Vivekanand Education Society's Institute of Technology

V.E.S.
Since 1962

Bachelor of Engineering

in

Computer Engineering

Second Year with Effect from AY 2023-2024

Third Year with Effect from AY 2023-2024

Final Year with Effect from AY 2023-2024

Under

Autonomous Scheme

Program Structure for Second Year Computer Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract	Tut.	Total
CSC301	Engineering Mathematics-III	3	--	1**	3	--	1	4
CSC302	Discrete Structures & Graph Theory	3	--		3	--	--	3
CSC303	Data Structure	3	--		3	--	--	3
CSC304	Digital Logic & Computer Architecture	3	--		3	--	--	3
CSC305	Computer Graphics	3	--		3	--	--	3
CSL301	Data Structure Lab	--	2		--	1	--	1
CSL302	Digital Logic & Computer Architecture Lab	--	2		--	1	--	1
CSL303	Computer Graphics Lab	--	2		--	1	--	1
CSL304	Skill base Lab course: Object Oriented Programming with Java	--	2+2**		--	2	--	2
CSM301	Mini Project – 1 A	--	$4^{\$}$		--	2	--	2
Total		**15**	**14**	**1**	**15**	**07**	**1**	**23**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & Oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
CSC301	Engineering Mathematics III	20	20	60	2	25	--	125
CSC302	Discrete Structures & Graph Theory	20	20	60	2	--	--	100
CSC303	Data Structure	20	20	60	2	--	--	100
CSC304	Digital Logic & Computer Architecture	20	20	60	2	--	--	100
CSC305	Computer Graphics	20	20	60	2	--	--	100
CSL301	Data Structure Lab	--	--	--	--	25	25	50
CSL302	Digital Logic & Computer Architecture Lab	--	--	--	--	25	--	25
CSL303	Computer Graphics Lab	--	--	--	--	25	25	50
CSL304	Skill base Lab course:Object Oriented Programming with Java	--	--	--	--	50	25	75
CSM301	Mini Project-1 A	--	--	--	--	25	25	50
Total		**100**	**100**	**300**	--	**175**	**100**	**775**

* indicates Continuous Assessment   **Should be conducted batch wise

$ indicates workload of Learner (Not Faculty), Students can form groups with minimum 2 (Two) and not more than 4 (Four), Faculty Load: 1 hour per week per four groups

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract	Tut.	Total
CSC401	Engineering Mathematics IV	3	--	1**	3	--	1	4
CSC402	Analysis of Algorithm	3	--	--	3	--	--	3
CSC403	Database Management System	3	--	--	3	--	--	3
CSC404	Operating System	3	--	--	3	--	--	3
CSC405	Microprocessor	3	--	--	3	--	--	3
CSL401	Analysis of Algorithm Lab	--	2	--	--	1	--	1
CSL402	Database Management System Lab	--	2	--	--	1	--	1
CSL403	Operating System Lab	--	2	--	--	1	--	1
CSL404	Microprocessor Lab	--	2	--	--	1	--	1
CSL405	Skill Base Lab Course: Python Programming	--	2+2**	--	--	2	--	2
CSM401	Mini Project 1-B	--	$4^{\$}$	--	--	2	--	2
Total		**15**	**16**	**1**	**15**	**8**	**1**	**24**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam. Duration (in Hrs)			
		Mid Test (MT)	CA*					
CSC401	Engineering Mathematics IV	20	20	60	2	25	--	125
CSC402	Analysis of Algorithm	20	20	60	2	--	--	100
CSC403	Database Management System	20	20	60	2	--	--	100
CSC404	Operating System	20	20	60	2	--	--	100
CSC405	Microprocessor	20	20	60	2	--	--	100
CSL401	Analysis of Algorithm Lab	--	--	--	--	25	25	50
CSL402	Database Management System Lab	--	--	--	--	25	25	50
CSL403	Operating System Lab	--	--	--	--	25	25	50
CSL404	Microprocessor Lab	--	--	--	--	25	--	25
CSL405	Skill Base Lab Course: Python Programming	--	--	--	--	25	--	25
CSM401	Mini Project 1-B	--	--	--	--	25	25	50
Total		**100**	**100**	**300**	--	**175**	**100**	**775**

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Program Structure for Third Year Computer Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	**Pract**	**Theory**	**Pract**	**Tut**	**Total**
CSC501	Theoretical Computer Science	3	--	3	--	1	4
CSC502	Software Engineering	3	--	3		--	3
CSC503	Computer Network	3	--	3	--	--	3
CSC504	Data Warehousing & Mining	3	--	3	--	--	3
CSDLO501x	Department Level Optional Course- 1	3	--	3	--	--	3
CSL501	Software Engineering Lab	--	2	--	1	--	1
CSL502	Computer Network Lab	--	2	--	1	--	1
CSL503	Data Warehousing & Mining Lab	--	2	--	1	--	1
CSL504	Professional Communication & Ethics- II	--	2+2**	--	2	--	2
CSM501	Mini Project: 2 A	--	$4^{\$}$	--	2	--	2
Total		**15**	**14**	**15**	**07**	**01**	**23**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
CSC501	Theoretical Computer Science	20	20	60	2	25	--	125
CSC502	Software Engineering	20	20	60	2	--	--	100
CSC503	Computer Network	20	20	60	2	--	--	100
CSC504	Data Warehousing & Mining	20	20	60	2	--	--	100
CSDLO501x	Department Level Optional Course -1	20	20	60	2	--	--	100
CSL501	Software Engineering Lab	--	--	--	--	25	25	50
CSL502	Computer Network Lab	--	--	--	--	25	25	50
CSL503	Data Warehousing & Mining Lab	--	--	--	--	25	25	50
CSL504	Professional Communication & Ethics- II	--	--	--	--	50	--	50
CSM501	Mini Project : 2A	--	--	--	--	25	25	50
Total		**100**	**100**	**300**	--	**175**	**100**	**775**

* indicates Continuous Assessment, ** Theory class to be conducted for full class and $ indicates workload of Learner (Not Faculty), students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1 hour per week per four groups.

Department Optional Courses

Department Level Optional Courses	Semester	Code & Course
Department Level Optional Course -1	V	CSDLO5011: Probabilistic Graphical Models CSDLO5012: Internet Programming CSDLO5013: Advanced Database Management System

Program Structure for Third Year Computer Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract/ Tut.	Theory	Pract	Total
CSC601	System Programming & Compiler Construction	3	--	3	--	3
CSC602	Cryptography & System Security	3	--	3		3
CSC603	Mobile Computing	3	--	3	--	3
CSC604	Artificial Intelligence	3	--	3	--	3
CSDLO601x	Department Level Optional Course -2	3	--	3	--	3
CSL601	System Programming & Compiler Construction Lab	--	2	--	1	1
CSL602	Cryptography & System Security Lab	--	2	--	1	1
CSL603	Mobile Computing Lab	--	2	--	1	1
CSL604	Artificial Intelligence Lab	--	2	--	1	1
CSL605	Skill base Lab Course: Cloud Computing	--	2+2**	--	2	2
CSM601	Mini Project Lab: 2B	--	$4^{\$}$	--	2	2
Total		**15**	**16**	**15**	**08**	**23**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam. Duration (in Hrs)			
		Mid Test (MT)	CA*					
CSC601	System Programming & Compiler Construction	20	20	60	2	--	--	100
CSC602	Cryptography & System Security	20	20	60	2	--	--	100
CSC603	Mobile Computing	20	20	60	2	--	--	100
CSC604	Artificial Intelligence	20	20	60	2	--	--	100
CSDLO601x	Department Level Optional Course -2	20	20	60	2	--	--	100
CSL601	System Programming & Compiler Construction Lab	--	--	--	--	25	25	50
CSL602	Cryptography & System Security Lab	--	--	--	--	25	--	25
CSL603	Mobile Computing Lab	--	--	--	--	25	-	25
CSL604	Artificial Intelligence Lab					25	25	50
CSL605	Skill base Lab Course: Cloud Computing	--	--	--	--	50	25	75
CSM601	Mini Project :2B	--	--	--	--	25	25	50
Total		**100**	**100**	**300**	--	**175**	**100**	**775**

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$ indicates workload of Learner (Not Faculty), students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1 hour per week per four groups.

Department Optional Courses

Department Level Optional Courses	Semester	Code & Course
Department Level Optional Course -2	VI	CSDLO6011: Internet of Things CSDLO6012: Digital Signal & Image Processing CSDLO6013: Quantitative Analysis

Program Structure for Fourth Year Computer Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Pract/ Tut.**	**Theory**	**Pract**	**Total**
CSC701	Machine Learning	3	--	3	--	3
CSC702	Big Data Analytics	3	--	3		3
CSDC701X	Department Level Optional Course-3	3	--	3	--	3
CSDC702X	Department Level Optional Course-4	3	--	3	--	3
ILO701X	Institute Level Optional Course-1	3	--	3	--	3
CSL701	Machine Learning Lab	--	2	--	1	1
CSL702	Big Data Analytics Lab	--	2	--	1	1
CSDL 701X	Department Level Optional Course-3 Lab	--	2	--	1	1
CSDL702X	Department Level Optional Course-4 Lab	--	2	--	1	1
CSP701	Major Project I	--	$6^{\$}$	--	3	3
Total		**15**	**14**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam. Duration (in Hrs)			
		Mid Test (MT)	CA*					
CSC701	Machine Learning	20	20	60	2	--	--	100
CSC702	Big Data Analysis	20	20	60	2	--	--	100
CSDC701X	Department Level Optional Course-3	20	20	60	2	--	--	100
CSDC702X	Department Level Optional Course-4	20	20	60	2	--	--	100
ILO701X	Institute Level Optional Course-1	20	20	60	2	--	--	100
CSL701	Machine Learning Lab	--	--	--	--	25	25	50
CSL702	Big Data Analytics Lab	--	--	--	--	25	25	50
CSDL701X	Department Level Optional Course-3 Lab					25	-	25
CSDL702X	Department Level Optional Course-4 Lab	--	--	--	--	25	-	25
CSP701	Major Project 1	--	--	--	--	50	25	75
Total		**100**	**100**	**300**	--	**150**	**75**	**725**

* indicates Continuous Assessment.

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract/ Tut.	Theory	Pract	Total
CSC801	Distributed Computing	3	--	3	--	3
CSDC801X	Department Level Optional Course -5	3	--	3	--	3
CSDC802X	Department Level Optional Course -6	3	--	3	--	3
ILO801X	Institute Level Optional Course -2	3	--	3	--	3
CSL801	Distributed Computing Lab	--	2	--	1	1
CSDL801X	Department Level Optional Course -5 Lab	--	2	--	1	1
CSDL802X	Department Level Optional Course -6 Lab	--	2	--	1	1
CSP801	Major Project II	--	12$	--	6	6
Total		**12**	**18**	**12**	**9**	**21**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & Oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (in Hrs)			
		Mid Test (MT)	CA*					
CSC801	Distributed Computing	20	20	60	2	--	--	100
CSDC801X	Department Level Optional Course -5	20	20	60	2	--	--	100
CSDC802X	Department Level Optional Course -6	20	20	60	2	--	--	100
ILO801X	Institute Level Optional Course -2	20	20	60	2	--	--	100
CSL801	Distributed Computing Lab	--	--	--	--	25	25	50
CSDL801X	Department Level Optional Course -5 Lab	--	--	--	--	25	25	50
CSDL802X	Department Level Optional Course - 6 Lab					25	25	50
CSP801	Major Project- 2	--	--	--	--	100	50	150
Total		**80**	**80**	**240**	--	**175**	**125**	**700**

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Major Project 1 and 2 :

· Students can form groups with minimum 2 (Two) and not more than 4 (Four)

· Faculty Load : In Semester VII – ½ hour per week per project group

-In Semester VIII – 1 hour per week per project group

Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject
VII	Department Optional Course -3	CSDC7011: Machine Vision CSDC7012: Quantum Computing CSDC7013: Natural Language Processing
	Department Optional Lab -3	CSDL7011: Machine Vision Lab CSDL7012: Quantum Computing Lab CSDL7013: Natural Language Processing Lab
	Department Optional Course -4	CSDC7021 : Augmented and Virtual Reality CSDC7022 : Block Chain CSDC7023 : Information Retrieval
	Department Optional Lab -4	CSDL7021 : Augmented and Virtual Reality Lab CSDL7022 : BlockChain Lab CSDL7023 : Information Retrieval Lab
	Institute level Optional Courses-I	ILO7011. Product Lifecycle Management ILO7012. Reliability Engineering ILO7013. Management Information System ILO7014. Design of Experiments ILO7015. Operation Research ILO7016. Cyber Security and Laws ILO7017. Disaster Management & Mitigation Measures ILO7018. Energy Audit and Management ILO7019. Development Engineering

Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject
VIII	Department Optional Course -5	CSDC8011 : Deep Learning CSDC8012 : Digital Forensic CSDC8013 : Applied Data Science
	Department Optional Lab -5	CSDL8011 : Deep Learning Lab CSDL8012 : Digital Forensic Lab CSDL8013 : Applied Data Science Lab
	Department Optional Course -6	CSDC8021 : Optimization in Machine Learning CSDC8022: High Performance Computing CSDC8023: Social Media Analytics
	Department Optional Lab -6	CSDL8021 : Optimization in Machine Learning Lab CSDL8022: High Performance Computing Lab CSDL8023: Social Media Analytics Lab
	Institute level Optional Courses-II	ILO8021. Project Management ILO8022. Finance Management ILO8023. Entrepreneurship Development and Management ILO8024. Human Resource Management ILO8025. Professional Ethics and CSR ILO8026. Research Methodology ILO8027. IPR and Patenting ILO8028. Digital Business Management ILO8029. Environmental Management

Second Year

With Effect from AY 2023-2024

Program Structure for Second Year Computer Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract**	**Tut.**	**Theory**	**Pract**	**Tut.**	**Total**
CSC301	Engineering Mathematics- III	3	--	1**	3	--	1	4
CSC302	Discrete Structures & Graph Theory	3	--		3	--	--	3
CSC303	Data Structure	3	--		3	--	--	3
CSC304	Digital Logic & Computer Architecture	3	--		3	--	--	3
CSC305	Computer Graphics	3	--		3	--	--	3
CSL301	Data Structure Lab	--	2		--	1	--	1
CSL302	Digital Logic & Computer Architecture Lab	--	2		--	1	--	1
CSL303	Computer Graphics Lab	--	2		--	1	--	1
CSL304	Skill base Lab course: Object Oriented Programming with Java	--	2+2**		--	2	--	2
CSM301	Mini Project – 1 A	--	$4^{\$}$		--	2	--	2
Total		**15**	**14**	**1**	**15**	**07**	**1**	**23**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & Oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
CSC301	Engineering Mathematics III	20	20	60	2	25	--	125
CSC302	Discrete Structures & Graph Theory	20	20	60	2	--	--	100
CSC303	Data Structure	20	20	60	2	--	--	100
CSC304	Digital Logic & Computer Architecture	20	20	60	2	--	--	100
CSC305	Computer Graphics	20	20	60	2	--	--	100
CSL301	Data Structure Lab	--	--	--	--	25	25	50
CSL302	Digital Logic & Computer Architecture Lab	--	--	--	--	25	--	25
CSL303	Computer Graphics Lab	--	--	--	--	25	25	50
CSL304	Skill base Lab course:Object Oriented Programming with Java	--	--	--	--	50	25	75
CSM301	Mini Project-1 A	--	--	--	--	25	25	50
Total		**100**	**100**	**300**	--	**175**	**100**	**775**

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$ indicates workload of Learner (Not Faculty), Students can form groups with minimum 2 (Two) and not more than 4 (Four), Faculty Load: 1 hour per week per four groups

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract	Tut.	Total
CSC401	Engineering Mathematics IV	3	--	1**	3	--	1	4
CSC402	Analysis of Algorithm	3	--	--	3	--	--	3
CSC403	Database Management System	3	--	--	3	--	--	3
CSC404	Operating System	3	--	--	3	--	--	3
CSC405	Microprocessor	3	--	--	3	--	--	3
CSL401	Analysis of Algorithm Lab	--	2	--	--	1	--	1
CSL402	Database Management System Lab	--	2	--	--	1	--	1
CSL403	Operating System Lab	--	2	--	--	1	--	1
CSL404	Microprocessor Lab	--	2	--	--	1	--	1
CSL405	Skill Base Lab Course: Python Programming	--	2+2**	--	--	2	--	2
CSM401	Mini Project 1-B	--	$4^{\$}$	--	--	2	--	2
Total		**15**	**16**	**1**	**15**	**8**	**1**	**24**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam. Duration (in Hrs)			
		Mid Test (MT)	CA*					
CSC401	Engineering Mathematics IV	20	20	60	2	25	--	125
CSC402	Analysis of Algorithm	20	20	60	2	--	--	100
CSC403	Database Management System	20	20	60	2	--	--	100
CSC404	Operating System	20	20	60	2	--	--	100
CSC405	Microprocessor	20	20	60	2	--	--	100
CSL401	Analysis of Algorithm Lab	--	--	--	--	25	25	50
CSL402	Database Management System Lab	--	--	--	--	25	25	50
CSL403	Operating System Lab	--	--	--	--	25	25	50
CSL404	Microprocessor Lab	--	--	--	--	25	--	25
CSL405	Skill Base Lab Course: Python Programming	--	--	--	--	25	--	25
CSM401	Mini Project 1-B	--	--	--	--	25	25	50
Total		**100**	**100**	**300**	--	**175**	**100**	**775**

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Course Code	Course Title	Credit
CSC301	**Engineering Mathematics III**	**4**

Prerequisite: Engineering Mathematics-I, Engineering Mathematics-II	
Course Objectives:	
1	To build a strong foundation in mathematics, provide students with mathematics fundamentals necessary to formulate, solve and analyse complex engineering problems.
2	To prepare student to apply reasoning informed by the contextual knowledge to engineering practice, to work as part of teams on multi-disciplinary projects.
3	To describe the ideas of Fourier and Laplace transforms and illustrate their application in the fields of PDE, Digital Signal Processing, Image Processing, Image Processing, Theory of wave equations, Differential equations, and many others .
4	To prepare the students to use the information from Laplace transform to convert a continuous signal from the time domain to the frequency domain.
5	To prepare the students for transforming a problem with inconvenient geometry into a one with appropriate geometry by the use of Complex mapping.
Course Outcomes:	
1	**Laplace transform:** . Students will be able to apply Laplace transform and its properties to find the transform of a given function and evaluate some integrals of real value functions.
2	**Inverse Laplace transform :** Students will be capable of solving ordinary differential equations using Laplace transform as well as problems based on determining the inverse Laplace transform of specified functions.
3	**Fourier Series :** Students will be able to expand a periodic function as a Fourier series in terms of sine and cosine functions
4	**Complex Variable:** Students will be proficient to construct an analytic function, obtain a family of orthogonal trajectories.
5	**Complex Integration :** Students will be able to evaluate integration of complex variable functions using the knowledge of Cauchy integral formula, residue of singular points.
6	**Z-transform :** Students will be able to find Z-transform of sequences using Properties and Inverse Z-transform using series expansion, partial fraction

Module		Content	Hours
1		**Laplace Transform**	**7**
	1.1	Definition and Condition of Existence of Laplace transform.	
	1.2	Laplace transform of standard functions like e^at , sin(at), cos(at), sinh(at),cosh(at) and t^n , $n \geq 0$.	
	1.3	Properties of Laplace transform: Linearity, First Shifting, Second Shifting, Change of Scale, Multiplication by t, Division by t, Laplace Transform of derivative, integral and convolution of two functions.	
	1.4	Evaluation of real improper integrals using Laplace transformation.	
	1.5	Laplace transform of some special functions: Heaviside's Unit Step function,Dirac Delta function.	
2		**Inverse Laplace Transform**	**7**
	2.1	Definition and Inverse Laplace transform of standard functions.	
	2.2	Inverse Laplace transform using Partial fractions, derivatives property.	
	2.3	Inverse Laplace transform using Convolution property.	
	2.4	Applications to solve initial and boundary value problems involving Ordinary differential equations.	
3		**Fourier Series**	**7**
	3.1	Drichlet's conditions, Definition of Fourier series and Parseval's Identity.	
	3.2	Fourier series of periodic function with period 2π and 2L	
	3.3	Fourier series of even and odd functions.	
	3.4	Half range Sine and Cosine Series.	
4		**Complex Variables**	**6**
	4.1	Function of complex variable f(z), Limit, Continuity and Differentiability of f(z), Analytic function. Necessary and sufficient conditions for f(z) to be Analytic. Cauchy-Riemann equations in Cartesian coordinates.	
	4.2	Milne-Thomson method: Determine analytic function f(z) when real part (u), imaginary part (v) or its combination is given	
	4.3	Harmonic function, Harmonic conjugate and Orthogonal trajectories.	

5		**Complex Integration**	**7**
	5.1	Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions, Cauchy's Integral formula.	
	5.2	Taylor's and Laurent's series expansion.	
	5.3	Definition of Singularity, Zeroes, Poles of f(z), Residues, Cauchy's Residue Theorem.	
6		**Z-Transform**	**5**
	6.1	Definition and Region of Convergence, Transform of Standard Functions: $\{k^n a^k\}$, $\{a^{\lvert k\rvert}\}$, $\{{}^{k+n}_{\ \ n}C.\ a^k\}$, $\{c^k \sin(\alpha k+\beta)\}$, $\{c^k \sinh \alpha k\}$, $\{c^k \cosh \alpha k\}$.	
	6.2	Properties of Z-Transform: Change of Scale, Shifting Property, Multiplication, and Division by k, Convolution theorem.	
	6.3	Inverse Z-Transform: Partial Fraction Method, Convolution Method.	
		Total	**39**

Textbooks:	
1	Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2	Linear Algebra and its Applications, D. C. Lay, Pearson
3	J.L Schiff , The Laplace Transform, Springer (1999)
4	H.Dym and H.P . Mckean , Fourier series and Integrals, Academic Press , 1972.
5	S.Ponnusamy and H. Silverman , Complex Variable with applications,Birkhauser,Boston , 2006
Reference Books:	
1	J H Mathews and R W Howell, Complex Analysis for Mathematics and Engineering, Narosa.
2	Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa Publication.
3	Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited.
4	Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education.
5	M.R. Spiegal , Laplace Transforms (Schaum's Series), Mc Graw – Hill , 1965.
6	R.Radha and S. Thangavelu . Fourier Analysis , Lecture Notes,2012 https://nptel.ac.in/courses/111106046

Internal Assessment:	
Internal Assessment will consist of one Midterm test which will be conducted when approximately 50% of the syllabus is completed. The duration of the test will be one hour.	
Continuous Assessment:	
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered based on following rubrics on approval by the subject teachers. 1. Content beyond syllabus presentation (10 marks) 2. Multiple Choice Questions (Quiz) (5 marks) Two Quiz/ Presentations (10 Marks each) of one hour duration can be taken based on overall syllabus and will be conducted during a semester (Preferably before and after mid semester exam). **Term work:** Total **25 Marks** Term work will be based on overall performance in the subject. Attendance+Tutorials/Assignment/Viva/Mini Project is based on the entire syllabus. Batch wise tutorials have to be conducted.	
End Semester Theory Examination:	
1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Credits
CSC302	**Discrete Structures & Graph Theory**	**3**

Prerequisite: Basic Mathematics	
Course Objectives:	
1	Cultivate clear thinking and creative problem solving.
2	Thoroughly train in the construction and understanding of mathematical proofs. Exercise common mathematical arguments and proof strategies.
3	To apply graph theory in solving practical problems.
4	Thoroughly prepare for the mathematical aspects of other Computer Engineering courses
Course Outcomes:	
1	Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving.
2	Ability to reason logically.
3	Ability to understand relations, functions, Digraph and Lattice.
4	Ability to understand and apply concepts of graph theory in solving real world problems.
5	Understand use of groups and codes in Encoding-Decoding
6	Analyse a complex computing problem and apply principles of discrete mathematics to identify solutions

Module	Content		Hours
1	**Logic**		6
	1.1	Propositional Logic, Predicate Logic, Laws of Logic, Quantifiers, Normal Forms, Inference Theory of Predicate Calculus, Mathematical Induction.	
2	**Relations and Functions**		**6**
	2.1	Basic concepts of Set Theory	

	2.2	Relations: Definition, Types of Relations, Representation of Relations, Closures of Relations, Warshall's algorithm, Equivalence relations and Equivalence Classes	
	2.3	Functions: Definition, Types of functions, Composition of functions, Identity and Inverse function	
3	**Posets and Lattice**		**5**
	3.1	Partial Order Relations, Poset, Hasse Diagram, Chain and Anti chains, Lattice, Types of Lattice, Sub lattice	
4	**Counting**		**6**
	4.1	Basic Counting Principle-Sum Rule, Product Rule, Inclusion Exclusion Principle, Pigeonhole Principle,	
	4.2	Recurrence relations, Solving recurrence relations	
5	**Algebraic Structures and advanced topics**		**8**
	5.1	Algebraic structures with one binary operation: Semi group, Monoid, Groups, Subgroups, Abelian Group, Cyclic group, Isomorphism	
	5.2	Algebraic structures with two binary operations: Ring	
	5.3	Coding Theory: Coding, binary information and error detection, decoding and error correction ,Maximum likelihood	
6	**Graphs**		**8**
	6.1	Graphs Types of graphs, Graph Representation, Sub graphs, Operations on Graphs, Walk, Path, Circuit, Connected Graphs, Disconnected Graph, Components, Homomorphism and Isomorphism of Graphs, Euler and Hamiltonian Graphs, Planar Graph, Cut Set, Cut Vertex,	
		Total	**39**

Textbooks:	
1	Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, “Discrete Mathematical Structures”, Pearson Education.
2	C. L. Liu “Elements of Discrete Mathematics”, second edition 1985, McGraw-Hill Book Company. Reprinted 2000.
3	K. H. Rosen, “Discrete Mathematics and applications”, fifth edition 2003, Tata McGraw Hill Publishing Company
References:	
1	Y N Singh, “Discrete Mathematical Structures”, Wiley-India
2	J. L. Mott, A. Kandel, T. P. Baker, “Discrete Mathematics for Computer Scientists and Mathematicians”, Second Edition 1986, Prentice Hall of India.
3	J. P. Trembley, R. Manohar “Discrete Mathematical Structures with Applications to Computer Science”, Tata McGraw Hill Publishing Company
4	Seymour Lipschutz, Marc Lars Lipson, “Discrete Mathematics” Schaum“s Outline, McGraw Hill Education.
5	Narsing Deo, “Graph Theory with applications to engineering and computer science”, PHI Publications.
6	P. K. Bisht, H. S. Dhami, “Discrete Mathematics”, Oxford press.
7	Rajesh Maurya,Ganesh M Magar,Swati R Maurya “Discrete Structures”,Wiley Publication

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks

4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
CSC303	Data Structure	3

Prerequisite: C Programming	
Course Objectives:	
1	To understand the significance of Data structures as a computer Professional.
2	To appreciate the concept of Linear data structures - Stack & Queues along with its Applications
3	To recognize the different types of Linked Lists and identify the appropriate one to solve a specific real world problem.
4	To introduce various types of Trees and their applications in practical scenario
5	To instigate the concept of Graphs and their traversals along with applications.
6	To understand various searching techniques and appreciate the role of Collision resolution Techniques in Hashing
Course Outcomes:	
1	Appreciate the role of Data Structures in day to day life.
2	Perform various operations like searching, insertion, deletion and traversals on Linear data structures - Stack & Queues.
3	Explain the different types of Linked List and select a suitable one for the given scenario
4	Illustrate the various types of Trees and identify an appropriate Tree data structure to solve a real life situation
5	Analyse and implement Graph traversals on a given problem..
6	Perform various searching techniques and collision resolution techniques in Hashing

Module		Content	Hours
1		**Introduction to Data Structures**	**—-3**
	1.1	Introduction to Pointers and Structures in C; Single and Multidimensional arrays: Memory representation, Operations on Arrays, Introduction to time and space complexity.	
	1.2	Introduction to Data Structures - Concept of ADT; Types of Data Structures - Primitive and Non Primitive Data structures; Linear and Non Linear Data structures; Operations on Data Structures.	
2		**Stack and Queues**	**10**
	2.1	Introduction to Stack - ADT of Stack; Operations on Stack; Array Implementation of Stack; Applications of Stack: Well form-ness of Parenthesis, Infix to Postfix Conversion, Postfix Evaluation, Recursion	
	2.2	Introduction to Queue - ADT of Queue; Operations on Queue; Array Implementation of Queue; Types of Queue - Circular Queue, Priority Queue, Introduction of Double Ended Queue; Applications of Queue	
3		**Linked list**	**10**
	3.1	Introduction to Linked List - Representation of Linked List; Linked List v/s Array; Types of Linked List - Singly Linked List, Circular Linked List, Doubly Linked List; Operations on Singly Linked List and Doubly Linked List; Implementation of Stack and Queue using Singly Linked List; Singly Linked List Applications - Polynomial Representation and Addition, Multiplication	
4		**Trees**	**10**
	4.1	Introduction to Trees - Tree Terminologies; Binary Tree Representation; Properties of Binary Tree; Types of Binary Trees; Operations on Binary Tree; Applications of Binary Tree - Expression Tree, Huffman Encoding.Binary Search Tree - Operations on BST. Search Trees - AVL Tree, Rotations in AVL Tree, Operations on AVL Tree; Introduction of B Tree, B+ Tree.	
5		**Graphs**	**4**
	5.1	Introduction to Graph - Graph Terminologies; Representation of Graph; Graph Traversals - Depth First Search (DFS) and Breadth First Search (BFS); Graph Application - Topological Sorting, Graph Colouring	
6		**Searching Techniques**	**2**
	6.1	Searching - Linear Search, Binary Search Introduction to Hashing, Hash Functions, Collision Resolution Techniques	
		Total	**39**

Textbooks:	
1	Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, “Data Structures Using C”, Pearson Publication.
2	Reema Thareja, “Data Structures using C”, Oxford Press.
3	Richard F. Gilberg and Behrouz A. Forouzan, “Data Structures: A Pseudocode Approach with C”, 2ndEdition, CENGAGE Learning.
4	Jean Paul Tremblay, P. G. Sorenson, “Introduction to Data Structure and Its Applications”, McGraw-Hill Higher Education
5	Data Structures Using C, ISRD Group, 2ndEdition, Tata McGraw-Hill.
6	Classic Data Structures, D. Samanta, Prentice Hall India Pvt., Limited, 2004
Reference Books:	
1	Prof. P. S. Deshpande, Prof. O. G. Kakde, “C and Data Structures”, DreamTech press.
2	E. Balagurusamy, “Data Structure Using C”, Tata McGraw-Hill Education India.
3	Rajesh K Shukla, “Data Structures using C and C++”, Wiley-India
4	GAV PAI, “Data Structures”, Schaum’s Outlines.
5	Robert Kruse, C. L. Tondo, Bruce Leung, “Data Structures and Program Design in C”, Pearson Edition

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks

4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
CSC304	**Digital Logic & Computer Architecture**	**3**

Prerequisite: Knowledge on number systems	
Course Objectives:	
1	To have a rough understanding of the basic structure and operation of basic digital circuits and a digital computer.
2	To discuss in detail arithmetic operations in digital systems.
3	To discuss generation of control signals and different ways of communication with I/O devices.
4	To study the hierarchical memory and principles of advanced computing.
Course Outcomes:	
1	To learn different number systems and basic structure of computer systems.
2	To demonstrate the arithmetic algorithms
3	To understand the basic concepts of digital components and processor organization.
4	To understand the concept of control unit design
5	To demonstrate the memory organization.
6	To describe the concepts of parallel processing.

Module		Content	Hours
1		**Computer Fundamentals**	**5**
	1.1	Introduction to Number System and Codes	
	1.2	Number Systems: Binary, Octal, Decimal, Hexadecimal,	
	1.3	Codes: Grey, BCD, Excess-3, ASCII, Boolean Algebra	
	1.4	Logic Gates: AND,OR,NOT,NAND,NOR,EX-OR	
2		**Data Representation and Arithmetic algorithms**	

	2.1	Binary Arithmetic: Addition, Subtraction, Multiplication, Division using Sign Magnitude, 1's and 2's complement, BCD and Hex Arithmetic Operation.	**8**
	2.2	Booth's Multiplication Algorithm, Restoring and Non-restoring Division Algorithms.	
	2.3	IEEE-754 Floating point Representation.	
3		**Processor Organization and Architecture**	**6**
	3.1	Introduction: Half adder, Full adder, MUX, DMUX, Encoder, Decoder(IC level).	
	3.2	Introduction to Flip Flop: SR, JK, D, T (Truth table).	
	3.3	Overview of computer organization and architecture.	
	3.4	Basic Organization of Computer and Block Level functional Units, Von- Neumann Model.	
4		**Control Unit Design**	**6**
	4.1	Hardwired Control Unit: State Table Method, Delay Element Methods	
	4.2	Microprogrammed Control Unit: Micro Instruction-Format, Sequencing and execution, Micro operations, Examples of microprograms.	
5		**Memory Organization**	**6**
	5.1	Introduction and characteristics of memory, Types of RAM and ROM, Memory Hierarchy, 2-level Memory Characteristic,	
	5.2	Cache Memory: Concept, locality of reference, Design problems based on mapping techniques, Cache coherence and write policies. Interleaved and Associative Memory.	
6		**Principles of Advanced Processor**	**8**
	6.1	Introduction to parallel processing concepts,pipeline processing, instruction pipelining, pipeline stages, pipeline hazards.Basic Pipelined Data path and control, data dependencies, data hazards, branch hazards, delayed branch, and branch prediction, Performance measures-CPI, Speedup, Efficiency, throughput	
	6.2	Flynn's Classification, Introduction to multicore architecture.	
		Total	**39**

Textbooks:	
1	R. P. Jain, “Modern Digital Electronic”, McGraw-Hill Publication, 4^{th}Edition.
2	William Stalling, “Computer Organization and Architecture: Designing and Performance”, Pearson Publication 10^{TH} Edition.
3	John P Hayes, “Computer Architecture and Organization”, McGraw-Hill Publication, 3^{RD}Edition.
4	Dr. M. Usha and T. S. Shrikanth, “Computer system Architecture and Organization”, Wiley publication
Reference Books:	
1	Andrew S. Tanenbaum, “Structured Computer Organization”, Pearson Publication.
2	B.Govindarajalu, “Computer Architecture and Organization”, McGraw-Hill Publication.
3	Malvino, “Digital computer Electronics”, McGraw-Hill Publication, 3^{rd}Edition.
4	Smruti Ranjan Sarangi, “Computer Organization and Architecture”,McGraw-Hill Publication.

Internal Assessment:		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment:		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.		
Sr. No	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks

6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code:	Course Title	Credit
CSC305	**Computer Graphics**	3

Prerequisite: Knowledge of C Programming and Basic Mathematics**.**	
Course Objectives:	
1	To equip students with the fundamental knowledge and basic technical competence in the field of Computer Graphics.
2	To emphasise on the implementation aspect of Computer Graphics Algorithms
3	To prepare the student for advance areas and professional avenues in the field of Computer Graphics
4	To comprehend and analyse the fundamentals of augmented reality, virtual reality, underlying technologies, principles, and applications.
Course Outcomes:	
1	Describe the basic concepts of Computer Graphics
2	Demonstrate various algorithms for basic graphics primitives and curve representation techniques.
3	Apply 2D and 3D geometric transformations on graphical objects.
4	Use various clipping algorithms on graphical objects and explore 3D projections methods.
5	Explain visible surface detection techniques and Animation.
6	To design an application with the principles of virtual reality and augmented reality

Module		Content	Hours
1		**Introduction and Overview of Graphics System:**	3
	1.1	Definition and Representative uses of computer graphics, Overview of coordinate system, Definition of scan conversion, rasterization and rendering.	
	1.2	Raster scan & random scan displays, Architecture of raster graphics system with display processor, Architecture of random scan systems	
2		**Output Primitives**	10
	2.1	Scan conversions of point, line and circle: DDA algorithm and Bresenham algorithm for line drawing, midpoint algorithm for circle, (Mathematical derivation for above algorithms is expected) Curves Generation: Bezier Curve, B-Spline Curve, Fractal-Geometry: Fractal Dimension, Koch Curve.	
	2.2	Aliasing, Antialiasing techniques like Pre and post filtering, super sampling, and pixel phasing).	
	2.3	Filled Area Primitive: Inside outside tests, Boundary Fill and Flood fill algorithm, Scan line Polygon Fill algorithm.	
3		**Two Dimensional and 3D Geometric Transformations**	8
	3.1	Basic transformations: 2D Transformations: Translation, Scaling, Rotation, Reflection and Shear, Composite Transformations,3D Transformations: Translation, Scaling, Rotation, Composite Transformations , Rotation about an arbitrary axis (3D)	
	3.2	Matrix representation and Homogeneous Coordinates (2D and 3D)	
4		**Two-Dimensional Viewing and Clipping**	8
	4.1	Viewing transformation pipeline and Window to Viewport coordinate transformation.	
	4.2	Projections – Parallel, Perspective. (Matrix Representation)	
	4.3	Clipping operations: Point clipping, Line clipping algorithms: Cohen-Sutherland, Liang: Barsky, Polygon Clipping Algorithms: Sutherland-Hodgeman, Weiler-Atherton, Text Clipping.	
5		**Visible Surface Detection and Animation:**	5
	5.1	Visible Surface Detection: Classification of Visible Surface Detection algorithm, Depth Buffer method,Area Subdivision method	

	5.2	**Animation:** Introduction to Animation, Principles of Animation, Key framing: Character and Facial Animation	
6		**Augmented reality and Virtual Reality:**	**5**
	6.1	Virtual Reality: Basic Concepts, Overview and perspective on virtual reality, Human sensation and perception. Classical Components of VR System, Types of VR Systems.	
	6.2	Technology and features of augmented reality, Difference between AR and VR, Challenges with AR, Augmented reality methods, visualisation techniques for augmented reality	
		Total	**39**

Textbooks:	
1	Hearn & Baker,"Computer Graphics C version", 2nd Edition, Pearson Publication
2	James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, "Computer Graphics Principles and Practice in C", 2ndEdition, Pearson Publication
3	Samit Bhattacharya,"Computer Graphics",Oxford Publication
4	R. K Maurya, "Computer Graphics with Virtual Reality", Wiley India.
Reference Books:	
1	D. Rogers, "Procedural Elements for Computer Graphics", Tata McGraw-Hill Publications.
2	Zhigang Xiang, Roy Plastock, "Computer Graphics", Schaum‟s Outlines McGraw-Hill Education
3	Rajesh K. Maurya,"Computer Graphics",Wiley India Publication.
4	F.S.Hill, "Computer Graphics using OpenGL", Third edition, Pearson Publications.
5	Grigore Burdea, Philippe Coiffet, "Virtual Reality Technology", Wiley
6	Vince, "Virtual Reality Systems", Pearson Education.

