product(SOP) LLO 4.2 Design and test the circuit for converting expression into product (POS).	4	* Conversion of expression to Sum-of-Product (SOP) and Product-of-Sum (POS)	2	CO2
LLO 5.1 Design a Combinational Circuit using Multiplexer IC-74LS153 (4:1 MUX). LLO 5.2 Design a Combinational Circuit using Demultiplexer IC -74139.	5	* Implement Multiplexer and Demultiplexer logic (The practical may be performed using virtual lab)	2	CO2
LLO 6.1 Verify states of the Latch using IC 74373.	6	Implementation of Latch	2	CO2
LLO 7.1 Develop an assembly language program to verify the contents of general purpose, segment registers, flags and contents of memory locations of segments	7	* Verification of contents of general purpose, segment registers, flags and memory locations of different segments during execution of the program	2	CO3
LLO 8.1 Develop an assembly language program to add 8 bit and 16-bit signed/unsigned hexadecimal numbers. LLO 8.2 Develop an assembly language program to Subtract two 8-bit and 16-bit signed/ unsigned hexadecimal numbers.	8	* Assembly language programming for addition and subtraction for hexadecimal numbers	2	CO4
LLO 9.1 Develop an assembly language program to add 8 bit and 16-bit BCD numbers. LLO 9.2 Develop an assembly language program to subtract two 8-bit and 16-bit BCD numbers.	9	Apply assembly language programming logic for addition, subtraction and multiplication for BCD numbers.	2	CO4
LLO 10.1 Develop assembly language programming for multiplication and division.	10	* Assembly language programming for multiplication and division	2	CO4
LLO 11.1 Develop assembly language programming for finding smallest /largest hexadecimal numbers.	11	Assembly language programming to find smallest /largest hexadecimal numbers	2	CO4
LLO 12.1 Develop an assembly language program to Sort numbers of given arrays in ascending order. LLO 12.2 Develop an assembly language program to Sort numbers of a given array in descending order.	12	* Assembly language programming for sorting of data	2	CO5
LLO 13.1 Develop assembly language programming for transfer of block of data.	13	Assembly language programming for transfer of block of data	2	CO5
LLO 14.1 Apply assembly language programming logic for counting the occurrence of a given number.	14	Count the occurrence of a given number from a block of data	2	CO5
LLO 15.1 Develop an assembly language program to shift given hex number to the left / right(with and without carry). LLO 15.2 Develop an assembly language program to rotate given hex number to the left / right(with and without carry).	15	* Implement shift and rotate instructions on given data	2	CO5

**Note : Out of above suggestive LLOs -**

- '\*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

**VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)****Micro project**

- Find the factorial of a given number using 8086 assembly language programming.
- Separate odd and even numbers from a given array using an assembly language program.
- Design shift register using JK Flipflop.
- Design a Burglar alarm using electronic components and digital ICs.

**Assignment**

- Write an assembly language program using 8086 to generate the Fibonacci series.
- Draw and implement the circuit on the breadboard for 1:16 DEMUX using 1:8 DEMUX. State the ICs used along with their description.

**Self Learning Activity**

- Develop an assembly language program to add 8-bit and 16-bit Unsigned numbers (using procedure).
- Write an assembly language program to add and subtract two BCD numbers(using MACRO).
- Write an ALP to multiply two BCD numbers (using MACRO).