Internal Assessment:		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment:		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.		
Sr. No	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	

2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Lab Code	Lab Name	Credit
CSL301	Data Structures Lab	1

Prerequisite: C Programming Language.	
Lab Objectives:	
1	To implement basic data structures such as arrays, linked lists, stacks and queues
2	Solve problem involving graphs, and trees
3	To develop application using data structure algorithms
4	Compute the complexity of various algorithms.
Lab Outcomes:	
1	Students will be able to implement linear data structures & be able to handle operations like insertion, deletion, searching and traversing on them.
2	Students will be able to implement nonlinear data structures & be able to handle operations like insertion, deletion, searching and traversing on them
3	Students will be able to choose appropriate data structure and apply it in various problems
4	Students will be able to select appropriate searching techniques for given problems.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Implement Stack ADT using array.
2	Convert an Infix expression to Postfix expression using stack ADT.
3	Evaluate Postfix Expression using Stack ADT.
4	Applications of Stack ADT.
5	Implement Linear Queue ADT using array.
6	Implement Circular Queue ADT using array.
7	Implement Priority Queue ADT using array.
8	Implement Singly Linked List ADT.
9	Implement Circular Linked List ADT.

10	Implement Doubly Linked List ADT.
11	Implement Stack / Linear Queue ADT using Linked List.
12	Implement Binary Search Tree ADT using Linked List.
13	Implement Graph Traversal techniques: a) Depth First Search b) Breadth First Search
14	Applications of Binary Search Technique.
15	Implementation of Topological sort.
16	Implementation of hashing functions with different collision resolution techniques
17	Implement Huffman Encoding

Useful Links:	
1	www.leetcode.com
2	www.hackerrank.com
3	www.cs.usfca.edu/~galles/visualization/Algorithms.html
4	www.codechef.com

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Practical & Oral exam	
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSL301and CSC303

Lab Code	Lab Name	Credit
CSL302	**Digital Logic & Computer Architecture Lab**	**1**

Prerequisite: C Programming Language.	
Lab Objectives:	
1	To implement operations of the arithmetic unit using algorithms.
2	Design and simulate different digital circuits.
3	To design memory subsystem including cache memory.
4	To demonstrate CPU and ALU design.
Lab Outcomes:	
1	To understand the basics of digital components
2	Design the basic building blocks of a computer: ALU, registers, CPU and memory
3	To recognize the importance of digital systems in computer architecture
4	To implement various algorithms for arithmetic operations.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	To verify the truth table of various logic gates using ICs.
2	To realise the gates using universal gates
3	Code conversion.
4	To realise half adder and full adder.
5	To implement logic operation using MUX IC.
6	To implement logic operation using DEMUX IC.
7	To implement logic operation decoder IC.
8	Study of flip flop IC.
9	To implement carry look ahead adder.
10	To implement Booth's algorithm.

11	To implement restoring division algorithm.
12	To implement non restoring division algorithm.
13	To implement ALU design.
14	Study of CPU.

Useful Links:	
1	Link http://cse10-iitkgp.virtual-labs.ac.in

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSL302and CSC304

Lab Code	Lab Name	Credit
CSL303	**Computer Graphics Lab**	**1**

Prerequisite: C Programming Language.	
Lab Objectives:	
1	Understand the need of developing graphics application
2	Learn algorithmic development of graphics primitives like: line, circle, polygon etc.
3	Learn the representation and transformation of graphical images and pictures
Lab Outcomes:	
1	Implement various output and filled area primitive algorithms
2	Apply transformation, projection and clipping algorithms on graphical objects.
3	Perform curve and fractal generation methods.
4	Develop a Graphical application/Animation based on learned concept
5.	Explore Virtual Reality Concepts.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Implement DDA Line Drawing algorithm (dotted/dashed/thick)
2	Implement Bresenham's Line algorithm(dotted/dashed/thick)
3	Implement midpoint Circle algorithm.
4	Implement Area Filling Algorithm: Boundary Fill, Flood Fill.
5	Implement Scan line Polygon Filling algorithm.
6	Implement Curve: Bezier for n control points, B Spline (Uniform)(at least one)
7	Implement Fractal generation method (anyone)
8	Character Generation: Bit Map method and Stroke Method

9	Implement 2D Transformations: Translation, Scaling, Rotation, Reflection, Shear.
10	Implement Line Clipping Algorithm: Cohen Sutherland / Liang Barsky.
11	Implement polygon clipping algorithm (at least one)
12	Program to perform 3D transformation.
13	Program to perform projection of a 3D object on Projection Plane: Parallel and Perspective.
14	Program to perform Animation (such as Rising Sun, Moving Vehicle, Smileys, Screen saver etc.)
15	Case Study: Virtual reality and sample program on VRML

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Practical & Oral exam	
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSL303and CSC305

Lab Code	Lab Name	Credit
CSL304	**Skill base Lab course:Object Oriented Programming with Java**	**2**

Prerequisite: C Programming Language.	
Lab Objectives:	
1	To learn the basic concepts of object-oriented programming
2	To study JAVA programming language
3	To study various concepts of JAVA programming like multithreading, exception Handling, packages, etc.
4	To explain components of GUI based programming.
Lab Outcomes:	
1	To apply fundamental programming constructs.
2	To illustrate the concept of class, object, packages, array, string and vector.
3	To implement the concept of inheritance and interfaces.
4	To implement the concept of exception handling and multithreading.
5	To develop GUI based application.
6	To illustrate the concept of MVC architecture,framework and design patterns

Module		Content	Hours
1		**Introduction to Object Oriented Programming**	**2**
	1.1	OOP concepts: Objects, class, Encapsulation, Abstraction, Inheritance,Polymorphism, message passing.	
	1.2	Java Virtual Machine	
	1.3	Basic programming constructs: variables, data types, operators, unsigned right shift operator, expressions, branching and looping.	
2		**Class, Object, Packages and Input/output**	**6**
	2.1	Class, object, data members, member functions, Constructors, types, static members and functions, Packages	

		in java, types, user defined packages, Input and output functions in Java	
	2.2	Array, Strings, String Buffer, Vectors	
3		**Inheritance and Interface**	**4**
	3.1	Types of inheritance, Method overriding, super, abstract class and abstract method, final, Multiple inheritance using interface, extends keyword	
4		**Exception handling and Multithreading**	**6**
	4.1	Exception handling using try, catch, finally, throw and throws, Multiple try and catch blocks, user defined exception Thread lifecycle, thread class methods, creating threads using extends and implements key word.	
5		**GUI programming in JAVA**	**4**
	5.1	AWT: working with windows, using AWT controls for GUI design	
	5.2	Swing class in JAVA	
	5.3	Introduction to JavaFX- Animation,Button,Canvas,Chart	
6		**MVC Architecture**	**4**
	6.1	Introduction to MVC architecture:Model Component,View Component,Controller Component MVC	
	6.2	Design Patterns in MVC:Observer pattern,Strategy pattern,Factory pattern ,Composite pattern	
		Total	**26**

Textbooks:	
1	Herbert Schildt, ‘JAVA: The Complete Reference’, Ninth Edition, Oracle Press.
2	E. Balagurusamy, ‘Programming with Java’, McGraw Hill Education.
Reference Books:	
1	Ivor Horton, “Beginning JAVA‟, Wiley India.
2	Dietal and Dietal, “Java: How to Program‟, 8th Edition, PHI .
3	JAVA Programming‟, Black Book, Dreamtech Press.
4	Learn to Master Java programming‟, Staredu solutions

Note : All the experiments below will be based on a case study. The case study will consist of CRUD operations to be performed on the entities involved in the scenario	
Suggested Experiments: Students are required to complete at least 12 experiments.	
Sr. No.	**Name of the Experiment**
1	**Implementing Many-to-Many Relationships using Classes and Objects** Description: This experiment aims to explore the implementation of a many-to-many relationship in Java using classes and objects. The objective is to create a robust and efficient solution to handle complex relationships between entities by designing an elegant and scalable system.
2	**Interactive Object Creation: Empowering Users to Generate Objects through Java Input** Description: The goal of this experiment is to empower users to generate objects interactively through Java input. The objective is to create the procedure to accept user inputs via different methods for the respective case study
2	**Implementing polymorphism using Method and Constructor for String Manipulation in Java** Description: The objective of this experiment is to demonstrate the concept of polymorphism in Java by implementing methods and constructors for string manipulation. The goal is to show how different methods with the same name but different parameter lists can be used to manipulate strings in various ways, and how constructors can be used to create objects with different initializations.
3	**Implementing Inheritance and Interfaces for the entities involved in the relationship of the case study.** Description: The objective of this experiment is to understand and compare the concepts of

	inheritance and interfaces in Java and their practical implementations. Also to know how the subclasses can override the methods inherited from the base class to provide their own implementation.
4	**Implementation of Abstract Class and Abstract Method for the entities of the relationship** Description: This experiment aims to understand the concepts of abstract classes and abstract methods in Java and their practical implementations. The experiment involves creating an abstract class and defining abstract methods within it. Object is to demonstrate how abstract classes and methods can be utilized to achieve code reusability and polymorphism for your chosen case study.
5	**Implementing Model Class in MVC Framework with JSON File Handling in Java to implement Create, Update and Delete data objects.** Description: Objective: The objective of this experiment is to implement the Model component of the MVC (Model-View-Controller) framework in Java, using JSON as the data format. This experiment will focus on handling JSON files, deserializing them into Java objects, and updating the Model accordingly.
6	**Implementing View Class & Model Class in MVC Framework with JSON File Handling in Java to view data objects.** Description : The experiment aims to implement the View and Model classes in the Model-View-Controller (MVC) framework using Java programming language. The primary focus of this experiment is to enable the viewing of data objects stored in a JSON file.
7	**Implementing View Class & Model Class in MVC Framework with 2D Array to handle the relationship between the entities of the case study.** Description : The objective of this experiment is to implement MVC and use 2D array to handle relationships between entities in a case study. The goal is to analyze how the MVC framework facilitates separation of concerns and how the 2D array enhances the representation and manipulation of entity relationships.
8	**Implement Exception Handling for your chosen case study with User Defined Exception** Description : The experiment aims to implement exception handling with user-defined exceptions in Java to handle exceptional situations effectively. The experiment involves creating custom exception classes, throwing and catching exceptions, and demonstrating the usage of try-catch blocks.
9	**Developing a Controller Class in Java for your chosen case study using MVC Architecture** Description : The objective of this experiment is to implement the Controller class in Java within the context of the Model-View-Controller (MVC) architectural pattern for your chosen case study. The goal is to demonstrate how the Controller mediates between the Model and View, handling user input, updating the Model, and reflecting changes in the View.
10	**Implementing View Class in Java using Swing and AWT for your chosen case study**

	using MVC Architecture Description : The objective of this experiment is to develop a View class in Java using Swing and AWT within the context of the Model-View-Controller (MVC) architectural pattern for your chosen case study. The goal is to demonstrate how the View class interacts with the Model and Controller to display and update student-related information in the user interface.
11	**Implementing Action Listeners for View Class in Java for your chosen case study using MVC Architecture** Description : The objective of this experiment is to implement Action Listeners for the View class in Java within the context of the Model-View-Controller (MVC) architectural pattern for your chosen case study. The goal is to demonstrate how the View class interacts with the Controller through Action Listeners to handle user actions and update the Model accordingly.
12	**Implementing Multi-Threading in Java for a File Processing Task needed to read data in the model** Description : The objective of this experiment is to implement multithreading in Java to enhance the file processing performance for a case study. The goal is to demonstrate how multi-threading can effectively distribute the workload among multiple threads and improve the overall processing speed.

Useful Links	
1	www.nptelvideos.in
2	www.w3schools.com
3	www.tutorialspoint.com
4	https://starcertification.org/Certifications/Certificate/securejava

Term Work:	
1	Term work should consist of 12 experiments.
2	Journal must include at least 2 assignments
3	Mini Project based on the content of the syllabus (Group of 2 students)
4	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
5	Continuous Assessment: 50-Marks - Experiments: 15-marks - Attendance: 05-marks - Assignments: 05-marks - Mini Project: 20-marks

	- MCQ as a part of lab assignments: 5-marks)
Practical & Oral exam	
Based on the entire syllabus of CSL304: **Skill base Lab course:Object Oriented Programming with Java**	

Course code	Course Name	Credits
CSM301	**Mini Project 1A**	**02**

Objectives	
1	To acquaint with the process of identifying the problem domain.
2	To identify and analyze real world problems by conducting appropriate literature survey.
3	To familiarize the basic engineering fundamentals for solving the problem.
4	To develop a feasible solution using systematic approach
5	To develop team building among the group members.
6	To inculcate the process of self-learning and research.
Outcome: Learner will be able to…	
1	Identify problem statements based on societal /research needs.
	Conduct a literature survey in the preferred field of study.
2	Apply knowledge gained to solve societal problems in a group.
3	Determine the inference model and analyze the impact of the solution in societal and environmental context.
4	Use standard norms of engineering practices.
5	To present the findings of the study in well documented format.
6	Identify problem statements based on societal /research needs.
Guidelines for Mini Project	
1	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
2	Students should identify needs, perform literature survey for the respective problem statement for the problem statements for mini projects in consultation with project guide / head of department / internal committee of faculties.
3	Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
4	A logbook to be prepared by each group, wherein the group can record weekly work progress, the guide/supervisor can verify and record notes/comments.
5	Students in a group shall understand problems effectively, propose multiple solutions and select the best possible solution in consultation with the guide/ supervisor.
6	Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.

Objectives	
1	To acquaint with the process of identifying the problem domain.
2	To identify and analyze real world problems by conducting appropriate literature survey.
3	To familiarize the basic engineering fundamentals for solving the problem.
4	To develop a feasible solution using systematic approach
5	To develop team building among the group members.
6	To inculcate the process of self-learning and research.
Outcome: Learner will be able to…	
1	Identify problem statements based on societal /research needs.
	Conduct a literature survey in the preferred field of study.
2	Apply knowledge gained to solve societal problems in a group.
3	Determine the inference model and analyze the impact of the solution in societal and environmental context.
4	Use standard norms of engineering practices.
7	The solution to be validated with proper justification and report to be compiled in standard format of the college.
8	With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
9	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project ideas in even semester. This policy can be adopted on a case by case basis.

Term Work	
The review/ progress monitoring committee shall be constituted by the senior faculty members. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.	
Continuous Assessment:	
In continuous assessment focus shall also be on each individual student, log book maintained and weekly meeting based on the same.	
Distribution of Term work / Continuous assessment marks for both semesters shall be as below:	**Marks**

1	Marks awarded by guide/supervisor based on logbook	10
2	Marks awarded by review committee	10
3	Quality of Project report	05

Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines

One-year project

1	In the first semester the entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on the presentation given by the student group. 1. First shall be for finalisation of problem 2. Second shall be on finalisation of the proposed solution of the problem.
2	In the second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. 1. First review is based on readiness of building working prototypes to be conducted. 2. Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

1	In this case in one semester students' group shall complete project in all aspects including, 1. Identification of need/problem 2. Proposed final solution 3. Procurement of components/systems 4. Building prototype and testing
2	Continuous assessment will be weekly based on a logbook. Two presentations will be conducted for review before a panel. 1. First shall be for finalization of the problem and proposed solution. 2. Second shall be for implementation and testing of solutions.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1	Quality of survey/ need identification
2	Clarity of Problem definition based on need.
3	Innovativeness in solutions
4	Feasibility of proposed problem solutions and selection of best solution
5	Cost effectiveness
6	Societal impact

7	Innovativeness
8	Cost effectiveness and Societal impact
9	Effective use of skill sets
10	Effective use of standard engineering norms
11	Contribution of an individual's as member or leader
12	Clarity in written and oral communication
13	Full functioning of working model as per stated requirements
14	Project report
	In one year, project, first semester evaluation may be based on first six criteria and remaining may be used for second semester evaluation of performance of students in mini projects.
	In case of half year project all criterias in generic may be considered for evaluation of performance of students in a mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:	
1	Report should be prepared as per the guidelines issued by the College.
2	Mini Project shall be assessed through a presentation and demonstration of a working model by the student project group to a panel of Examiners. Each team will prepare a report that will summarize the results of the literature survey and the project proposal. The list of papers surveyed must be clearly documented.
3	Students shall be motivated to publish a paper based on the work in Conferences/students competitions.
4	Oral exams will be conducted on the project done by the students.
Mini Project shall be assessed based on following points;	
1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact
4	Full functioning of working model as per stated requirements
5	Effective use of skill sets
6	Effective use of standard engineering norms
7	Contribution of an individual's as member or leader
8	Clarity in written and oral communication

Assessment: Total Marks = Term work +Oral = (25+25)
Term Work for 25 Marks:

Term work will be based on assessment of Project Implementation and a Logbook which is filled by students on a weekly basis as per their weekly progress.

Oral Exam for 25 Marks: Based on Project Implementation and Presentation.

Course Code	Course Title	Credit
CSC401	Engineering Mathematics IV	4

Prerequisite: Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III	
Course Objectives:	
1	To build a strong foundation in mathematics, provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.and make aware the students about the applications of various forms of Linear Programming.
2	To prepare student to apply reasoning informed by the contextual knowledge to engineering practice, to work as part of teams on multi-disciplinary projects.
3	To acknowledge the importance of sampling design and analysis methods for research and management in many other fields
4	To get familiar with the mathematical formulation of a real world problem, acquaint with the problem solving techniques theoretically, tackle several parameters into account while dealing with the problem and make aware the students about the applications of various forms of Linear Programming.
5	To prepare students to apply linear algebra concepts to model, solve and analyse real-world situations.
6	To prepare students to apply the concept of eigenvalues and Eigen vector which will further be useful in applications like Google page rank algorithms, principal component analysis (biometric systems), and natural frequency for a structure.
7	To prepare the students to use a powerful statistical software platform SPSS (Statistical Package for the Social Sciences) for the analysis of statistical data in the future.
Course Outcomes:	
1	**Probability theory:** Students will understand various probability measures, distribution functions, and their characteristics. They will be able to Compute probability using probability distribution of discrete and continuous Random variable.Additionally,the knowledge regarding Bayes theorem will help them take various real-life problems that arise in the medical fields and industries
2	**Probability Distribution and Sampling Theory** : Students will know fundamental concepts of testing of hypothesis, formulation of statistical hypothesis in real-life situations, developing best test procedures to test the hypothesis, and the principles underlying sampling as a means of making inferences about a population. They can also apply the idea of probability distribution to engineering problems
3	**Statistical Techniques:** Students will apply the concept of Correlation and Regression, fitting of curve to the given data sets.

4	**Eigenvalues and Eigenvectors**: Students will be able to execute matrix diagonalization and perform basic eigenvalue and eigenvector computations.
5	**Linear Programming Problems:** Students should be able to formulate a given simplified description of a suitable real-world problem as a linear programming model in general, standard and canonical forms.linear programming models can be solved by them using the simplex method , Big M method and Dual simplex method.
6	**Non Linear Programming Problems:** Students will be able to solve Non Linear Optimization problems using Lagrange's multiplier method and Karush Kuhn Tucker Method.

Module		Content	Hours
1		**Probability**	**8**
	1.1	Definition and basics of probability, conditional probability. Total Probability theorem and Bayes' theorem.	
	1.2	Discrete and continuous random variable with probability distribution and probability density function.	
	1.3	Expectation, Variance, Moment generating function, Raw and central Moments, Covariance, Skewness and Kurtosis of distribution and their properties.	
	1.4	Probability Distribution: Binomial, Poisson and Normal distribution.	
2		**Probability Distribution and Sampling Theory**	**7**
	2.1	Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Test of significance of mean and difference between the means of two samples for Large samples.	
	2.2	Degree of freedom, Student's t-distribution, Test of significance of mean and difference between the means of two samples for Small samples. .	
	2.3	Chi-Square Test: Test of goodness of fit. Contingency table and Test of independence of attributes..	
3		**Statistical Techniques**	**5**
	3.1	Karl Pearson's coefficient of correlation ®.	
	3.2	Spearman's Rank correlation coefficient (R) (with repeated and non-repeated ranks).	
	3.3	Fitting of first and second degree curves	
	3.4	Lines of regression	

4		**Linear Algebra (Theory of Matrices)**	**7**
	4.1	Characteristic Equation, Eigen values and Eigen vectors, and properties.	
	4.2	Cayley-Hamilton Theorem ,verification and reduction of higher degree polynomials.	
	4.3	Similarity of matrices, diagonalizable and non-diagonalizable matrices.	
5		**Linear Programming Problems**	**6**
	5.1	Types of solutions, Standard and Canonical of LPP, Basic and Feasible solutions, slack variables, surplus variables, Simplex method.	
	5.2	Artificial variables, Big-M method (Method of penalty)	
	5.3	Duality, Dual of LPP and Dual Simplex Method.	
6		**Nonlinear Programming Problems**	**6**
	6.1	NLPP with no constraint, one equality constraint (two or three variables) using the method of Lagrange's multipliers.	
	6.2	NLPP with two equality constraints.	
	6.3	NLPP with inequality constraint: Karush-Kuhn-Tucker (KKT) conditions.	
		Total	**39**

Textbooks:	
1	Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa.
2	Gupta and Kapoor, Fundamental of Mathematical Statistics, S Chand
3	Operations Research, Hira and Gupta, S. Chand Publication.
4	E.K.P. Chong, and S.H. Zak: An Introduction to Optimization , 3rd Edn, Wiley Interscience 2008
5.	Linear Algebra and its Applications, D. C. Lay, Pearson.
Reference Books:	
1	Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons.
2	.Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill Education.
3	Operations Research: An Introduction, Hamdy A Taha, Pearson..
4	D.G. Luenberger , Linear and NonLinear Programming, 2nd Edn, Kluwer,2003.
5	5 Draper ,N.R., and Smith, H .(2003) , Applied Regression Analysis,New York Wiley
6	Feller , William. An Introduction to Probability Theory and its Applications. Vol. I and II . New York,NY: Wiley ,1968-1971

Internal Assessment:	
Internal Assessment will consist of one Midterm test which will be conducted when approximately 50% of the syllabus is completed. The duration of the test will be one hour .	
Continuous Assessment:	
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered based on following rubrics on approval by the subject teachers. 1. Content beyond syllabus presentation (10 marks) 2. Multiple Choice Questions (Quiz) (5 marks) Two Quiz/ Presentations (10 Marks each) of one hour duration can be taken based on overall syllabus and will be conducted during a semester (Preferably before and after mid semester exam). **Term work:** Total **25 Marks** Term work will be based on overall performance in the subject. Attendance+Tutorials/Assignment/Viva/Mini Project is based on the entire syllabus. Batch wise tutorials have to be conducted**.**	
End Semester Theory Examination:	
1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5.	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Title	Credit
CSC402	**Analysis of Algorithms**	**3**

Prerequisite: Data structure concepts, Discrete structures	
Course Objectives:	
1	To provide mathematical approaches for Analysis of Algorithms
2	To understand and solve problems using various algorithmic approaches
3	To analyze algorithms using various methods
Course Outcomes:	
1	Analyze the running time and space complexity of algorithms.
2	Describe, apply and analyze the complexity of divide and conquer strategy.
3	Describe, apply and analyze the complexity of greedy strategy.
4	Describe, apply and analyze the complexity of dynamic programming strategy.
5	Explain and apply backtracking, branch and bound.
6	Explain and apply string matching techniques.

Module		Content	Hours
1		**Introduction to Analysis of Algorithms**	**10**
	1.1	Performance analysis, space, and time complexity Growth of function, Big-Oh, Omega Theta notation Mathematical background for algorithm analysis. Analysis of selection sort, insertion sort.	
	1.2	Recurrences: The substitution method, Recursion tree method, Master method	
	1.3	Divide and Conquer Approach: General method, Merge sort, Quick sort, Analysis of Binary search	
2		**Greedy Method Approach**	**6**
	2.1	General Method, Single source shortest path: Dijkstra Algorithm Fractional Knapsack problem, Job sequencing with deadlines, Minimum cost spanning trees: Kruskal and Prim's algorithms	

3		**Dynamic Programming Approach**	**9**
	3.1	General Method, Multistage graphs, Single source shortest path: Bellman Ford Algorithm All pair shortest path: Floyd Warshall Algorithm, Assembly-line scheduling Problem, 0/1 knapsack Problem, Travelling Salesperson problem, Longest common subsequence	
4		**Backtracking and Branch and bound**	**6**
	4.1	General Method, Backtracking: N-queen problem, Sum of subsets, Graph colouring	
	4.2	Branch and Bound: 15 Puzzle problem, 0/1 knapsack problem- LC Branch and Bound solution, FIFO Branch and Bound solution.	
5		**String Matching Algorithms**	**4**
	5.1	The Naïve string-matching algorithm, The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm	
6		**Non-deterministic Polynomial Algorithms**	**4**
	6.1	Complexity class: Definition of P, NP, NP-Hard, NP-Complete	
		Total	**39**

Textbooks:	
1	T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005.
2	Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.
Reference Books:	
1	Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw Hill Edition.
2	S. K. Basu, "Design Methods and Analysis of Algorithm", PHI.
3	J. Kleinberg and E. Tardos, Algorithm Design, Pearson International Edition, 2005.

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.		
Sr. No	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	

5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Title	Credit
CSC403	Database Management System	3

Prerequisite: Data Structures	
Course Objectives:	
1	Develop entity relationship data model and its mapping to relational model
2	Learn relational algebra and Formulate SQL queries
3	Apply normalization techniques to normalize the database
4	Understand the concept of transaction, concurrency control and recovery techniques.
Course Outcomes:	
1	Recognize the need of database management system
2	Design ER and EER diagram for real life applications
3	Construct relational model and write relational algebra queries.
4	Formulate SQL queries
5	Apply the concept of normalization to relational database design.
6	Describe the concept of transaction, concurrency and recovery.

Module		Contents	Hours
1		**Introduction Database Concepts**	**3**
	1.1	Introduction, Characteristics of databases, File system v/s Database system, Data abstraction and data Independence, DBMS system architecture, Database Administrator	
2		**Entity–Relationship Data Model**	**6**
	2.1	The Entity-Relationship (ER) Model: Entity types: Weak and strong entity sets, Entity sets, Types of Attributes, Keys, Relationship constraints: Cardinality and Participation, Extended Entity-Relationship (EER) Model: Generalization, Specialization and Aggregation	

3		**Relational Model and relational Algebra**	**8**
	3.1	**Relational Model**: Relational schema and concept of keys. Mapping the ER and EER Model to the Relational Model **Relational Algebra**: Unary and Binary operators, Relational Algebra Queries.	
4		**Structured Query Language (SQL)**	**10**
	4.1	**Overview of SQL**: Data Definition Commands, Integrity constraints: key constraints, Domain Constraints, Referential integrity , check constraints, Data Manipulation commands, Data Control commands, Set and string operations, aggregate function-group by, having, Views in SQL, joins, Nested and complex queries, Triggers.	
5		**Relational-Database Design**	**6**
	5.1	**Relational-Database Design:** Pitfalls in Relational-Database designs, Concept of normalisation Function Dependencies:Attribute Closure and applications Decomposition: Lossy and Lossless Decomposition Normal Forms: First Normal Form, 2NF, 3NF, BCNF.	
6		**Transactions Management and Concurrency and Recovery**	**6**
	6.1	Transaction concept, Transaction states, ACID properties, Transaction Control Commands, Concurrent Executions, Serializability-Conflict and View, Concurrency Control: Lock-based, Timestamp-based protocols, Recovery System: Log based recovery	
		Total	**39**

Textbooks:	
1	Korth, Slberchatz, Sudarshan, Database System Concepts, 6thEdition, McGraw Hill
2	Elmasri and Navathe, Fundamentals of Database Systems, 5thEdition, Pearson Education
3	Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH
Reference Books:	
1	Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management‖, Thomson Learning, 5thEdition.
2	Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
3	G. K. Gupta, Database Management Systems, McGraw Hill, 2012

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks

9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
CSC404	**Operating System**	3

Prerequisite: Data structures and Computer architecture	
Course Objectives:	
1	To introduce basic concepts and functions of operating systems.
2	To understand the concept of process, thread and resource management.
3	To understand the concepts of process synchronization and deadlock.
4	To understand various Memory, I/O and File management techniques.
5	To study the need and fundamentals of special-purpose operating systems with the advent of new emerging technologies.
Course Outcomes:	
1	Understand the objectives and functions of OS.
2	Analyze the concept of Process Management and evaluate performance of process scheduling
3	Understand and apply concepts of Synchronization and deadlock
4	Evaluate Performance of Memory allocation and replacement policies
5	Understand the concepts of file Management and I/O management and analyze techniques of disk scheduling
6	Compare the functions of various special-purpose Operating Systems

Module		Content	Hours
1		**Operating system Overview**	**4**
	1.1	Introduction, Objectives, Functions and Evolution of Operating System	
	1.2	Operating system structures:Layered, Monolithic and Microkernel	
	1.3	Linux Kernel, Shell and System Calls	
2		**Process and Process Scheduling**	**8**

	2.1	Concept of Process, Process States,Process Description, Process Control Block.	
	2.2	Uniprocessor Scheduling-Types:Preemptive and Non-preemptive scheduling algorithms (FCFS, SJF, SRTN, Priority,RR)	
	2.3	Threads:Definitions and Types,Concept of Multithreading,Introduction to Thread Scheduling	
3		**Process Synchronization and Deadlocks**	**8**
	3.1	Concurrency: Principles of Concurrency, Inter-Process Communication, Process Synchronization.	
	3.2	Mutual Exclusion: Requirements, Hardware Support (TSL), Operating System Support (Semaphores), Producer and Consumer problem, Dining Philosophers Problem,Solution to Dining Philosophers Problem using Semaphores.	
	3.3	Principles of Deadlock: Conditions and Resource, Resource Allocation Graph,Multi - Instance Resource Allocation Graph, Deadlock Prevention,Deadlock Avoidance: Banker's Algorithm, Deadlock Detection and Recovery.	
4		**Memory Management**	**9**
	4.1	Memory Management Requirements,Memory Partitioning: Fixed, Partitioning, Dynamic Partitioning, Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit,Paging and Segmentation, TLB	
	4.2	Virtual Memory: Demand Paging, Page Replacement Strategies: FIFO, Optimal, LRU,Thrashing, Belady's Anomaly	
5		**File Management and I/O management**	**6**
	5.1	Overview, File Attributes and File Organization and Access, File Directories structures, File Allocation methods Sharing,Real Time OS, Mobile OS	
	5.2	I/O devices, Organization of the I/O Function, Disk Organization, I/O Management and Disk Scheduling:FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK	
6		**Special Purpose Operating System**	**4**
	6.1	Open-source and Proprietary Operating System; Fundamentals of Distributed Operating System; Network Operating System;Embedded Operating Systems;Cloud and IoT Operating Systems; Real-Time Operating System;Mobile Operating System; Multimedia Operating System;Comparison between Functions of various Special-purpose Operating Systems.	
		Total	**39**

Textbooks:	
1	William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8thEdition, 2014, ISBN-10: 0133805913 • ISBN-13: 9780133805918.
2	Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley &Sons, Inc., 9thEdition, 2016, ISBN 978-81-265-5427-0
3	A. Tanenbaum, Modern Operating Systems, Pearson, 4th ed., 2015.
Reference Books:	
1	Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3rdEdition
2	Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rdEdition.
3	Maurice J. Bach, "Design of UNIX Operating System", PHI

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks

9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
CSC405	**Microprocessor**	3

Prerequisite:. Basic Knowledge of Digital Logic and Computer Architecture	
Course Objectives:	
1	To equip students with the fundamental knowledge and basic technical competence in the field of Microprocessors.
2	To emphasize on instruction set and logic to build assembly language programs.
3	To prepare students for higher processor architectures and embedded systems
Course Outcomes:	
1	Describe core concepts of 8086 microprocessors.
2	Interpret the instructions of 8086 and write assembly and Mixed language programs.
3	Design 8086 based system using memory and peripheral chips.
4	Understanding the Interrupt structure and its servicing
5	Correlating the core concept of 80386 with 8086
6	Appraise the architecture of advanced processors

Module		Content	Hours
1		**The Intel Microprocessors 8086 Architecture**	**8**
	1.1	8086 CPU Architecture,	
	1.2	Programmer's Model	
	1.3	Functional Pin Diagram	
	1.4	Memory Segmentation	
	1.5	Banking in 8086	
	1.6	Demultiplexing of Address/Data bus	
	1.7	Functioning of 8086 in Minimum mode and Maximum mode	
	1.8	Timing diagrams for Read and Write operations in minimum and maximum mode	

2		**Instruction Set and Programming**	**6**
	2.1	Assembler Directives and Assembly Language Programming, Macros, Procedures	
	2.2	Addressing Modes	
	2.3	Instruction set-Data Transfer Instructions, String Instructions, Logical Instructions, Arithmetic Instructions, Transfer of Control Instructions, Processor Control Instructions	
3		**Memory and Peripherals interfacing**	**8**
	3.1	Memory Interfacing - RAM and ROM Decoding Techniques – Partial and Absolute	
	3.2	8255-PPI-Block diagram, CWR, operating modes, interfacing with 8086.	
	3.3	8257-DMAC-Block diagram, DMA operations and transfer modes.	
4		**8086 Interrupts**	**4**
	4.1	Interrupt structure and its servicing	
	4.2	Programmable Interrupt Controller 8259-Block Diagram	
	4.3	Interfacing the 8259 in single and cascaded mode	
5		**Intel 80386DX Processor**	**7**
	5.1	Architecture of 80386 microprocessor	
	5.2	80386 registers–General purpose Registers, EFLAGS and Control	
	5.3	Real mode, Protected mode, virtual 8086 mode	
	5.4	80386 memory management in Protected Mode – Descriptors and selectors, descriptor tables, the memory paging mechanism	
6		**Pentium Processor**	**6**
	6.1	Pentium Architecture	
	6.2	Superscalar Operation,	
	6.3	Integer & Floating-Point Pipeline Stages,	
	6.4	Branch Prediction Logic,	
	6.5	Cache Organization and	
	6.6	MESI protocol	
	6.7	Comparative study of 8086, 80386, Pentium I, Pentium II and Pentium	

		III	
	6.8	Pentium 4: Net burst microarchitecture.	
		Total	**39**

Textbooks:	
1	John Uffenbeck, "8086/8088 family: Design Programming and Interfacing", PHI.
2	Yu-Cheng Liu, Glenn A. Gibson, "Microcomputer System: The 8086/8088 Family, Architecture, Programming and Design", Prentice Hall
3	Walter A. Triebel, "The 80386DX Microprocessor: hardware, Software and Interfacing", Prentice Hall
4	Tom Shanley and Don Anderson, "Pentium Processor System Architecture", Addison-Wesley.
5	K. M. Bhurchandani and A. K. Ray, "Advanced Microprocessors and Peripherals", McGraw Hill
Reference Books:	
1	Barry B. Brey, "Intel Microprocessors", 8thEdition, Pearson Education India
2	Douglas Hall, "Microprocessor and Interfacing", Tata McGraw Hill.
3	Intel Manual
4	Peter Abel, "IBM PC Assembly language and Programming", 5th Edition, PHI
5	James Antonakons, "The Pentium Microprocessor", Pearson Education

Internal Assessment:		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment:		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.		
Sr. No	**Rubrics**	**Marks**

1	Multiple Choice Questions (Quiz)	5 Marks
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3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
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10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
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*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Name	Lab Name	Credit
CSL401	**Analysis of Algorithms Lab**	**1**

Prerequisite: Basic knowledge of programming and data structure	
Lab Objectives:	
1	To introduce the methods of designing and analyzing algorithms
2	Design and implement efficient algorithms for a specified application
3	Strengthen the ability to identify and apply the suitable algorithm for the given real-world problem.
4	Analyze worst-case running time of algorithms and understand fundamental algorithmic problems.
Lab Outcomes:	
1	To introduce the methods of designing and analyzing algorithms
2	Design and implement efficient algorithms for a specified application
3	Strengthen the ability to identify and apply the suitable algorithm for the given real-world problem.
4	Analyze worst-case running time of algorithms and understand fundamental algorithmic problems.

Suggested Practical List:		
Sr No		**Suggested Experiment List**
1		**Introduction**
	1.1	Selection sort, Insertion sort
	1.2	Divide and Conquer Approach: Merge sort, Quick sort, Binary search
2		**Greedy Method Approach**
	2.1	Single source shortest path- Dijkstra Fractional Knapsack problem Job sequencing with deadlines Minimum cost spanning trees-Kruskal and Prim's algorithm

3		**Dynamic Programming Approach**
	3.1	Single source shortest path- Bellman Ford All pair shortest path- Floyd Warshall 0/1 knapsack Travelling salesperson problem Longest common subsequence
4		**Backtracking and Branch and bound**
	4.1	N-queen problem Sum of subsets Graph coloring
5		**String Matching Algorithms**
	5.1	The Naïve string-matching Algorithms The Rabin Karp algorithm The Knuth-Morris-Pratt algorithm
6		**Non-deterministic Algorithms**
	6.1	Write a case study on Complexity Classes: P, NP, NP-Hard, NP-Complete

Note:Programs to be implemented in Programming Languages like C ,java, Python.

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Practical & Oral exam	
Continuous Assessment Exam:	
1	Based on the entire syllabus of **CSC401**: Analysis and Algorithms and CSL401: Analysis and Algorithms Lab

Lab Code	Lab Name	Credit
CSL402	Database Management System Lab	1

Prerequisite: Discrete Structures	
Lab Objectives:	
1	To explore design and develop of relational model
2	To present SQL and procedural interfaces to SQL comprehensively
3	To introduce the concepts of transactions and transaction processing
Lab Outcomes:	
1	Design ER /EER diagram and convert to relational model for the real world application.
2	Apply DDL, DML, DCL and TCL commands
3	Write simple and complex queries
4	UsePL / SQL Constructs.
5	Demonstrate the concept of concurrent transactions execution and frontend-backend connectivity

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Identify the case study and detailed statement of the problem. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.
2	Mapping ER/EER to Relational schema model.
3	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified System
4	Apply DML Commands for the specified system
5	Perform Simple queries, string manipulation operations and aggregate functions.
6	Implement various Join operations and Views
7	Perform Nested and Complex queries.

8	Perform DCL and TCL commands
9	Implementation and demonstration of Transaction and Concurrency control techniques using locks .
10	Implement procedure and functions(PL/SQL)
11	Implementation of Triggers.
12	Implementation of Explicit Cursor
13	Demonstrate Database connectivity

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Practical & Oral exam	
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSL402and CSC403

Lab Code	Lab Name	Credit
CSL403	Operating System Lab	1

Prerequisite: Knowledge on Operating system principle	
Lab Objectives:	
1	To gain practical experience with designing and implementing concepts of operating systems such as system calls, CPU scheduling, process management, memory management, file systems and deadlock handling using C language in Linux environment.
2	To familiarise students with the architecture of Linux OS.
3	To provide necessary skills for developing and debugging programs in Linux environment.
4	To learn programmatically to implement simple operation system mechanisms
Lab Outcomes:	
1	Demonstrate basic Operating system Commands, Shell scripts, System Calls and API wrt Linux
2	Implement various process scheduling algorithms and evaluate their performance.
3	Implement and analyze concepts of synchronization and deadlocks.
4	Implement various Memory Management techniques and evaluate their performance.
5	Implement and analyze concepts of virtual memory.
6	Demonstrate and analyze concepts of file management and I/O management techniques.

Suggested List of Experiments		
Sr. No.		**Content**
1		**Explore Linux Commands**
	1.1	Explore usage of basic Linux Commands and system calls for file, directory and process management. For eg: (mkdir, chdir, cat, ls, chown, chmod, chgrp, ps etc. system calls: open, read, write, close, getpid, setpid, getuid, getgid, getegid, geteuid. sort, grep, awk, etc.)
2		**Linux shell script**

	2.1	Write shell scripts to do the following: a. Display OS version, release number, kernel version b. Display top 10 processes in descending order c. Display processes with highest memory usage. d. Display current logged in user and log name. Display current shell, home directory, operating system type, current path setting, current working directory.
3		**Linux- API**
	3.1	Implement any one basic commands of linux like ls, cp, mv and others using kernel APIs.
4		**Linux- Process**
	4.1	a. Create a child process in Linux using the fork system call. From the child process obtain the process ID of both child and parent by using getpid and get ppid system call. b. Explore wait and waitpid before termination of process.
5		**Process Management: Scheduling**
	5.1	a. Write a program to demonstrate the concept of non-preemptive scheduling algorithms. b. Write a program to demonstrate the concept of preemptive scheduling algorithms
6		**Process Management: Synchronization**
	6.1	**a.** Write a C program to implement solution of Producer consumer problem through Semaphore
7		**Process Management: Deadlock**
	7.1	a. Write a program to demonstrate the concept of deadlock avoidance through Banker's Algorithm b. Write a program demonstrate the concept of Dining Philospher's Problem
8		**Memory Management**
	8.1	a. Write a program to demonstrate the concept of MVT and MFT memory management techniques b. Write a program to demonstrate the concept of dynamic partitioning placement algorithms i.e. Best Fit, First Fit, Worst-Fit etc.
9		**Memory Management: Virtual Memory**
	9.1	a. Write a program to demonstrate the concept of demand paging for simulation of Virtual Memory implementation b. Write a program in C demonstrating the concept of page replacement policies for handling page faults eg: FIFO, LRU etc.
10		**File Management & I/O Management**
	10.1	a. Write a C program to simulate File allocation strategies typically sequential,

		indexed and linked files b. Write a C program to simulate file organization of multi-level directory structure. **c.** Write a program in C to do disk scheduling - FCFS, SCAN, C-SCAN d. Write a C program to simulate file organization of multi-level directory structure e. Building own file system

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Practical & Oral exam	
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSL403 and CSC404

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Lab Code	Lab Name	Credit
CSL404	**Microprocessor Lab**	**1**

Prerequisite: Basic Knowledge of Digital Logic and Computer Architecture	
Lab Objectives:	
1	To emphasize on use of Assembly language program.
2	To prepare students for advanced subjects like embedded system and IOT.
Lab Outcomes:	
1	Demonstrate the execution and debugging of assembly language program
2	Use of appropriate instructions to perform various task
3	Develop the program in assembly/ mixed language for Intel 8086 processor
4	Apply the concept of Interfacing 8086 with peripheral devices

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	IntroductiontoTASM/MASM to perform basic arithmetic operations on 8-bit/16-bit data
2	Assembly programming for 16-bit addition, subtraction, multiplication and division (menu based)
3	Assembly programming for 16-bit Logical operators(AND,OR,NOT,XOR,Shift Rotate operators)
4	Assembly program based on string instructions (overlapping/non-overlapping block transfer/ string search/ string length)
5	Assembly program to display the contents of the flag register.
6	Any Mixed Language programs.
7	Assembly program to find the GCD/ LCM of two numbers
8	Assembly program to sort numbers in ascending/ descending order
9	Assembly program to find minimum/ maximum number from a given array.
10	Assembly program using procedure.

11	Assembly program using macro.
12	Program and interfacing using 8255.
13	Program and interfacing of ADC/ DAC/ Stepper motor.
14	Program for device driver (printer / mouse / keyboard)

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSL404and CSC405

Lab Code	Lab Name	Credit
CSL405	**Skill Base Lab Course: Python Programming**	**2**

Prerequisite: Knowledge of some programming language like C, Java	
Lab Objectives:	
1	Basics of Python programming
2	Decision Making, Data structure and Functions in Python
3	Object Oriented Programming using Python
4	Web framework for developing
Lab Outcomes:	
1	To understand basic concepts in python.
2	To explore contents of files, directories and text processing with python
3	To develop a program for data structure using built in functions in python.
4	To explore the django web framework for developing python-based web applications.
5	To understand Multithreading concepts using python.

Module		Detailed Content	Hours
1		**Python basics**	**5**
	1.1	Data types in python, Operators in python, Input and Output, Control statement, Arrays in python, String and Character in python, Functions, List and Tuples, set & Dictionaries, Exceptions	
2		**Advanced Python**	**4**
	2.1	Files in Python, Directories, Building Modules, Packages, Text Processing, Regular expression in python. Link List, Stack, Queues, Dequeues	
3		**Python Integration Primer**	**4**
	3.1	Graphical User interface, Networking in Python, Python database connectivity	
4		**Introduction to Django**	**3**

	4.1	Django Intro ,Django Get Started,Create Virtual Environment,Install Django,Create Project, Create App, Views, URLs, Templates, Models, Insert Data, Update Data, Delete Data, Update Model	
5		**Classes and Objects**	**4**
	5.1	Overview of Object-oriented programming, Creating Classes and Objects, Self-Variable, Constructors, Inner class, Static method, Namespaces. Inheritance: Types of Inheritance (Single, Multiple, Multi-level, Hierarchical), Super() method, Constructors in inheritance, operator overloading, Method overloading, Method overriding, Abstract class, Abstract method, Interfaces in Python.	
6		**NumPy and Pandas**	**6**
	6.1	Creating NumPy arrays, Indexing and slicing in NumPy, creating multidimensional arrays, NumPy Data types, Array Attribute, Indexing and Slicing, Creating array views copies, Manipulating array shapes I/O, Matplotlib	
	6.2	Basics of Pandas, Using multilevel series, Series and Data Frames, Grouping, aggregating, Merge Data Frames	
		Total	**26**

Textbooks:	
1	Dr. R. Nageswara Rao, “Core Python Programming”, Dreamtech Press
2	Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox Publication
3	Anurag Gupta, G. P. Biswas, “Python Programming”, McGraw-Hill
4	E. Balagurusamy, “Introduction to computing and problem-solving using python”, McGraw Hill Education
References:	
1	Learn Python the Hard Way, 3rd Edition, Zed Shaw's Hard Way Series
2	Laura Cassell, Alan Gauld, “Python Projects”, Wrox Publication

Digital material:	
1	"The Python Tutorial",http://docs.python.org/release/3.0.1/tutorial/
2	Beginning Perl,https://www.perl.org/books/beginning-perl/
3	http://spoken-tutorial.org
4	https://starcertification.org/Certifications/Certificate/python

Suggested experiments using Python	
Sr.No	**Title of Experiments**
1	Exploring basics of python like data types (strings, list, array, dictionaries, set, tuples) and control statements.
2	Exploring Files and directories a. Python program to append data to existing file and then display the entire file b. Python program to count number of lines, words and characters in a file. c. Python program to display file available in current directory
3	Creating GUI with python containing widgets such as labels, textbox, radio, checkboxes and custom dialog boxes.
4	Menu driven program for data structure using built in function for link list, stack and queue.
5	Program to demonstrate CRUD (**create, read, update and delete)** operations on databases (SQLite/ MySQL) using python.
6	Creation of simple socket for basic information exchange between server and client.
7	Creating web application using Django web framework to demonstrate functionality of user login and registration (also validating user detail using regular expression).
8	Write python programs to understand Classes, Objects, Constructors, Inner class and Static method a. Different types of Inheritance b. Polymorphism using Operator overloading, Method overloading, Method overriding, Abstract class, Abstract method and Interfaces in Python.
9	Exploring basics of NumPy Methods.
10	Program to demonstrate use of NumPy: Array objects.
11	Write python programs to implement Different types of plots using Numpy and Matplotlib
12	Program to demonstrate Data Series and Data Frames using Pandas.
13	Program to send email and read content of URL.

Term Work:	
1	Term work should consist of 12 experiments.
2	Journal must include at least 2 assignments
3	Mini Project based on the content of the syllabus (Group of 2-3 students)

4	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
5	Total 25 Marks (Journal: 10-marks, Attendance: 05-marks, and Mini Project: 10-marks)
Continuous Assessment Exam:	
1	Based on the subject content and related lab of CSL405

Course code	Course Name	Credits
CSM401	Mini Project 1 B	02

Objectives	
1	To acquaint with the process of identifying the problem domain.
2	To identify and analyse real world problems by conducting appropriate literature survey.
3	To familiarise the basic engineering fundamentals for solving the problem.
4	To develop a feasible solution using systematic approach
5	To develop team building among the group members.
6	To inculcate the process of self-learning and research.
Outcome: Learner will be able to	
1	Identify problem statements based on societal /research needs.
2	Conduct a literature survey in the preferred field of study.
3	Apply knowledge gained to solve societal problems in a group.
4	Determine the inference model and analyze the impact of the solution in societal and environmental context.
5	Use standard norms of engineering practices
6	To present the findings of the study in well documented format.
Guidelines for Mini Project	
1	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
2	Students should identify needs, perform literature survey for the respective problem statement for the mini project in consultation with project mentor / head of department / internal committee of faculties.
3	Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
4	A logbook to be prepared by each group, wherein the group can record weekly work progress, project guide should verify and record notes/comments.
5	Students in a group shall understand problems effectively, propose multiple solutions and select the best possible solution in consultation with the project guide.
6	Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.

7	The solution to be validated with proper justification and report to be compiled in standard format of the college.
8	With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
9	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project ideas in even semester. This policy can be adopted on a case by case basis.

<table>
<tr><td colspan="3">Term Work</td></tr>
<tr><td colspan="3">The review/ progress monitoring committee shall be constituted by the senior faculty members. The progress of the mini project to be evaluated on a continuous basis, minimum two reviews in each semester.</td></tr>
<tr><td colspan="3">Continuous Assessment:</td></tr>
<tr><td colspan="3">In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions, log book maintained and weekly meeting based on the same.</td></tr>
<tr><td colspan="2">Distribution of Term work / Continuous assessment marks for both semesters shall be as below:</td><td>Marks</td></tr>
<tr><td>1</td><td>Marks awarded by project guide based on logbook</td><td>10</td></tr>
<tr><td>2</td><td>Marks awarded by review committee</td><td>10</td></tr>
<tr><td>3</td><td>Timely submission of project report</td><td>05</td></tr>
<tr><td colspan="3">Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines</td></tr>
<tr><td colspan="3">One-year project:</td></tr>
<tr><td>1</td><td colspan="2">In the first semester the entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on the presentation given by the student group.
1. First shall be for finalisation of problem</td></tr>
</table>

	2. Second shall be on finalisation of proposed solution of problem.
2	In the second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. 1. First review is based on readiness of building working prototypes to be conducted. 2. Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.
Half-year project:	
1	In this case in one semester students' group shall complete project in all aspects including, 1. Identification of need/problem 2. Proposed final solution 3. Procurement of components/systems 4. Building prototype and testing
2	Continuous assessment will be weekly based on a logbook. Two presentations will be conducted for review before a panel. 1. First shall be for finalization of the problem and proposed solution. 2. Second shall be for implementation and testing of solutions.
Assessment criteria of Mini Project.	
Mini Project shall be assessed based on following criteria:	
1	Quality of survey/ need identification
2	Clarity of Problem definition based on need.
3	Innovativeness in solutions
4	Feasibility of proposed problem solutions and selection of best solution
5	Cost effectiveness
6	Societal impact
7	Innovativeness
8	Cost effectiveness and Societal impact
9	Effective use of skill sets.
10	Effective use of standard engineering norms
11	Contribution of an individual's as member or leader
12	Clarity in written and oral communication
13	Full functioning of working model as per stated requirements
14	Project report
In one year, project, first semester evaluation may be based on first six criteria and remaining may be used for second semester evaluation of performance of students in mini projects.	

In case of half year project all criterias in generic may be considered for evaluation of performance of students in a mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:	
1	Report should be prepared as per the guidelines issued by the College.
2	Mini Project shall be assessed through a presentation and demonstration of a working model by the student project group to a panel of Examiners. Each team will prepare a report that will summarize the results of the literature survey and the project proposal. The list of papers surveyed must be clearly documented.
3	Students shall be motivated to publish a paper based on the work in Conferences/students competitions.
4	Oral exams will be conducted on the project done by the students.
Mini Project shall be assessed based on following points;	
1	Quality of problem and Clarity.
2	Innovativeness in solutions.
3	Cost effectiveness and Societal impact.
4	Full functioning of the working model as per stated requirements.
5	Effective use of skill sets.
6	Effective use of standard engineering norms.
7	Contribution of an individual as member or leader.
8	Clarity in written and oral communication.

Assessment: Total Marks = Term work + Oral = (25+25)

Term Work for 25 Marks:

Term work will be based on assessment of Project Implementation and a Logbook which is filled by students on a weekly basis as per their weekly progress.

Oral Exam for 25 Marks: Based on Project Implementation and Presentation.

Third Year

With Effect from AY 2023-2024

Program Structure for Third Year Computer Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
CSC501	Theoretical Computer Science	3	--	3	--	1	4
CSC502	Software Engineering	3	--	3	–	--	3
CSC503	Computer Network	3	--	3	--	--	3
CSC504	Data Warehousing & Mining	3	--	3	--	--	3
CSDLO501x	Department Level Optional Course- 1	3	--	3	--	--	3
CSL501	Software Engineering Lab	--	2	--	1	--	1
CSL502	Computer Network Lab	--	2	--	1	--	1
CSL503	Data Warehousing & Mining Lab	--	2	--	1	--	1
CSL504	Professional Communication & Ethics-II	--	2+2**	--	2	--	2
CSM501	Mini Project: 2A	--	4$	--	2	--	2
Total		**15**	**14**	**15**	**07**	**01**	**23**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
CSC501	Theoretical Computer Science	20	20	60	2	25	--	125
CSC502	Software Engineering	20	20	60	2	--	--	100
CSC503	Computer Network	20	20	60	2	--	--	100
CSC504	Data Warehousing & Mining	20	20	60	2	--	--	100
CSDLO501x	Department Level Optional Course -1	20	20	60	2	--	--	100
CSL501	Software Engineering Lab	--	--	--	--	25	25	50
CSL502	Computer Network Lab	--	--	--	--	25	25	50
CSL503	Data Warehousing & Mining Lab	--	--	--	--	25	25	50
CSL504	Professional Communication & Ethics- II	--	--	--	--	50	--	50
CSM501	Mini Project : 2A	--	--	--	--	25	25	50
Total		**100**	**100**	**300**	--	**175**	**100**	**775**

* indicates Continuous Assessment, ** Theory class to be conducted for full class and $ indicates workload of Learner (Not Faculty), students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1 hour per week per four groups.

Department Optional Courses

Department Level Optional Courses	Semester	Code & Course
Department Level Optional Course -1	V	CSDLO5011: Probabilistic Graphical Models CSDLO5012: Internet Programming CSDLO5013: Advanced Database Management System

Program Structure for Third Year Computer Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Pract/ Tut.**	**Theory**	**Pract**	**Total**
CSC601	System Programming & Compiler Construction	3	--	3	--	3
CSC602	Cryptography & System Security	3	--	3		3
CSC603	Mobile Computing	3	--	3	--	3
CSC604	Artificial Intelligence	3	--	3	--	3
CSDLO601x	Department Level Optional Course -2	3	--	3	--	3
CSL601	System Programming & Compiler Construction Lab	--	2	--	1	1
CSL602	Cryptography & System Security Lab	--	2	--	1	1
CSL603	Mobile Computing Lab	--	2	--	1	1
CSL604	Artificial Intelligence Lab	--	2	--	1	1
CSL605	Skill base Lab Course: Cloud Computing	--	2**+2	--	2	2
CSM601	Mini Project Lab: 2B	--	$4^{\$}$	--	2	2
Total		**15**	**16**	**15**	**08**	**23**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam. Duration (in Hrs)			
		Mid Test (MT)	CA*					
CSC601	System Programming & Compiler Construction	20	20	60	2	--	--	100
CSC602	Cryptography & System Security	20	20	60	2	--	--	100
CSC603	Mobile Computing	20	20	60	2	--	--	100
CSC604	Artificial Intelligence	20	20	60	2	--	--	100
CSDLO601x	Department Level Optional Course -2	20	20	60	2	--	--	100
CSL601	System Programming & Compiler Construction Lab	--	--	--	--	25	25	50
CSL602	Cryptography & System Security Lab	--	--	--	--	25	--	25
CSL603	Mobile Computing Lab	--	--	--	--	25	-	25
CSL604	Artificial Intelligence Lab					25	25	50
CSL605	Skill base Lab Course: Cloud Computing	--	--	--	--	50	25	75
CSM601	Mini Project :2B	--	--	--	--	25	25	50
Total		**100**	**100**	**300**	--	**175**	**100**	**775**

* indicates Continuous Assessment, ** Theory class to be conducted for full class

$ indicates workload of Learner (Not Faculty), students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1 hour per week per four groups.

Department Optional Courses

Department Level Optional Courses	**Semester**	**Code & Course**
Department Level Optional Course -2	VI	CSDLO6011: Internet of Things CSDLO6012: Digital Signal & Image Processing CSDLO6013: Quantitative Analysis

Course Code:	Course Title	Credit
CSC501	Theoretical Computer Science	4

Prerequisite: Discrete Structures	
Course Objectives:	
1	Acquire conceptual understanding of fundamentals of grammars and languages.
2	Build concepts of theoretical design of deterministic and non-deterministic finite automata and push down automata.
3	Develop understanding of different types of Turing machines and applications
4	Understand the concept of Undecidability.
Course Outcomes:	
1	Identify the central concepts in theory of computation and differentiate between deterministic and nondeterministic automata, also obtain equivalence of NFA and DFA.
2	Acquire conceptual understanding of fundamentals of grammars and languages.
3	Devise regular, context free grammars while recognizing the strings and tokens
4	Build concepts of theoretical design of deterministic and non-deterministic push down automata.
5	Develop understanding of different types of Turing machines and applications.
6	Understand the concept of Undecidability.

Module		Content	Hours
1		**Basic Concepts and Finite Automata**	09
	1.1	Importance of TCS, Alphabets, Strings, Languages, Closure properties, Finite Automata (FA) and Finite State machine (FSM)	
	1.2	Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA): Definitions, transition diagrams and Language recognizers, Equivalence between NFA with and without ε- transitions, NFA to DFA Conversion, Minimization of DFA, FSM with output: Moore and Mealy machines, Applications and limitations of FA.	
2		**Regular Expressions and Languages**	07
	2.1	Regular Expression (RE),Equivalence of RE and FA, Arden‘s Theorem, RE Applications	
	2.2	Regular Language (RL), Closure properties of RLs, Decision properties of RLs, Pumping lemma for RLs.	

3		**Grammars**	08
	3.1	Grammars and Chomsky hierarchy	
	3.2	Regular Grammar (RG), Equivalence of Left and Right linear grammar, Equivalence of RG and FA.	
	3.3	**Context Free Grammars (CFG)** Definition, Sentential forms, Leftmost and Rightmost derivations, Parse tree, Ambiguity, Simplification and Applications, Normal Forms: Chomsky Normal Forms (CNF) and Greibach Normal Forms (GNF), Context Free language (CFL) - Pumping lemma, Closure properties.	
4		**Pushdown Automata(PDA)**	04
	4.1	Definition, Language of PDA,PDA as generator, decider and acceptor of CFG, Deterministic PDA , Non-Deterministic PDA, Application of PDA.	
5		**Turing Machine (TM)**	09
	5.1	Definition, Design of TM as generator, decider and acceptor, Variants of TM: Multitrack, Multitape, Universal TM, Applications, Power and Limitations of TMs.	
6		**Undecidability**	02
	6.1	Decidability and Undecidability, Recursive and Recursively Enumerable Languages, Halting Problem, Rice's Theorem, Post Correspondence Problem.	
		Total	**39**

Textbooks:	
1	John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, *"Introduction to Automata Theory, Languages and Computation"*, 3rd Edition, Pearson Education, 2008.
2	Michael Sipser, **"**Theory of Computation**"**, 3rd Edition, Cengage learning. 2013.
3	Vivek Kulkarni, **"***Theory of Computation***",** Illustrated Edition, Oxford University Press, (12 April 2013) India.
Reference Books:	
1	J. C. Martin, **"***Introduction to Languages and the Theory of Computation***",** 4th Edition, Tata McGraw Hill Publication, 2013.
2	N. Chandrashekhar & K.L.P. Mishra, "*Theory of Computer Science, Automata Languages & Computations*", PHI publications.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks

*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to comple the certification, the grading has to be done accordingly.

Indirect Assessment

1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture

End Semester Theory Examination:

1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Term Work		**Credit**
1	Course	3
2	Total 25 Marks (Tutorial: 20-marks, Attendance :05-marks)	1

Course Code:	Course Title	Credit
CSC502	**Software Engineering**	**3**

Prerequisite: Object Oriented Programming with Java , Python Programming	
Course Objectives:	
1	To provide the knowledge of software engineering discipline.
2	To apply analysis, design and testing principles to software project development.
3	To demonstrate and evaluate real world software projects
Course Outcomes: On successful completion of course, learners will be able to:	
1	Identify requirements, apply modeling techniques & assess the process models.
2	Plan, schedule and track the progress of the projects.
3	Create software architecture styles and design patterns for the software projects.
4	Develop test cases and perform manual and automated testing of software projects using various approaches.
5	Explore and manage the configuration changes and to assure quality in software projects.
6	Understand and integrate the software development life cycle process using Devops tool

Module		Content	Hours
1		**Introduction To Software Engineering and Process Models**	7
	1.1	Software Engineering-process framework, the Capability Maturity Model (CMM), Advanced Trends in Software Engineering.	
	1.2	Prescriptive Process Models: The Waterfall ,V Model, Incremental Process Models, Evolutionary Process Models: RAD & Spiral.	
	1.3	Introduction to Agile process model.	
2		**Software Requirements Analysis and Modeling**	6

	2.1	Introduction to requirement gathering : Requirement gathering techniques - Open ended and close ended questionnaires, Survey, Joint Application Design, Functional and non-functional requirements, user requirements, system requirements, interface specification.	
	2.2	Structured Modeling : Data flow diagram, Deployment Diagram. Behavioural Modeling - Sequence Diagram, Use case Diagram, State Transition Diagram.	
	2.3	Software Requirement Specification document format(IEEE).	
3		**Software Estimation and Project Scheduling**	5
	3.1	Software Metrics: LOC, FP, Introduction to Basic COCOMO model and COCOMO II Model.	
	3.2	Project Scheduling & Tracking : Work breakdown structure – Gantt Chart – CPM / PERT .	
4		**Software Architecture and Design Patterns**	6
	4.1	Design Patterns (According to industry specifications) ● Software design – cohesion – coupling – types of coupling and cohesion ● Concepts of software architecture – Architectural Patterns – connector roles – connector types - examples ● Architecture styles – Conventional architectural styles – Applied architectures and styles. ● Domain specific software architecture	
5		**Software Testing Automated Industrial Tools**	7
	5.1	Unit testing, Integration testing,Validation testing, System testing	
	5.2	Testing Techniques: white-box testing - Basis path, Control structure testing. Black-box testing - Graph based, Equivalence, Boundary Value, Introduction to automated industrial software testing tools (Selenium).	
6		**Software Configuration Management, Quality Assurance and Maintenance and Latest Trends in Software development**	8
	6.1	The Software Configuration Management : Introduction, SCM Process, Version Control and Change Control management, Industrial Trends for version Control and change control (Github).	
	6.2	Quality Concepts and Software Quality assurance Metrics, Formal Technical Reviews, Software Reliability.	
	6.3	Types of Software Maintenance, Re-Engineering, Reverse Engineering.	
	6.4	DevOps: DevOps Architecture, DevOps Toolchain.	
		Total	**39**

Textbooks:	
1	Roger Pressman, "*Software Engineering: A Practitioner's Approach*", 9th edition , McGraw-Hill Publications, 2019
2	Ian Sommerville, "*Software Engineering*", 9th edition, Pearson Education, 2011
3	Ali Behfrooz and Fredeick J. Hudson, *"Software Engineering Fundamentals"*, Oxford University Press, 1997
4	Grady Booch, James Rambaugh, Ivar Jacobson, *"The unified modeling language user guide"*, 2nd edition, Pearson Education, 2005
5	"Machine Learning Applications in Software Engineering" Volume 16, World Scientific by Du Zhang and P Tsai
6	"Software Architecture: Foundations, Theory , and Practice" by Richard N. Taylor, Nenad Medvidovic, Eric Dashofy, ISBN:978-0-470-16774-8
Reference Books:	
1	Pankaj Jalote, *"An integrated approach to Software Engineering"*, 3rd edition, Springer, 2005
2	Rajib Mall, *"Fundamentals of Software Engineering"*, 5th edition, Prentice Hall India, 2014
3	Jibitesh Mishra and Ashok Mohanty, "*Software Engineering*", Pearson , 2011
4	Ugrasen Suman, "*Software Engineering – Concepts and Practices*", Cengage Learning, 2013
5	Waman S Jawadekar, "*Software Engineering principles and practice*", McGraw Hill Education, 2004

Internal Assessment:		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment:		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.		
Sr. No	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5 Marks
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5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
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*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to comple the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code:	Course Title	Credit
CSC503	Computer Network	3

Prerequisite: None	
Course Objectives:	
1	To introduce concepts and fundamentals of data communication and computer networks.
2	To explore the inter-working of various layers of OSI.
3	To explore the issues and challenges of protocol design while delving into TCP/IP protocol suite.
4	To assess the strengths and weaknesses of various routing algorithms.
5	To understand various transport layer and application layer protocols.
Course Outcomes: On successful completion of course, learners will be able to:	
1	Demonstrate the concepts of data communication at the physical layer and compare ISO - OSI model with TCP/IP model.
2	Explore different design issues at the data link layer.
3	Design the network using IP addressing and subnetting / supernetting schemes.
4	Analyze transport layer protocols and congestion control algorithms.
5	Explore protocols at the application layer.
6	Study advanced concepts of Computer Networks such as Network Performance Assessment and Software Defined Networking.

Module		Content	Hours
1		**Introduction to Networking**	6
	1.1	Introduction to computer network, network application, network software and hardware components (Interconnection networking devices), Network topology, protocol hierarchies, design issues for the layers,connection oriented and connectionless services.	
	1.2	Reference models: Layer details of OSI, TCP/IP models. Communication between layers.	
	1.3	Physical Layer: Introduction to Communication Electromagnetic Spectrum Guided Transmission Media: Twisted pair, Coaxial, Fiber optics.	
2		**Data Link Layer**	8
	2.1	Data Link Layer:	

		Design Issues: Framing, Error Control: Error Detection and Correction (Hamming Code, CRC, Checksum), Flow Control: Stop and Wait, Sliding Window (Go Back N, Selective Repeat), Elementary Data Link protocols.	
	2.2	Medium Access Control Sublayer: Channel Allocation problem, Multiple Access Protocol (Aloha, Carrier Sense Multiple Access (CSMA/CA, CSMA/CD), Wired LANS: Ethernet, Ethernet Standards, Virtual LANs.	
3		**Network layer**	11
	3.1	Network Layer design issues, Communication Primitives: Unicast, Multicast, Broadcast. IPv4 Addressing (classful and classless), Subnetting, Supernetting design problems, IPv4 Protocol,Network Address Translation (NAT), IPv6.	
	3.2	Routing algorithms Dynamic Routing : Distance Vector Routing, Link state routing, Path Vector Routing, RIP, OSPF, BGP.	
	3.3	Network Layer Protocols - ARP,RARP, ICMP, IGMP.	
	3.4	Congestion control algorithms**:** Open loop congestion control, Closed loop congestion control, QoS parameters, Token & Leaky bucket algorithms.	
4		**Transport Layer**	7
	4.1	The Transport Service: Transport service primitives, Berkeley Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers.	
	4.2	TCP Flow control (sliding Window), TCP Congestion Control: Slow Start.	
5		**Application Layer**	3
	5.1	Application Layer :DNS: Name Space, Resource Record and Types of Name Server. HTTP, SMTP, Telnet, FTP, DHCP.	
6		**Advance Networking**	4
	6.1	Introduction to Network measurement, design and management.	
	6.2	Software Defined Networking: Introduction and Overview.	
		Total	**39**

Textbooks:	
1	A.S. Tanenbaum, Computer Networks,4th edition Pearson Education
2	B.A. Forouzan, Data Communications and Networking, 5th edition, TMH
3	James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet,6th edition, Addison Wesley
4	J. Richard Burke, Network Management: Concepts and Practice: A Hands-on Approach, Prentice Hall, 2004
Reference Books:	
1	S.Keshav,An Engineering Approach To Computer Networking, Pearson
2	Natalia Olifer & Victor Olifer,Computer Networks: Principles, Technologies & Protocols for Network Design, Wiley India, 2011.
3	Larry L.Peterson, Bruce S.Davie, Computer Networks: A Systems Approach, Second Edition ,The Morgan Kaufmann Series in Networking

Internal Assessment:

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Continuous Assessment:

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8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks

10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
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Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code:	Course Title	Credit
CSC504	**Data Warehousing & Mining**	3

Prerequisite: Database Concepts	
Course Objectives:	
1	To identify the significance of Data Warehousing and Mining.
2	To analyze data, choose relevant models and algorithms for respective applications.
3	To study web data mining.
4	To develop research interest towards advances in data mining.
Course Outcomes: On successful completion of course, learners will be able to:	
1	Understand data warehouse fundamentals and design data warehouse with dimensional modeling and apply OLAP operations.
2	Perform ETL process to create the data warehouse and apply OLAP operations.
3	Understand data mining principles and perform data preprocessing and visualization
4	Identify appropriate data mining algorithms to solve real world problems
5	Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining
6	Describe various aspects and methods with respect to spatial & web mining

Module		Content	Hours
1		**Data Warehousing Fundamentals**	5
	1.1	Introduction to Data Warehouse, Data warehouse architecture, Data warehouse versus Data Marts, Top-down versus Bottom-up approach, E-R Modeling versus Dimensional Modeling, Information Package Diagram, Data Warehouse Schemas; Star Schema, Snowflake Schema, Factless Fact Table, Fact Constellation Schema. Slowly Changing Dimension.	
2		**ETL & OLAP**	6
	2.1	Major steps in ETL process, Data extraction: Techniques, Data transformation: Basic tasks, Major transformation types, Data Loading: Applying Data, OLTP Vs OLAP, OLAP definition, Dimensional Analysis, Hypercubes, OLAP operations: Drill down, Roll up, Slice,	

		Dice and Rotation, OLAP models: MOLAP, ROLAP.	
3		**Introduction to Data Mining, Data Exploration and Data Pre-processing**	9
	3.1	Data Mining Task Primitives, Architecture, KDD process, Issues in Data Mining, Applications of Data Mining, Data Exploration: Types of Attributes, Statistical Description of Data, Data Visualization, Data Preprocessing: Descriptive data summarization, Cleaning, Integration & transformation, Data reduction, Data Discretization and Concept hierarchy generation.	
4		**Classification and Clustering**	10
	4.1	Basic Concepts, Decision Tree Induction - ID3, C4.5 & CART, Naive Bayesian Classification, Accuracy and Error measures, Evaluating the Accuracy of a Classifier: Holdout & Random Subsampling, Cross Validation, Bootstrap. Types of data in Cluster analysis, Partitioning Methods (*k*-Means, *k*-Medoids), Hierarchical Methods (Agglomerative, Divisive), Density Based Clustering (DBSCAN)	
5		**Mining frequent patterns and associations**	6
	5.1	Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule, Frequent Pattern Mining, Apriori Algorithm, Association Rule Generation, Improving the Efficiency of Apriori, Mining Frequent Itemsets without candidate generation, Introduction to Mining Multilevel Association Rules and Mining, Multidimensional Association Rules.	
6		**Spatial and Web Mining**	3
	6.1	Spatial Data, Spatial Vs. Classical Data Mining, Spatial Data Structures, Web Mining: Web Content Mining, Web Structure Mining, Web Usage mining, Applications of Web Mining	
		Total	**39**

Textbooks:	
1	Paulraj Ponniah, *" Data Warehousing: Fundamentals for IT Professionals"*, Wiley India.
2	Han, Kamber, *"Data Mining Concepts and Techniques"*, Morgan Kaufmann 2nd edition.
3	M.H. Dunham, *"Data Mining Introductory and Advanced Topics"*, Pearson Education.
Reference Books:	
1	Reema Theraja, *"Data warehousing"*, Oxford University Press 2009.
2	Pang-Ning Tan, Michael Steinbach and Vipin Kumar, *"Introduction to Data Mining"*, Pearson Publisher 2nd edition.
3	Ian H. Witten, Eibe Frank and Mark A. Hall, *"Data Mining"*, Morgan Kaufmann 3rd edition.

Internal Assessment:		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment:		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.		
Sr. No	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	

5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code:	Course Title	Credit
CSDLO5011	**Probabilistic Graphical Models**	**3**

Prerequisite:Engineering Mathematics, Discrete Structure	
Course Objectives:	
1	To give comprehensive introduction of probabilistic graphical models
2	To make inferences, learning, actions and decisions while applying these models
3	To introduce real-world trade-offs when using probabilistic graphical models in practice
4	To develop the knowledge and skills necessary to apply these models to solve real world problems.
Course Outcomes: On successful completion of course, learners will be able to:	
1	Understand basic concepts of probabilistic graphical modeling.
2	Model and extract inference from Bayesian Networks and represent real world problems
3	Model and extract inference from Markov Models and represent real world problems
4	Understand Hidden Markov Model and its applications
5	Perform learning task using probabilistic graphical models
6	Take actions and decisions using probabilistic graphical models

Module		Content	Hours
1		**Introduction to Probabilistic Graphical Modeling**	5
	1.1	Introduction to Probability Theory: Probability Theory, Basic Concepts in Probability, Random Variables and Joint Distribution, Independence and Conditional Independence, Continuous Spaces, Expectation and Variances	
	1.2	Introduction to Graphs: Nodes and Edges, Subgraphs, Paths and Trails, Cycles and Loops	
	1.3	Introduction to Probabilistic Graph Models: Bayesian Network, Markov Model, Hidden Markov Model	
2		**Bayesian Network Model and Inference**	11
	2.1	Directed Graph Model: Bayesian Network-Exploiting Independence	

		Properties, Naive Bayes Model, Bayesian Network Model, Reasoning Patterns, Basic Independencies in Bayesian Networks, Bayesian Network Semantics, Graphs and Distributions. Modeling: Picking variables, Picking Structure, Picking Probabilities, D- separation	
	2.2	Local Probabilistic Models: Tabular CPDs, Deterministic CPDs, Context Specific CPDs, Generalized Linear Models.	
	2.3	Exact inference variable elimination: Analysis of Complexity, Variable Elimination, Conditioning, Inference with Structured CPDs.	
	2.4	Application of Bayesian Networks: Classification, Forecasting, Decision Making	
3		**Markov Network Model and Inference**	9
	3.1	Undirected Graph Model : Markov Model-Markov Network, Parameterization of Markov Network, Gibb's distribution, Reduced Markov Network, Markov Network Independencies, From Distributions to Graphs, Fine Grained Parameterization, Over Parameterization	
	3.2	Exact inference variable elimination: Graph Theoretic Analysis for Variable Elimination, Conditioning	
	3.3	Application of Markov Models: Cost Effectiveness Analysis, Relational Markov Model and its Applications, Application in Portfolio Optimization	
4		**Hidden Markov Model and Inference**	7
	4.1	Template Based Graph Model : HMM- Temporal Models, Template Variables and Template Factors, Directed Probabilistic Models, Undirected Representation, Structural Uncertainty.	
	4.2	Application of HMM: Speech Recognition, Part of Speech Tagging, Bioinformatics.	
5		**Learning Graphical Models**	4
	5.1	Goals of Learning, Density Estimation, Specific Prediction Tasks, Knowledge Discovery.	
	5.2	Parameter Estimation: Maximum Likelihood Estimation, MLE for Bayesian Networks	
6		**Taking Actions and Decisions**	3
	6.1	Causality: Conditioning and Intervention, Correlation and Causation, Causal Models.	
	6.2	Utilities and Decisions: Maximizing Expected Utility, Utility Curves, Utility Elicitation. Structured Decision Problems: Decision Tree	
		Total	**39**

Textbooks:	
1	Daphne Koller and Nir Friedman, "Probabilistic Graphical Models: Principles and Techniques", Cambridge, MA: The MIT Press, 2009 (ISBN 978-0-262-0139- 2).
2	David Barber, "Bayesian Reasoning and Machine Learning", Cambridge University Press, 1st edition, 2011.
Reference Books:	
1	Finn Jensen and Thomas Nielsen, "Bayesian Networks and Decision Graphs (Information Science and Statistics)", 2nd Edition, Springer, 2007.
2	Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
3	Martin Wainwright and Michael Jordan, M., "Graphical Models, Exponential Families, and Variational Inference", 2008.