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicious mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

**VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	1) Digital Multimeter: 3 and 1/2 digit 2) Pulse Generator/Function Generator: TTL Pulse Generator 20mA per Channel(max), 0 to 5.0 V (max) 3) DC Regulated Power Supply: 2 x 0-30 V; 0-2 A Automatic Overload (Current Protection) Constant Voltage and Constant Current Operation Digital Display for Voltage and Current Adjustable Current Limiter Excellent Line and Load Regulation 4) Basic logic gates (AND-7408, OR- 7432, NOT- 7404), Universal gates (NAND-7400, NOR-7402) EX-OR-7486, EX-NOR-74266 5) 4:1 Multiplexer IC-74LS153 6) Demultiplexer IC -74139 7) Bread boards, connecting wires, Stripper, Soldering Gun, Soldering Metal, Flux, IC Tester, LEDs, Digital ICs, Data sheets of ICs used in Lab.	1,2,3,4,5,6
2	1) Personal Computer Intel Pentium Onwards Minimum 2GB RAM. 500Gbyte HDD) installed with Windows 2000 onwards 2) Any Editor to write/edit programs 3) Turbo/Macro Assembler (TASM / MASM) 4) Turbo Linker (TLINK/LINK 5) Turbo Debugger (ID/Debug), (DOSBOX utility for higher-end operating systems) (Minimum 20 computers for a batch of 20 students) with the shared printer. 8086 freeware/open source based simulator to demonstrate internal functioning of microprocessor (Desirable)	8,10,9,11,13,12,14,15,7

**IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Number Systems and Digital Logic Gates	CO1	8	2	4	6	12
2	II	Combinational and Sequential Logic Circuits	CO2	10	2	8	6	16
3	III	16-Bit Microprocessor 8086	CO3	8	2	4	6	12
4	IV	Basic assembly Language Programming using 8086	CO4	10	4	6	6	16
5	V	Assembly Language Programming using Loops and Branching instructions	CO5	9	2	6	6	14
<b>Grand Total</b>				<b>45</b>	<b>12</b>	<b>28</b>	<b>30</b>	<b>70</b>

**X. ASSESSMENT METHODOLOGIES/TOOLS****Formative assessment (Assessment for Learning)**

- Two offline unit tests of 30 marks and average of two unit test.
- For formative assessment of Laboratory learning 25 marks marks will be consider for out of 30 marks
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

**Summative Assessment (Assessment of Learning)**

- End semester assessment of 70 marks.
- End semester summative assessment of 25 marks for laboratory learning

**XI. SUGGESTED COS - POS MATRIX FORM**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	1	1	1	-	1	1			
CO2	2	1	2	2	-	1	1			
CO3	2	-	-	1	-	-	1			
CO4	2	1	2	2	-	1	1			
CO5	2	1	2	2	-	1	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -

\*PSOs are to be formulated at institute level

**XII. SUGGESTED LEARNING MATERIALS / BOOKS**

Sr.No	Author	Title	Publisher with ISBN Number
1	Jain R.P.	Modern Digital Electronics	McGraw Hill Education , New Delhi, 2016, ISBN: 978-0070669116
2	Leach Donald P., Malvino Albert Paul, Saha Gautam	Digital Principles and Applications 5/E	Tata McGraw Hill Education, New Delhi, ISBN: 978-0028018218
3	Savaliya M. T.	8086 Programming and advanced processor architecture	Wiley India New Delhi, 2013, ISBN: 978-8126530915

Sr.No	Author	Title	Publisher with ISBN Number
4	Bhurchandi K. M., Roy A. K.	Advanced microprocessors and peripherals 3/E	Tata McGraw Hill Education, New Delhi, 2016, ISBN:9781259006135
5	Triebel, Walter, Singh A., Avtar	The 8088 and 8086 Microprocessors	SCITECH Publications, Chennai 2015, ISBN:978-8183717021

### XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	<a href="https://dld-iitb.vlabs.ac.in/">https://dld-iitb.vlabs.ac.in/</a>	Virtual Lab IIT, Bombay
2	<a href="https://www.falstad.com/circuit/">https://www.falstad.com/circuit/</a>	Paul Falstad Circuit Simulator
3	<a href="https://logic.ly/">https://logic.ly/</a>	Online Simulator for Digital Techniques
4	<a href="https://cse15-iiith.vlabs.ac.in/">https://cse15-iiith.vlabs.ac.in/</a>	Virtual Lab IIT, Delhi

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students