Useful Links:	
1	https://www.coursera.org/specializations/probabilistic-graphical-models
2	https://www.mooc-list.com/tags/probabilistic-graphical-models
3	https://scholarship.claremont.edu/cgi/viewcontent.cgi?referer=https://www.google.c om/&httpsredir=1&article=2690&context=cmc_theses
4	https://www.upgrad.com/blog/bayesian-networks/
5	https://www.utas.edu.au/ data/assets/pdf_file/0009/588474/TR_14_BNs_a_resour ce_guide.pdf
6	https://math.libretexts.org/Bookshelves/Applied_Mathematics/Book%3A_Applied_ Finite_Mathematics_(Sekhon_and_Bloom)/10%3A_Markov_Chains/10.02%3A_A pplications_of_Markov_Chains/10.2.01%3A_Applications_of_Markov_Chains_(E xercises)
7	https://link.springer.com/chapter/10.1007/978-3-319-43742-2_24
8	https://homes.cs.washington.edu/~pedrod/papers/kdd02a.pdf
9	https://core.ac.uk/download/pdf/191938826.pdf
10	https://cs.brown.edu/research/pubs/theses/ugrad/2005/dbooksta.pdf
11	https://web.ece.ucsb.edu/Faculty/Rabiner/ece259/Reprints/tutorial%20on%20hmm %20and%20applications.pdf
12	https://mi.eng.cam.ac.uk/~mjfg/mjfg_NOW.pdf
13	http://bioinfo.au.tsinghua.edu.cn/member/jgu/pgm/materials/Chapter3-LocalProbabilisticModels.pdf

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

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1	Multiple Choice Questions (Quiz)	5 Marks
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6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
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Indirect Assessment

1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture

End Semester Theory Examination:

1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code:	Course Title	Credit
CSDLO5012	**Internet Programming**	**3**

Prerequisite: Data Structures, Programming Languages- JAVA, Python	
Course Objectives:	
1	To get familiar with the basics of Internet Programming and web UI Design.
2	To acquire knowledge and skills for creation of web site considering both client and server-side programming.
3	To gain the ability to develop responsive web applications and explore different web services standards.
4	To explore and design web applications using RIA and appropriate web frameworks.
Course Outcomes: On successful completion of course, learners will be able to:	
1	Design user friendly web application wireframes using digital prototype tools.
2	Implement interactive web page(s) using HTML and CSS.
3	Design a responsive web site using Client side and server side scripting languages with MySQL.
4	Demonstrate Rich Internet Application using Ajax and jQuery.
5	Develop the mini project and Integrate the web application using APIs.
6	Explore web frameworks and develop mini projects using Django.

Module		Content	Hours
1		**Introduction to Web Essentials and UI Design**	4
	1.1	Web Essentials: Clients, Servers and Communication, Web System Architecture, HTTP Request Message, HTTP Response Message	
	1.2	Web UI Design : Designing the User Interface - Paper Prototype and Digital prototype. User Interface prototyping,Introduction to Wireframing.	
2		**Front End Web Technologies**	12
	2.1	HTML5 – Fundamental syntax and semantics, Tables, Lists, Image, HTML5 control elements, Semantic elements, Drag and Drop, Audio Video controls.	
	2.2	CSS3 – Inline, embedded and external style sheets – Rule cascading, Inheritance, Backgrounds, Border Images, Colors, Shadows, Text, Transformations, Transitions, Animation.	

	2.3	Java Script: An introduction to DHTML, JavaScript DOM Model, Built-in objects, Regular Expressions, Validation, Event Handling, Exception Handling.	
3		**Back End Development**	6
	3.1	Introduction to PHP- Data types, control structures, built in functions, building web applications using PHP- Session handling Mechanisms, PHP and MySQL database connectivity with example, JSON introduction – Syntax, Http Request , SQL.	
4		**Rich Internet Application (RIA)**	4
	4.1	Characteristics of RIA,Introduction to AJAX: AJAX design basics, AJAX vs Traditional Approach, Rich User Interface using Ajax, jQuery framework with AJAX.	
5		**Full Stack Development**	9
	5.1	React js: Introduction, React features, App "Hello World" Application, Introduction to JSX, Simple Application using JSX.	
	5.2	Introduction to Web APIs: REST Architecture. Web form API, Web Storage API, Web Fetch API.	
	5.3	Introduction to GraphQL: Simple application using ReactJS and jQuery client to consume the graphQL API	
6		**Web Framework**	4
	6.1	Introduction to Django, Django Installation, Django project creations, Django Models and CRUD Operations.	
		Total	**39**

Textbooks:	
1	Ralph Moseley, M.T. Savliya, “Developing Web Applications", Willy India, Second Edition, ISBN: 978-81-265-3867-6
2	“Web Technology Black Book”, Dreamtech Press, First Edition, 978-7722-997
3	Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O'REILLY, 2014. (http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL_Javascript_CSS_HTML5_Robin_Nixon_3e.pdf)
4	Dana Moore, Raymond Budd, Edward Benson,Professional Rich Internet Applications: AJAX and Beyond Wiley publications. https://ebooks-it.org/0470082801-ebook.htm
5	Alex Banks and Eve Porcello, Learning React Functional Web Development with React and Redux,O'REILLY, First Edition
6	Staiano, F. (2022). Designing and Prototyping Interfaces with Figma: Learn Essential UX/UI Design Principles by Creating Interactive Prototypes for Mobile, Tablet, and Desktop. United Kingdom: Packt Publishing.
Reference Books:	
1	Harvey & Paul Deitel & Associates, Harvey Deitel and Abbey Deitel, Internet and World Wide Web - How To Program, Fifth Edition, Pearson Education, 2011.
2	Achyut S Godbole and AtulKahate, ―Web Technologies, Second Edition, Tata McGraw Hill, 2012.
3	Thomas A Powell, Fritz Schneider, ―JavaScript: The Complete Reference, Third Edition,Tata McGraw Hill, 2013
4	David Flanagan, ―JavaScript: The Definitive Guide, Sixth Edition, O'Reilly Media, 2011
5	Steven Holzner ―The Complete Reference - PHP, Tata McGraw Hill, 2008
6	Mike Mcgrath―PHP & MySQL in Easy Steps, Tata McGraw Hill, 2012.
7	George, Nigel. Build a Website with Django 3: A Complete Introduction to Django 3. N.p.: GNW Independent Publishing, 2021.
8	Masse, M. (2011). REST API Design Rulebook. Germany: O'Reilly Media.
9	Porcello, E., Banks, A. (2018). Learning GraphQL: Declarative Data Fetching for Modern Web Apps. China: O'Reilly Media.

Internal Assessment:
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Continuous Assessment:

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Indirect Assessment

1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture

End Semester Theory Examination:

1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
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Course Code:	Course Title	Credit
CSDLO5013	Advanced Database Management System	3

Prerequisite: Data Structure , XML, Database Management System	
Course Objectives:	
1	To provide insights into distributed database designing
2	To specify the various approaches used for using XML and JSON technologies.
3	To apply the concepts behind the various types of NoSQL databases and utilize it for Mongodb
4	To learn about the trends in advance databases
Course Outcomes:	
1	Design distributed database using the various techniques for query processing
2	Measure query cost and perform distributed transaction management
3	Organize the data using XML and JSON database for better interoperability
4	Compare different types of NoSQL databases
5	Formulate NoSQL queries using Mongodb
6	Describe various trends in advanced databases

Module		Content	Hours
1		**Query processing and Optimization in centralized Databases**	6
	1.1	Query Processing : Overview , Measures of Query cost , Selection operation ,Join Operations, and other Operations Evaluation of Expression	
	1.2	Query Optimization : Translations of SQL Queries into relational algebra, Heuristic approach & Cost based Optimization	
2		**Distributed Databases**	4
	2.1	Introduction,Distributed DBMS Architecture, Data Fragmentation,Replication and Allocation Techniques for Distributed Database Design.	
3		**Distributed Database Handling**	8
	3.1	Distributed Transaction Management – Definition, properties, types, architecture Distributed Query Processing - Characterization of Query Processors, Layers/ phases of query processing.	
	3.2	Distributed Concurrency Control- Taxonomy, Locking based, Basic TO algorithm,Recovery in Distributed Databases: Failures in distributed	

		database, 2PC and 3PC protocol.	
4		**NoSQL Distribution Model**	9
	4.1	NoSQL database concepts: NoSQL data modeling, Benefits of NoSQL,comparison between SQL and NoSQL database systems.	
	4.2	Replication and sharding, Distribution Models Consistency in distributed data, CAP theorem, Notion of ACID Vs BASE, handling Transactions,consistency and eventual consistency	
	4.3	Types of NoSQL databases: Key-value data store, Document database and Column Family Data store, Comparison of NoSQL databases w.r.t CAP theorem and ACID properties.	
5		**NoSQL using MongoDB**	6
	5.1	NoSQL using MongoDB: Introduction to MongoDB Shell, Running the MongoDB shell, MongoDB client, Basic operations with MongoDB shell,Basic Data Types, Arrays, Embedded Documents	
	5.2	Querying MongoDB using find() functions, advanced queries using logical operators and sorting, simple aggregate functions, saving and updating documents. MongoDB Distributed environment: Concepts of replication and horizontal scaling through sharding in MongoDB	
6		**Trends in advance databases**	6
	6.1	Temporal database: Concepts, time representation, time dimension, incorporating time in relational databases	
	6.2	Graph Database: Introduction, Features, Transactions, consistency,Availability, Querying, Case Study Neo4J	
	6.3	Spatial database: Introduction, data types, models, operators and queries	
		Total	**39**

Textbooks:	
1	Korth, Siberchatz,Sudarshan, “Database System Concepts”, 6thEdition, McGraw Hill
2	Elmasri and Navathe, “Fundamentals of Database Systems”, 5thEdition, Pearson Education
3	Ozsu, M. Tamer, Valduriez, Patrick, “Principles of distributed database systems”,3rd Edition,Pearson Education, Inc.
4	Pramod Sadalge, Martin Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Addison Wesely/ Pearson
5	Jeff Friesen , Java XML and JSON,Second Edition, 2019, après Inc.
Reference Books:	
1	Peter Rob and Carlos Coronel,Database Systems Design,Implementation and Management,Thomson Learning, 5thEdition.
2	Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
3	Adam Fowler, NoSQL for dummies, John Wiley & Sons, Inc.
4	Shashank Tiwari, Professional NOSQL, John Willy & Sons. Inc
5	Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH
6	MongoDB Manual : https://docs.mongodb.com/manual

Internal Assessment:

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Continuous Assessment:

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Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Lab Code	Lab Name	Credit
CSL501	**Software Engineering Lab**	**1**

Prerequisite: Object Oriented Programming with Java , Python Programming	
Lab Objectives:	
1	To solve real life problems by applying software engineering principles
2	To impart state-of-the-art knowledge on Software Engineering
Lab Outcomes:	
1	Identify requirements and apply software process models to selected case study.
2	Develop architectural models for the selected case study
3	Plan, schedule and track the progress of the projects.
4	Use computer-aided software engineering (CASE) tools

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Name of the Experiment
1	Select case study using Traditional model or Agile Model as per the given problem statement.
2	Apply requirement gathering techniques and prepare Software Requirement Specification (SRS) documents in IEEE format.
3	Design UML Diagrams for the selected Case Study(draw.io).
4	Implement an appropriate design pattern for chosen problem Statement
5	Apply software metrics to estimate the cost of the project using COCOMO 2.0
6	Prepare a timeline chart (Gantt chart) for the selected case study using automated tool (MS Project)
7	Design Test cases and perform the black box testing using automated tools.(selenium)
8	Design test cases and perform white box testing. (evaluate code and the internal structure of software.)
9	Identify the various software engineering tools and implement version control for the selected problem statement using Github.
10	Case Study on DevOps application.(gitlabs)

Useful Links:

1	https://nptel.ac.in/courses/106/105/106105182/
2	https://www.mooc-list.com/course/software-engineering-introduction-edx
3	https://www.selenium.dev/

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSC502 and CSL501 syllabus

Lab Code	Lab Name	Credit
CSL502	Computer Network Lab	1

Prerequisite: None	
Lab Objectives:	
1	To practically explore OSI layers and understand the usage of simulation tools.
2	To analyze, specify and design the topological and routing strategies for an IP based networking infrastructure.
3	To identify the various issues of a packet transfer from source to destination, and how they are resolved by the various existing protocols
Lab Outcomes:	
1	Design and setup networking environment in Linux.
2	Use Network tools and simulators such as NS2, Wireshark etc. to explore networking algorithms and protocols.
3	Implement programs using core programming APIs for understanding networking concepts
4	Apply the concepts of subnetting, routing and Software Defined Networks.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Understand and interpret the roles and functions of components like routers, switches, access points, servers, endpoints, firewalls, IPS, and controllers.
2	To build a simple network topology and configure it for static routing protocol using packet tracer. Setup a network and configure IP addressing, subnetting, masking.
3	Understand and apply the basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP, RARP, ip, ifconfig, dig, route)
4	Understand the operation of TCP/IP layers using Wire shark Ethernet Layer: Frame header, Frame size etc. ● Data Link Layer: MAC address, ARP (IP and MAC address binding) ● Network Layer: IP Packet (header, fragmentation), ICMP (Query and Echo) ● Transport Layer: TCP Ports, TCP handshake segments etc. ● Application Layer: DHCP, FTP, HTTP header formats
5	Installation & Configuration of Network Simulator (NS2) in Linux environment. & Building of wired & wireless topology using NS2.
6	Apply network simulator tools (viz NS2/Netsim) to understand the functioning of ALOHA, CSMA/CD.
7	Design a network a) to set up multiple IP addresses on a single LAN.

	b)to use nestat and route commands of Linux, to explore the following ● View current routing table ● Add and delete routes ● Change default gateway c)To Perform packet filtering by enabling IP forwarding using IPtables in Linux.
8	Demonstrate network communication using Socket programming (TCP and UDP)
9	Perform File Transfer protocol using FTP and Remote login using Telnet.
10	Stop and wait protocol/ sliding window (selective repeat / Go back N)
11	Illustrate basic Mininet operations for Software Defined Networking
12	WAP(in java) to Implement a Shortest Path Routing Algorithm . Explore the same using a virtual lab :Bellman ford Algorithm). http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/comp_networks/labs/index.php

Useful Links:	
1	https://www.netacad.com/courses/packet-tracer/introduction-packet-tracer
2	https://www.coursera.org/projects/data-forwarding-computer-networks
3	https://www.edx.org/course/ilabx-the-internet-masterclass
4	https://networklessons.com/cisco/ccna-routing-switching-icnd2-200-105/introduction-to-sdn-software-defined-networking

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSC503 and CSL502

Lab Code	Lab Name	Credit
CSL503	Data Warehousing and Mining Lab	1

Prerequisite: Database Concepts	
Lab Objectives:	
1	Learn how to build a data warehouse
2	Learn about the data sets and data preprocessing.
3	Demonstrate the working of algorithms for data mining tasks such Classification, clustering, Association rule mining & Web mining
4	Explore open source software (like Orange) to perform data mining tasks
Lab Outcomes:	
1	Design data warehouses and perform various OLAP operations
2	Implement data mining algorithms like classification.
3	Understand & Implement various clustering algorithms on a given set of data samples**.**
4	Implement Association rule mining & web mining algorithm.

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Name of the Experiment
1	One case study on building Data warehouse/Data Mart ● Write Detailed Problem statement and design dimensional modeling (creation of star and snowflake schema)
2	Implementation of all dimension table and fact table based on experiment 1 case study
3	Implementation of OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot based on experiment 1 case study
4	Implementation of Bayesian algorithm
5	Implementation of Data Discretization (any one) & Visualization (any one)
6	Perform data Pre-processing task and demonstrate Classification, Clustering, Association algorithm on data sets using data mining tool (Python)
7	Implementation of Classification algorithm (ID3/C4.5)
8	Implementation of Clustering algorithm (K-means/K-medoids)
9	Implementation of Clustering algorithm (DBSCAN)

10	Implementation of Association Rule Mining algorithm (Apriori / FP Growth)

Useful Links:	
1	https://onlinecourses.nptel.ac.in/noc20_cs12/preview
2	https://www.coursera.org/specializations/data-mining

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSC504 and CSL503

Course Code:	Course Name	Credit
CSL504	**Professional Communication and Ethics-II**	2

Prerequisite: Professional Communication and Ethics-I	
Course Objectives:	
1	To discern and develop an effective style of writing important technical/business documents.
2	To investigate possible resources and plan a successful job campaign.
3	To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
4	To develop creative and impactful presentation skills.
5	To analyze personal traits, interests, values, aptitudes and skills.
6	To understand the importance of integrity and develop a personal code of ethics.
Course Outcomes:	
1	Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.
2	Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
3	Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
4	Deliver persuasive and professional presentations.
5	Develop creative thinking and interpersonal skills required for effective professional communication.
6	Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Module		Topics	Hours
1		**ADVANCED TECHNICAL WRITING :PROJECT/PROBLEM BASED LEARNING (PBL)**	**6**
	1.1	**Purpose and Classification of Reports:** **Classification on the basis of:** ● Subject Matter (Technology, Accounting, Finance, Marketing, etc.) ● Time Interval (Periodic, One-time, Special) ● Function (Informational, Analytical, etc.) ● Physical Factors (Memorandum, Letter, Short & Long	
	1.2	**Parts of a Long Formal Report:** ● Prefatory Parts (Front Matter) ● Report Proper (Main Body)	

		● Appended Parts (Back Matter)	
	1.3	**Language and Style of Reports** ● Tense, Person & Voice of Reports ● Numbering Style of Chapters, Sections, Figures, Tables and ● Equations ● Referencing Styles in APA & MLA Format ● Proofreading through Plagiarism Checkers	
	1.4	**Definition, Purpose & Types of Proposals** ● Solicited (in conformance with RFP) & Unsolicited Proposals ● Types (Short and Long proposals)	
	1.5	**Parts of a Proposal** ● Elements ● Scope and Limitations ● Conclusion	
2		**EMPLOYMENT SKILLS**	**6**
	2.1	**Cover Letter & Resume** ● Parts and Content of a Cover Letter ● Difference between Bio-data, Resume & CV ● Essential Parts of a Resume ● Types of Resume (Chronological, Functional & Combination)	
	2.2	**Statement of Purpose** ● Importance of SOP ● Tips for Writing an Effective SOP	
	2.3	**Group Discussions** ● Purpose of a GD ● Parameters of Evaluating a GD ● Types of GDs (Normal, Case-based & Role Plays) ● GD Etiquettes	
	2.4	**Personal Interviews** ● Planning and Preparation ● Types of Questions ● Types of Interviews (Structured, Stress, Behavioural, Problem ● Solving & Case-based) ● Modes of Interviews: Face-to-face (One-to one and Panel) ● Telephonic, Virtual	
3		**BUSINESS MEETINGS**	**2**
	3.1	**Conducting Business Meetings** ● Types of Meetings ● Roles and Responsibilities of Chairperson, Secretary and Members ● Meeting Etiquette	
	3.2	**Documentation** ● Notice ● Agenda ● Minutes	
4		**TECHNICAL/ BUSINESS PRESENTATIONS**	**2**
	4.1	**Effective Presentation Strategies** ● Defining Purpose ● Analyzing Audience, Location and Event ● Gathering, Selecting &Arranging Material ● Structuring a Presentation ● Making Effective Slides ● Types of Presentations Aids ● Closing a Presentation ● Platform skills	

	4.2	**Group Presentations** ● Sharing Responsibility in a Team ● Building the contents and visuals together ● Transition Phases	
5		**INTERPERSONAL SKILLS**	**8**
	5.1	**Interpersonal Skills** ● Emotional Intelligence ● Leadership & Motivation ● Conflict Management & Negotiation ● Time Management ● Assertiveness ● Decision Making	
6		**CORPORATE ETHICS**	**2**
		6.1Intellectual Property Rights ● Copyrights ● Trademarks ● Patents ● Industrial Designs	
		Case Studies ● Cases related to Business/ Corporate Ethics	
		Total	**26**

Textbooks:	
1	Fred Luthans, “Organisational Behavior” , McGraw Hill, edition
2	Robbins Stephen judge timothy “Organisational Behavior” Pearson
3	R.C Sharma and Krishna Mohan, “Business Correspondence and Report Writing”
4	Foundation course in Human values and Professional Ethics L R R Gaur, R. Asthana, G.P. Bagaria
Reference Books:	
1	Lesiker and Petit, “Report Writing for Business” , McGraw Hill, edition
2	Wallace and Masters, “Personal Development for Life and Work” , Thomson Learning, 12th edition
3	B N Ghosh, “Managing Soft Skills for Personality Development”, Tata McGraw Hill.Lehman,

Internal Assessment:
Internal assessment will be for 50 Marks as given below

Sr No	Headings		Marks
A	Assignments		10 Marks
B	Continuous Assessment		20 Marks
C	a)Report	10 Marks	10 Marks
	b)Presentation	10 Marks	
D	Group Discussion		10 Marks
	Total		50 Marks

A) Assignments : List of assignments are as given below. The assignments have to be discussed in the group and approach approved by faculty. Each student in the group will have to write the assignments individually (10 Marks)

Sr No	List of Assignments
1.	Proposal
2.	Resume and Cover Letter /SOP
3.	Notice ,Agenda and Minutes of Meeting
4	Case Study /Role Play on Interpersonal Skills
5	Case study on Ethics

B) Continuous Assessment:-

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	**Rubrics**	**Marks**
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

C) Report on presentation: A detail typed report has to be prepared of minimum 25 pages and maximum 30 pages in the given format.

D) A final Group Discussion Round will be conducted and every student must participate in the group discussion

Tutorials will be conducted batch wise.

Course Code:	Course Title	Credit
CSM501	Mini Project 2A	2

Prerequisite:	
Course Objectives:	
1	To understand and identify the problem statement
2	To apply basic engineering fundamentals and attempt to find solutions to the chosen problem statement
3	Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
4	To develop communication skills and improve teamwork amongst group members.
5	To apply standard principles of project management and validate the project using appropriate evaluation measures
6	To inculcate the process of self-learning and research.
Course Outcomes:	
1	Identify societal / research / innovation / entrepreneurship problems through appropriate literature surveys
2	Identify methodology for solving above problem and apply engineering knowledge and skills to solve it
3	Validate, Verify the results using test cases/benchmark data/theoretical/ inferences/experiments/simulations
4	Analyze and evaluate the impact of solution / product / research / innovation / entrepreneurship towards societal / environmental / sustainable development
5	Use standard norms of engineering practices and project management principles during project work
6	Communicate through technical report writing and oral presentation. ● The work may result in research / white paper / article / patent / blog writing and research publication ● The work may result in business plan for entrepreneurship product created
7	Gain technical competency by participating in project competitions, hackathons, etc.
8	Demonstrate capabilities of self-learning, leading to lifelong learning.
9	Develop interpersonal skills to work in a group.

Guidelines for Mini Project		
1	Mini project may be carried out in one or more form of following: Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification / development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society / environment, research oriented and application areas, etc.	
2	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.	
3	Students should do surveys and identify needs, which shall be converted into problem statements for a mini project in consultation with project mentor / head of the department / internal committee of faculties.	
4	Students shall submit an implementation plan in the form of Gantt / PERT / CPM chart using state-of-the-art industry tools, which will cover weekly activity of mini projects	
5	A logbook may be prepared by each group, wherein the group shall record weekly work progress, project guide shall verify and record notes / comments.	
6	Students under the guidance of the project guide shall convert the best solution into a working model using various components of their domain areas and demonstrate.	
7	The solution to be validated with proper justification and report to be compiled in standard format . Software requirement specification (SRS) documents as per IEEE format, research papers, competition certificates may be submitted as part of annexure to the report.	
8	With the focus on self-learning, innovation, addressing societal / research / innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project 2 in semesters V and VI.	
9	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements / modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.	
Term Work		
The review / progress monitoring committee shall be constituted by the heads of departments of each institute. The progress of the mini project to be evaluated on a continuous basis, based on the SRS document submitted. Minimum two reviews in each semester		
Distribution of Term work marks for both semesters shall be as below:		**Marks (25)**
1	Marks awarded by project mentor based on logbook	10
2	Marks awarded by review committee	10
3	**Timeliness** of Project report	05
Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines		
One-year project:		
1	In the one year project (sem V and VI), first semester the entire theoretical solution shall be made ready, including components / system selection, cost, feasibility analysis**,** conceptual and Detailed design. Two reviews will be conducted based on a presentation given by a student	

	group. ● First shall be for finalization of problem ● Second shall be on finalization of the proposed solution of the problem
2	In the second semester expected work shall be procurement of component's / systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. ● First review is based on readiness of building working prototypes to be conducted. ● Second review shall be based on poster presentation cum demonstration of working model in the last month of the said semester.
Half-year project	
1	In this case in one semester students' group shall complete project in all aspects including, ● Identification of need/problem ● Proposed final solution ● Procurement of components/systems ● Building prototype and testing
2	Two reviews will be conducted for continuous assessment, ● First shall be for finalization of problem and proposed solution ● Second shall be for implementation and testing of solutions.
Mini Project shall be assessed based on following point	
1	Clarity of problem and quality of literature Survey for problem identification
2	Requirement Gathering via Software Requirement Specification (SRS) / Feasibility Study
3	Completeness of methodology implemented
4	Design, Analysis and Further Plan
5	Novelty, Originality or Innovativeness of project
6	Societal / Research impact
7	Effective use of skill set : Standard engineering practices and Project management standard
8	Contribution of an individual's as member or leader
9	Clarity in written and oral communication
10	Verification and validation of the solution / Test Cases using open source testing tools as per trends in industry
11	Full functioning of working model as per stated requirements
12	Technical writing /competition/hackathon outcome being met
In a one year project (sem V and VI), first semester evaluation may be based on the first 10 criteria and remaining may be used for second semester evaluation of performance of students in mini projects.	
In case of half year projects (completing in V sem) all criterias in generic may be considered for evaluation of performance of students in mini projects.	
Guidelines for Assessment of Mini Project Practical / Oral Examination	
1	Report should be prepared as per the guidelines issued.
2	The Mini Project shall be assessed through a presentation and demonstration of the working model by the student project group to a panel of Internal and External Examiners preferably

	from industry or research organizations having experience of more than five years approved by the head of Institution.
3	Students shall be motivated to publish a research paper / patent / participate in competition based on the work in conferences / students competitions

Course Code	Course Title	Credit
CSC601	**System Programming & Compiler Construction**	**3**

Prerequisite: Theoretical computer science, Operating system. Computer Organization and Architecture .	
Course Objectives:	
1	To understand the role and functionality of various system programs over application programs.
2	To understand basic concepts, structure and design of assemblers, macro processors.
3	To understand the basic principles of compiler design, its various constituent parts, algorithms and data structures are required to be used in the compiler.
4	To understand the need to follow the syntax in writing an application program and to learn how the analysis phase of the compiler is designed to understand the programmer's requirements without ambiguity.
5	To synthesize the analysis phase outcomes to produce the object code that is efficient in terms of space and execution time.
Course Outcomes:	
1	Identify the relevance of different system programs.
2	Explore various data structures used for assembler design.
3	Explore various data structures used for macro processor design.
4	Understand fundamentals analysis phase of compiler design.
5	Explore different methods for intermediate code generations and machine code optimization techniques for the synthesis phase of compiler design.
6	Apply various Error Recovery mechanisms.

Module		Content	Hours
1		**Introduction to System Software**	2
	1.1	Concept of System Software, Goals of system software, system program and system programming, Introduction to various system programs such as Assembler, Macro processor, Loader, Linker, Compiler, Interpreter, Device Drivers, Operating system, Editors, Debuggers.	
2		**Assemblers**	6
	2.1	Elements of Assembly Language programming, Assembly scheme, pass	

		structure of assembler, Assembler Design: Two pass assembler Design (IBM 360/370) and data structures used.	
3		**Macros and Macro Processor**	6
	3.1	Introduction, Macro definition and call, Features of Macro facility: Simple, parameterized, conditional and nested. Design of Two pass macro processor, data structures used.	
4		**Compilers: Analysis Phase**	10
	4.1	Introduction to compilers, Phases of compilers: Lexical Analysis- Role of Finite State Automata in Lexical Analysis, Design of Lexical analyzer, data structures used.	
	4.2	Syntax Analysis- Types of Parsers: Top down parser- LL(1), Bottom up parser- SR Parser, Operator precedence parser, SLR. Semantic Analysis: Syntax directed definitions.	
5		**Compilers: Synthesis phase**	10
	5.1	Intermediate Code Generation: Types of Intermediate codes: Syntax tree, Postfix notation, three address codes: Triples and Quadruples, indirect triple. Code Optimization: Need and sources of optimization, Code optimization techniques: Machine Dependent and Machine Independent. Code Generation: Issues in the design of code generator, code generation algorithm. Basic block and flow graph.	
6		**Runtime Environment Management**	5
	6.1	Data Structures for symbol table, representing scope information, Error detection and recovery, Error handling Storage allocation strategies, parameter passing, introduction to garbage collection and compaction.	
		Total	**39**

Textbooks:	
1	D. M Dhamdhere: *Systems programming and Operating Systems,* Tata McGraw Hill, Revised Second Edition
2	A. V. Aho, R. Shethi, Monica Lam, J.D. Ulman: *Compilers Principles, Techniques and Tools*, Pearson Education, Second Edition.
3	J. J. Donovan: *Systems Programming* Tata McGraw Hill, Edition 1991
Reference Books:	
1	John R. Levine, Tony Mason & Doug Brown, *Lex & YACC*, O 'Reilly publication, second Edition
2	D, M .Dhamdhere ,*Compiler construction* 2e, Macmillan publication, second edition .
3	Kenneth C. Louden ,*Compiler construction: principles and practices*, Cengage Learning
4	Leland L. Beck, *System software: An introduction to system programming*, Pearson publication, Third Edition

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks

11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code:	Course Title	Credit
CSC602	Cryptography & System Security	3

Prerequisite: Computer Networks	
Course Objectives:	
1	To introduce system security goals, ethical hacking and system security concepts.
2	To explore the classical encryption techniques, working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms.
3	To explore the design issues and working principles of various authentication protocols, PKI standards and various secure communication standards including Kerberos, IPsec, and SSL/TLS.
4	To develop the ability to use existing cryptographic utilities to build programs for secure communication
5	To understand cyber crimes and cyber security.
Course Outcomes:	
1	Understand system security goals, ethical hacking and concepts,–analyze and apply system security concepts to recognize malicious code.
2	Understand classical encryption techniques, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication
3	Understand and analyze the symmetric public-key cryptography, RSA and other public-key cryptosystems ,the key distribution and management schemes
4	Apply different message digest and digital signature algorithms to verify integrity and achieve authentication and design secure applications
5	Understand network security basics, analyze different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPSec, and PGP and S/MIME
6	Understand various cyber crimes and cyber security

Module		Content	Hours
1		**Introduction - Number Theory and Basic Cryptography**	8
	1.1	Security Goals, Attacks, Services and Mechanisms, Techniques. Concept of Ethical Hacking and essential terminologies-Threat,Attack,Vulnerabilities, Reconnaissance and Footprinting.	

	1.2	System Security: Buffer Overflow, malicious Programs: Worms and Viruses	
	1.3	Modular Arithmetic: Euclidean Algorithm, Fermat's and Euler's theorem Classical Encryption techniques, Symmetric cipher model, monoalphabetic and polyalphabetic substitution techniques: Vigenere cipher, playfair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers	
2		**Symmetric and Asymmetric key Cryptography and key Management**	8
	2.1	Block cipher principles, block cipher modes of operation, DES, Double DES, Triple DES, Advanced Encryption Standard (AES), Introduction to Stream Ciphers	
	2.2	Public key cryptography: Principles of public key cryptosystems- The RSA Cryptosystem	
3		**Cryptographic Hash Functions & Key Distribution**	6
	3.1	Cryptographic Hash Functions: Properties of secure hash function, SHA-512, MAC, HMAC	
	3.2	Symmetric Key Distribution: KDC, Needham-schroeder protocol. Kerberos: Kerberos Authentication protocol, Symmetric key agreement: Diffie Hellman, Public key Distribution: Digital Certificate: X.509	
4		**Authentication Protocols & Digital Signature Schemes**	4
	4.1	User Authentication, Entity Authentication: Password Base, Challenge Response Based	
	4.2	Digital Signature, Attacks on Digital Signature, Digital Signature Scheme: RSA.	
5		**Network Security and Applications**	8
	5.1	Network security basics: TCP/IP vulnerabilities (Layer wise), Network Attacks: Packet Sniffing, ARP spoofing, port scanning, IP spoofing.	
	5.2	Denial of Service: DOS attacks, ICMP flood, SYN flood, UDP flood, Distributed Denial of Service.	
	5.3	Internet Security Protocols: SSL, IPSEC, PGP. Network security: IDS, Firewalls.	
6		**Cyber Crime And Cyber Security**	5
	6.1	CyberCrime and Information Security, Classifications of Cyber Crimes – Tools and Methods –Password Cracking, Keyloggers, Spywares, SQL Injection – Network Access Control.	
	6.2	Web Security: Electronic Payment SET.	
		Total	**39**

Textbooks:	
1	William Stallings, *"Cryptography and Network Security, Principles and Practice"*, 6th Edition, Pearson Education, March 2013
2	Behrouz A. Ferouzan, *"Cryptography & Network Security"*, Tata McGraw Hill
3	Behrouz A. Forouzan & Debdeep Mukhopadhyay, *"Cryptography and Network Security"* 3rd Edition, McGraw Hill
4	Nina Godbole, Sunit Belapure, "*Cyber Security: Understanding Cyber crimes, Computer Forensics and Legal Perspectives*", First Edition, Wiley India, 2011.
5	*Open Source Intelligence Methods and Tools: A Practical Guide to Online Intelligence* by Nihad A. Hassan (Author), Rami Hijazi (Author)
Reference Books:	
1	Bruce Schneier, *"Applied Cryptography, Protocols Algorithms and Source Code in C",* Second Edition, Wiley.
2	Atul Kahate, *"Cryptography and Network Security",* Tata McGraw-Hill Education, 2003.
3	Charles Pfleeger, Shari Pfleeger, Jonathan Margulies, "*Security in Computing*", Fifth Edition, Prentice Hall, New Delhi, 2015.
4	Eric Cole, *"Network Security Bible",* Second Edition, Wiley, 2011.
5	*OSINT Techniques - Resources for Uncovering Online Information* - 10th Edition (2023) by Michael Bazzell

Internal Assessment:		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment:		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.		
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1	Multiple Choice Questions (Quiz)	5 Marks
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5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks

6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
CSC603	**Mobile Computing**	**3**

Prerequisite: Computer Networks	
Course Objectives:	
1	To introduce the basic concepts and principles in mobile computing. This includes major techniques involved, and networks & systems issues for the design and implementation of mobile computing systems and applications.
2	To explore both theoretical and practical issues of mobile computing.
3	To provide an opportunity for students to understand the key components and technologies involved and to gain hands-on experiences in building mobile applications.
Course Outcomes:	
1	To identify basic concepts and principles in computing, cellular architecture.
2	To describe architecture and interfaces of GSM,GPRS , UTRAN,LTE,VoLTE and SON-LTE
3	To describe the concepts of Infrastructure based WLAN and its standards.
4	To identify Ad hoc WLAN networks- Bluetooth, MANET and VANET.
5	To identify various components and components of Mobile IP and Mobile TCP
6	To describe advancements in the field of mobile communication

Module		Content	Hours
1		**Introduction to Mobile Computing**	4
	1.1	Introduction to Mobile Computing, Electromagnetic Spectrum, Telecommunication Generations, Cellular systems, Spread Spectrum: DSSS & FHSS, Co-channel interference	
2		**Cellular Networks**	9
	2.1	GSM Mobile services, System Architecture, Localization and Calling, Handover, GSM security (A3, A5 & A8)	
	2.2	GPRS system and protocol architecture	
	2.3	MTS , LTE, Voice over LTE (VoLTE)	
	2.4	Self-Organizing Network (SON-LTE), Comparison between Different Generations (2G, 3G, 4G and 5G)	

3		**Wireless Local Area Networks - Infrastructure**	6
	3.1	Wireless Local Area Networks: Introduction, Infrastructure and ad-hoc network, Medium Access Protocol: CSMA/CA, MACA (with Hidden/Exposed station problems)	
	3.2	IEEE 802.11:System architecture , Protocol architecture , Physical layer, Medium access control layer, MAC management, 802.11x, WiFi Security: WEP ,WPA	
4		**Wireless Local Area Networks - Adhoc Networks**	8
	4.1	Bluetooth: Introduction, User Scenario, Architecture, protocol stack	
	4.2	MANETs : DSR, DSDV, AODV, VANETs : Architecture	
5		**Mobile Networking**	8
	5.1	Mobile IP: IP Packet Delivery, Agent Advertisement and Discovery, Registration, Tunneling and Encapsulation, Reverse Tunneling. Mobility Management : Introduction, IP Mobility, Optimization	
	5.2	Mobile TCP**:** Traditional TCP, Classical TCP Improvements like Indirect TCP, Snooping TCP & Mobile TCP, Fast Retransmit/ Fast Recovery, Transmission/Timeout Freezing, Selective Retransmission	
6		**Trends in Mobile Computing**	4
	6.1	IOT Mobile App , AI Mobile App, Mobile Cloud Computing, Edge Computing, AR/VR Applications, M Commerce, Mobile Cross Platform	
		Total	**39**

Textbooks:	
1	Jochen Schiller,‖Mobile Communication, Addision wesley,Pearson Education
2	.Wireless Communications & Networks,By William Stallings, Second Edition, Pearson Education
3	Raj Kamal, Mobile Computing, 2/e , Oxford University Press-New Delhi
Reference Books:	
1	LTE Self-Organizing Networks (SON): Network Management Automation for Operational Efficiency, Seppo Hamalainen, Henning Sanneck , Cinzia Sartori, Wiley publications
2	Christopher Cox, ―An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications,‖ Wiley publications
3	Mobility Protocols and Handover Optimization: Design, Evaluation and Application By Ashutosh Dutta, Henning Schulzrinne, IEEE Press, Wiley Publication
4	Michael Gregg, ―Build your own security lab,‖ Wiley India edition
5	Emerging Wireless Technologies and the Future Mobile Internet, Dipankar Raychaudhuri, Mario Gerla, Cambridge.
6	Andreas F.Molisch, ―Wireless Communications,‖ Second Edition, Wiley Publications.
7	Agilent Technologies, Moray Rumney ,“LTE and the Evolution to 4G Wireless_ Design and Measurement Challenges”,Wiley Publication(2013)
8	Jonathan Rodriguez - Fundamentals of 5G Mobile Networks-Wiley (2015)

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
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4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks

6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
CSC604	**Artificial Intelligence**	**3**

Prerequisite: Discrete Mathematics, Data Structures, Analysis of Algorithms	
Course Objectives:	
1	To conceptualize the basic ideas and techniques underlying the design of intelligent systems.
2	To understand problem formulation and various searching techniques for solving problems.
3	To analyze and create knowledge base, represent knowledge and apply reasoning using AI language.
4	To impart the knowledge of various types of planning and forms of learning
Course Outcomes:	
1	Develop a basic understanding of AI building blocks presented in intelligent agents.
2	Analyze appropriate searching techniques for problem solving.
3	Understand adversarial search algorithms to develop gaming applications.
4	Apply knowledge base and reasoning for a given problem.
5	Plan and design an AI model using appropriate learning methods
6	Design and develop AI applications in real world scenarios

Module		Content	Hours
1		**Introduction to Artificial Intelligence and Intelligent Agents**	4
	1.1	Introduction, History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI. Intelligent Agents: Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Agents.	
2		**Problem Solving and Searching Techniques**	8
	2.1	Solving problems by Searching: Problem Solving Agent, Formulating Problems, Example Problems.	
	2.2	Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Uniform Cost Search, Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Methods: Greedy best first Search, A* Search, Memory bounded heuristic Search.	
3		**Optimization and Adversarial Search**	5

	3.1	Local Search Algorithms and Optimization Problems: Hill climbing search Simulated annealing, Local beam search, Genetic algorithms	
	3.2	Adversarial Search: Game Playing, Min-Max Search, Alpha Beta Pruning	
4		**Knowledge and Reasoning**	10
	4.1	Knowledge based Agents, Brief Overview of propositional logic, First Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, backward Chaining.	
	4.2	Knowledge Engineering in First-Order Logic, Unification, Resolution, Various approaches to Knowledge Representation**.**	
	4.3	Uncertain Knowledge and Reasoning: Uncertainty, Representing knowledge in an uncertain domain, Introduction to Bayesian Belief Network.	
5		**Planning and Learning**	8
	5.1	The planning problem, Planning with state space search, Partial order planning, Hierarchical planning and Introduction to Planning and Acting in Nondeterministic Domain.	
	5.2	Learning: Forms of Learning, Theory of Learning, PAC learning. Introduction to Reinforcement learning: Learning from Rewards, Passive Reinforcement Learning, Active reinforcement Learning.	
6		**AI tools and Industrial Trends**	4
	6.1	AI tools : Stable diffusion using Dreamstudio, Lumen5, Deep Nostalgia, Looka.	
	6.2	Industrial trends in AI : Generative AI, Ethics and regulation	
		Total	**39**

Textbooks:	
1	Stuart J. Russell and Peter Norvig, "*Artificial Intelligence: A Modern Approach*", Fourth Edition" Pearson Education, 2020.
2	Saroj Kaushik, "*Artificial Intelligence*", Cengage Learning, First edition, 2011
3	George F Luger, "*Artificial Intelligence*" Low Price Edition, Fourth edition, Pearson Education.,2005
4	Practical Artificial Intelligence: Machine Learning, Bots, and Agent Solutions Using C#, Arnaldo Pérez Castaño
5	Applied Artificial Intelligence: A Handbook For Business Leaders, Mariya Yao, Adelyn Zhou, Marlene Jia.
Reference Books:	
1	Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.
2	Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
3	Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education
4	Elaine Rich and Kevin Knight, "*Artificial Intelligence*", Third Edition, McGraw Hill Education,2017.
5	AI-Structures and Strategies for Complex Problem Solving., George Lugar, . 4/e, 2002, Pearson Education
6	https://courses.cs.washington.edu/courses/cse473/06sp/pddl.pdf

Internal Assessment:		
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Continuous Assessment:		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.		
Sr. No	**Rubrics**	**Marks**
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Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
CSDLO6011	**Internet of Things (IoT)**	**3**

Prerequisite: C programming, Digital Logic and Computer Architecture, Microprocessor, Computer Networks.	
Course Objectives:	
1	To equip students with the fundamental knowledge and basic technical competence in the field of the Internet of Things (IoT).
2	To emphasize to learn core IoT functional Stack and application layer protocols
3	To study and understand the different sensors, actuators, and IoT enabling technologies IoT and apply the knowledge to IoT industries.
4	To examine prototyping boards like Arduino and Raspberry Pi to develop useful projects or products.
Course Outcomes:	
1	Understand the concepts of IoT and the Things in IoT. Understand the concepts of the IoT and its architecture.
2	Describe the things in IoT and IoT enabling technologies.
3	Understand the core IoT functional Stack and application protocols for IoT.
4	Apply the knowledge to build a small application using development boards.
5	Apply IoT knowledge to key industries that IoT is revolutionizing.
6	Gain and apply the knowledge to integrate AI with IoT for necessary applications.

Module		Content	Hours
1		**Introduction to Internet of Things (IoT) and IoT Architecture**	7
	1.1	What is IoT? - IoT and Digitization, Convergence of IT and OT, IoT Challenge	
	1.2	Drivers Behind New Network Architectures	
	1.3	Comparing IoT Architectures: The oneM2M IoT Standardized Architecture, The IoT World Forum (IoTWF) Standardized Architecture	
	1.4	A Simplified IoT Architecture	
2		**The “Things” in IoT and Enabling IoT Technologies**	7
	2.1	Sensors and actuators definition, principles, classifications, types, characteristics, and specifications	

	2.2	Smart Objects: A Definition, Trends in Smart Objects	
	2.3	Sensor Networks – Architecture of Wireless Sensor Network, Network Topologies	
	2.4	Enabling IoT Technologies - Radio Frequency Identification Technology, Micro-Electro-Mechanical Systems (MEMS), NFC (Near Field Communication),Bluetooth Low Energy (BLE), LTE-A (LTE Advanced), IEEE 802.15.4–Standardization and Alliances, ZigBee	
3		**Core IoT Functional Stack and application layer protocols**	10
	3.1	The Core IoT Functional Stack Layer 1 – Things: Sensors and Actuators Layer Layer 2 – Communications Network Layer, Access Network Sublayer, Gateways and Backhaul Sublayer, Network Transport Sublayer, IoT Network Management Sublayer Layer 3 – Applications and Analytics Layer, Analytics Vs. Control Applications, Data Vs. Network Analytics	
	3.2	IoT Data Management and Compute Stack – Design considerations and Data related problems, Fog Computing, Edge Computing, The Hierarchy of Edge, Fog and Cloud	
	3.3	IoT Application Transport Methods, Application Layer Protocol Not Present, SCADA, Generic Web-Based Protocols,Application Layer protocols: COAP, MQTT and REST API	
4		**Build your own IoT**	5
	4.1	Introduction to Arduino- Features, pin configuration, interfacing to build an application	
	4.2	Introduction to RaspberryPi- Features, pin configuration, interfacing to build an application. Comparison of Arduino and RaspberryPi	
5		**IoT applications**	6
	5.1	Home Automation and smart cities – Smart Parking, Smart Lighting, Smart Appliances,smart roads	
	5.2	Health & Lifestyle – Health & Fitness Monitoring, Wearable Electronics	
	5.3	Agriculture – Smart Irrigation, GreenHouse Control, Precision agriculture	
	5.4	Industry – Machine Diagnostics & Prognosis, Indoor Air Quality Monitoring	
	5.5	Logistics – Route Generation & Scheduling, Shipment Monitoring	
	5.6	Environment – Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection	
	5.7	Energy – Smart Grids, Renewable Energy Systems	
	5.8	Retail – Inventory Management, Smart Payments, Smart Vending Machines	
6		IIoT: Industrial Internet of Things and AIoT: Integration of AI with IoT	4

	6.1	Introduction to IIoT, challenges and applications	
	6.2	Introduction to AIoT, Necessity, Benefit and applications	
		Total	**39**

Textbooks:	
1	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, “IoT Fundamentals – Networking Technologies, Protocols, and Use Cases for the Internet of Things”, 1st Edition, Published by Pearson Education, Inc, publishing as Cisco Press, 2017
2	Hakima Chaouchi, “The Internet of Things - Connecting Objects to the Web”, 1st Edition, Wiley, 2010
3	Perry Lea, “Internet of things For Architects”, 1st Edition, Packt Publication, 2018
4	Arshdeep Bahga, Vijay Madisetti, “Internet of Things – Hands-On Approach”, 2nd Edition, Universities Press, 2016.
Reference Books:	
1	Adrian McEwen & Hakim Cassimally, “Designing the Internet of Things”, 1st Edition, Wiley, 2014.
2	Donald Norris, “Raspberry Pi – Projects for the Evil Genius”, 2nd Edition, McGraw Hill, 2014.
3	Anand Tamboli ,“Build Your Own IoT Platform”, 1st Edition, Apress, 2019.

Internal Assessment:

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Continuous Assessment:

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1	Mock Viva/Practical	
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End Semester Theory Examination:		
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2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code:	Course Title	Credit
CSDLO6012	**Digital Signal & Image Processing**	**3**

Prerequisite: Applied Engineering Mathematics	
Course Objectives:	
1	To understand the fundamental concepts of digital signal processing and Image processing
2	To explore DFT for 1-D and 2-D signal and FFT for 1-D signal
3	To apply processing techniques on 1-D and Image signals
4	To apply digital image processing techniques for edge detection
Course Outcomes:	
1	Understand the concept of DT Signal and DT Systems
2	Classify and analyze discrete time signals and systems
3	Implement Digital Signal Transform techniques DFT and FFT
4	Differentiate between the advantages and disadvantages of different edge detection techniques
5	Use the enhancement techniques for digital Image Processing
6	Apply image segmentation techniques

Module		Content	Hours
1		**Discrete-Time Signal and Discrete-Time System**	10
	1.1	Introduction to Digital Signal Processing, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations (shifting, reversal, scaling, addition, multiplication).	
	1.2	Classification of Discrete-Time Signals, Classification of DiscreteSystems	
	1.3	Linear Convolution formulation for 1-D signal (without mathematical proof), Circular Convolution (without mathematical proof), Linear convolution using Circular Convolution. Auto and Cross Correlation formula evaluation, Concept of LTI system, Output of DT system using Time Domain Linear Convolution.	
2		**Discrete Fourier Transform**	5
	2.1	Introduction to DTFT, DFT, Relation between DFT and DTFT, IDFT	

	2.2	Properties of DFT without mathematical proof (Scaling and Linearity, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parseval's Energy Theorem). DFT computation using DFT properties.	
	2.3	Convolution of long sequences, Introduction to 2-D DFT	
3		**Fast Fourier Transform**	4
	3.1	Need of FFT, Radix-2 DIT-FFT algorithm	
	3.2	DIT-FFT Flow graph for N=4 and 8, Inverse FFT algorithm	
	3.3	Spectral Analysis using FFT	
4		**Digital Image Fundamentals**	5
	4.1	Introduction to Digital Image, Digital Image Processing System, Sampling and Quantization	
	4.2	Representation of Digital Image, Connectivity	
	4.3	Image File Formats: BMP, TIFF and JPEG.	
5		**Image Enhancement in Spatial domain**	9
	5.1	Gray Level Transformations, Zero Memory Point Operations,	
	5.2	Histogram Processing, Histogram equalization.	
	5.3	Neighborhood processing, Image averaging, Image Subtraction, Smoothing Filters - Low pass averaging, Sharpening Filters-High Pass Filter, High Boost Filter, Median Filter for reduction of noise	
6		Image Segmentation	6
	6.1	Fundamentals, Segmentation based on Discontinuities and Similarities	
	6.2	Point, line and Edge Detection, Image edge detection using Robert, Prewitt and Sobel masks, Image edge Detection using Laplacian mask	
	6.3	Region based segmentation: Region Growing, Region Splitting and Merging	
		Total	**39**

Textbooks:	
1	John G. Proakis, Dimitris and G .Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, 4th Edition, Pearson Education, 2007
2	A. Anand Kumar, “Digital Signal Processing”, 2nd Edition, PHI Learning Pvt. Ltd. 2014
3	Rafel C. Gonzalez and Richard E. Woods, “Digital Image Processing”, Pearson Education Asia, 4th Edition, 2018.
4	S. Sridhar, “Digital Image Processing”, 2nd Edition, Oxford University Press, 2012.
Reference Books:	
1	Sanjit Mitra, “Digital Signal Processing: A Computer Based Approach”, 4th Edition, Tata McGraw Hill, 2013
2	S. Salivahanan, A. Vallavaraj, and C. Gnanapriya, “Digital Signal Processing”, 2nd Edition, Tata McGraw Hill Publication, 2011.
3	S. Jayaraman, E. Esakkirajan and T. Veerkumar, “Digital Image Processing”, 3rd Edition, Tata McGraw Hill Education Private Ltd, 2009.
4	Anil K. Jain, “Fundamentals of Digital Image Processing”, 4th Edition, Prentice Hall of India Private Ltd,.1989

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9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
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Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code:	Course Title	Credit
CSDLO6013	Quantitative Analysis	3

Prerequisite: Applied Mathematics	
Course Objectives:	
1	Introduction to the basic concepts in Statistics
2	Understand the concept of data collection & sampling methods.
3	Introduction to Correlation and Regression
4	Introduction to Multiple Linear Regression
5	Draw inference using Probability Distributions
6	Tests of Hypothesis
Course Outcomes:	
1	Recognize the need of Statistics and Quantitative Analysis
2	Apply the data collection and the sampling methods.
3	Analyze using concepts of Correlation and Simple Linear Regression
4	Analyze using concepts of Multiple Linear Regression
5	Apply the concept of Probability Distributions in real life examples
6	Apply Testing of Hypothesis

Module		Content	Hours
1		**Introduction to Statistics**	4
	1.1	Functions – Importance – Uses and Limitations of Statistics. Statistical data– Classification, Tabulation, Diagrammatic & Graphic representation of data	
2		**Data Collection & Sampling Methods**	6
	2.1	Primary & Secondary data, Sources of data, Methods of collecting data. Sampling – Census & Sample methods –Methods of sampling, Probability Sampling and Non-Probability Sampling	
3		**Introduction to Regression**	6
	3.1	Mathematical and Statistical Equation – Meaning of Intercept and Slope – Error term – Measure for Model Fit –R2 – MAE – MAPE.	

4		**Introduction to Multiple Linear Regression**	6
	4.1	Multiple Linear Regression Model, Partial Regression Coefficients, Testing Significance overall significance of Overall fit of the model, Testing for Individual Regression Coefficients	
5		**Probability Distributions**	8
	5.1	Binomial Distribution, Poisson Distribution, Normal Distribution, Standard Normal Variate, Central Limit Theorem, Chi-Square Test	
6		**Tests of Hypothesis**	9
	6.1	Hypothesis, Null and Alternative hypothesis, Types of errors: Type - I and Type - II errors, One Tailed and Two Tailed Test, Student's t-distribution (Small Samples test), z-test (Large Samples Test),	
		Total	**39**

Textbooks:	
1	Agarwal, B.L. (2006):-Basic Statistics. Wiley Eastern Ltd., New Delhi
2	Gupta, S. P. (2011):-Statistical Methods. Sultan chand & Sons, New Delhi
3	Sivathanu Pillai, M & Rajagopal, K. R. (1979):-Statistics for Economics Students.
4	Hogg ,R.V. and Craig, A.T.(2006), An introduction to mathematical statistics, Amerind publications.
Reference Books:	
1	Arora, P.N., SumeetArora, S. Arora (2007):- Comprehensive Statistical Methods. Sultan Chand, New Delhi
2	Montgomery,D.C. ,Peck E.A, & Vining G.G.(2003). Introduction to Linear Regression Analysis. John Wiley and Sons,Inc.NY
3	Mood AM, Graybill FA, and Boes, D.C.(1985), Introduction to the theory of statistics, McGrawhill Book Company, New Delhi.
4	Kapur, J.N. and Saxena,H.C.(1970), Mathematical statistics, Sultan Chand & company, New Delhi..

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Indirect Assessment	
1	Mock Viva/Practical
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3	Extra Assignments/lab/lecture

End Semester Theory Examination:	
1	Question Paper will comprise a total of six questions
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Lab Code	Lab Name	Credit
CSL601	**System Programming and Compiler Construction Lab**	**1**

Prerequisite: Theoretical computer science, Operating system. Computer Organization and Architecture	
Lab Objectives:	
1	To understand the basic concepts and designing of assembler and macro processor.
2	To Explore the analysis and synthesis phase of the compiler.
3	To understand the role of compiler generation tools like LEx and YACC.
Lab Outcomes:	
1	Generate machine code by implementing two pass assemblers.
2	Implement a two pass macro processor.
3	Parse the given input string by constructing Top down/Bottom-up parser.
4	Identify and Validate tokens for given high level language and Implement synthesis phase of compiler.
5.	Explore LEX & YACC tools and implement phases of compiler using the same.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Implementation of Lexical Analyzer in C / Java / Python.
2	Implement Lexical Analyzer using FLEX a. Count no of Vowels & Consonants. b. Count no of Words, characters & lines c. Count no of keywords,identifiers & operators. d. Identify Even & odd integers. e. Count of printf & scanf statements in C program. f. Classify English words as verbs, adverbs, adjectives etc..
3	Implementation of Left Recursion Removal.
4	Write a program to find FIRST & FOLLOW Symbols for the given grammar.
5	Implement Syntax Analyzer(LL1) using C / Java / Python a. Generate the Predictive Parsing Table (take FIRST and FOLLOW as input for any grammar). b. Perform Parsing action for valid & invalid inputs based on the Parsing Table Generated.
6	Implement programs using parser generator tool : YACC

	a. Implement Simple Calculator. b. Recognize nested 'If' statements and display levels. c. Write a program to recognize a valid variable in C language.
7	Implement code optimization techniques.
8	Implement Intermediate Code Generation using LEX and YACC.
9	Implement data structure for Pass-1 of Two Pass Assembler.
10	Implement Pass-2 of Two Pass Assembler taking required data structure as input.
11	Implement data structure for two Pass Macro-Processor.

Useful Links:	
1	https://gnuwin32.sourceforge.net/packages/flex.htm
2	https://gnuwin32.sourceforge.net/packages/bison.htm

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks).
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSC601 and CSL601 syllabus

Lab Code	Lab Name	Credit
CSL602	**Cryptography & System Security Lab**	**1**

Prerequisite: Computer Network	
Lab Objectives:	
1	To apply various encryption techniques
2	To study and implement various security mechanism
3	To explore the network security concept and tools
4	To incorporate ethical usage of OSINT tools
Lab Outcomes:	
1	Apply the knowledge of symmetric and asymmetric cryptography to implement simple ciphers.
2	Explore the different network reconnaissance tools to gather information about networks
3	Explore and use tools like sniffers, port scanners and other related tools for analysing packets in a Network.
4	Set up firewalls and intrusion detection systems using open-source technologies and to explore email security.
5	Explore various attacks like buffer-overflow and web application attacks.
6	Use Open Source Intelligent tools for analysis of fake news, image, video data.

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Name of the Experiment
1	Design and Implementation using Substitution ciphers:Caesar Cipher Auto Key Cipher, PlayFair Cipher
2	Design and Implementation using Transposition ciphers:Keyed transposition cipher, Keyless transposition Cipher
3	(i) Implementation and analysis of RSA cryptosystem. (ii) Implementation of Diffie Hellman Key exchange algorithm
4	For varying message sizes, test integrity of message and analyse the performance of the protocols. Use crypt APIs.
5	(i) Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, UDP port scan, xmas scan etc. (ii) Detects ARP spoofing using nmap and/or open-source tool ARPWATCH and wireshark. Use arping tool to generate gratuitous arps and monitor using wireshark
6	(i) Explore the GPG tool of linux to implement email security

	(ii) SQL injection attack, Cross-Site Scripting attack simulation
7	Using OSINT tools such as (theHarvester) you can gather information like emails, subdomains, hosts, employee names, open ports and banners from different public sources like search engines, PGP key servers.
8	(i) Utilize website crawling OSINT tools to gather a comprehensive list of URLs, internal links, and structure of the website. (ii) Use OSINT Tools to identify the technologies and frameworks used by the website, such as content management systems (CMS), server software, programming languages, or analytics tools and create vulnerability reports.
9	Determine the geolocation (country, city, or approximate location) of each IP address (atleast 10) One can use online IP geolocation tools, databases, and various techniques to gather information and accurately identify the physical location associated with each IP Link: https://www.kali.org/tools/spiderfoot/
10	Case Study /Seminar: Topic beyond syllabus related to topics covered. Example: Fake News detection - Analyze at least 5 OSINT tools to detect, verify, authenticate, fake news and report .

Useful Links:	
1	https://www.kali.org/tools/theharvester/
2	https://www.kali.org/tools/spiderfoot/
3	https://www.kali.org/tools/gospider/
4	https://seon.io/try-for-free/
5	https://help.shodan.io/command-line-interface/0-installation
6	https://www.kali.org/tools/recon-ng/
7	https://www.kali.org/tools/metagoofil/

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSC602 and CSL602

Lab Code	Lab Name	Credit
CSL603	**Mobile Computing Lab**	**1**

Prerequisite: Computer network	
Lab Objectives:	
1	To learn , design,develop and deploy mobile applications for popular platforms
2	To Learn and apply UI/UX design principles for mobile interface development
Lab Outcomes:	
1	Design Mobile Application UI keeping principles of UI design
2	Implement creative UI using Animations,Navigation and Multiple screens
3	Implement forms and storage for mobile applications and data handling using RESTFUL API
4	Implement user data security with authentication and authorization
5	Implement multimedia and device features
6	To test and optimize the designed UI

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Name of the Experiment
1	Title : Basic UI Design Objective: Understand the fundamentals of UI design for mobile applications. Experiment: ● Introduction to mobile UI design principles and guidelines. ● Analyze popular mobile apps to identify common UI elements. ● Design a basic UI layout using wireframing tools like Figma / Adobe XD ● Implement basic UI elements such as buttons, text fields, and labels. ● Experiment with different layout options and color schemes. ● Test the UI design on a mobile device or emulator for usability and responsiveness
2	Title : Implementing Animations Objective: Explore animations and create visually appealing UI effects. Experiment: ● Build an app that incorporates animations. ● Experiment with different animation types such as fade-ins, slide transitions, or rotation effects. ● Apply animations to widgets, screens, or specific UI elements to enhance the user experience.
3	Title : Navigation and Multiple Screens Objective: Understanding Screen Navigation using buttons or gestures.

	Experiment : ● Expand on the previous experiment by adding multiple screens to your mobile app. ● Implement navigation between screens using buttons or gestures. ● Experiment with different navigation patterns such as tab bars or side menus.
4	Title : Data Input and Storage Objective : To understand working of forms and storage in mobile app Experiment : ● Add functionality to input data into your app, such as a form or questionnaire. ● Explore different data input controls like checkboxes, dropdowns, and sliders. ● Store and retrieve data using local storage or a simple database like SQLite.
5	Title : RESTFUL API Integration Objective : To learn Data handling using API's Experiment : ● Make your own API to Connect your mobile app (Flask / Django) ● Connect your mobile app to an external API (e.g., weather, news, or social media API). ● Retrieve data from the API and display it in your app. ● Implement basic error handling and data validation.
6	Title : User Authentication and Authorization Objective: To implement data security with authentication and authorization Experiment: ● Implement user registration and login functionality in your app. ● Use a standard secure authentication mechanism ● Restrict access to certain app features based on user roles or permissions.
7	Title : Multimedia Features Objective: To learn handling on multimedia content on mobile app Experiment: ● Incorporate multimedia features like the camera, photo gallery, or audio/video playback. ● Implement a QR code scanner
8	Title : Device Features Objective: Experiment: ● Experiment with device-specific features like a. GPS b. Bluetooth c. Biometric d. Accelerometer e. Gyroscope ● Implement features like shake detection, tilt control, or step counting.
9	Title : UI Testing(using UI Automator) Objective: To test the how different features are supported by the UI Experiment: ● Add UIAutomator library dependency ● Create a UIAutomator test ● Write the test case ● Run the test
10	Title : Performance Testing Objective: To use standard tools to test the performance of the app (Eg: Espresso / Appium) Experiment:

	● Analyze and optimize your app's performance, including startup time, response time, and memory usage. ● Test your app on different devices and network conditions to identify and address performance bottlenecks.
11	Title : Optimization Objective: To optimize the performance of the app in different scenarios (Eg: Espresso / Appium) Experiment: ● Implement techniques like lazy loading, caching, or background processing to improve performance.

Useful Links:	
1	https://www.coursera.org/learn/smart-device-mobile-emerging-technologies 2
2	https://nptel.ac.in/courses/106/106/106106167/

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSC603 and CSL603

Lab Code	Lab Name	Credit
CSL604	**Artificial Intelligence Lab**	**1**

Prerequisite: Theoretical computer science, Operating system. Computer Organization and Architecture	
Lab Objectives:	
1	To realize the basic techniques to build expert systems
2	To apply appropriate search techniques used in problem solving
3	To create knowledge base and apply reasoning for real world problems
4	To distinguish between various planning and learning techniques
Lab Outcomes:	
1	Identify languages and technologies for Artificial Intelligence
2	Understand and implement uninformed, informed and local searching techniques for real world problems.
3	Create a knowledge base and apply reasoning using any AI language
4	Identify and analyze the appropriate planning and learning techniques.
5	Design and implement expert systems for real world problems.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Identify and formulate an appropriate real world problem statement relevant to AI and define its PEAS descriptor and various properties of the environment.
2	Implement Family Tree / Tower of Hanoi / Water Jug Problem in PROLOG
3	Implement any one of the uninformed Searching algorithms (BFS / DFS / DLS / IDDFS) by identifying and analyzing the given problem to reach the goal state.
4	Implement A* search algorithm by identifying and analyzing the given problem to reach the goal state.
5	Implement Adversarial search for Game playing algorithms.
6	Implement Local Search algorithm for optimization : Hill climbing search / Genetic Algorithm
7	To create a knowledge base for a Rule based Expert System in a real world scenario using FOL in PROLOG.

8	Identify, analyze, implement a planning problem using PDDL
9	Implement passive or active reinforcement learning.
10	Implement AI trends using any one of the AI tools - Dreamstudio, Looka, Lumen5, Deep Nostalgia.

Useful Links:	
1	https://www.analyticsvidhya.com/blog/2023/05/emerging-trends-in-ai-and-machine-learning
2	https://influencermarketinghub.com/ai-trends
3	https://www.forbes.com/sites/bernardmarr/2023/02/28/beyond-chatgpt-14-mind-blowing-ai-tools-everyone-should-be-trying-out-now/

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSC604 and CSL604

Lab Code	Lab Name	Credit
CSL605	**Cloud Computing Lab**	**2**

Prerequisite: Computer Networks	
Lab Objectives:	
1	To make students familiar with key concepts of virtualization.
2	To make students familiar with various deployment models of cloud such as private, public, hybrid and community so that they start using and adopting appropriate types of cloud for their application.
3	To make students familiar with various service models such as IaaS, SaaS, PaaS and Security as a Service (SECaaS) .
4	To make students familiar with security and privacy issues in cloud computing and how to address them.
Lab Outcomes:	
1	Implement different types of virtualization techniques.
2	Analyze various cloud computing service models and implement them to solve the given problems.
3	Design and develop real world web applications and deploy them on commercial cloud(s).
4	Explore security issues in the cloud and mechanisms to address them.
5	Explore various commercially available cloud services with their features and recommend the appropriate one for the given application.
6	Implement the concept of containerization

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Title: Introduction and overview of cloud computing. Objective: To understand the origin of cloud computing, cloud cube model, NIST model, characteristics of cloud, different deployment models, service models, advantages and disadvantages.
2	Title**:** To study and implement Hosted Virtualization using VirtualBox & KVM. Objective**:** To know the concept of Virtualization along with their types, structures and mechanisms. This experiment should demonstrate the creating and running Virtual machines inside hosted hypervisors like VirtualBox and KVM with their comparison based on various virtualization parameters.

3	Title: To study and Implement Bare-metal Virtualization using Xen, HyperV or VMware Esxi. Objective: To understand the functionality of Bare-metal hypervisors and their relevance in cloud computing platforms. This experiment should have demonstration of install, configure and manage Bare Metal hypervisor along with instructions to create and run virtual machines inside it. It should also emphasize on accessing VMs in different environments along with additional services provided by them like Load balancing, Auto-Scaling, Security etc.
4	Title: To study andImplement Infrastructure as a Service using AWS/Microsoft Azure. Objective: To demonstrate the steps to create and run virtual machines inside Public cloud platform. This experiment should emphasize on creating and running Linux/Windows Virtual machine inside Amazon EC2 or Microsoft Azure Compute and accessing them using RDP or VNC tools.
5	Title: To study andImplement Platform as a Service using AWS Elastic Beanstalk/ Microsoft Azure App Service. Objective: To demonstrate the steps to deploy Web applications or Web services written in different languages on AWS Elastic Beanstalk/ Microsoft Azure App Service.
6	Title: To study andImplementStorage as a Service using Own Cloud/ AWS S3, Glaciers/ Azure Storage. Objective: To understand the concept of Cloud storage and to demonstrate the different types of storages like object storage, block level storages etc. supported by Cloud Platforms like Own Cloud/ AWS S3, Glaciers/ Azure Storage.
7	Title: Serverless computing - Develop a simple serverless function using a platform like AWS Lambda or Google Cloud Functions. Trigger the function based on events or schedules. Objective: Explore the serverless computing paradigm, understand its benefits (e.g., reduced operational overhead, scalability), and gain hands-on experience with event-driven architectures
8	Title: To study andImplementSecurity as a Service on AWS/Azure Objective**:** To understand the Security practices available in public cloud platforms and to demonstrate various Threat detection, Data protection and Infrastructure protection services in AWS and Azure.
9	Title: Provisioning and scaling resources Objective: To know provisioning by using a cloud platform like Amazon Web Services (AWS) or Microsoft Azure to provision virtual machines (VMs) or containers, and experiment with scaling resources up and down.
10	Title: To study and Implement Containerization using Docker Objective: To know the basic differences between Virtual machine and Container. It involves demonstration of creating, finding, building, installing, and running Linux/Windows application containers inside local machine or cloud platform
11	Title: To study and implement container orchestration using Kubernetes Objective: To understand the steps to deploy Kubernetes Cluster on local systems, deploy applications on Kubernetes, creating a Service in Kubernetes, develop Kubernetes configuration files in YAML and creating a deployment in Kubernetes using YAML
12	Mini-project: Design a Web Application hosted on public cloud platform [It should cover the concept of IaaS, PaaS, DBaaS, Storage as a Service, Security as a Service etc.]

Useful Links:

1	https://www.nist.gov/system/files/documents /itl/cloud/NIST_SP-500-291_Version- 2_2013_June18_FINAL.pdf
2	https://phoenixnap.com/kb/ubuntu-install- kvm\
3	https://docs.citrix.com/en-us/xenserver/7- 1/install.html
4	1) AWS https://docs.aws.amazon.com/ 2) MS Azure https://docs.microsoft.com/en-us/azure
5	https://docs.docker.com/get-started/
6	https://kubernetes.io/docs/home/

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 50 Marks (Experiments: 15-marks, Mini project (Implementation) 15 marks, Mini Project Presentation & Report [for deployment, utilization, monitoring and billing] 10 Marks, Attendance 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSL605

Course Code	Course Title	Credit
CSM601	**Mini Project 2B**	**2**

The project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification, analyzing the problem and designing solutions.	
Course Objectives:	
1	To understand and identify the problem statement
2	To apply basic engineering fundamentals and attempt to find solutions to the chosen problem statement
3	Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
4	To develop communication skills and improve teamwork amongst group members.
5	To apply standard principles of project management and validate the project using appropriate evaluation measures
6	To inculcate the process of self-learning and research.
Course Outcomes:	
1	Identify societal / research / innovation / entrepreneurship problems through appropriate literature surveys
2	Identify methodology for solving above problem and apply engineering knowledge and skills to solve it
3	Validate, Verify the results using test cases/benchmark data/theoretical/ inferences/experiments/simulations
4	Analyze and evaluate the impact of solution / product / research / innovation / entrepreneurship towards societal / environmental / sustainable development
5	Use standard norms of engineering practices and project management principles during project work
6	Communicate through technical report writing and oral presentation. ● The work may result in research / white paper / article / patent / blog writing and research publication ● The work may result in business plan for entrepreneurship product created
7	Gain technical competency by participating in project competitions, hackathons, etc.
8	Demonstrate capabilities of self-learning, leading to lifelong learning.
9	Develop interpersonal skills to work in a group.

Guidelines for Mini Project	
1	Mini project may be carried out in one or more form of following: Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification / development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society / environment, research oriented and application areas, etc.
2	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
3	Students should do surveys and identify needs, which shall be converted into problem statement for a mini project in consultation with project mentor / head of the department / internal committee of faculties.
4	Students shall submit an implementation plan in the form of Gantt / PERT / CPM chart using state-of-the-art industry tools, which will cover weekly activity of mini projects
5	A logbook may be prepared by each group, wherein the group shall record weekly work progress, project guide shall verify and record notes / comments.
6	Students under the guidance of the project guide shall convert the best solution into a working model using various components of their domain areas and demonstrate.
7	The solution to be validated with proper justification and report to be compiled in standard format as per guidelines. Software requirement specification (SRS) documents as per IEEE format, research papers, competition certificates may be submitted as part of annexure to the report.
8	With the focus on self-learning, innovation, addressing societal / research / innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project 2 in semesters V and VI.
9	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements / modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

Term Work		
The review / progress monitoring committee shall be constituted by the heads of departments of each institute. The progress of the mini project to be evaluated on a continuous basis, based on the SRS document submitted. Minimum two reviews in each semester		
Distribution of Term work marks for both semesters shall be as below:		**Marks 25**
1	Marks awarded by project mentor based on logbook	10
2	Marks awarded by review committee	10
3	Timeliness of Project report	05
Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines		
One-year project:		

1	In the one year project (sem V and VI), first semester the entire theoretical solution shall be made ready, including components / system selection, cost, feasibility analysis, conceptual and Detailed design. Two reviews will be conducted based on a presentation given by a student group. ● First shall be for finalization of problem ● Second shall be on finalization of the proposed solution of the problem
2	In the second semester expected work shall be procurement of component's / systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. ● First review is based on readiness of building working prototypes to be conducted. ● Second review shall be based on poster presentation cum demonstration of working model in the last month of the said semester.
Half-year project	
1	In this case in one semester students' group shall complete project in all aspects including, ● Identification of need/problem ● Proposed final solution ● Procurement of components/systems ● Building prototype and testing
2	Two reviews will be conducted for continuous assessment, ● First shall be for finalization of problem and proposed solution ● Second shall be for implementation and testing of solutions.
Mini Project shall be assessed based on following point	
1	Clarity of problem and quality of literature Survey for problem identification
2	Requirement Gathering via Software Requirement Specification (SRS) / Feasibility Study
3	Completeness of methodology implemented
4	Design, Analysis and Further Plan
5	Novelty, Originality or Innovativeness of project
6	Societal / Research impact
7	Effective use of skill set : Standard engineering practices and Project management standard
8	Contribution of an individual's as member or leader
9	Clarity in written and oral communication
10	Verification and validation of the solution / Test Cases using open source testing tools as per trends in industry
11	Full functioning of working model as per stated requirements
12	Technical writing /competition/hackathon outcome being met
In a one year project (sem V and VI), first semester evaluation may be based on the first 10 criteria and remaining may be used for second semester evaluation of performance of students in mini projects.	
In case of half year projects (completing in V sem) all criterias in generic may be considered for evaluation of performance of students in mini projects.	
Guidelines for Assessment of Mini Project Practical / Oral Examination	

1	Report should be prepared as per the guidelines issued .
2	The Mini Project shall be assessed through a presentation and demonstration of the working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by the head of Institution.
3	Students shall be motivated to publish a research paper / patent / participate in competition based on the work in conferences / students competitions

Final Year

With Effect from AY 2023-2024

Program Structure for Fourth Year Computer Engineering

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract / Tut.	Theory	Pract	Total
CSC701	Machine Learning	3	--	3	--	3
CSC702	Big Data Analytics	3	--	3		3
CSDC701X	Department Level Optional Course-3	3	--	3	--	3
CSDC702X	Department Level Optional Course-4	3	--	3	--	3
ILO701X	Institute Level Optional Course-1	3	--	3	--	3
CSL701	Machine Learning Lab	--	2	--	1	1
CSL702	Big Data Analytics Lab	--	2	--	1	1
CSDL 701X	Department Level Optional Course-3 Lab	--	2	--	1	1
CSDL702X	Department Level Optional Course-4 Lab	--	2	--	1	1
CSP701	Major Project I	--	$6^{\$}$	--	3	3
Total		**15**	**14**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam. Duration (in Hrs)			
		Mid Test (MT)	CA*					
CSC701	Machine Learning	20	20	60	2	--	--	100
CSC702	Big Data Analysis	20	20	60	2	--	--	100
CSDC701X	Department Level Optional Course-3	20	20	60	2	--	--	100
CSDC702X	Department Level Optional Course-4	20	20	60	2	--	--	100
ILO701X	Institute Level Optional Course-1	20	20	60	2	--	--	100
CSL701	Machine Learning Lab	--	--	--	--	25	25	50
CSL702	Big Data Analytics Lab	--	--	--	--	25	25	50
CSDL701X	Department Level Optional Course-3 Lab					25	-	25
CSDL702X	Department Level Optional Course-4 Lab	--	--	--	--	25	-	25
CSP701	Major Project 1	--	--	--	--	50	25	75
Total		**100**	**100**	**300**	--	**150**	**75**	**725**

* indicates Continuous Assessment.

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract / Tut.	Theory	Pract	Total
CSC801	Distributed Computing	3	--	3	--	3
CSDC801X	Department Level Optional Course -5	3	--	3	--	3
CSDC802X	Department Level Optional Course -6	3	--	3	--	3
ILO801X	Institute Level Optional Course -2	3	--	3	--	3
CSL801	Distributed Computing Lab	--	2	--	1	1
CSDL801X	Department Level Optional Course -5 Lab	--	2	--	1	1
CSDL802X	Department Level Optional Course -6 Lab	--	2	--	1	1
CSP801	Major Project II	--	$12^{\$}$	--	6	6
Total		**12**	**18**	**12**	**9**	**21**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & Oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (in Hrs)			
		Mid Test (MT)	CA*					
CSC801	Distributed Computing	20	20	60	2	--	--	100
CSDC801 X	Department Level Optional Course -5	20	20	60	2	--	--	100
CSDC802 X	Department Level Optional Course -6	20	20	60	2	--	--	100
ILO801X	Institute Level Optional Course -2	20	20	60	2	--	--	100
CSL801	Distributed Computing Lab	--	--	--	--	25	25	50
CSDL801 X	Department Level Optional Course -5 Lab	--	--	--	--	25	25	50
CSDL802 X	Department Level Optional Course -6 Lab					25	25	50
CSP801	Major Project- 2	--	--	--	--	100	50	150
Total		**80**	**80**	**240**	--	**175**	**125**	**700**

* indicates Continuous Assessment
$ indicates workload of Learner (Not Faculty), students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1 hour per week per four groups.

Major Project 1 and 2 :

· Students can form groups with minimum 2 (Two) and not more than 4 (Four)
· Faculty Load : In Semester VII – ½ hour per week per project group
-In Semester VIII – 1 hour per week per project group

Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject
VII	Department Optional Course -3	CSDC7011: Machine Vision CSDC7012: Quantum Computing CSDC7013: Natural Language Processing
	Department Optional Lab -3	CSDL7011: Machine Vision Lab CSDL7012: Quantum Computing Lab CSDL7013: Natural Language Processing Lab
	Department Optional Course -4	CSDC7021 : Augmented and Virtual Reality CSDC7022 : Block Chain CSDC7023 : Information Retrieval
	Department Optional Lab -4	CSDL7021 : Augmented and Virtual Reality Lab CSDL7022 : BlockChain Lab CSDL7023 : Information Retrieval Lab
	Institute level Optional Courses-I	ILO7011. Product Lifecycle Management ILO7012. Reliability Engineering ILO7013. Management Information System ILO7014. Design of Experiments ILO7015. Operation Research ILO7016. Cyber Security and Laws ILO7017. Disaster Management & Mitigation Measures ILO7018. Energy Audit and Management ILO7019. Development Engineering

Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject
VIII	Department Optional Course -5	CSDC8011 : Deep Learning CSDC8012 : Digital Forensic CSDC8013 : Applied Data Science
	Department Optional Lab -5	CSDL8011 : Deep Learning Lab CSDL8012 : Digital Forensic Lab CSDL8013 : Applied Data Science Lab
	Department Optional Course -6	CSDC8021 : Optimization in Machine Learning CSDC8022: High Performance Computing CSDC8023: Social Media Analytics
	Department Optional Lab -6	CSDL8021 : Optimization in Machine Learning Lab CSDL8022: High Performance Computing Lab CSDL8023: Social Media Analytics Lab
	Institute level Optional Courses-II	ILO8021. Project Management ILO8022. Finance Management ILO8023. Entrepreneurship Development and Management ILO8024. Human Resource Management ILO8025. Professional Ethics and CSR ILO8026. Research Methodology ILO8027. IPR and Patenting ILO8028. Digital Business Management ILO8029. Environmental Management

Course Code	Course Title	Credit
CSC701	Machine Learning	3

Prerequisite: Engineering Mathematics, Data Structures, Algorithms	
Course Objectives:	
1	To introduce the basic concepts and techniques of Machine Learning.
2	To acquire in depth understanding of various supervised and unsupervised algorithms
3	To be able to apply various ensemble techniques for combining ML models.
4	To demonstrate dimensionality reduction techniques.
Course Outcomes: Students will be able	
1	To acquire fundamental knowledge necessary for developing machine learning models.
2	To select, apply and evaluate an appropriate machine learning model for the given application.
3	To identify the classification problem and apply the SVM for classification purposes.
4	To demonstrate ensemble techniques to combine predictions from different models.
5	To apply the clustering methods for an appropriate application and demonstrate the dimensionality reduction techniques.
6	To emphasize on applying the knowledge to solve real world problems and study the latest trends.

Module		Content	Hours
1		**Introduction to Machine Learning**	**03**
	1.1	Machine Learning, Types of Machine Learning- Supervised, unsupervised and reinforcement, Issues in Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application.	
	1.2	Training Error, Generalization error, Overfitting, Underfitting, Bias Variance trade-off.	
2		**Learning with Regression and Trees**	**08**
	2.1	Learning with Regression: Linear Regression, Multivariate Linear Regression, Logistic Regression.	

	2.2	Learning with Trees: Decision Trees, Constructing Decision Trees using Gini Index (Regression), Classification and Regression Trees (CART)	
	2.3	Performance Measures : Model evaluation and selection, Confusion Matrix & Basic Evaluation Metrics, Precision-recall and ROC curves	
3		**Learning with Classification**	**06**
	3.1	Introduction to classification, Training binary classifier, Multi classification, Multilabel and multioutput classification	
	3.2	Support Vector Machine Introduction to SVM, Hyperplane,Optimal decision boundary, Margins and support vectors, linear SVM, Nonlinear SVM, Kernelized SVM, SVM Regression.	
4		**Ensemble Learning**	**08**
	4.1	Understanding Ensembles, K-fold cross validation, Boosting, XGBoost	
	4.2	Bagging, Random Forest, Comparison with Boosting, Different ways to combine classifiers	
5		**Learning with Clustering and Dimensionality Reduction**	**08**
	5.1	Introduction to clustering with overview of distance metrics and major clustering approaches.	
	5.2	Graph Based Clustering: Clustering with minimal spanning tree Model based Clustering: Expectation Maximization Algorithm, Density Based Clustering: DBSCAN	
	5.3	Dimensionality Reduction Techniques, Principal Component Analysis, Linear Discriminant Analysis, Singular Value Decomposition.	
6		**Current Trends and tools used in ML**	**06**
	6.1	Introduction to Reinforcement learning, Transfer Learning	
	6.2	Machine Learning projects handling different types of data and tools in industries such as Education, Health Care, Agriculture, Energy.	
		Total	**39**

Textbooks:	
1	Peter Harrington, ―Machine Learning n Action‖, DreamTech Press
2	Ethem Alpaydın, ―Introduction to Machine Learning‖, MIT Press

3	Tom M. Mitchell, ―Machine Learning‖ McGraw Hill
4	Dr. Deepali Vora, Dr. Gresha Bhatia, Python for Machine Learning projects
5	Stephen Marsland, ―Machine Learning An Algorithmic Perspective‖, CRC Press
References:	
1	Han Kamber, ―Data Mining Concepts and Techniques‖, Morgan Kaufmann Publishers
2	Margaret. H. Dunham, ―Data Mining Introductory and Advanced Topics, Pearson Education
3	Kevin P. Murphy , Machine Learning ― A Probabilistic Perspective‖
4	Machine Learning For Absolute Beginners: A Plain English Introduction (Second Edition), Oliver Theobald
5	Richard Duda, Peter Hart, David G. Stork, ―Pattern Classification‖, Second Edition, Wiley Publications.
6	Approaching (Almost) Any Machine Learning Problem, Abhishek Thakur

Useful Links	
1	Datasets for Machine Learning algorithms: https://www.kaggle.com/datasets
2	Machine Learning repository- https://archive.ics.uci.edu/ml/index.php
3	Machine Learning from Coursera
4	https://towardsdatascience.com/machine-learning/home
5	https://onlinecourses.nptel.ac.in/noc21_cs85/preview

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks

2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code:	Course Title	Credit
CSC702	**Big Data Analytics**	3

Prerequisite: Database, Data mining.	
Course Objectives:	
1	To provide an overview of the big data platforms, its use cases and Hadoop ecosystem
2	To introduce programming skills to build simple solutions using big data technologies such as MapReduce, Scripting for No SQL and distributed processing using Spark
3	To learn the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability
4	To enable students to have skills that will help them to solve complex big data real-world problems for business
Course Outcomes:	
1	Understand the building blocks of Big Data Analytics.
2	Apply fundamental enabling techniques like Hadoop and MapReduce in solving real world problems
3	Understand different NoSQL systems and how it handles big data.
4	Apply advanced techniques for emerging applications like stream analytics
5	Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications, etc.
6	Apply distributed processing techniques for analyzing big data.

Module		Content	Hours
1		**Introduction to Big Data and Hadoop**	**02**
	1.1	Introduction to Big Data - Big Data characteristics and Types of Big Data	
	1.2	Traditional vs. Big Data business approach	
	1.3	Case Study of Big Data Solutions	
	1.4	Concept of Hadoop, Core Hadoop Components; Hadoop Ecosystem	
2		**Hadoop HDFS and MapReduce**	**08**

	2.1	Distributed File Systems: Physical Organization of Compute Nodes, Large Scale File-System Organization.	
	2.2	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.	
	2.3	Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union ,Intersection, and Difference by MapReduce	
	2.4	Hadoop Limitations	
3		**NoSQL**	**08**
	3.1	Introduction to NoSQL, NoSQL Business Drivers	
	3.2	NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable)stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study	
	3.3	NoSQL solution for big data, Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; NoSQL systems to handle big data problems.	
4		**Mining Data Streams**	**10**
	4.1	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing.	
	4.2	Sampling Data techniques in a Stream	
	4.3	Filtering Streams: Bloom Filter with Analysis.	
	4.4	Counting Distinct Elements in a Stream,Count Distinct Problem, Flajolet-Martin Algorithm, Combining Estimates, Space Requirements	
	4.5	Counting Ones in a Window: The Cost of Exact Counts,The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in theDGIM Algorithm, Decaying Windows., Data Ste	
5		**Real-Time Big Data Models**	**04**
	5.1	Page rank algorithm, A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering	
	5.2	Case Study: Product Recommendation	
	5.3	Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities in a social graph	
6		**Distributed Data Processing with Spark**	**07**

	6.1	Spark Basics, RDDs (Resilient Distributed Datasets) Functional Programming in Spark, working with spark,Pair RDDs,Machine Learning with MLlib.	
	6.2	SparkSQL and Data Frames,Machine Learning with MLlib,Developingand Deploying Spark Applications	
	6.3	Common Spark Use Cases, Iterative Algorithms in Spark Graph Processing and Analysis,Data Visualization: Types, Applications	
		Total	**39**

Textbooks:	
1	Cre Anand Rajaraman and Jeff Ullman ―Mining of Massive Datasets‖, Cambridge UniversityPress
2	Alex Holmes ―Hadoop in Practice‖, Manning Press, Dreamtech Press.
3	Dan Mcary and Ann Kelly ―Making Sense of NoSQL‖ – A guide for managers and the rest of us, Manning Press.
4	**Learning Spark, by Karau, Konwinski, Wendell, and Zaharia**
5	EMC Education Services,‖Data Science and Big Data Analytics‖,Wiley
Reference Books:	
1	Bill Franks , ―Taming The Big Data Tidal Wave: Finding Opportunities In HugeData StreamsWithAdvancedAnalytics‖,Wiley
2	Chuck Lam, ―Hadoop inAction‖, Dreamtech Press
3	Jared Dean, ―Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners‖,Wiley India Private Limited, 2014.
4	Jiawei Han and Micheline Kamber, ―Data Mining: Concepts and Techniques‖, Morgan Kaufmann Publishers, 3rd ed, 2010.
5	Lior Rokach and Oded Maimon, ―Data Mining and Knowledge Discovery Handbook‖, Springer, 2nd edition,2010.
6	Ronen Feldman and James Sanger, ―The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data‖, Cambridge University Press, 2006.
7	Vojislav Kecman, ―Learning and Soft Computing‖, MITPress, 2010.

Useful Links

1	https://nptel.ac.in/courses/106104189
2	https://www.coursera.org/specializations/big-data#courses
3	https://www.digimat.in/nptel/courses/video/106106169/L01.html
4	https://www.coursera.org/learn/nosql-databases#syllabus
5	https://www.coursera.org/learn/basic-recommender-systems#syllabus

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Indirect Assessment

1	Mock Viva/Practical
2	Skill Enhancement Lecture

3	Extra Assignments/lab/lecture
End Semester Theory Examination:	
1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Title	Credit
CSDC7011	**Machine Vision**	**03**

Prerequisite: Computer Graphics	
Course Objectives:	
1	To understand the need and significance Machine Vision
2	To explore basics of image processing
3	To explore the components of Machine Vision System
4	To develop application using machine Vision
5	To study transformation, interpolation, filters
Course Outcomes:	
1	Elaborate the components of Machine Vision Application
2	Perform image ,video preprocessing operations
3	Explain various transformations, interpolation
4	Elaborate motion tracking in video
5	Analyze and Implement appropriate filtering techniques for a given problem
6	Develop applications based on machine vision..

Module		Content	Hours
1		**Introduction to Machine Vision**	04
	1.1	Computer and Human Vision Systems., The Human Eye, Computer versus Human Vision Systems, Evolution of Computer Vision, Computer/Machine Vision and Image Processing, Applications of Computer Vision	
2		**Digital Image Fundamentals**	08
	2.1	Digital Image, Monochrome and Color Images, Image Brightness and Contrast., 2D, 3D, and 4D Images, Digital Image Representation, Digital Image File Formats, Fundamental Image Operations, Points, Edges, and Vertices , Point Operations , Thresholding ,Brightness, Geometric Transformations , Spatial Transformation , Affine Transformation, Image Interpolation ,Nearest-Neighbor Interpolation ,Bilinear Interpolation , Bi-cubic Interpolation ,Fundamental Steps in	

		Digital Image Processing.	
3		**Machine Vision and System Components**	**08**
	3.1	Machine Vision System, Machine Vision Camera: CCD and CMOS Image Sensors, TDI Sensor, Camera Type - Area Scan Cameras, Line Scan Cameras, Smart Cameras, Camera Lens Resolution, Contrast and Sharpness, Lenses and their parameters: Types of Lenses, Lens Mounts, Lens Selection Examples-Field of View Much larger than Camera sensor size or Smaller or close to Camera Sensor size, Machine Vision Lighting: Lighting: Light Sources in Machine Vision, Illumination Techniques-Backlighting, Front Lighting, Diffused Lighting, Oblique Lighting, Dark Field Lighting, Infrared and Ultraviolet Light, Filters, Machine Vision Software, Machine Vision Automation, Integration of Machine Vision Components	
4		**Digital Image Processing for Machine Vision Applications**	**10**
	4.1	Preprocessing., Image Filtering, Normalized Box Filter Gaussian Filter Bilateral Filter, Comparison of Filter Techniques, Sub sampling/Scaling Histogram, Image Segmentation, Threshold Based Segmentation Edge-Based Segmentation First-Order Derivative Edge Detection. Second-Order Derivative Operators, Comparison of Edge Detection Techniques, Region-Based Segmentation Region Growing Methods, Region Split and Merge Method, Morphological Image Processing: Dilation, Erosion, Opening, Closing, Hit-or-Miss transformation, Object Recognition. Template Matching. Blob Analysis	
5		**Motion Analysis**	**04**
	5.1	Differential motion Analysis, Optical Flow, Analysis based on correspondence of interest points, Detection of specific motion Patterns, Video Tracking	
6		**Emerging Trends in Machine Vision**	**05**
	6.1	History of Industrial Revolution(s), Machine Vision and Industry 4.0, Emerging Vision Trends in Manufacturing, 3D Imaging, Emerging Vision Trends in Manufacturing,	
	6.2	Applications in Machine/ Computer Vision: Face detection, face recognition, eigen faces, car on roads	
		Total	**39**

Textbooks:	
1	Sheila Anand and L.Priya , ―A Guide for Machine Vision in Quality Control‖, Taylor & Francis Inc, Imprint CRC Press Inc, Dec 2019
2	Rafael C. Gonzalez and Richard E. Woods, ―Digital Image Processing‖, Pearson

Textbooks:	
3	Carsten Stegar, Markus Ulrich, and Christian Wiedemann , ―Machine Vision Algorithms and Applications‖,Second completely Revised and Enlarged Edition
4	Milan Sonka, Vaclav Hlavac, Roger Boyle, ―Image Processing Analysis and Machine Vision‖, Second Edition, Cengage Learning.
Reference Books:	
1	Chiranji Lal Chowdhary, Mamoun Alazab, Ankit Chaudhary, SaqibHakak and Thippa Reddy Gadekallu ,‖Computer Vision and Recognition Systems Using Machine and Deep Learning Approaches, Fundamentals, technologies and applications‖ , IET COMPUTING SERIES 42
2	Joe Minichino Joseph Howse ,‖Learning OpenCV 3 Computer Vision with Python‖, Second Edition, Packt Publishing Ltd.
3	Alexander Hornberg,, ― Handbook of Machine and Computer Vision The Guide for Developers and Users,

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Indirect Assessment		
1	Mock Viva/Practical	
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3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Name	Credit
CSDC7012	**Quantum Computing**	**03**

Prerequisite: Engineering Mathematics, Data Structures and Algorithm, Python Programming	
Course Objectives:	
1	To understand basics of quantum computing
2	To understand mathematics required for quantum computing
3	To understand building blocks of quantum computing and design algorithms
4	To understand quantum hardware principles and tools for quantum computing.
Course Outcomes: After successful completion of the course student will be able to	
1	Understand basic concepts of quantum computing
2	Illustrate building blocks of quantum computing through architecture and programming models.
3	Appraise various mathematical models required for quantum computing
4	Discuss various quantum hardware building principles.
5	Identify the various quantum algorithms
6	Describe usage of tools for quantum computing.

Module		Content	Hours
1		**Introduction to Quantum Computing**	**07**
	1.1	Motivation for studying Quantum Computing Origin of Quantum Computing Quantum Computer vs. Classical Computer Introduction to Quantum mechanics	
	1.2	Overview of major concepts in Quantum Computing Qubits and multi-qubits states Bloch Sphere representation Quantum Superposition Quantum Entanglement Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.)	
2		**Mathematical Foundations for Quantum Computing**	**05**
	2.1	Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.	
3		**Building Blocks for Quantum Program**	**08**
	3.1	Architecture of a Quantum Computing platform Details of q-bit system of information representation: Block Sphere Multi-qubits States Quantum superposition of qubits (valid and invalid superposition)	

		Quantum Entanglement Useful states from quantum algorithmic perspective e.g. Bell State Operation on qubits: Measuring and transforming using gates.Quantum Logic gates and Circuit No Cloning Theorem and Teleportation	
	3.2	Programming model for a Quantum Computing Program Steps performed on classical computer Steps performed on Quantum Computer Moving data between bits and qubits	
4		**Quantum Algorithms and Error correction**	**06**
	4.1	Quantum Algorithms, Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch -Jozsa Algorithm	
	4.2	Quantum error correction using repetition codes 3 qubit codes, Shor's 9 qubit error correction Code	
5		**Quantum Hardware**	**10**
	5.1	Ion Trap Qubits, The DiVincenzo Criteria, Lagrangian and Hamiltonian Dynamics in a Nutshell: Dynamics of a Translating	
	5.2	Rotor Quantum Mechanics of a Free Rotor: A Poor Person's Atomic	
	5.3	Model: Rotor Dynamics and the Hadamard Gate, Two-Qubit Gates The Cirac-Zoller Mechanism:Quantum Theory of Simple Harmonic Motion, A Phonon-Qubit Pair Hamiltonian, Light-Induced Rotor-Phonon Interactions, Trapped Ion Qubits, Mølmer-Sørenson Coupling	
	5.4	Cavity Quantum Electrodynamics (cQED): Eigenstates of theJaynes-Cummings Hamiltonian Circuit QED (cirQED): Quantum LC Circuits, Artificial Atoms,Superconducting QubitsQuantum computing with spins:Quantum inverter realized with two exchange coupled spins in quantum dots, A 2-qubit spintronic universal quantum gate.	
6		**Quantum Mechanics of a Free Rotor:**	**03**
	6.1	IBM quantum experience Microsoft Q, Rigetti PyQuil (QPU/QVM)	
		Total	**39**

Textbooks:	
1	Michael A. Nielsen, ―Quantum Computation and Quantum Information‖, Cambridge University Press.
2	David McMahon, ―Quantum Computing Explained‖, Wiley ,2008
3	Qiskit textbook https://qiskit.org/textbook-beta/
4	Vladimir Silva, Practical Quantum Computing for Developers,2018
Reference Books:	
1	Bernard Zygelman, A First Introduction to Quantum Computing and Information,2018
2	Supriyo Bandopadhyay and Marc Cahy, ―Introduction to Spintronics‖, CRC Press, 2008
3	The Second Quantum Revolution: From Entanglement to Quantum Computing and Other Super-Technologies, Lars Jaeger
4	La Guardia, Giuliano Gladioli ―Quantum Error correction codes‖Springer,2021

Useful Links
https://onlinecourses.nptel.ac.in/noc21_cs103/preview
https://www.coursera.org/courses?query=quantum%20computing
https://www.cl.cam.ac.uk/teaching/1617/QuantComp/

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Indirect Assessment		
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End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
CSDC7013	**Natural Language Processing**	**03**

Prerequisite: Theory of Computer Science, System Programming & Compiler Construction	
Course Objectives:	
1	To define natural language processing and to learn various stages of natural language processing.
2	To describe basic concepts and algorithmic description of the main language levels: Morphology, Syntax, Semantics, and Pragmatics & Discourse analysis.
3	To design and implement various language models and POS tagging techniques.
4	To design and learn NLP applications such as Information Extraction, Question answering.
5	To design and implement applications based on natural language processing.
6	To learn advanced NLP techniques for developing real world NLP applications.
Course Outcomes:	
1	Have a broad understanding of the field of natural language processing.
2	To design a language model for word level analysis for text processing.
3	To design various POS tagging techniques and parsers.
4	To design, implement and test algorithms for semantic and pragmatic analysis.
5	To formulate the discourse segmentation and anaphora resolution.
6	To apply advanced NLP techniques to design and develop real-world NLP applications, including machine translation, text categorization, text summarization, information extraction etc.

Module		Content	Hours
1		**Introduction to NLP**	**03**
	1.1	Origin & History of NLP; Language, Knowledge and Grammar in language processing; Stages in NLP;Ambiguities and its types in English and Indian Regional Languages; Challenges of NLP;Applications of NLP	
	1.2	Self-Learning topics: Variety types of tools for regional languages pre-processing and other functionalities	

2		**Word Level Analysis**	**08**
	2.1	Basic Terms: Tokenization, Stemming, Lemmatization; Survey of English Morphology, Inflectional Morphology, Derivational Morphology; Regular expression with types; Morphological Models: Dictionary lookup, finite state morphology; Morphological parsing with FST (Finite State Transducer);Lexicon free FST Porter Stemmer algorithm; Grams and its variation: Bigram, Trigram; Simple (Unsmoothed) N-grams; N-gram Sensitivity to the Training Corpus; Unknown Words: Open versus closed vocabulary tasks; Evaluating N-grams: Perplexity; Smoothing: Laplace Smoothing, Good-Turing Discounting;	
	2.2	Self-Learning topics: Evaluating parsers, Parsers based language modeling, Regional languages POS tree banks	
3		**Syntax analysis**	**08**
	3.1	Part-Of-Speech tagging(POS); Tag set for English (Upenn Treebank); Difficulties /Challenges in POS tagging; Rule-based, Stochastic and Transformation-based tagging; Generative Model: Hidden Markov Model /HMM Viterbi for POS tagging; Issues in HMM POS tagging; Discriminative Model: Maximum Entropy model, Conditional random Field (CRF); Parsers: Top down and Bottom up;Bottom Up Parser: Shift Reduce Parser	
	3.2	Self-Learning topics: Evaluating parsers, Parsers based language modelling, Regional languages POS tree banks	
4		**Semantic Analysi**s	**07**
	4.1	Introduction, meaning representation; Lexical Semantics; Corpus study; Study of Various language dictionaries like WorldNet, Babelnet**,**FrameNet; Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy; Semantic Ambiguity; Word Sense Disambiguation (WSD); Knowledge based approach(Lesk‘s Algorithm), Supervised (Naïve Bayes, Decision List), Unsupervised (Hyperlex)	
	4.2	Self-Learning topics: Dictionaries for regional languages, Distributional Semantics, Topic Models	
5		**Pragmatic & Discourse Processing**	**05**
	5.1	Discourse: Reference Resolution, Reference Phenomena, Syntactic & Semantic constraint on coherence; Anaphora Resolution using Hobbs algorithm.	
	5.2	Self-Learning topics: Discourse segmentation, Conference resolution	
6		**Applications of NLP & Neural Models for Advanced Applications**	**08**

	6.1	Case Studies in Machine Translation, Text Summarization, Sentiment Analysis, Information Retrieval, Question Answering Systems, Information Extraction, NER, and ChatGPT	
	6.2	Deep Learning for Natural Language Processing (NLP): Exploring the Bag-of-Words Model, Word Embedding Model, Word2Vec, GloVe, BERT etc.	
	6.3	Neural Models for Document Classification and Sentiment Analysis,Enhancing Language Understanding and Generation with Neural Networks,Character-Based and Word-Based Neural Language Models for text generation	
	6.4	Self-Learning topics: Applications based on Deep Neural Network with NLP such as LSTM network, Recurrent Neural network etc	
		Total	**39**

Textbooks:	
1	Daniel Jurafsky, James H. Martin "Speech and Language Processing" Second Edition, Prentice Hall, 2008.
2	Christopher D.Manning and Hinrich Schutze, " Foundations of Statistical Natural Language Processing ", MIT Press, 1999.
3	Deep Learning for Natural Language Processing,by machine learning mastery by Jason Brownlee
References:	
1	Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2	Daniel M Bikel and ImedZitouni — Multilingual natural language processing applications:from theory to practice, IBM Press, 2013.
3	Alexander Clark, Chris Fox, Shalom Lappin — The Handbook of Computational Linguistics and Natural Language Processing, John Wiley and Sons, 2012.
4	Nitin Indurkhya and Fred J. Damerau, —Handbook of Natural Language Processing,Second Edition, Chapman and Hall/CRC Press, 2010.
5	Niel J le Roux and SugnetLubbe, A step by step tutorial: An introduction into R application and programming.
6	Steven Bird, Ewan Klein and Edward Loper, Natural language processing with Python:analyzing text with the natural language toolkit, O_Reilly Media, 2009.

Useful Digital Links

1	http://www.cse.iitb.ac.in/~cs626-449
2	http://cse24-iiith.virtual-labs.ac.in/#
3	https://nptel.ac.in/courses/106105158

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks

*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

Indirect Assessment

1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture

End Semester Theory Examination:

1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Title	Credit
CSDC7021	**Augmented and Virtual Reality**	**3**

Prerequisite: Computer Graphics	
Course Objectives:	
1	To understand the need and significance of Virtual Reality.
2	To explore the concepts of Virtual reality and develop 3D virtual environments.
3	To understand the technical and engineering aspects of virtual reality systems.
4	To analyze various techniques for applying virtual reality.
5	To provide a foundation to the fast growing field of AR and make the students aware of the various AR devices.
Course Outcomes:	
1	Describe how VR systems work and list the applications of VR
2	Elaborate geometric presentation of the virtual world and its operations.
3	Explain the concepts of motion and tracking in VR systems.
4	Design and implementation of the hardware that enables VR systems tobe built
5	Describe how AR systems work and analyze the hardware requirement of AR
6	Analyze and understand the working of various state of the art AR devices.

Module	Content	Hours
1	**Introduction to Virtual Reality**	**05**
	What is virtual reality? ,The beginnings of VR , VR paradigms , Collaboration, Virtual reality systems, Representation ,User interaction	
2	**The Geometry of Virtual Worlds**	**06**
	Geometric Models, Changing Position and Orientation, Axis-Angle	

	Representations of Rotation, Viewing Transformations, Chaining the Transformations	
3	**Motion in Real and Virtual Worlds**	**06**
	Velocities and Accelerations , The Vestibular System , Physics in the Virtual World , Mismatched Motion and Vection	
4	**Applying Virtual Reality**	**07**
	Virtual reality: the medium, Form and genre, What makes an application a good candidate for VR, Promising application fields, Demonstrated benefits of virtual reality , More recent trends in virtual reality application development, A framework for VR application development	
5	**Augmented Reality**	**08**
	Terminology, Simple augmented reality, Augmented reality as an emerging technology, Augmented reality applications, Marker detection, Marker pose, Marker types and identification: Template markers, 2D bar-code markers, Imperceptible markers: Image markers, Infrared markers, Miniature markers, Discussion on marker use, General marker detection application	
6	**AR Development & Applications**	**07**
	User interfaces, Avoiding physical contacts , Practical experiences with head-mounted displays , Authoring and dynamic content ,AR applications and future visions, How to design an AR application ,Technology adoption and acceptance , Where to use augmented reality	
	Total	**39**

Textbooks:	
1	Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2	Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)‖. Morgan Kaufmann Publishers, San Francisco, CA, 2002
3	Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig,William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.
4	Theory and applications of marker-based augmented reality SanniSiltanen
Reference Books:	
1	AR Game Development‖, 1st Edition,Allan Fowler, A press Publications, 2018, ISBN 978- 1484236178

Textbooks:	
2	Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494
3	Learning Virtual Reality, Tony Parisi,O'Reilly Media, Inc., 2015, ISBN- 9781491922835

Digital Useful Links	
1	https://freevideolectures.com/course/3693/virtual-reality
2	https://www.vrlabacademy.com/
3	https://arvr.google.com/ar/
4	https://konterball.com/

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.
Continuous Assessment:
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks

*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.	
Indirect Assessment	
1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture
End Semester Theory Examination:	
1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Title	Credit
CSDC7022	**Blockchain**	**3**

Prerequisite: Cryptography and System Security	
Course Objectives:	
1	Understand blockchain platforms and its terminologies.
2	Understand the use of cryptography required for blockchain
3	Understand smart contracts, wallets, and consensus protocols.
4	Design and develop blockchain applications.
Course Outcomes:	
1	Explain blockchain concepts
2	Apply cryptographic hash required for blockchain
3	Apply the concepts of smart contracts for an application.
4	Design a public blockchain using Ethereum.
5	Design a private blockchain using Hyperledger
6	Use different types of tools for blockchain applications.

Module		Content	Hours
1		**Introduction to Blockchain:**	**04**
	1.1	What is a blockchain, Origin of blockchain (cryptographically secure hash functions), Foundation of blockchain: Merkle trees	
	1.2	Components of blockchain, Block in blockchain, Types: Public, Private, and Consortium, Consensus Protocol, Limitations and Challenges of blockchain	
2		**Cryptocurrency:**	**08**
	2.1	Cryptocurrency: Bitcoin, Altcoin, and Tokens (Utility and Security), Cryptocurrency wallets: Hot and cold wallets, Cryptocurrency usage, Transactions in Blockchain, UTXO and double spending problem	

	2.2	Bitcoin Blockchain, Consensus in Bitcoin, Proof of Work (PoW), Proof of Burn(PoB), Proof of Stake (PoS), Proof of Elapsed Time (PoET), Life of a miner, Mining Difficulty, Mining Pools and its methods	
3		**Programming for Blockchain:**	**08**
	3.1	Introduction to Smart Contracts, Types of Smart Contracts, Structure of a Smart Contract, Smart Contract Approaches, Limitations of Smart Contracts	
	3.2	Introduction to Programming: Solidity Programming – Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Special Arrays-Bytes and strings, Struct, Mapping, Inheritance, Error handling	
	3.3	Case Study – Voting Contract App, Preparing for smart contract development	
4		**Public Blockchain**	**08**
	4.1	Introduction to Public Blockchain, Ethereum and its Components, Mining in Ethereum, Ethereum Virtual Machine (EVM), Transaction, Accounts, Architecture and Workflow, Comparison between Bitcoin and Ethereum	
	4.2	Types of test-networks used in Ethereum, Transferring Ethers using Metamask, Mist Wallet, Ethereum frameworks, Case study of Ganache for Ethereum blockchain, Exploring etherscan.io and ether block structure	
5		**Private Blockchain**	**08**
	5.1	Introduction, Key characteristics, Need of Private Blockchain, Smart Contract in a Private Environment, State Machine Replication, Consensus Algorithms for Private Blockchain - PAXOS and RAFT, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT**,** Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT	
	5.2	Introduction to Hyperledger, Tools and Frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric & Other Technologies.	
6		**Tools and Applications of Blockchain:**	**03**
	6.1	Blockchain in Action: Use Cases Financial Services, Insurance, Government, Supply Chain Management, Healthcare, Healthcare payments pre-authorization, The Internet of Things (IoT)	
		Total	**39**

Textbooks:	
1	Blockchain Technology, Chandramouli Subramanian, Asha A. George, Abhilash K. A and Meena Karthikeyen, Universities Press.
2	Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3	Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Packt Publishing
4	"Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN", 2nd Edition by Andreas M. Antonopoulos, June 2017, Publisher(s): O'Reilly Media, Inc. ISBN: 9781491954386.
5	"Blockchain for Enterprise Application Developers", Ambadas, Arshad SarfarzAriff, Sham – Wiley
Reference Books:	
1	Blockchain for Beginners, Yathish R and Tejaswini N, SPD
2	Blockchain Basics, A non Technical Introduction in 25 Steps, Daniel Drescher, Apress.
3	Blockchain with Hyperledger Fabric,Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing

Digital Useful Links	
1	Blockchain By Example, Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, November 2018, Implement decentralized blockchain applications to build scalable Dapps.
2	Blockchain for Business, https://www.ibm.com/downloads/cas/3EGWKGX7
3	https://www.hyperledger.org/use/fabric
4	NPTEL: https://onlinecourses.nptel.ac.in/noc19_cs63/preview

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks

3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
CSDC7023	Information Retrieval	03

Prerequisite:	
Course Objectives:	
1	To learn the fundamentals of Information Retrieval
2	To analyze various Information retrieval modeling techniques
3	To understand query processing and its applications
4	To explore the various indexing and scoring techniques
5	To assess the various evaluation methods
6	To analyze various information retrieval for real world application
Course Outcomes:	
1	Define and describe the basic concepts of the Information retrieval system.
2	Design the various modeling techniques for information retrieval systems.
3	Understand the query structure and various query operations
4	Analyzing the indexing and scoring operation in information retrieval systems
5	Perform the evaluation of information retrieval systems
6	Analyze various information retrieval for real world application

Module		Content	Hours
1		**Introduction to Information Retrieval**	**04**
	1.1	Introduction to Information Retrieval, Basic Concepts, Information Versus Data, Trends and research issues in information retrieval	
	1.2	The retrieval process, Information retrieval in the library, web and digital libraries.	
2		**Modeling in Information Retrieval**	**08**

	2.1	Taxonomy of Information Retrieval models, Classic Information Retrieval, Alternate set: Theoretical model, Alternative Algebraic models, Alternative Probabilistic models	
	2.2	Structured text Retrieval models, Models for browsing	
3		**Query and Operations in Information Retrieval**	**08**
	3.1	Query structures, Keyboard based querying, Pattern matching, Structured queries	
	3.2	User relevance feedback, Automatic local analysis, Automatic global analysis	
4		**Indexing and Scoring in Information Systems**	**08**
	4.1	Introduction, Inverted Files, Other Indices for Text, Boolean queries and Introduction to Sequential searching	
	4.2	Scoring, term weighting and the vector space model, Parametric and zone indexes, Weighted zone scoring, Learning weights, The optimal weight, Term frequency and weighting, Inverse document frequency, Tf-idf weighting. The vector space model for scoring, Queries as vectors, Computing vector scores, Efficient scoring and ranking, Inexact top K document retrieval	
5		**Evaluation of Information Retrieval Systems**	**06**
	5.1	Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing and justifying the concept of relevance	
	5.2	System quality and user utility, System issues, Refining a deployed system	
6		**Applications of Information Retrieval Systems**	**05**
	6.1	Introduction to Multimedia Information Retrieval	
	6.2	Introduction to Distributed Information Retrieval	
		Total	**39**

Textbooks:	
1	Modern information retrieval, Baeza-Yates, R. and Ribeiro-Neto, B., 1999. ACM press.

Textbooks:	
2	Introduction to Information Retrieval By Christopher D. Manning and PrabhakarRaghavan, Cambridge University Press
3	Information Storage & Retrieval By Robert Korfhage – John Wiley & Sons
Reference Books:	
1	Storage Network Management and Retrieval, Vaishali Khairnar
2	Introduction to Modern Information Retrieval. G.G. Chowdhury. NealSchuman
3	Natural Language Processing and Information Retrieval by Tanveer Siddiqui, U.S Tiwarey

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks

*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

Indirect Assessment	
1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture
End Semester Theory Examination:	
1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code:	Course Title	Credit
ILO7011	**Product Life Cycle Management**	3

Prerequisite:	
Course Objectives:	
1	To familiarize the Learner with the need, benefits, and components of PLM
2	To Enable the learners to product design and development processes.
3	To acquaint Learner with Product Data Management & PLM strategies
4	To give insights into new product development program and guidelines for designing and developing a product
5	To familiarize the Learner with Virtual Product Development
6	To familiarize the Learner with design for environments, Life cycle assessment.
Course Outcomes:	
1	Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study.
2	Illustrate various approaches and techniques for designing and developing products.
3	Apply product engineering guidelines / thumb rules in designing products.
4	Understand the concept of product data ,product data management and PDM implementation.
5	Understand and illustrate the concept of product design for the environment and life cycle assessment.
6	Acquire knowledge in applying virtual product development tools

Module		Content	Hours
1		**Introduction to Product Lifecycle Management (PLM)**	**08**
	1.1	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, spread of PLM, Focus and Application	

	1.2	PLM Strategies: Industrial strategies, Strategy elements, Developing PLM Vision and PLM Strategy , Change management for PLM	
2		**Product Design**	**10**
	2.1	Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model,	
	2.2	Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management,	
	2.3	The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
3		**Product Data Management (PDM)**	**05**
	3.1	Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system	
	3.2	Financial justification of PDM, barriers to PDM implementation	
4		**From sustainable Development to design for environment**	**06**
	4.1	Sustainable Development, Key factors in sustainable Development, Design for Environment	
	4.2	The Environment driving PLM- External Drivers: scale, Complexity , cycle times, globalization, regulations , Internal Drivers- Productivity innovation, collaboration, quality. Boardroom Driver-IT Value Map: income, revenue, costs. Comparing lean manufacturing, ERP,CRM and PLM	
5		**Life Cycle Assessment and Life Cycle Cost Analysis**	**06**
	5.1	Premises,Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment.	
	5.2	Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	
6		**Virtual Product Development Tool**	**04**
	6.1	Introduction VPD, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies.	
		Total	**39**

Reference Books:	
1	John Stark, ―Product Lifecycle Management: Paradigm for 21st Century Product Realisation‖, Springer-Verlag, 2004. ISBN: 1852338105
2	Fabio Giudice, Guido La Rosa, Antonino Risitano, ―Product Design for the environment- A life cycle approach‖, Taylor & Francis 2006, ISBN: 0849327229
3	Saaksvuori Antti, Immonen Anselmie, ―Product Life Cycle Management‖, Springer, Dreamtech, ISBN: 3540257314
4	Michael Grieve, ―Product Lifecycle Management: Driving the next generation of lean thinking‖, Tata McGraw Hill, 2006, ISBN: 0070636265

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No.	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab etc	10 marks
6.	Case based Assignment/test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code:	Course Title	Credit
ILO7013	**Management Information System**	**03**

Prerequisite:	
Course Objectives:	
1	To discuss the roles played by information technology in today's business.
2	To understand the Intelligent Techniques for Data Analytics.
3	To determine ethical and privacy issues in management systems.
4	To understand the requirements for various Business Operations
5	To define various technologies on which information systems are built
6	To determine the types of systems used for enterprise-wide knowledge management and the way they provide value for businesses.
Course Outcomes: Learner will be able to understand	
1	The impact of information systems on an organisation's growth.
2	The principal tools and technologies for accessing information from databases to improve business performance and decision making.
3	The ethical frameworks and security concerns in information systems.
4	The various business models used for social computing.
5	IT infrastructure and its components and its current trends
6	Various enterprise-wide knowledge management systems and its functionalities.

Module	Content	Hours
1	**Introduction to Information Systems (IS):**	**04**
	Computer Based Information Systems, Impact of IT on organisations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	
2	**Database and Business Intelligence:**	**08**
	Database Approach, Big Data, Data warehouse and Data Marts, Managing data resources:establishing an information policy, ensuring data quality	

	Business intelligence (BI):-Decision Making Process, BI for Data analytics and Presenting Results	
3	**Ethical and Social Issues in Information Systems:**	**06**
	Ethical issues and Privacy, Information Security. Threat to IS, and Security Controls	
4	**Social Computing (SC):**	**07**
	SC in business-shopping, Marketing, Operational and Analytical CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	
5	**Emerging Technologies:**	**07**
	The Emerging Mobile Digital Platform: Consumerization of IT and BYOD (Bring Your Own Device), Grid Computing, Virtualization, Cloud Computing, Green Computing, High-Performance and Power-Saving Processors, Autonomic Computing Contemporary Software Platform Trends: Web Services and Service-Oriented Architecture, Software Outsourcing and Cloud Services Management Issues: Dealing with Platform and Infrastructure Change Management and Governance	
6	**Information System within Organization:**	**07**
	Knowledge management System, Knowledge management value chain, Decision Support System, Transaction Processing Systems, ERP and ERP support of Business Process.	
	Total	**39**

Textbooks:	
1	Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2	K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 13th Ed. © Pearson Education Limited 2014
Reference Books:	
1	MIS: Management Perspective, D.P. Goyal, Vikas Publishing House Pvt. Ltd, 4th Edition.
2	D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1.	Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Mini Project	10 marks
4.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
5.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Title	Credit
ILO7016	**Cyber Security and Laws**	**3**

Prerequisite:	
Course Objectives:	
1	To understand and identify different types cybercrime and cyber law
2	To recognized Indian IT Act 2008 and its latest amendments
3	To learn various types of security standards compliances
Course Outcomes:	
1	To be able to understand the history of cyber crime and need for cyber law.
2	To be able to recognise various types of cyber crimes and related security issues
3	To be able to identify the tools and methods used in cyber crime
4	To be able to discuss the need for cyber space for transactions and interactions
5	To be able to appreciate the evolution of IT act.
6	To be able to interpret the necessity of information security standards and compliances.

Module		Content	Hours
1		**Introduction to Cybercrime**	**04**
	1.1	Cybercrime definition, history and threats to security goals, Classifications of cybercrime, How criminal plan the attacks	
	1.2	The Need for an Indian Cyber Law, Introduction to Indian ITA 2000	
2		**Cyber frauds and Security issues**	**04**
	2.1	Social Engg, Cyber stalking, Online Drug Trafficking, Botnets, Attack vector, Credit Card Frauds in Mobile and Wireless Computing Era	
	2.2	Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, work from home cybersecurity Tips and Risks	
	2.3	Attacks on Mobile/Cell Phones, Mobile Devices: Security	

		Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	
		Self Learning Topics: Types of Cyber Frauds and security issues	
3		**Tools and Methods Used in Cybercrime**	**10**
	3.1	Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography	
	3.2	DoS and DDoS Attacks, SQL Injection, Buffer OverFlow,	
	3.3	Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	
4		**The Concept of Cyberspace**	**07**
	4.1	E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law	
	4.2	The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking	
5		**Indian IT Act**	**08**
	5.1	Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	
		Self Learning Topics: Case Studies	
6		**Information Security Standard compliances**	**06**
	6.1	SOX, HIPAA, ISO	
		Self Learning Topics: FISMA, NERC, PCI, GLBA	
		Total	**39**

Textbooks:	
1	Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi 2 3
2	Cyber Security and Lawas, Madhumati Chatterjee, Sangita Chaudhary, Gaurav Sharma, Staredu solutions

3	Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
Reference Books:	
1	The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
2	The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi
3	Nina Godbole, Information Systems Security, Wiley India, New Delhi
4	Kennetch J. Knapp, Cyber Security & Global Information Assurance Information Science Publishing.
5	William Stallings, Cryptography and Network Security, Pearson Publication

Useful Links:	
1	The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
2	A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer- professionals-33538

Internal Assessment:		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment:		
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.		
Sr. No	**Rubrics**	**Marks**
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 Marks
2.	Wins in the event/competition/hackathon	10 Marks
3.	Content beyond syllabus presentation	10 Marks
4.	Creating Proof of concept	10 Marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
6.	GATE Based Assignment test/Tutorials etc	10 Marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 Marks
8.	Multiple Choice Questions (Quiz)	5 Marks
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Lab Code	Lab Name	Credit
CSL701	**Machine Learning Lab**	**1**

Prerequisite: Data Structures, Analysis of Algorithms	
Lab Objectives:	
1	To implement an appropriate machine learning model for the given application.
2	To acquire an in-depth understanding of various supervised and unsupervised algorithms.
3	To apply various ensemble techniques for combining ML models
4	To apply various ensemble techniques for combining ML models
Lab Outcomes:	
1	To study and use different methods of data visualization in machine learning.
2	To study and apply various regression techniques.
3	To implement ensemble techniques to combine predictions from different models.
4	To identify and implement suitable classification technique for a given problem
5	To apply and use different clustering techniques and dimension reduction methods.
6	To apply knowledge for solving real world problems across various domains.

Suggested Experiments: Students are required to complete at least 8 experiments.	
Sr. No.	**Name of the Experiment**
1	To study and implement different data visualization methods..
2	To apply Linear Regression for prediction purposes and estimate the errors associated with it.
3	To identify the classification problem which can be solved using trees, evaluate the performance measures.
4	To use Support Vector Machine to solve the classification problem and evaluate the performance measure
5	To implement Ensemble Learning(bagging/boosting) for complex pattern recognition tasks

6	To study and implement Multivariate Regression
7	To use DBSCAN/K Means clustering for an appropriate problem statement
8	To apply PCA/SVD for dimension reduction
9	To implement a Mini project for solving a real world problems in domain agriculture, energy, healthcare or any other domain for societal use

Term Work:	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSL701and CSC701

Lab Code	Lab Name	Credit
CSL702	**Big Data Analytics Lab**	**1**

Prerequisite: C Programming Language.	
Lab Objectives:	
1	Solve Big Data problems using Map Reduce Technique and apply to various algorithms.
2	Identify various types of NoSQL databases and execute NOSQL commands
3	Understand implementation of various analytic techniques using Hive/PIG/Spark etc.
4	Apply streaming analytics to real time applications.
Lab Outcomes:	
1	To interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
2	To implement algorithms that uses Map Reduce to apply on structured and unstructured data
3	To perform hands-on NoSql databases such as Cassandra, HadoopHbase, MongoDB, etc.
4	To implement various data streams algorithms.
5	To develop big data analytics applications using spark.

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Name of the Experiment
1	Hadoop HDFS Practical: -HDFS Basics, Hadoop Ecosystem Tools Overview. -Installing Hadoop. -Copying File to Hadoop. -Copy from Hadoop File system and delete file. -Moving and displaying files in HDFS. -Programming exercises on Hadoop
2	Use of Sqoop tool to transfer data between Hadoop and relational database servers. a. Sqoop - Installation.

	b. To execute basic commands of Hadoop ecosystem component sqoop.
3	To install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL commands
4	Experiment on Hadoop Map-Reduce: Write a program to implement a word count program using MapReduce.
5	Experiment on Hadoop Map-Reduce: Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc
6	Create HIVE Database and Descriptive analytics-basic statistics.
7	Data Stream Algorithms (any one): Implementing DGIM algorithm using any Programming Language - Implement Bloom Filter using any programming language Implement Flajolet Martin algorithm using any programming language
8	Implement iterative algorithm/Page rank using Spark
9	Create Big data analytics application dashboard using Hive and Impala
10	Design and Develop Big data application using Mllib and Spark
11	Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web). -Streaming data analysis – use flume for data capture, HIVE/PYSpark for analysis of twitter data, chat data, weblog analysis etc. -Recommendation System (for example: Health Care System, Stock Market Prediction, Movie Recommendation, etc.) SpatioTemporal DataAnalytics

Useful Links:	
1	https://spark.apache.org
2	https://hadoop.apahe.org
3	https://www.cloudera.com
4	http://www.mongodb.com
5	https://kafka.apache.org

Term Work:	
1	Term work should consist of 10 experiments.

2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSL702and CSC702

Lab Code	Lab Name	Credit
CSDL7011	**Machine Vision Lab**	**1**

Prerequisite: C Programming Language.	
Lab Objectives:	
1	To perform basic image processing operations
2	To explore different preprocessing technique
3	To develop application related to Machine vision
4	To detect and recognize objects
Lab Outcomes:	
1	Students will be able to read image and video file, perform different processing
2	Students will be able to do edge detection ,depth estimation
3	Students will be able to choose appropriate algo for segmentation
4	Students will be able to implement object detection technique

Suggested Experiments: Students are required to complete at least 8 experiments.

Sr. No.	Name of the Experiment
1	**Handling Files, Cameras, and GUIs** Basic I/O scripts ,Reading/writing an image file, Converting between an image and raw bytes, Accessing image data with numpy.array, Reading/writing a video file Capturing camera frames, Displaying images in a window, Displaying camera frames in a window
2	**Processing Images** with OpenCV 3 Converting between different color spaces, The Fourier Transform, High pass filter, Low pass filter,
3	**Edge detection** with Canny, Contour detection, Contours – bounding box, minimum area rectangle, and minimum enclosing circle, Contours – convex contours and the Douglas-Peucker algorithm, Line and circle detection
4	**Depth Estimation** Capturing frames from a depth camera

	Creating a mask from a disparity map Masking a copy operation Depth estimation with a normal camera
5	**Object segmentation** using the Watershed and GrabCut algorithms Example of foreground detection with GrabCut Image segmentation with the Watershed algorithm
6	**Detecting and Recognizing Faces** Conceptualizing Haar cascades Getting Haar cascade data Using OpenCV to perform face detection Performing face detection on a still image
7	**Performing face detection on video** Performing face recognition Generating the data for face recognition Recognizing faces Preparing the training data Loading the data and recognizing faces Performing an Eigenfaces recognition
8	**Retrieving Images and Searching** Using Image Descriptors , Feature detection algorithms, Defining features Detecting features – corners Feature extraction and description using DoG and SIFT Anatomy of a keypoint
9	**Detecting and Recognizing Objects** Object detection and recognition techniques HOG descriptors The scale issue The location issue Non-maximum (or non-maxima) suppression Support vector machines People detection
10	**Creating and training an object detector** Bag-of-words BOW in computer vision Detecting cars in a scene

Useful Links:	
1	Learning OpenCV 3 Computer Vision with Python Second Edition, by Joe Minichino Joseph Howse Published by Packt Publishing Ltd.
2	http://iitk.ac.in/ee/computer-vision-lab
3	https://nptel.ac.in/courses/108103174

4	https://docs.opencv.org/3.4/d9/df8/tutorial_root.html

Term Work:	
1	Term work should consist of at least 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSDL7011 and CSDC7011

Lab Code	Lab Name	Credit
CSDL7012	**Quantum Computing Lab**	**1**

Prerequisite: Python Programming Language.	
Lab Objectives:	
1	To implement fundamental quantum computing concepts
2	To learn quantum computation and quantum information
3	To understand quantum entanglement, quantum algorithms
4	To understand quantum information theory and channels
Lab Outcomes: Students will be able to	
1	Implement basic quantum computing logic by building dice and random numbers using open source simulation tools.
2	Understand quantum logic gates using open source simulation tools.
3	Implement quantum circuits using open source simulation tools.
4	I implement quantum algorithms using open source simulation tools.

Suggested Experiments: Students are required to complete at least 10 experiments.Faculty may develop their own set of experiments for students. List below is only suggestive.

Sr. No.	Name of the Experiment
1	Building Quantum dice
2	Building Quantum Random No. Generation
3	Composing simple quantum circuits with q-gates and measuring the output into classical bits.
4	Implementation of Shor‘s Algorithms
5	Implementation of Grover‘s Algorithm
6	Implementation of Deutsch‘s Algorithm
7	Implementation of Deutsch-Jozsa‘s Algorithm
8	Quantum Circuits
9	Qubit Gates
10	Bell Circuit & GHZ Circuit
11	Accuracy of Quantum Phase Estimation

12	Mini Project such as implementing an API for efficient search using Grover's Algorithms or Integer factorization using Shor's Algorithm.

Useful Links:	
1	IBM Experience: https://quantum-computing.ibm.com/
2	Microsoft Quantum Development Kit https://azure.microsoft.com/en-us/resources/development-kit/quantum-computing/#overview
3	Forest SDK PyQuil: https://pyquil-docs.rigetti.com/en/stable/
4	Google Quantum CIRQ https://quantumai.google/cirq
5	Qiskit Labs IBM https://learn.qiskit.org/course/ch-labs/lab-1-quantum-circuits

Term Work:	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSDL7012 and CSDC7012

Lab Code	Lab Name	Credit
CSDL7013	**Natural Language Processing Lab**	**1**

Prerequisite: Java/Python	
Lab Objectives:	
1	To understand the key concepts of NLP.
2	To learn various phases of NLP.
3	To design and implement various language models and POS tagging techniques
4	To understand various NLP Algorithms.
5	To learn NLP applications such as Information Extraction, Sentiment Analysis, Question answering, Machine translation etc.
6	To design and implement applications based on natural language processing.
Lab Outcomes:	
1	Apply various text processing techniques.
2	Design a language model for word-level analysis.
3	Model linguistic phenomena with formal grammar.
4	Design, implement, and analyze NLP algorithms.
5	To apply NLP techniques to design real-world NLP applications such as machine translation, sentiment analysis, text summarization, Information extraction, Question Answering systems etc.
6	Implement a proper experimental methodology for training and evaluating empirical NLP systems.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Study various applications of NLP and Formulate the Problem Statement for Mini Project based on chosen real world NLP applications: [Machine Translation, Text Categorization, Text summarization, chat Bot, Plagiarism, Spelling & Grammar checkers, Sentiment / opinion analysis, Question answering, Personal Assistant, Tutoring Systems, etc.]

2	Apply various text preprocessing techniques for any given Indian Regional Language text: Tokenization and Filtration.
3	Apply various other text preprocessing techniques for any given text: Stop Word Removal, Lemmatization / Stemming.
4	Implement the N-Gram model for the given text input.
5	Study the different POS taggers, perform POS tagging on the given text, and Perform Chunking for the given text input.
6	Implement a Named Entity Recognizer for the given text input. (Domain-specific example bank, political news, tourism)
7	Implement a Text Similarity Recognizer(news similarity) for the chosen text documents.
8	Exploratory data analysis of a given text (Word Cloud)
9	To develop a Bag-of-Words Model for Sentiment Analysis.
10	Develop a Character-Based or word-based Neural Language Model for text generation.
11	Mini Project Report: For anyone chosen real-world NLP application.
12	Implementation and Presentation of Mini Project

Useful Links:	
1	Natural Language Toolkit NLTK https://www.nltk.org/
2	SpaCy https://spacy.io/
3	PyTorch-NLP https://pytorchnlp.readthedocs.io/en/latest/
4	StanfordNLP https://corenlp.run/
5	KenLM **:** https://kheafield.com/code/kenlm/
6	SRILM : http://www.speech.sri.com/projects/srilm
7	Google n-gram viewer : https://books.google.com/ngrams/

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSDL 7013 and CSDC7013

Lab Code	Lab Name	Credit
CSDL7021	**Augmented and Virtual Reality Lab**	**1**

Prerequisite: Computer Graphics, Image Processing, Python	
Lab Objectives:	
1	To perform installation of Unity
2	To explore working of VR Gadget
3	To develop scene VR application
4	To track objects in virtual environment
Lab Outcomes:	
1	Setup VR development environment
2	Use HTC Vive/ Google Cardboard/ Google Daydream and Samsung gear VR.
3	Develop VR scene and place object
4	Work with Augmented Faces features.

Suggested Experiments: Students are required to complete at least 8 experiments.

Sr. No.	Name of the Experiment
1	Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
2	Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.
3	Develop a scene in Unity that includes: i. a cube, plane and sphere, apply transformations on the 3 game objects. ii. add a video and audio source
4	Develop a scene in Unity that includes a cube, plane and sphere. Create a new material and texture separately for three Game objects. Change the colour, material and texture of each Game object separately in the scene. Write a C# program in visual studio to change the colour and material/texture of the game objects dynamically on button click.

5	Develop a scene in Unity that includes a sphere and plane . Apply Rigid body component, material and Box collider to the game Objects. Write a C# program to grab and throw the sphere using the vr controller.
6	Develop a simple UI(User interface) menu with images, canvas, sprites and buttons. Write a C# program to interact with UI menu through VR trigger button such that on each successful trigger interaction display a score on scene
7	Place a three-dimensional ARCore pawn on detected AR plane surfaces
8	Using the Augmented Faces feature in your own apps.

Term Work:	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSDL7021 and CSDC7021

Lab Code	Lab Name	Credit
CSDL7022	**Blockchain Lab**	**1**

Prerequisite: Cryptography and Network Security	
Lab Objectives:	
1	To explore Blockchain concepts.
2	To implement public and private Blockchain.
3	To create applications using Blockchain.
Lab Outcomes:	
1	Creating Cryptographic hash using merkle tree.
2	Design Smart Contract using Solidity.
3	Implementing ethereum blockchain using Geth.
4	Demonstrate the concept of blockchain in real world application.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Cryptography in Blockchain, Merkle root tree hash
2	Create a Blockchain using Python
3	Create a Crypto Currency using Python for the blockchain implemented experiment 2
4	Case Study on different blockchain platforms.
Identify a Domain as per your choice and perform the below experiments with respect to the selected domain	
5	Creating Smart Contract and performing transactions using Solidity and Remix IDE
6	Implement the embedding wallet and transaction using Solidity
7	Implement the Blockchain platform ethereum using Geth
8	Implement the Blockchain platform Ganache
9	Testing Interoperability and Cross-Chain Communication between platforms
10	Presentation on a suitable platform that meets the need of the Mini Project

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSDC7022 and CSDL7022

Lab Code	Lab Name	Credit
CSDL7023	**Information Retrieval Lab**	**1**

Prerequisite:	
Lab Objectives:	
1	To understand the formation of queries.
2	To implement the various modeling techniques for IR.
3	To execute query expansion techniques.
4	To evaluate Information retrieval systems.
Lab Outcomes:	
1	To frame queries for information retrieval
2	To implement modeling techniques
3	To perform query expansion techniques
4	To demonstrate evaluation techniques for IR

Suggested Experiments: Students are required to perform any **5 experiments** from the suggested list along with **a case study** (* indicates compulsory experiment)

Sr. No.	Name of the Experiment
1	To understand the query structure and execute various structured queries
2	To implement any IR modeling technique
3	To implement Pattern matching method used for IR
4	To execute query expansion technique (Local/Global)
5	To design inverted indices for any information retrieval model
6	To implement tf-id weighting
7	To evaluate the system/application under study
8	To understand the Case Study and generate a report for the same

Term Work:	
1	Term work should consist of 5 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSDL7023 and CSDC7023

Course Code	Course Title	Credit
CSP701	**Major Project 1**	**3**

The project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification, analyzing the problem and designing solutions	
Course Objectives:	
1	To identify and define an appropriate problem statement.
2	To perform extensive literature survey and feasibility study for the chosen problem statement.
3	To propose suitable methodology for solving the defined problem.
4	To design and implement solutions which will impact society and the environment in a positive manner.
5	To inculcate team spirit, professional, ethical behavior and leadership skills
6	To create well formatted documents using standard engineering practices
Course Outcomes:	
1	Develop the understanding of the problem domain through extensive review of literature.
2	Identify and analyze the problem in detail to define its scope with problem specific data.
3	To know various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
4	To design solutions for real-time problems that will positively impact society and the environment..
5	To develop clarity of presentation based on communication,teamwork and leadership skills.
6	To inculcate professional and ethical behavior.

Guidelines:
1. Project topic selection and allocation:
Project topic selection process to be defined and followed: ● Project orientation can be given at the end of sixth semester. ● Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects. ● Student's should be recommended to refer papers from reputed conferences / journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature. ● Students can certainly take ideas from anywhere, but be sure that they should evolve them in a unique way to suit their project requirements. Students can be informed to refer to Digital India portal, SIH portal or any other hackathon portal for problem selection. **Topics can be finalized with respect to following criterion:** ● Topic Selection: The topics selected should be novel in nature (Product based, Application based or Research based) or should work towards removing the lacuna in currently existing systems. ● Technology Used: Use of latest technology or modern tools can be encouraged. o Students should not repeat work done previously (work done in the last three years). ● Project work must be carried out by the group of at least 3 students and maximum 4. ● The project work can be undertaken in a research institute or organization/ industry/ any business establishment (out-house projects). ● The project proposal presentations can be scheduled according to the domains and should be judged by faculty who are experts in the domain. ● Head of the department and senior staff along with project coordinators will take decisions regarding final selection of projects. ● Guide allocation should be done and students have to submit weekly progress reports to the internal guide. ● Internal guide has to keep track of the progress of the project and also has to maintain attendance reports. This progress report can be used for awarding term work marks. ● In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels.
2. Project Report Format:

At the end of semester, each group needs to prepare a project report as per the guidelines issued. A project report should preferably contain at least following details: ● Abstract ● Introduction ● Literature survey of existing system ● Limitation of existing system or research gap ● Problem statement and objectives ● Timeline Chart for Term1 and Term-II (Project Management tools can be used.) ● Proposed system ● Conceptual(block & modular diagram) ● Detailed design (DFDs, Use case, activity diagrams, etc,.) ● Methodology (your approach to solve the problem) ● Proposed Experimental Set up ● Details of Dataset ● Performance Evaluation Parameters (for Validation) ● Conclusion ● References ● Implementation Plan for Next Semester Desirable Students can be asked to undergo Certification courses during the semester timeline (for the technical skill set that will be useful and applicable for projects.)
3.Term Work: (50)
Distribution of marks for term work shall be done based on following: ● Weekly Log Report ● Project Work Contribution ● Project Report (Spiral Bound) (both side print) ● Term End Presentation (Internal) The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.
In continuous assessment focus shall also be on each individual student,assessment based on individual's contribution in group activity, their understanding and response to questions.
4. Oral and Practical:
Oral and Practical examination (Final Project Evaluation) of Project 1 should be conducted by Internal and External examiners approved ,at the end of the semester. Suggested quality evaluation parameters are as follows: ● Quality of problem selected ● Clarity of problem definition and feasibility of problem solution ● Relevance to the specialization / industrial trends ● Originality ● Clarity of objective and scope ● Quality of analysis and design ● Quality of written and oral presentation ● Individual as well as team work

Course Code:	Course Title	Credit
CSC801	**Distributed Computing**	**3**

Prerequisite: Computer Networks and Operating Systems.	
Course Objectives:	
1	To provide students with contemporary knowledge in distributed systems.
2	To explore the various methods used for communication in distributed systems.
3	To provide skills to measure the performance of distributed synchronization algorithms.
4	To provide knowledge of resource management, and process management including process migration.
5	To learn issues involved in replication, consistency, and file management.
6	To learn the concept of a distributed file system and middleware technologies
Course Outcomes:	
1	Demonstrate knowledge of the basic elements and concepts related to distributed system technologies
2	Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object based middleware.
3	Analyze the various techniques used for clock synchronization, mutual exclusion and deadlock.
4	Demonstrate the concepts of Resource and Process management.
5	Demonstrate the concepts of Consistency, Replication Management and fault Tolerance.
6	Apply the knowledge of Distributed File systems and middleware technologies.

Module		Content	Hours
1		**Introduction to Distributed Systems**	04
	1.1	Characterization of Distributed Systems:,Issues, Goals, and Types of distributed systems, Hardware and Software Concepts: NOS, DOS.	
	1.2	**Middleware:** Models of middleware, Services offered by middleware**.**	
2		**Communication**	**04**

	2.1	Interprocess communication (IPC): Remote Procedure Call (RPC), Remote Method Invocation (RMI).	
	2.2	Message-Oriented Communication, Stream Oriented Communication, Multicast Communication, Gossip Protocol, Group Communication	
3		**Synchronization**	**10**
	3.1	Clock Synchronization: Physical clock, Logical Clocks, Election Algorithms	
	3.2	Distributed Mutual Exclusion, Requirements of Mutual Exclusion Algorithms and Performance measures. Non- token Based Algorithms: Lamport, Ricart–Agrawala's and Maekawa's Algorithms; Token-based Algorithms: Suzuki-Kasami's Broadcast Algorithms and Raymond's Tree-based Algorithm; and Comparative Performance Analysis	
	3.3	Deadlock detection in distributed systems: Introduction – System model – Models of deadlocks – Chandy–Misra–Haas algorithm	
4		**Resource and Process Management**	**07**
	4.1	Desirable Features of Global Scheduling algorithm, Task assignment Approach, Load balancing approach and load sharing approach	
	4.2	Introduction to Process Management, Process Migration, Code Migration.	
5		**Replication, Consistency and Fault Tolerance**	**08**
	5.1	Distributed Shared Memory: Architecture, design issues.Algorithms for Implementing DSM, Memory Coherence, Coherence Protocols	
	5.2	Introduction to replication and consistency, Data-Centric and Client-Centric Consistency Models, Replica Management.	
	5.3	Fault Tolerance: Introduction, Design Issues, Failure Masking and Replication, Agreement in Faulty Systems, Failure Detection, Process resilience, Recovery.	
6		**Current Trends and Case studies**	**06**
	6.1	Introduction and features of DFS, File models, File Accessing models, File Caching Schemes, File Replication, File System Performance and Scalability	
	6.2	Case Studies of Distributed File Systems ,Hadoop HDFS, Google File System, Apache Cassandra File System (CFS),Amazon S3 etc.	
	6.3	Case studies of middleware: Content Management Middleware, Payment Gateway Middleware, Message-Oriented Middleware (MOM), API Management Middleware, CORBA etc.	

		Total	**39**

Textbooks:	
1	Andrew S. Tanenbaum and Maarten Van Steen, Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education.
2	Mukesh Singhal, Niranjan G. Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems", MC Graw Hill education.
3	Pradeep K.Sinha, "Distributed Operating System-Concepts and design", PHI.
Reference Books:	
1	M. L. Liu, ―Distributed Computing Principles and Applications‖, Pearson Addison Wesley, 2004
2	George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems: Concepts and Design", 4th Edition, Pearson Education, 2005

Useful Digital Links	
1	https://nptel.ac.in/courses/106106107
2	https://nptel.ac.in/courses/106106168
3	http://csis.pace.edu/~marchese/CS865/Lectures/Chap7/Chapter7fin.htm
4	https://nptel.ac.in/courses/106104182

Internal Assessment:

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Continuous Assessment:

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8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
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Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
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2	All Question carries equal Marks	
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4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
CSDC8011	**Deep Learning**	**3**

Prerequisite: Basic mathematics and Statistical concepts, Linear Algebra, Machine Learning	
Course Objectives:	
1	To learn the fundamentals of Neural networks.
2	To gain an in-depth understanding of training Deep Neural Networks.
3	To acquire knowledge of advanced concepts of Convolution Neural Networks, Autoencoders, and Recurrent Neural Networks.
4	Students should be familiar with the recent trends in Deep Learning
Course Outcomes:	
1	Gain basic knowledge of Neural Networks.
2	Acquire an in-depth understanding of training Deep Neural Networks.
3	Design appropriate DNN model for supervised applications.
4	Design appropriate DNN model for unsupervised applications.
5	Design appropriate DNN models for sequence learning applications.
6	Gain familiarity with recent trends and applications of Deep Learning.

Module		Content	Hours
1		**Fundamentals of Neural Network**	**04**
	1.1	Biological neuron, Mc-Culloch Pitts Neuron, Perceptron, Perceptron Learning, Delta learning, Multilayer Perceptron	
	1.2	Linearly separable, linearly non-separable classes, Deep Networks: Fundamentals, Brief History, Three Classes of Deep Learning Basic Terminologies of Deep Learning,	
2		**Training, Optimization and Regularization of Deep Neural Network**	**10**
	2.1	Training Feedforward DNN Multi-Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function	

	2.2	Optimization**:** Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp	
	2.3	Regularization**:** Overview of Overfitting, Types of biases, Bias Variance Tradeoff Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output,	
3		**Autoencoders: Unsupervised Learning**	**05**
	3.1	Introduction, Linear Autoencoder, Under complete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders	
	3.2	Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders	
	3.3	Application of Autoencoders: Image Compression	
4		**Convolutional Neural Networks (CNN): Supervised Learning**	**06**
	4.1	Convolution operation, Padding, Stride, Relation between input, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function	
	4.2	Modern Deep Learning Architectures: LeNET: Architecture, AlexNET: Architecture	
5		**Recurrent Neural Networks (RNN):**	**08**
	5.1	Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNNBackpropagation Through Time (BTT), Vanishing and Exploding Gradients, Truncated BTT	
	5.2	Long Short-Term Memory: Selective Read, Selective write, Selective Forget, Gated Recurrent Unit	
6		**Recent Trends and Applications:**	**06**
	6.1	Transfer Learning, Customize a pre-trained model: Feature Extraction, Fine-Tuning, Transfer Learning Implementation using VGG16 Model/ MobileNetV2/YOLO/GloVe/ ResNet50	
	6.2	Generative Adversarial Network (GAN): Architecture, Applications: Image Generation, DeepFake, ChatGPT	
		Total	**39**

Textbooks:	
1	Ian Goodfellow, Yoshua Bengio, Aaron Courville. ―Deep Learning‖, MIT Press Ltd, 2016
2	Li Deng and Dong Yu, ―Deep Learning Methods and Applications‖, Publishers Inc.
3	Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4	JM Zurada ―Introduction to Artificial Neural Systems‖, Jaico Publishing House
5	M. J. Kochenderfer, Tim A. Wheeler. ―Algorithms for Optimization‖, MIt Press..
Reference Books:	
1	Buduma, N. and Locascio, N., ―Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc.".
2	François Chollet. ―Deep learning with Python ―(Vol. 361). 2018 New York: Manning.
3	Douwe Osinga. ―Deep Learning Cookbook‖, O'REILLY, SPD Publishers, Delhi.
4	Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc
5	Charu.C.Aggarwal, "Neural Networks and Deep Learning", Springer, 1st Edition
6	S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India

Useful Links	
1	https://nptel.ac.in https://deeplearning.cs.cmu.edu/S21/index.html
2	http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3	https://nptel.ac.in/courses/106/106/106106184/
4	https://www.deeplearningbook.org/
5	https://www.coursera.org/specializations/deep-learning

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Course Code	Course Title	Credit
CSDC8012	**Digital Forensics**	**3**

Prerequisite:	
Course Objectives:	
1	To discuss the need and process of digital forensics and Incident Response Methodology.
2	To explore the procedures for identification, preservation, and acquisition of digital evidence.
3	To explore techniques and tools used in digital forensics for Operating system and malware investigation
4	To explore techniques and tools used for Mobile forensics and browser, email forensics
Course Outcomes:	
1	Discuss the phases of Digital Forensics and methodology to handle the computer security incident.
2	Describe the process of collection, analysis and recovery of the digital evidence.
3	Explore various tools to analyze malwares and acquired images of RAM/hard drive
4	Acquire adequate perspectives of digital forensic investigation in mobile devices
5	Analyze the source and content authentication of emails and browsers
6	Produce unambiguous investigation reports which offer valid conclusions.

Module		Content	Hours
1		**Introduction to Digital Forensics**	**06**
	1.1	Digital Forensics Definition, Digital Forensics Goals, Digital Forensics Categories - Computer Forensics, Mobile Forensics, Network Forensics, Database Forensics	
	1.2	Introduction to Incident - Computer Security Incident, Goals of Incident Response, CSIRT, Incident Response Methodology, Phase after detection of an incident	
2		**Digital Evidence, Forensics Duplication and Digital Evidence Acquisition**	**09**
	2.1	Digital evidence, Types of Digital Evidence, Challenges in acquiring Digital evidence, Admissibility of evidence, Challenges in evidence handling, Chain of Custody	

	2.2	Digital Forensics Examination Process - Seizure, Acquisition, Analysis, Reporting. Necessity of forensic duplication, Forensic image formats, Forensic duplication techniques,.	
	2.3	Acquiring Digital Evidence - Forensic Image File Format, Acquiring Volatile Memory (Live Acquisition), Acquiring Nonvolatile Memory (Static Acquisition), Hard Drive Imaging Risks and Challenges, Network Acquisition	
3		**Forensics Investigation**	**04**
	3.1	Analyzing Hard Drive Forensic Images, Analyzing RAM Forensic Image, Investigating Routers	
	3.2	Malware Analysis - Malware, Viruses, Worms, Essential skills and tools for Malware Analysis, List of Malware Analysis Tools and Techniques	
4		**Windows and Unix Forensics Investigation**	**08**
	4.1	Investigating Windows Systems - File Recovery, Windows Recycle Bin Forensics, Data Carving, Windows Registry Analysis, USB Device Forensics, File Format Identification, Windows Features Forensics Analysis, Windows 10 Forensics, Cortana Forensics	
	4.2	Investigating Unix Systems - Reviewing Pertinent Logs, Performing Keyword Searches, Reviewing Relevant Files, Identifying Unauthorized User Accounts or Groups, Identifying Rogue Processes, Checking for Unauthorized Access Points, Analyzing Trust Relationships	
5		**Mobile Forensics**	**08**
	5.1	Android Forensics, Mobile Device Forensic Investigation - Storage location, Acquisition methods, Data Analysis	
	5.2	GPS forensics - GPS Evidentiary data, GPS Exchange Format (GPX), GPX Files, Extraction of Waypoints and TrackPoints, Display the Tracks on a Map.	
	5.3	SIM Cards Forensics - The Subscriber Identification Module (SIM), SIM Architecture, Security, Evidence Extraction.	
6		**Browser, Email Forensic & Forensic Investigation Reporting**	**04**
	6.1	Web Browser Forensics, Google chrome, Other web browser investigation Email forensics - Sender Policy Framework (SPF), Domain Key Identified Mail (DKIM), Domain based Message Authentication Reporting and Confirmation (DMARC)	

	6.2	Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report	
		Total	**39**

Textbooks:	
1	Kevin Mandia, Chris Prosise, ―Incident Response and computer forensics‖, Tata McGrawHill, 2006
2	Digital Forensics Basics A Practical Guide Using Windows OS — Nihad A. Hassan, APress Publication, 2019
3	Xiaodong Lin, ―Introductory Computer Forensics: A Hands-on Practical Approach‖, Springer Nature, 2018

Suggested MOOC Course Links	
1	Course on ―Ethical Hacking‖ https://nptel.ac.in/courses/106/105/106105217/
2	Course on ―Digital Forensics‖ https://onlinecourses.swayam2.ac.in/cec20_lb06/preview
3	Course on Cyber Incident Response https://www.coursera.org/learn/incident-response
4	Course on ―Penetration Testing, Incident Responses and Forensics‖ https://www.coursera.org/learn/ibm-penetration-testing-incident-response-forensics

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Course Code:	Course Title	Credit
CSDC8013	**Applied Data Science**	3

Prerequisite: Engineering Mathematics, Machine Learning, Data Structures & Algorithms	
Course Objectives:	
1	To introduce students to the basic concepts of data science.
2	To acquire an in-depth understanding of data exploration and data visualization.
3	To be familiar with various anomaly detection techniques.
4	To understand the data science techniques for different applications.
Course Outcomes:	
1	To gain fundamental knowledge of the data science process.
2	Apply different methodologies and evaluation strategies.
3	To apply data exploration and visualization techniques
4	To apply anomaly detection techniques.
5	To gain an in-depth understanding of time-series forecasting.
6	To apply Optimization Techniques and explore data science techniques to real world applications.

Module		Content	Hours
1		**Introduction to Data Science**	05
	1.1	Introduction to Data Science, Data Science Process	
	1.2	Motivation to use Data Science Techniques: Volume, Dimensions and Complexity, Data Science Tasks and Examples	
	1.3	Overview of Data Preparation, Modeling, Difference between data science and data analytics	
2		**Data Exploration**	10
	2.1	Descriptive Statistics: Univariate Exploration: Measure of Central Tendency(Methods to calculate Arithmetic Mean,Weighted Mean,Median,Mode) Measure of Dispersion(Range,Quartile Deviation,IQR),Measures of Skewness (Karl Pearson Coeff.of skewness, Bowley's Coefficient of skewness), Measures of Kurtosis	

		Multivariate Exploration:Correlation Analysis, Concept of Correlation,Bivariate Distribution,Covariance Types of correlation, Karl Pearson's Coefficient of Correlation	
	2.2	Inferential Statistics: Overview of Various forms of distributions: Normal, Poisson Statistical Inference-Tests of Significance: Procedure for testing a Hypothesis,Significance tests in Attributes,Test of significance of a single Mean, Central limit theorem, Confidence Interval, Z-test, t-test, Type-I, Type-II Errors, F-Distribution and Analysis of Variance(ANOVA)	
3		**Methodology and Data Visualization**	**06**
	3.1	Methodology: Overview of model building, Cross Validation, K-fold cross validation, leave-1 out, Bootstrapping	
	3.2	Data Visualization Univariate Visualization: Histogram, Quartile, Distribution Chart Multivariate Visualization: Scatter Plot, Scatter Matrix, Bubble chart, Density Chart, Roadmap for Data Exploration	
		Self-Learning Topics: Visualizing high dimensional data: Parallel chart, Deviation chart, Andrews Curves.	
4		**Anomaly Detection**	**06**
	4.1	Outliers, Causes of Outliers, Anomaly detection techniques, Outlier Detection using Statistics	
	4.2	Outlier Detection using Distance based method, Outlier detection using density-based methods, SMOTE	
5		**Time Series Forecasting**	**08**
	5.1	Taxonomy of Time Series Forecasting methods, Time Series Decomposition	
	5.2	Smoothening Methods: Average method, Moving Average smoothing, Time series analysis using linear regression, ARIMA Model, Performance Evaluation: Mean Absolute Error, Root Mean Square Error, Mean Absolute Percentage Error, Mean Absolute Scaled Error	
	5.3	Self Learning Topics**:** Evaluation parameters for Classification, regression and clustering.	
6		**Optimization Techniques and Applications of Data Science**	
	6.1	Optimization: Global and local optima; Unconstrained and constrained optimization; Introduction to least-squares optimization	**04**
	6.2	Predictive Modeling: House price prediction, Fraud Detection Clustering: Customer Segmentation,Use cases for Health care, Time series forecasting: Weather Forecasting, Recommendation engines: Product recommendation	
		Total	**39**

Textbooks:	
1	Vijay Kotu, Bala Deshpande. “Data Science Concepts and Practice”, Elsevier, M.K. Publishers.
2	Steven Skiena, “Data Science Design Manual”, Springer International Publishing AG
3	Samir Madhavan. “Mastering Python for Data Science”, PACKT Publishing
4	Dr. P. N. Arora, Sumeet Arora, S. Arora, Ameet Arora, “Comprehensive Statistical Methods”, S.Chand Publications, New Delhi.
Reference Books:	
1	Jake VanderPlas. “Python Data Science Handbook”, O’reilly Publications.
2	Francesco Ricci, Lior Rokach, Bracha Shapira, Paul B. Kantor, “Recommender Systems Handbook”, Springer.
3	S.C. Gupta, V. K. Kapoor “Fundamentals of Mathematical Statistics”, S. Chand and Sons, New Delhi.
4	B .L .Agrawal. “Basic Statistics”, New Age Publications, Delhi.

Useful Links	
1	https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2	https://onlinecourses.nptel.ac.in/noc21_cs69/preview
3	https://www.coursera.org/specializations/applied-data-science
4	www.IntroDataScience.com.
5	https://rapidminer.com/
6	https://julialang.org/
7	https://towardsdatascience.com/machine-learning/home

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Course Code:	Course Title	Credit
CSDC8021	**Optimization in Machine learning**	**3**

Prerequisite: Engineering Mathematics, Algorithms and data structures	
Course Objectives:	
1	Understand, analyze and apply existing derivative based optimization algorithms
2	Analyze and apply stochastic methods in optimization
3	Analyze convex optimization for machine learning problems
4	Understand real life problems and apply evolutionary methods to optimize them
Course Outcomes:	
1	To apply foundational optimization ideas
2	To understand first order optimization methods
3	To compare various stochastic methods of optimization
4	To apply convex optimization algorithm
5	To analyze and demonstrate several population methods in Evolutionary Computation
6	To apply advanced evolutionary algorithms such as particle swarm and ant colony optimization

Module		Content	Hours
1		**Introduction and Background to Optimization Theory**	**04**
	1.1	Basic Ingredients of Optimization Problems, Optimization Problem Classifications, Optima Types, Optimization Method Classes, Overview of Unconstrained and Constrained Optimization, Basics of convex optimization	
2		**Derivative based Optimization**	**10**
	2.1	The Basics of Optimization (univariate, bivariate and multivariate optimization), Convex Objective Functions	

	2.2	First-Order optimization Methods : Gradient Descent, Conjugate Gradient, Momentum, Nesterov Momentum, Adagrad, RMSProp, learning rate optimization	
	2.3	Second order optimization: Newton method	
3		**Stochastic Methods**	**06**
		Noisy Descent, Mesh Adaptive Direct Search, Cross-Entropy Method, Natural Evolution Strategies, Covariance Matrix Adaptation	
4		**Convex Optimization**	**06**
		Optimization problems, Convex optimization, Linear optimization problems, Quadratic optimization problems, Geometric programming, Overview of Generalized inequality constraints and Vector optimization	
5		**Evolutionary Methods**	**08**
	5.1	Introduction to Evolutionary Computation: Generic Evolutionary Algorithm, Representation: The Chromosome, Initial Population, Fitness Function, Selection: Selective Pressure, Random Selection, Proportional Selection, Tournament Selection, Rank-Based Selection, Elitism and Evolutionary Computation versus Classical Optimization, Stopping conditions	
	5.2	Canonical Genetic Algorithm, Binary Representations of Crossover and Mutation: Binary Representations, Control Parameters	
6		**Advance Evolutionary Methods**	**05**
	6.1	Basic Particle Swarm Optimization, Global Best PSO, Local Best PSO, g-best versus l-best PSO, Velocity Components, Geometric Illustration, Algorithm Aspects, Social Network Structures	
	6.2	Ant Colony Optimization Meta-Heuristic, Foraging Behavior of Ants, Stigmergy and Artificial Pheromone, Simple Ant Colony Optimization, Ant System, Ant Colony System	
		Total	**39**

Textbooks:	
1	Algorithms for Optimization, Mykel J. Kochenderfer, Tim A.Wheeler, The MIT Press (2019)
2	Computational Intelligence-An Introduction, Andries P Engelbrecht, Second-Edition, Wiley publication
3	Linear Algebra and Optimization for Machine Learning, Charu C. Aggarwal, A Textbook, Springer (2020)
Reference Books:	
1	Convex Optimization, Stephen Boyd, Department of Electrical Engineering, Stanford University and Lieven Vandenberghe, Electrical Engineering Department, University of California, Los Angeles, Cambridge University Press
2	Genetic Algorithms in Search, optimization and machine learning, David D Goldberg, Addison Wesley
3	Optimization for Machine Learning, Suvrit Sra, Sebastian Nowozin, Stephen J. Wright, - The MIT Press
4	Optimization techniques and applications with examples, Xin-She Yang Middlesex University London, Wiley
5	Introduction to Evolutionary Computing, A.E. Eiben, J. E. Smith, Springer

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2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
CSDC8022	**High Performance Computing**	**3**

Prerequisite: Computer Architecture, Operating System, Cloud Computing	
Course Objectives:	
1	Introduce the fundamental concepts of high-performance computing (HPC) architecture and parallel computing
2	Provide foundations for developing, analyzing, and implementing parallel algorithms using parallelization paradigms like MPI, OpenMP, OpenCL, and CUDA.
3	Introduce range of activities associated with HPC in Cloud
Course Outcomes:	
1	Understand parallel and pipeline processing approaches
2	Design a parallel algorithm to solve computational problems and identify issues in parallel programming.
3	Analyze the performance of parallel computing systems for clusters in terms of execution time, total parallel overhead, speedup.
4	Develop efficient and high-performance parallel algorithms using OpenMP and message passing paradigm
5	Develop high-performance parallel programming using CUDA framework
6	Perform the range of activities associated with High Performance Computing in CloudComputing

Module		Content	Hrs
1		**Introduction to Parallel Computing**	**05**
	1.1	Parallelism (What, Why, Applications), Levels of parallelism (instruction, transaction, task, thread, memory, function)	
	1.2	Classification Models: Architectural Schemes (Flynn‘s, Shore‘s, Feng‘s, Handler‘s)	
	1.3	Memory Access: Distributed Memory, Shared Memory, Hybrid DistributedShared Memory	
	1.4	Parallel Architecture: Pipeline Architecture: Arithmetic pipelines, Floating Point, Array Processor	

2		**Parallel Programming Platform and Algorithm Design**	10
	2.1	Parallel Programming Platform: Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines	
	2.2	Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models.	
3		**Performance Measures**	**04**
		Performance Measures: Speedup, execution time, efficiency, cost, scalability, Effect of granularity on performance, Scalability of Parallel Systems, Folk Theorem, Amdahl's Law, Gustafson's Law, Performance Bottlenecks, The Karp Flatt Metric.	
4		**Message Passing**	**05**
		Principles of Message Passing Programming, The Building Blocks Operations, Message Passing Interface, Topology and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations	
5		**HPC Programming: OpenMP and MPI**	**10**
		Thread Basics, The POSIX Thread API, Thread Basics Thread Synchronization, Attributes, Thread Cancellation, Composite Synchronization Constructs. Share memory Architecture, Multi-core processors and Hyperthreading, Fork and join model. OpenMP directives, Processes, Multiprocessor programming model, Distributed system programming model, Inter-process communication using message passing: Asynchronous and Synchronous, MPI Programming, Message passing vs Share memory communication: Advantages and disadvantage	
6		**Parallel programming using accelerators and recent trends**	**05**
	6.1	An Overview of GPGPUs, Introduction to CUDA, Introduction to Heterogeneous Computing using OpenCL, An Overview of OpenCL API, Heterogeneous Programming in OpenCL.	
	6.2	Virtualization and Containerization, HPC in the Cloud Use Cases.	
		Total	**39**

Textbooks:	
1	AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar ―Introduction to Parallel Computing‖, 2nd edition, Addison Wesley, 2003.
2	Shane Cook, Morgan Kaufmann ―CUDA Programming: A Developer's Guide to Parallel Computing with GPUs, 2012.
3	M. R. Bhujade ―Parallel Computing‖,2nd edition, New Age International Publishers, 2009.
4	Kai Hwang, Naresh Jotwani, ―Advanced Computer Architecture: Parallelism, Scalability, Programmability McGraw Hill, Second Edition, 2010.
5	Georg Hager, Gerhard Wellein, Chapman ―Introduction to High Performance Computing for Scientists and Engineers Hall/CRC Computational Science Series, 2011.
Reference Books:	
1	Michael J. Quinn ―Parallel Programming in C with MPI and OpenMPI‖ by, McGraw Hill Education, 2008.
2	Kai Hwang, Zhiwei, Scalable Parallel ComputingTechnology, Architecture,Programming‖, McGraw-Hill Education, 1998.
3	Laurence T. Yang, Minyi Guo, ―High-Performance Computing: Paradigm and Infrastructure‖, by, Wiley, 2006.

Useful Links	
1	https://nptel.ac.in/courses/112105293
2	https://archive.nptel.ac.in/courses/128/106/128106014/

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks

6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
CSDC8023	Social Media Analytics	03

Prerequisite: Graph Theory, Data Mining, Python/R programming	
Course Objectives:	
1	Familiarize the learners with the concept of social media
2	Familiarize the learners with the concept of social media analytics and understand its significance
3	Enable the learners to develop skills required for analyzing the effectiveness of social media.
4	Familiarize the learners with different tools of social media analytics.
5	Familiarize the learner with different visualization techniques for Social media analytics.
6	Familiarize the ethical and legal implications of leveraging social media analytics for business intelligence.
Course Outcomes:	
1	Understand the concept of Social media
2	Understand the concept of social media Analytics and its significance.
3	Learners will be able to analyze the effectiveness of social media
4	Learners will be able to use different Social media analytics tools effectively and efficiently.
5	Learners will be able to use different effective Visualization techniques to represent social media analytics.
6	Acquire the fundamental perspectives, hands-on skills, and ethical knowledge to responsibly leverage social media data for informed business decision-making,

Module		Content	Hours
1		**Social Media Analytics: An Overview**	**06**
		Core Characteristics of Social Media, Types of Social Media, Social media landscape, Need for Social Media Analytics (SMA), SMA in small & large organizations.	

		Purpose of Social Media Analytics, Social Media vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, Social Media Analytics Tools	
2		**Social Network Structure, Measures & Visualization**	**06**
		Basics of Social Network Structure - Nodes, Edges & Tie Describing the Networks Measures - Degree Distribution, Density, Connectivity, Centralization, Tie Strength & Trust Network Visualization - Graph Layout, Visualizing Network features, Scale Issues. Social Media Network Analytics - Common Network Terms, Common Social Media Network Types, Types of Networks, Common Network Terminologies, Network Analytics Tools.	
3		**Social Media Text, Action & Hyperlink Analytics**	**08**
		Social Media Text Analytics - Types of Social Media Text, Purpose of Text Analytics, Steps in Text Analytics, Social Media Text Analysis Tools Social Media Action Analytics - What Is Actions Analytics? Common Social Media Actions, Actions Analytics Tools Social Media Hyperlink Analytics - Types of Hyperlinks, Types of Hyperlink Analytics, Hyperlink Analytics Tools	
4		**Social Media Location & Search Engine Analytics**	**06**
		Location Analytics - Sources of Location Data, Categories of Location Analytics, Location Analytics and Privacy Concerns, Location Analytics Tools Search Engine Analytics - Types of Search Engines, Search Engine Analytics, Search Engine Analytics Tools	
5		**Social Information Filtering**	**06**
		Social Information Filtering - Social Sharing and filtering , Automated Recommendation systems, Traditional Vs social Recommendation Systems Understanding Social Media and Business Alignment, Social Media KPI, Formulating a Social Media Strategy, Managing Social Media Risks	
6		**Digital Marketing, Social Media Analytics Applications and Privacy**	**07**
	6.1	Social media applications in public and private sector, Digital Marketing, Digital marketing and its significance in today's business landscape,Predictive Analytics in Digital Marketing Privacy - Privacy policies, data ownership and maintaining privacy online.	
			39

Textbooks:	
1	Seven Layers of Social Media Analytics_ Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, and Location Data, GoharF. Khan,(ISBN-10: 1507823207).
2	Analyzing the Social Web 1st Edition by Jennifer Golbeck
3	Mining the Social Web_ Analyzing Data from Facebook, Twitter, LinkedIn, and Other Social Media Sites, Matthew A Russell, O'Reilly
4	Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die 2nd Edition, Kindle Editionby Eric Siegel (Author)
Reference Books:	
1	Social Media Analytics [2015], Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, AvinashKohirkar, IBM Press
2	Social Media Analytics Strategy_ Using Data to Optimize Business Performance, Alex Gonçalves, APress Business Team
3	Social Media Data Mining and Analytics, Szabo, G., G. Polatkan, O. Boykin & A. Chalkiopoulos (2019), Wiley, ISBN 978-1-118-82485-6

Useful Links	
1	https://cse.iitkgp.ac.in/~pawang/courses/SC16.html
2	https://onlinecourses.nptel.ac.in/noc20_cs78/preview
3	https://nptel.ac.in/courses/106106146
4	https://7layersanalytics.com/

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks

5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
ILO8021	**Project Management**	**3**

Prerequisite: Software Engineering and its concepts.	
Course Objectives:	
1	To familiarize the students with the use of a structured methodology/approach for each and every unique project
2	Awareness about the utilizing project management concepts, tools and techniques in managing the Project
3	To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure
4	Focus on Planning and Risk management techniques in the development of a Project
5	Effective Techniques for Monitoring and Control of the Projects.
6	Awareness about the ethics to be followed in a project and quality of leadership.
Course Outcomes:	
1	To understand the Necessity of Project management and Project Management Knowledge Areas.
2	Apply selection criteria and select an appropriate project from different options.
3	Perform SWOT Analysis and Prepare a Work Breakdown Structure for a project and develop a schedule based on it.
4	Identify the Risk and solution to it
5	To understand Project Monitoring and Control using various Techniques
6	Project Management towards Effective Leadership and Quality of the project.

Module		Content	Hours
1		**Project Management Foundation:**	
		Definition of a project, Project v/s Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and Role of project manager. Different Forms of Project Management, Project Environment, Project Management for Industry, Service Sector and Public Sector.	**06**

		Negotiations and resolving conflicts. PM knowledge areas as per Project Management Institute (PMI).	
2		**Initiating Projects:**	**06**
		How to get a project started, Selecting projects strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	
3		**Software Project Planning & Software Cost Estimation:**	**08**
		Business Case, Project selection and Approval, Project charter, Project Scope management, Creating the Work Breakdown Structures (WBS). Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS). Software Estimation: Size Estimation: Function Point (Numericals). Cost Estimation: COCOMO (Numericals), COCOMO-II (Numericals) till Early design model.	
4		**Planning Projects:**	**07**
		Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Software Risk Management: Identify IT Project Risk, Risk Analysis and Assessment, Risk Strategies, Risk Monitoring and Control, Risk Response and Evaluation.	
5		**Monitoring and Controlling Projects:**	**06**
		Project Organization, Agile Project Management and Team Building, Earned Value Management techniques for measuring value of work completed; Change Management. Project Contracting : Project procurement management, contracting and outsourcing	
6		**Project Leadership and Ethics:**	**06**
		Introduction to project leadership, ethics in projects. Multicultural and virtual projects. Project Quality Management: Concept of Quality, Process of Quality Management , Quality Assurance Techniques Closing the Project: Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures;	
		Total	**39**

Textbooks:	
1	Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd
2	Gido Clements, Project Management, Cengage Learning.
3	Gopalan, Project Management, , WileyIndia
4	John M Nicholas, Herman Steyn , Project Management for Engineering, Business and Technology, Routledge, Taylor Francis Group.
Reference Books:	
1	Dennis Lock, Project Management, Gower Publishing England, 9 thEd.
2	Managing Information Technology Project, 6th Edition, by Kathy Schwalbe, Cengage Learning publication

Internal Assessment:		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment:		
Sr. No	**Rubrics**	**Marks**
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Activity on Design Thinking and Agile Methodology	10 Marks
3.	Content beyond syllabus presentation	10 Marks
5.	Extra Assignment / Case Studies Assignment	10 Marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 Marks
8.	Multiple Choice Questions (Quiz)	5 Marks
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	

4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code:	Course Title	Credit
ILO 8022	**Finance Management**	**3**

Prerequisite:	
Course Objectives:	
1	To know about the Indian financial system, instruments and market.
2	To understand the relationship between risk, return and time value of Money.
3	To understand the financial statements and ratio analysis.
4	To understand capital budgeting and working capital management.
5	To know about Capital structure and its approaches.
6	To understand different dividend policy theories.
Course Outcomes:	
1	To explain Indian financial system , instrument and market
2	To determine risk, return and time value of Money with respect to financial decisions.
3	To decide investment decisions for projects with the help of financial ratios.
4	To explain capital budgeting structure and working capital management.
5	To discuss the concept of capital structure and its approaches.
6	To apply dividend policies with respect to various scenarios.

Module		Content	Hours
1		**Indian Financial System**	**08**
	1.1	Characteristics, Components and Functions of Financial System. Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares,Bonds-Debentures, Certificates of Deposit, Treasury Bills, Trade credit.	

	1.2	Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and ForeignCurrency Market	
	1.3	Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	
2		**Financial Risk and Returns**	**06**
	2.1	Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio	
	2.2	Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio	
	2.3	Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting	
3		**Corporate Finance**	**09**
	3.1	Overview of Corporate Finance: Objectives of Corporate Finance;Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision	
	3.2	Overview of Financial Statements,Balance Sheet, Profit and Loss Account, and Cash Flow Statement.	
	3.3	Financial Ratio Analysis: Purpose of Financial Ratio Analysis.Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
4		**Capital Budgeting**	**10**
	4.1	Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions	
	4.2	Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV),Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)	
	4.3	Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity‘s Working Capital Needs; Estimation of Working Capital Requirements, Management of Inventories; Management of Receivables, and Management of Cash and Marketable Securities	
5		**Capital Structure**	**03**
	5.1	Factors Affecting an Entity‘s Capital Structure, Overview of Capital Structure Theories	

	5.2	Capital Structure Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
6		**Dividend Policy**	**03**
	6.1	Meaning and Importance of Dividend Policy; Factors Affecting an Entity‘s Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon‘s Approach, Walter‘s Approach and Modigliani Miller Approach	
		Total	**39**

Reference Books:	
1	Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2	Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi
3	Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4	Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L)& Company Limited, New Delhi.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks

6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Course Code	Course Title	Credit
ILO8023	**Entrepreneurship Development and Management**	**3**

Prerequisite: Computer Networks and Operating Systems.	
Course Objectives:	
1	To acquaint with entrepreneurship and management of business
2	Understand Indian environment for entrepreneurship
3	Idea of EDP, MSME
Course Outcome	
1	Understand the Difference between Entrepreneur and Businessman
2	Understand the concept of business plan and ownerships
3	Importance of Women Entrepreneurs in Development
4	Interpret key regulations and legal aspects of entrepreneurship in India
5	Understand government policies for entrepreneurs
6	Concept of success in small business

Module		Content	Hours
1		**Overview of Entrepreneurship:**	
	1.1	Definitions, Businessman v/s entrepreneur, competencies , Roles and Functions of Entrepreneurship,	
	1.2	History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur	**04**
	1.3	Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development:	
	1.4	Contribution of Government Agencies in Sourcing information for Entrepreneurship	
2		**Business Plans And Importance Of Capital To Entrepreneurship: Entrepreneurship And Business Development**	**09**
	2.1	Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected	

		Financial Statements	
	2.2	Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur	
	2.3	Starting a New Business, Buying an Existing Business, New Product Development	
	2.4	Business Growth and the Entrepreneur Law and its Relevance to Business Operations	
3		**Women‘s Entrepreneurship Development**	**05**
	3.1	Social entrepreneurship-role and need	
	3.2	EDP cell, role of sustainability	
	3.3	sustainable development for SMEs, case studies, exercises	
4		**Indian Environment for Entrepreneurship:**	**08**
	4.1	key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc.,	
	4.2	Role of State governments in terms of infrastructure developments and support etc., Public private partnerships,National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
5		**Effective Management of Business:**	**08**
	5.1	Issues and problems faced by micro and small enterprises and effective management of M and S enterprises	
	5.2	BCG matrix,risk management, credit availability, technology innovation,	
	5.3	Supply chain management, linkage with large industries, exercises, e-Marketing	
6		**Achieving Success In The Small Business**	**05**
	6.1	Stages of the small business life cycle, four types of firm-level growth strategies, Options	
	6.2	harvesting or closing small business Critical Success factors of small business	
		Total	**39**

Textbooks:	
1	Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
2	Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
Reference Books:	
1	T N Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
2	C N Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
3	Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
4	Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
5	Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
6	Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
7	Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
8	Laghu Udyog Samachar
9	www.msme.gov.in www.dcmesme.gov.in www.msmetraining.gov.in

Internal Assessment:		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment:		
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3.	Content beyond syllabus presentation	10 marks
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5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject(in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Title	Credit
ILO8029	**Environmental Management**	3

Prerequisite: Knowledge of Environmental Sciences	
Course Objectives:	
1	Understand and identify environmental issues relevant to India and global concerns
2	Understand the global environmental concerns.
3	Learn concepts of ecology
4	Familiarise environment related legislations.
5	Understand concepts of quality management and corporate responsibilities
6	Learn all environmental acts
Course Outcomes:	
1	Understand the concept of environmental management
2	Understand global warming, ozone depletion , and hazards.
3	Understand ecosystem and interdependence, food chain etc.
4	Understand and interpret environment related legislations.
5	Understand total quality management and ISO certification.
6	Understand acts related to air, water, pollution, factories, wildlife and forest protection.

Module		Content	Hrs
1		**Introduction and Definition of Environment:**	**10**
	1.1	Significance of Environment Management for contemporary managers, Career opportunities.	
	1.2	Environmental issues relevant to India, Sustainable Development, the Energy scenario	
2		**Global Environmental concerns** :	**06**
	2.1	Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes.	

	2.2	Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	
3		**Concepts of Ecology**:	**05**
	3.1	Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity.	
4		**Scope of Environment Management**:	**10**
	4.1	Role & functions of Government as a planning and regulating agency.	
	4.2	Environment Quality Management and Corporate Environmental Responsibility	
5		**Total Quality Environmental Management**	**05**
	5.1	ISO-14000, EMS certification	
6		**General overview of major legislations**	**03**
	6.1	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc	
		Total	**39**

Reference Books:	
1	C J Barrow, Environmental Management: Principles and Practice, Routledge Publishers London, 1999
2	Jon C. Lovett and David G. Ockwell, A Handbook of Environmental Management, Edward Elgar Publishing
3	T V Ramachandra and Vijay Kulkarni, Environmental Management, TERI Press
4	Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5	S N Chary and Vinod Vyasulu, Environmental Management: An Indian Perspective, Maclillan India, 2000
6	Mary K Theodore and Louise Theodore, Introduction to Environmental Management, CRC Press Environment and Ecology, Majid Hussain, 3 rd Ed. Access Publishing 2015

Internal Assessment:		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment:		
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers.		
Sr No.	**Rubrics**	**Marks**
1	Content beyond syllabus presentation (case studies)	10 Marks
2	Multiple Choice Questions (Quiz)	10 Marks
End Semester Theory Examination:		
1	Question Paper will comprise a total of six questions	
2	All Question carries equal Marks	
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3	
4	Only Four Questions need to be solved	
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.	

Lab Code	Lab Name	Credit
CSL801	**Distributed Computing Lab**	**1**

Prerequisite: C Programming Language.	
Lab Objectives:	
1	To understand basic underlying concepts of forming distributed systems
2	To learn the concept of clock Synchronization
3	To learn Election Algorithms.
4	To explore mutual exclusion algorithms.
5	To study deadlock handling in the distributed system
6	To understand the Distributed File System
Lab Outcomes:	
1	Develop test and debug using Message-Oriented Communication or RPC/RMI based client-server programs.
2	Implement techniques for clock synchronization
3	Implement techniques for Election Algorithms.
4	Demonstrate mutual exclusion algorithms .
5	Implement techniques of Deadlock handling in distributed system
6	Describe the concepts of distributed File Systems along with case studies.

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Name of the Experiment
1	Write a program to demonstrate Inter-process communication in Client Server Environment.
2	Write a program to design a client server application using Java RMI.
3	Write a program to implement gossip protocol.
4	Write a program to demonstrate Berkeley Clock Synchronization algorithm
5	Write a program to Implement Bully Election algorithm.

6	Write a program to demonstrate Lamport's Algorithm for Distributed Mutual Exclusion
7	Write a program to demonstrate Chandy Mishra Hass algorithm for Deadlock Management in Distributed Systems.
8	Experiment with the application programming interface OpenMP which supports multi-platform shared-memory and multiprocessing programming
9	Experiment with Message Passing Interface Standard (MPI).
10	Case study on any Distributed File System (AFS,HDFS.GFS,NFS, CFS,SMB etc)

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSL801and CSC801

Lab Code	Lab Name	Credit
CSDL8011	**Deep Learning Lab**	**1**

Prerequisite: C Programming Language.	
Lab Objectives:	
1	To implement basic neural network models for simulating logic gates.
2	To implement various training algorithms for feedforward neural networks.
3	To design deep learning models for supervised, unsupervised, and sequence learning.
Lab Outcomes:	
1	Implement basic neural network models to learn logic functions.
2	Design and train feedforward neural networks using various learning algorithms.
3	Build and train deep learning models such as Autoencoders.
4	Build and train deep learning models such as CNNs, RNN, LSTM, and GRU.

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Name of the Experiment
1	McCulloch Pitts model using Virtual Lab 1. Implement McCulloch Pitts model for binary logic functions. 2. To explore Python libraries for deep learning e.g. Theano, TensorFlow, Lasagne , Keras, Scikit-learn, Caffe, MXNet etc.
2	Perceptron Model using Virtual Lab 1. Implement the Perceptron algorithm to simulate any logic gate. 2. Implement a Multilayer Perceptron algorithm to simulate the XOR gate
3	Training, Optimization, and Regularization of Deep Neural Network Apply any of the following learning algorithms to learn the parameters of the supervised single-layer feed-forward neural network. a. Stochastic Gradient Descent b. Mini Batch Gradient Descent c. Momentum GD d. Nestorev GD e. Adagrad GD f. Adam Learning GD

4	Implement a backpropagation algorithm to train a DNN with at least 2 hidden layers.
5	Design and implement a fully connected deep neural network with at least 2 hidden layers for a classification application. Use appropriate Learning Algorithm, output function, and loss function
6	Autoencoders 1. Design the architecture and implement the autoencoder model for Image Compression. 2. Design the architecture and implement the autoencoder model for Image denoising.
7	Convolutional Neural Networks (CNN) 1. Design and implement a CNN model for digit recognition applications. 2. Design and implement a CNN model for image classification.
8	Recurrent Neural Networks (RNN) (any two) 1. To design and implement RNN(Recurrent Neural Network) by using LSTM layer for Multiclass Classification on text data 2. To design and implement an RNN(Recurrent Neural Network) by using GRU layer for Multiclass Classification on text data 3. Implement Dinosaur Island - Character-Level Language Modeling using RNN
9	Case study on Transfer Learning
10	Mini Project focusing on Agriculture / Healthcare / Education /Society domain need to be carried out by the students by using the concepts of deep learning

Useful Links:	
1	TensorFlow (www.tensorflow.org)
2	Keras (keras.io)
3	PyTorch (pytorch.org)
4	Scikit (https://scikit-learn.org/stable/)
5	OpenNN (www.opennn.net)
6	Theano https://github.com/Theano/Theano
7	Caffe https://caffe.berkeleyvision.org/

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.

3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSDL8011and CSDC8011

Lab Code	Lab Name	Credit
CSDL8012	**Digital Forensics Lab**	**1**

Prerequisite: Computer Network, Cryptography and System Security	
Lab Objectives:	
1	To demonstrate the procedures for identification, preservation, and acquisition of digital evidence.
2	To demonstrate techniques and tools used in digital forensics for operating systems and malware investigation.
3	To demonstrate tools for mobile forensics and browser, email forensics
4	To explore scenario based crime forensics investigations.
Lab Outcomes:	
1	Explore various forensics tools and use them to acquire, duplicate and analyze data and recover deleted data.
2	Implement penetration testing using forensics tools.
3	Explore various forensics tools and use them to acquire and analyze live and static data.
4	Verification of source and content authentication of emails and browsers.
5	Demonstrate Timeline Report Analysis using forensics tools.
6	Discuss real time crime forensics investigations scenarios.

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Name of the Experiment
1	Analysis of forensic images using open source tools. ● FTK Imager ● Autopsy
2	Explore forensics tools in kali linux for acquiring, analyzing and duplicating data. ● dd ● dcfldd
3	Performing penetration testing using Metasploit - kali Linux.
4	Performing RAM Forensic to analyze memory images to find traces of an attack. ● Capturing RAM Using the DumpIt Tool ● Volatility tool

5	Network forensics using Network Miner.
6	Windows Recycle Bin Forensics
7	Data Carving using open source tools ● Foremost ● Scalpel ● Jpg Carver
8	USB Device Forensics using ● USBDeview ● USB Detective
9	Web Browser Forensics using DB Browser for SQLite
10	Generate a Timeline Report Using Autopsy
11	Email Analysis
12	Case Study

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSDC8012 and CSDL 8012

Lab Code	Lab Name	Credit
CSDL8013	**Applied Data Science Lab**	**1**

Prerequisite: Engineering Mathematics, Machine Learning, Programming fundamentals	
Lab Objectives:	
1	To explore various stages in the data science lifecycle
2	To understand data preparation, exploration and visualization techniques.
3	To model and evaluate different supervised/unsupervised learning techniques
Lab Outcomes:	
1	Apply various stages of the data science lifecycle for the selected case study.
2	Apply inferential statistics, predictive analytics, and data mining to informatics-related field
3	Demonstrate data preparation, exploration and visualization techniques
4	Implement and evaluate different supervised and unsupervised techniques.

Suggested Experiments: Students are required to complete at least 8 experiments.

Sr. No.	Name of the Experiment
1	Explore the descriptive and inferential statistics on the given dataset.
2	Apply data cleaning techniques (e.g. Data Imputation)
3	Explore data visualization techniques.
4	Implement and explore performance evaluation metrics for Data Models (Supervised/Unsupervised Learning)
5	Use SMOTE technique to generate synthetic data.(to solve the problem of class imbalance)
6	Outlier detection using distance based/density based method.
7	Implement time series forecasting for Healthcare diagnosis
8	Illustrate data science lifecycle for selected case study. (Prepare case study document for the selected case study) Suggested Case Studies: 1. Customer Segmentation 2. Fraud Detection 3. House Price prediction

	4. Product Recommendation 5. Stock price prediction 6. Weather prediction

Term Work:	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSDL8013and CSDC8013

Lab Code	Lab Name	Credit
CSDL8021	**Optimization in Machine Learning Lab**	**1**

Prerequisite: Engineering Mathematics, Algorithms and data structures	
Lab Objectives:	
1	To apply derivative based optimization techniques
2	To understand evolutionary optimization to a given machine learning problem.
3	To apply advanced evolutionary optimization
4	To design and analyze optimization problems for real world applications
Lab Outcomes:	
1	To implement derivative based optimization techniques
2	To implement evolutionary optimization
3	To implement advanced evolutionary optimization
4	To apply efficient optimization algorithm for real world applications

Suggested Experiments: Students are required to complete at least 8 experiments.	
Sr. No.	**Name of the Experiment**
1	To implement Gradient Descent algorithm
2	To implement the Stochastic Gradient Descent algorithm
3	To implement Newton method
4	To apply Genetic Algorithm for real world problem
5	To compare and implement different selection mechanism using genetic algorithm
6	To implement various mutation and crossover mechanisms
7	To implement Particles Swarm optimization
8	To implement Ant colony optimization

Term Work:	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSDL8021 and CSDC8021

Lab Code	Lab Name	Credit
CSDL8022	High Performance Computing Lab	1

Prerequisite: C Programming	
Lab Objectives:	
1	Enable students to build the logic to parallelize the programming task.
2	Give insight about performance of parallel computing systems.
3	Provide hands-on experience on parallel programming platforms/frameworks
Lab Outcomes:	
1	Perform Linux based commands on remote machine
2	Compare the performance of sequential algorithms with parallel algorithms in terms of execution time, speedup and throughput.
3	Implement parallel program using OpenMP library and analyze its performance
4	Implement parallel program using MPIplatform and analyze its performance
5	Implement parallel program using OpenCL framework and analyze its performance
6	Implement parallel program using CUDA framework and analyze its performance

Suggested Experiments: Students are required to complete at least 8 experiments..	
Sr. No.	**Name of the Experiment**
1	To analyse the Linux based computer systems using following commands: a. top , b.ps , c. kill, d. cat /proc/cpuinfoe.vmstat Hardware/Software Requirement: Linux Operating System
2	To set up SSH passwordless logins for two or more Linux based machines and execute commands on a remote machine. Hardware/Software Requirement: Linux Operating System, Multi-core computer systems
3	Write a program in C to multiply two matrices of size 10000 x 10000 each and find its execution-time using the "time" command. Try to run this program on two or more machines having different configurations and compare execution-times obtained in each run. Comment on which factors affect the performance of the program.

	Hardware/Software Requirement: Linux Operating System, gcc compiler,Multi-core computer systems
4	Writing a "Hello World" program using the OpenMP library also displays the number of threads created during execution. Hardware/Software Requirement**:** Linux Operating System, gcc compiler,Dual core with HT or Quad-core or higher computer system.
5	Write a parallel program to calculate the value of PI/Area of Circle using OpenMP library. Hardware/Software Requirement: Linux Operating System, gcc compiler,Dual core with HT or Quad-core or higher computer system
6	Write a parallel program to multiply two matrices using openMP library and compare the execution time with its serial version. Also change the number of threads using omp_set_num_threads() function and analyse how thread count affects the execution time. Hardware/Software Requirement: Linux Operating System, gcc compiler,Dual core with HT or Quad-core or higher computer system.
7	Install MPICH library and write a "Hello World" program for the same. Hardware/Software Requirement: Linux Operating System, MPICH, Multi-processor systems or MPI Cluster.
8	Write a parallel program to multiply two matrices using MPI library and compare the execution-time with its OpenMP and serial version. Hardware/Software Requirement: Linux Operating System, MPICH, gcc, Multi processor systems, or MPI Cluster.
9	Implement a parallel program to demonstrate the cube of N number within a set range using MPI/OpenMP/OpenCL/CUDA. Hardware/Software Requirement: Linux Operating System, MPICH, Multi-processor systems or MPI Cluster. A CUDA-capable GPU,A supported version of Microsoft Windows,A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit
10	Implement Two Vector addition using OpenCL/CUDA/ Parallel Matlab Hardware/Software Requirement: A CUDA-capable GPU, A supported version of Microsoft Windows,A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks

	(Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSDL 8022and CSDC 8022

Lab Code	Lab Name	Credit
CSDL8023	**Social Media Analytics Lab**	**1**

Prerequisite: Types of Graphs, Data Mining, Data Analytics	
Lab Objectives:	
1	To understand the fundamental concepts of social media networks.
2	To learn various social media analytics tools and evaluation matrices.
3	To collect and store social media data.
4	To analyze and visualize social media data
5	To design and develop social media analytics models.
6	To design and build a social media analytics application.
Lab Outcomes:	
1	Understand characteristics and types of social media networks.
2	Use social media analytics tools for business
3	Collect, monitor , store and track social media data
4	Analyze and visualize social media data from multiple platforms
5	Design and develop content and structure based social media analytics models.
6	Design and implement social media data based predictive analytics application for business intelligence.

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	Name of the Experiment
1	Study various - i) Social Media platforms (Facebook, twitter, YouTubeetc) ii) Social Media analytics tools (Facebook insights, google analytics net lyticetc) iii) Social Media Analytics techniques and engagement metrics (page level, post level, member level) iv) Applications of Social media analytics for business. e.g. Google Analytics https://marketingplatform.google.com/about/analytics/ https://netlytic.org/
2	Data Collection-Select the social media platforms of your choice (Twitter, Facebook, LinkedIn, YouTube, Web blogs etc) ,connect to and capture social media data for business (scraping, crawling, parsing).

3	Data Cleaning and Storage- Preprocess, filter and store social media data for business (Using Python, MongoDB, R, etc).
4	Exploratory Data Analysis and visualization of Social Media Data for business.
5	Develop Content (text, emoticons, image, audio, video) based social media analytics model for business. (e.g. Content Based Analysis :Topic , Issue ,Trend, sentiment/opinion analysis, audio, video, image analytics)
6	Develop Structure based social media analytics model for any business. (e.g. Structure Based Models -community detection, influence analysis)
7	Develop a dashboard and reporting tool based on real time social media data.
8	Design the creative content for promotion of your business on social media platform
9	Develop social media text analytics models for comparing competitors and your existing product/service by analyzing customers reviews/ comments.
10	Develop social media data based predictive analytics application (Identifying prospect customers/ predicting analytics for digital marketing campaign ,etc)

Reference Books:	
1	Python Social Media Analytics: Analyze and visualize data from Twitter, YouTube, GitHub, and more Kindle Edition by Siddhartha Chatterjee, Michal Krystyanczuk
2	Learning Social Media Analytics with R,byRaghav Bali, Dipanjan Sarkar, Tushar Sharma.
3	Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013
4	Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github, and More, 2nd Edition, O'Reilly Media, 2013
5	Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks

	(Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Continuous Assessment Exam:	
1	Based on the subject and related lab of CSDL8023 and CSDC 8023

Course Code	Course Title	Credit
CSP801	**Major Project 2**	**6**

The primary objective is to meet the milestones formed in the overall project plan decided in Project -I. The idea presented in Project -I should be implemented in Project -II with results, conclusion and future work. The project will culminate in the production of a thesis by each individual student.	
Course Objectives:	
1	To identify and define an appropriate problem statement.
2	To perform extensive literature survey and feasibility study for the chosen problem statement.
3	To propose suitable methodology for solving the defined problem.
4	To design and implement solutions which will impact society and the environment in a positive manner.
5	To inculcate team spirit, professional, ethical behavior and leadership skills
6	To create well formatted documents using standard engineering practices
Course Outcomes:	
1	Develop the understanding of the problem domain through extensive review of literature.
2	Identify and analyze the problem in detail to define its scope with problem specific data.
3	To know various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
4	To design solutions for real-time problems that will positively impact society and the environment..
5	To develop clarity of presentation based on communication,teamwork and leadership skills.
6	To inculcate professional and ethical behavior.

Guidelines:
Project Report Format: At the end of semester a student needs to prepare a project report as per the guidelines issued. Along with the project report a CD containing: project

documentation, Implementation code, required utilities, Software's and user Manuals need to be attached.

A project report should preferably contain at least following details:
1. Introduction
2. Literature Survey
3. Requirement Gathering for the Proposed System
4. Proposed Design
5. Implementation of the Proposed System
6. Testing of the Proposed System
7. Results and Discussion
8. Conclusion
9. References

Term Work: (100)
Students have to submit a weekly progress report to the internal guide and the internal guide has to keep track of the progress of the project and also has to maintain attendance reports. This progress report can be used for awarding term work marks. In case of industry projects, visits by an internal guide will be preferred to get the status of the project.
Distribution of marks for term work shall be as follows:
a) Weekly Attendance on Project Day
b) Project work contributions as per objective
c) Project Report (Hard Bound)
d) Term End Presentation (Internal)
e) Mid term Review
f) Paper Publications
OR
e)Effort taken by students

• Paper publish/publishing patent/creation of product/start-up
• Idea/project/poster/TPP competition (National/international)
The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.
In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Oral and Practical:

Oral & Practical :
Oral & Practical examination of Project- II should be conducted by Internal and External examiners approved. Students have to give presentation and demonstration on the Project II